

An In-depth Study of Work- related Road Traffic Accidents

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David D. Clarke, Pat Ward, Craig Bartle and Wendy Truman
School of Psychology
University of Nottingham

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Department for Transport
Great Minster House
76 Marsham Street
London SW1P 4DR
Tel: 020 7944 8300
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1 EXECUTIVE SUMMARY

Road traffic accidents whilst at work are the single largest cause of occupational fatality in the United Kingdom. Work-related road accidents do not comprise a homogeneous group, but take many forms, encompassing the use of varying types of vehicle used for diverse purposes and including special sub-groups such as those working in, on, or near the highway.

A sample of 2111 accident cases was considered, including 1009 in detail, from Midland police forces, involving drivers/workers of all ages and covering the years 1996–2004 inclusive. Each case was summarised on a database including the main objective features (such as time and place) and a summary narrative, a sketch plan and a list of explanatory factors. The summary narrative, in particular, included judgements by the researchers that emphasised the sequence of events leading up to the accident.

The main findings were as follows:

- There were six main classes of accident-involved vehicle, which covered 88% of the sample. These were company cars, vans/pickups, lorries – large goods vehicles (LGVs), buses – passenger carrying vehicles (PCVs), taxis/minicabs and emergency vehicles. Sub-groups in the remaining 12% of the sample included people driving miscellaneous vehicle types and those working in, on, or near the road.
- The drivers of company cars, vans/pickups and lorries (LGVs) all appeared to have a high ‘blameworthiness’ ratio in their accident involvement. Company car drivers showed excess speed as a causal factor, whereas van drivers showed more observational failures, and LGV drivers showed more fatigue and vehicle defects as factors.
- The drivers of buses (PCVs), taxis/minicabs and emergency vehicles showed a low ‘blameworthiness’ ratio in their accident involvement. Their problems seemed to be primarily with the other drivers/parties with whom they share the road. While they made a variety of mistakes or errors, they were more likely to become the victim of another party’s mistake or error.
- Workers on, in, or near the road seemed to come to grief through the behaviour of drivers who sometimes seemed to be aggressively asserting their right of way over pedestrians with little regard to their safety.

2 INTRODUCTION

According to both The Royal Society for the Prevention of Accidents (RoSPA, 1998) and the Trades Union Congress (TUC, 2004), traffic accidents while at work are the single biggest cause of employment-related fatality in the UK. The TUC quote statistics that show that the annual cost of workers killed or injured on the roads is £3.5 billion. RoSPA have claimed that work-related drivers who cover average employment mileages are exposed to a similar risk of death as they would be in traditional high-risk occupations such as construction or mining.

Research carried out over recent years has suggested that drivers who drive for business purposes are at an above average risk of accident involvement relative to the general driving population. Lynn and Lockwood (1998), for example, found that company car drivers in the UK are 49% more likely to be involved in an accident than an ordinary driver, even after demographic variables and their relatively high mileages are taken into account. Grayson's (1999) work on fleet drivers draws similar conclusions, and it is noted that the reasons for fleet drivers' higher accident liability are still poorly understood, though several possibilities have been suggested. These include time pressure exposure, work schedule fatigue, larger average engine size of fleet cars, reduced personal cost of accidents, and psychological characteristics such as aggression or extraversion. Research by Broughton *et al.* (2003) compared company car drivers with a sample of non-business drivers, matched for factors such as age, gender, annual mileage and percentage of annual mileage done on motorways. Drivers who drove more than 80% of their annual mileage on work-related journeys had about 53% more accidents than similar drivers who had no work-related mileage. High-mileage high-risk work-related drivers were found to admit to undertaking long journeys after a full day of work, driving under time pressure to reach specific destinations, and performing potentially distracting tasks while driving, e.g. mobile phone conversations and eating or drinking on the move.

Work schedule fatigue has been identified as a risk factor for working drivers. The RAC plc (RAC, 2001) have reported that company car drivers were more likely to have accidents resulting from falling asleep at the wheel than other drivers, and they identified driver fatigue as a significant but largely ignored problem in road accidents in general.

Work-related drivers have shown higher levels of risk-taking behaviour than others across various studies. Stradling (2001) showed that such drivers on average drove faster than other drivers, and the road safety charity BRAKE (2001) found that high-mileage company car drivers were more likely to use mobile phones while driving than other drivers.

With regard to speeding and time pressure, a questionnaire study of UK company car drivers by Adams-Guppy and Guppy (1995) revealed that over half of their sample of 572 drivers reported that they often exceeded the motorway speed limit by at least 10 mph, and that these drivers in particular viewed being on time for appointments as desirable while being less likely to view speeding as an important risk factor in accidents. It was recommended that organisational measures to reduce perceived time pressure within business vehicle users could be beneficial.

What has been termed the 'under pressure' factor has also been identified by Dimmer and Parker (1999) in their Driver Behaviour Questionnaire (DBQ) study of company car drivers. This factor was the only one in their study to significantly differentiate between accident-involved and accident-free drivers.

Work that has investigated the effectiveness of various measures to reduce road accidents involving business drivers includes that of Gregersen *et al.* (1996). This research on drivers in a large Swedish company showed that interventions such as structured driver training and group discussions with company drivers produced decreased accident involvements over the two years after the interventions. A lesser improvement was shown with monetary bonuses for accident-free driving, while an information campaign showed the least improvement. All interventions, however, produced significantly improved results over the control group. Later work by Gregersen (1999) led him to conclude that improvements in safety shown in the most effective interventions occurred as a result of improving drivers' risk awareness.

However, the situation in the UK detailed by Grayson (1999) led him to believe that there is little evidence that measures currently employed to improve fleet safety are effective. This is perhaps because measures that might work in a single large organisation are not necessarily applicable to all fleet drivers. Grayson points out that fleet drivers are a highly diverse group, making it unlikely that their accidents are homogeneous and susceptible to a single remedial measure.

Research work already carried out in the School of Psychology at Nottingham (Chapman *et al.*, 2000) has indeed found that employees who differ in employee status and business mileage requirements show important differences in self-reported driving behaviours, accident frequency, and in the types of accident reported. Company drivers who drove a car that could be described as a 'perk' car (received as part of a remuneration package) and sales staff driving company cars appeared to be at a particularly increased risk of an accident. Staff driving their own vehicles on business mileage allowances and staff driving liveried vehicles appeared to have an accident rate much closer to that of the general driving population. Chapman *et al.* comment that these findings highlight the importance of understanding that company car drivers are not a single homogeneous group.

Research by Bomel Ltd (2004) showed how organisational culture in the workplace is important in terms of levels of work-related road accidents. They examined company vehicle drivers in both small and large companies, driving mainly company cars and LGVs. There was a key relationship shown between safety culture, driver attitudes and accident liability. LGV drivers (particularly those transporting hazardous loads) had more safety measures applied to their driving than equivalent company car users, and safety management systems were sometimes found to be lacking in smaller companies when compared with larger companies. Cross-company comparisons showed that the lowest accident rate (and highest positive scores on a driver attitude scale) were shown by a company with 'clear driving standards and rules, excellent driver training, and a policy to report and try and learn from all driving incidents'. The company with the worst accident rate (and most negative driver attitudes) had 'no formal driver training, unclear rules/reporting requirements, and relatively ineffective lines of communication'. Corbett (2003) also regards organisational culture as a key component in road safety, and points out that there is a general societal tendency to 'blame working drivers for crashes rather than seek root causes that may be connected with the safety culture of organisations'. Both Corbett (2003) and Stradling (2001) point out that employers have an obligation to select, train and supervise workers who use large and dangerous machines as part of their employment, but no equivalent measures are usually taken with employees who are expected to use vehicles as part of their work. Broughton *et al.* (2003) have commented that, in any case, it may not be enough for organisations to concentrate on driver training; they should also take steps to change the conditions under which employees drive, so that time pressure and fatigue are reduced, and attention-demanding tasks are kept to a minimum. If this is not done, safety may be effectively undermined by day-to-day working practices.

3 METHOD

Our method largely relies on the human interpretation of road accident case reports. Furthermore, the construction of interpretations, typologies and models has not been driven by theory in the main but has been generated primarily from the data themselves, although theoretical models are acknowledged. The most attention is given to the full sequential nature of the accident story in each individual case, which is where the technique of qualitative human judgement methodology proves more useful than more traditional statistical methods applied to aggregated data.

The first step was to draw a heterogeneous sample of police road accident files involving drivers and others using the roads in connection with their work. The files were found to contain varying amounts of information depending on the circumstances of the accident and any subsequent legal proceedings. The minimum contained in each file is a report sheet/card, which is a summary of information about the accident, such as date, time, location, weather conditions, junction type etc. The sheet also includes a brief accident story as interpreted by the attending police officer. This is constructed by the officer a short time after the accident by reference to his or her pocket book. It contains the actions and, in some cases, the reported intentions and behaviours of drivers and witnesses.

In addition to the report sheet/card, the most detailed files (classified as 'A' grade) contain a range of further items, which help to fill out the often complex circumstances of the accident. These include maps, photographs, statements of vehicle examiners and, perhaps most importantly, interview and witness statements, which are often rich in information. The interpretation consists of the reconstruction of an entire accident story from the information available in the police file. Details from somewhat less detailed files (classified as 'B' grade) are also entered for purposes of statistical comparison.

3.1 The accident database

The data were entered into a FileMaker Pro database customised to handle the information and search parameters required for this project. Figure 1 shows the standard data entry set-up.

Figure 1: A standard data entry sheet on the database

Driver 1 Age	<input type="text" value="38"/>	<input checked="" type="radio"/> M <input type="radio"/> F	Grade of Info.	<input checked="" type="radio"/> A <input type="radio"/> B
Driver 2 Age	<input type="text" value="17"/>	<input type="radio"/> M <input checked="" type="radio"/> F	How Work Related?	<input type="text" value="Definitely driving on business"/>
Vehicle 1 Owner	<input type="text" value="Livered company"/>			
Primary blame	<input type="text" value="Driver 1"/>			
	<input checked="" type="radio"/> Active <input type="radio"/> Passive			
Severity	Slight			
Date	7/4/98			
Day	Tuesday			
Time 24hrs	12:30			
Road Type	A class			
Speed Limit	<input type="text" value="60"/>			
Area	<input checked="" type="radio"/> Rural <input type="radio"/> Urban			
Type of Vehicle1	<input type="text" value="Lorry (LGV/HGV)"/>			
Type of vehicle2	<input type="text" value="Private car"/>			
Drivers Familiar?	yes			
Passengers?	<input type="text" value="None"/>			
Passengers age,sex	N/A			
Test Pass Date	N/A			
Charges	none			
Prose Account	<p>It was about lunchtime on a fine day in Spring. The driver (M,38) of an ERF 38 tonne HGV (1) was travelling along a rural A road with a 60mph limit. The road had shallow bends in it, with the view around some of them reduced because of vegetation such as hedges etc. The driver rounded a slight bend and then saw ahead of him a Renault Megane (2), driven by (F,17) that was stationary in the middle of the road waiting to turn right into an unclassified road. The lorry driver braked, but realised that he would not be able to stop in time, as he was travelling too fast. He deliberately steered nearside, and missed the waiting car, but ran off the</p>			
Map				
Minimum Set of Explanations	Driver 1: B3 Excess speed for conditions			
	PF <input type="text" value="4"/>	CF1 <input type="text" value="21B"/>	CF2 <input type="text" value="51A"/>	CF3 <input type="text"/>
Alc. Level	<input type="text" value="N/A"/>			
Avoiding Action Attempted	swerves n/s			
Violation / Error type	<input type="text" value="Rear end shunt avoidance"/>			
	Turns	Shunts		
	<input type="text" value="N/A"/>	<input type="text" value="N/A"/>		
Comments / Quotes/ Special Factors				
Bend Errors	<input type="text"/>			Shunt errors
	<input type="text"/>			<input type="text"/>
CM Driver 1	<input type="checkbox"/> 1	<input type="checkbox"/> 9	<input type="checkbox"/> 17	<input type="checkbox"/> 25
	<input type="checkbox"/> 2	<input type="checkbox"/> 10	<input type="checkbox"/> 18	<input type="checkbox"/> 26
	<input type="checkbox"/> 3	<input type="checkbox"/> 11	<input type="checkbox"/> 19	<input type="checkbox"/> 27
	<input type="checkbox"/> 4	<input type="checkbox"/> 12	<input type="checkbox"/> 20	<input type="checkbox"/> 28
	<input type="checkbox"/> 5	<input type="checkbox"/> 13	<input type="checkbox"/> 21	<input type="checkbox"/> 29
	<input type="checkbox"/> 6	<input type="checkbox"/> 14	<input type="checkbox"/> 22	<input type="checkbox"/> 30
	<input type="checkbox"/> 7	<input type="checkbox"/> 15	<input type="checkbox"/> 23	
	<input type="checkbox"/> 8	<input type="checkbox"/> 16	<input type="checkbox"/> 24	
CM Other	<input type="checkbox"/> 1	<input type="checkbox"/> 9	<input type="checkbox"/> 17	<input type="checkbox"/> 25
	<input type="checkbox"/> 2	<input type="checkbox"/> 10	<input type="checkbox"/> 18	<input type="checkbox"/> 26
	<input type="checkbox"/> 3	<input type="checkbox"/> 11	<input type="checkbox"/> 19	<input type="checkbox"/> 27
	<input type="checkbox"/> 4	<input type="checkbox"/> 12	<input type="checkbox"/> 20	<input type="checkbox"/> 28
	<input type="checkbox"/> 5	<input type="checkbox"/> 13	<input type="checkbox"/> 21	<input type="checkbox"/> 29
	<input type="checkbox"/> 6	<input type="checkbox"/> 14	<input type="checkbox"/> 22	<input type="checkbox"/> 30
	<input type="checkbox"/> 7	<input type="checkbox"/> 15	<input type="checkbox"/> 23	
	<input type="checkbox"/> 8	<input type="checkbox"/> 16	<input type="checkbox"/> 24	
Text Detail level	910			
Average Text Detail Level	759.9			

Data are entered describing the relatively objective facts of each case: time of day, speed limit, class of road etc. The database includes some fields configured as check boxes or 'radio buttons'; these provide quick access to selected cases during further analysis. Summary fields are also used to calculate things such as the mean age of the involved drivers. Any combination of fields in the database can be used to search for cases matching a variety of criteria. A variety of layouts are also used to present and analyse the data, in addition to the data entry layout shown in Figure 1.

A 'prose account' is also entered for each case, giving a step-by-step description of the accident. The causal story is always written from the viewpoint of the working driver, who is labelled as 'driver 1', though much consideration is also given to other road users' actions and intentions. The prose accounts give a detailed summary of the available facts, including information from witnesses that appears to be sufficiently reliable. Discrepancies can occur between the interviews of drivers and the statements of independent witnesses, but these can usually be resolved by considering all statements together with various other reported facts. These can include the measurement of skid marks by police, vehicle damage reports etc. Figure 1, it should be noted, only shows part of a typical prose account because the text is held in an expandable field in the database.

Next, a sketch plan of each accident is made from sources in the file. The orientations of the sketch plan and the icons contained in it are standardised for speed of entry and to allow direct comparisons between example or prototype cases.

A minimum set of possible explanations for each accident is recorded from a standard checklist adapted and developed from a previous study (Clarke *et al.*, 1998). The list has subsections for the road environment, vehicle and driver characteristics, and specific driver actions. The emphasis throughout is on giving the finest grain description possible of each accident, not for use as a formal coding scheme but rather to provide search and selection aids to identify homogeneous groups of cases for further qualitative analysis. In addition, we entered data for a version of a national 'contributory factors in accidents' form developed at TRL Ltd (TRL) which involves the identification of one major precipitating factor (PF) from a possible list of 15, and a further coding of up to four contributory factors (CFs), together with a confidence rating in the CFs identified. Finally, entries are made in additional fields for comments and quotes from involved drivers and others.

The ultimate aim of entering facts and figures, prose accounts, standardised graphics and explanatory factors in the database was to build a library of analysed cases stored as a series of case studies. In this sense, the database is used to find groups and recurring patterns, rather than being considered as 'raw' data awaiting analysis. In this way it was possible to find patterns, sequences and processes within each group of accidents. Statistical examinations were not the primary focus of the study, even though simple statistics were used to characterise the sample.

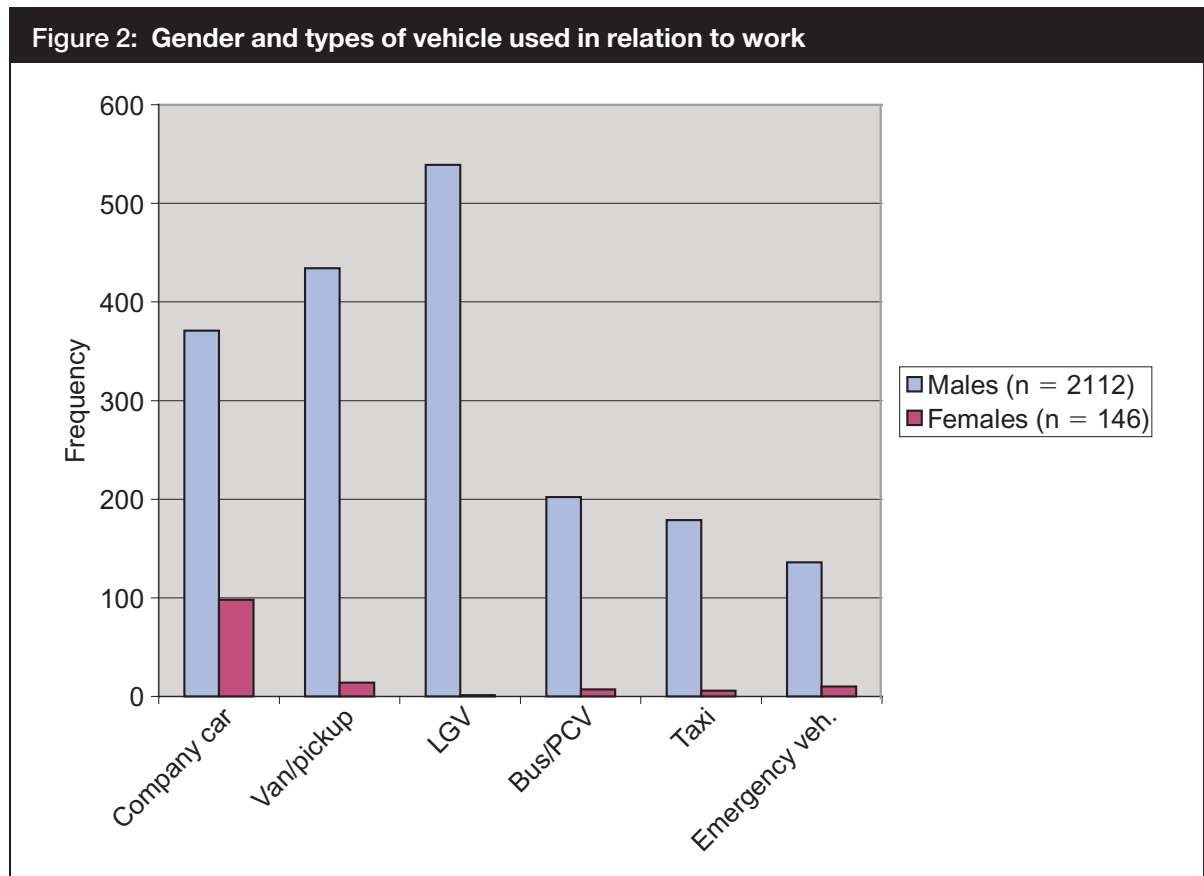
4 RESULTS

A total of 2111 work-related road accident files have been examined. There were 1009 (48%) of the most detailed 'A' grade type. In the total sample, there were 103 fatal accidents (4.9%) and a further 249 (11.8%) involving serious injuries to a driver/worker.

4.1 Age, gender and type of vehicle

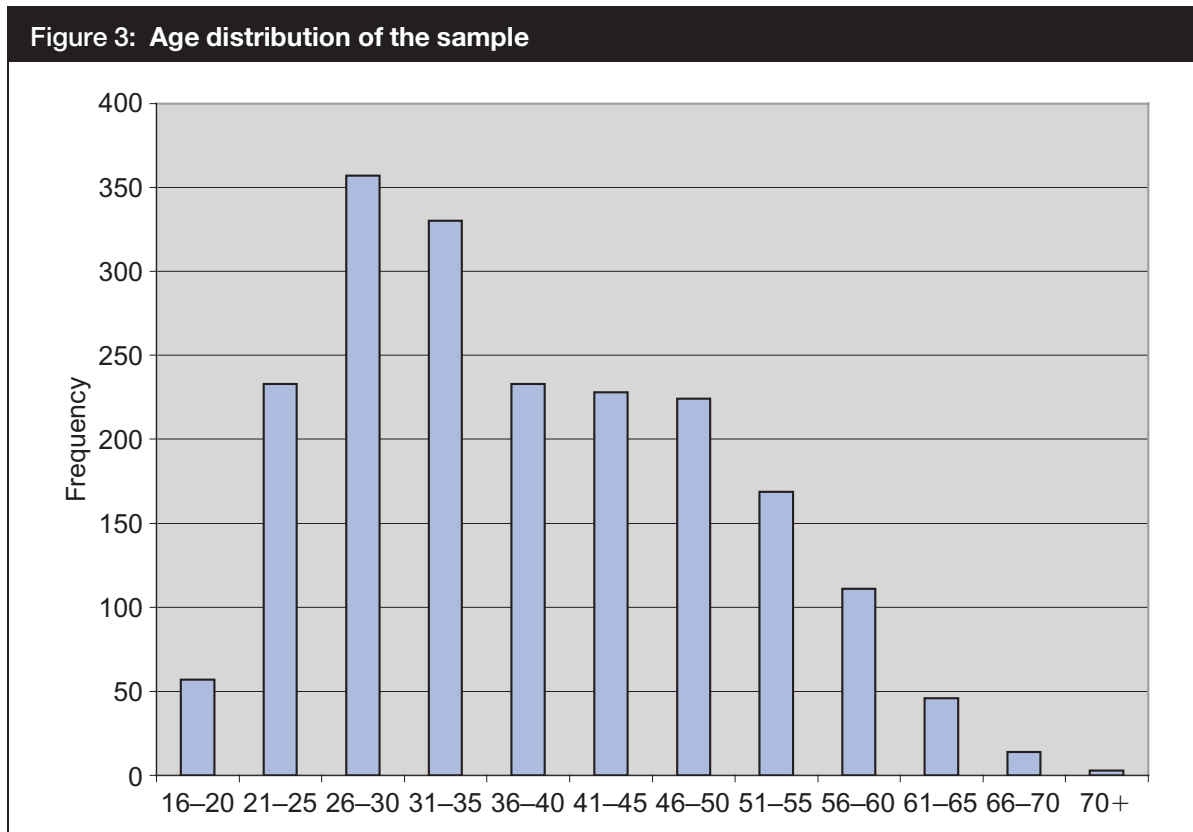
Figures 2 and 3 show the age and gender distribution in the sample as a whole. There were 15 types of vehicle (including 'miscellaneous or other') entered into the database. Six classifications of vehicle were found to be most commonly involved in work-related road traffic accidents (WRRTAs). These were: company cars; vans/pickups, lorries (HGV/LGVs of all weights); buses (PCVs); taxis (including Hackney carriages and minicabs); and emergency vehicles (EVs). These top six vehicle categories covered over 88% of the sample as a whole.

There was found to be a large gender difference in accident-involved drivers and workers, as shown below in Figure 2.

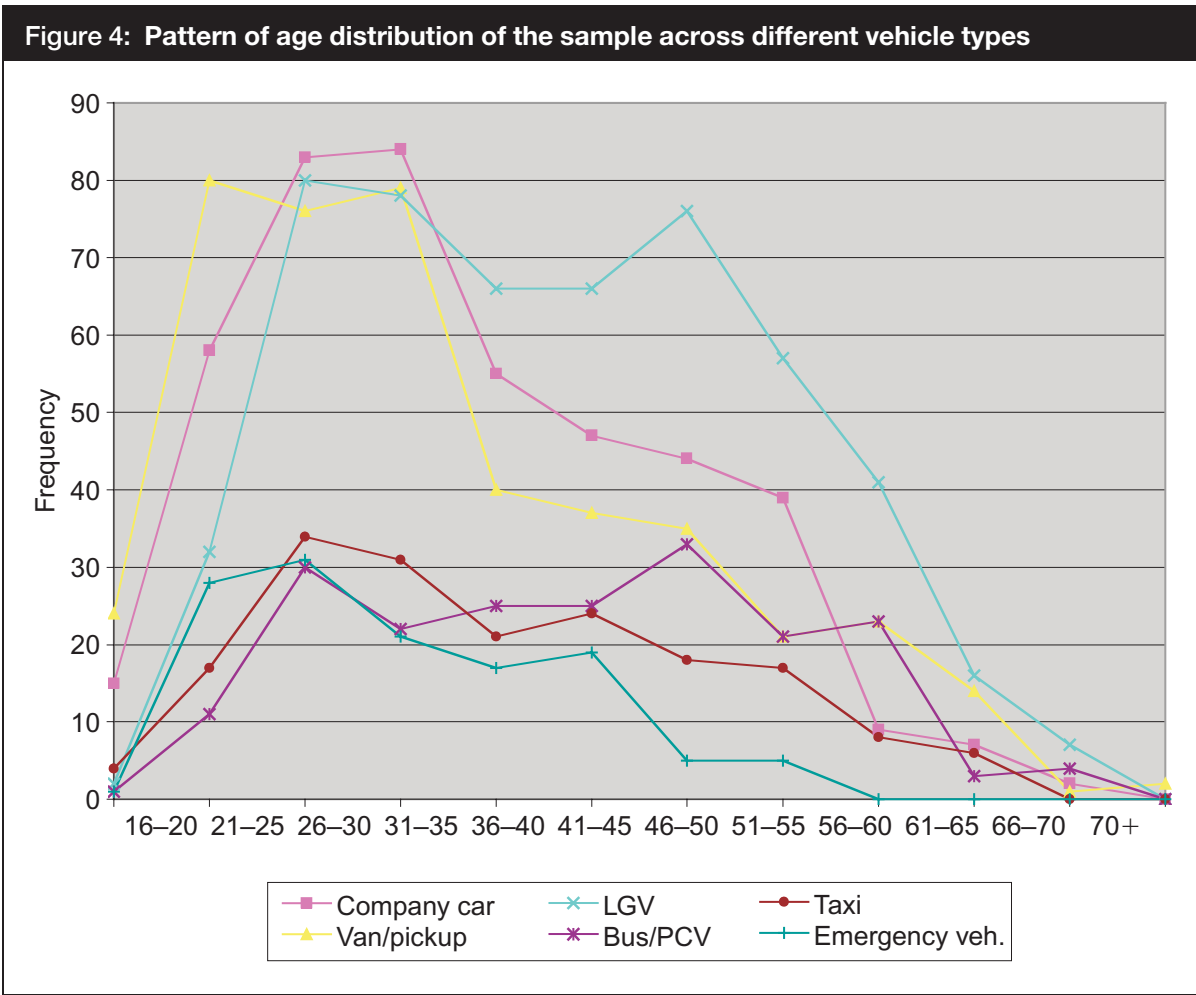


It can be seen in Figure 2 that involvement in WRRTAs was heavily biased towards male drivers/workers; females only figured at all prominently in the 'company car' category.

Figure 3, below, shows the overall age distribution of the sample.



The distribution of ages appears to show no real surprises. The age distributions for vehicles of different types are shown in Figure 4.



It can be seen in Figure 4 that drivers of both company cars and vans/pickups had their peak accident numbers in the earlier age bands, which is probably at least partly due to the younger age at which drivers are legally allowed to drive such vehicles. The peaks occurred in later age bands with all other vehicle types. The most notable distribution pattern is that relating to LGVs, which continued to show a high number of accidents through a large selection of the middle age ranges. Bus/PCV involvement showed a lower overall number of accidents than LGVs, but similarly showed an even distribution through the age bands.

4.2 Blameworthiness ratios

All cases were assessed by coders as to the blameworthiness of any participants in the incident. Drivers could be rated as either ‘to blame’, ‘at least partly to blame’ or ‘not to blame’ in any given accident, and there are also codings for pedestrian fault, unforeseen mechanical failure and miscellaneous others. Table 1 shows the blameworthiness ratios for drivers of the six main types of vehicle we have identified, i.e. the number of accidents where the driver is rated as at least partly or fully to blame, divided by the number of accidents caused by all other factors, most usually another road user/driver. Here, a ratio of 1.0 indicates that the driver is

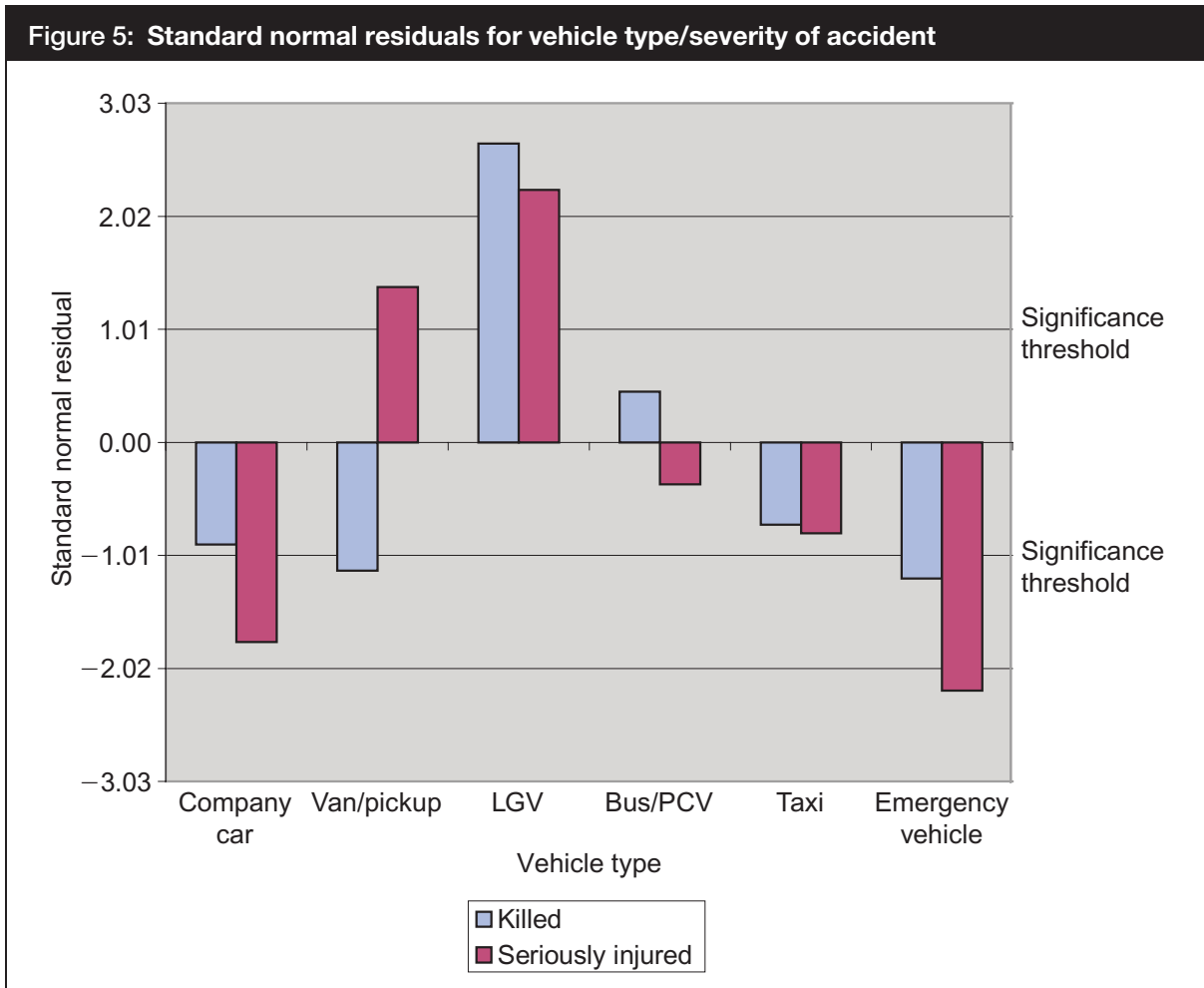
equally likely to cause an accident as he/she is to become the victim of an accident caused by another. The ratio for all work-related drivers in the sample is also shown for comparison.

Table 1: Blameworthiness ratios (in order of magnitude) for six types of work vehicle in road accidents	
Vehicle type	Blameworthiness ratio
Lorry/LGV	2.46
Van/pickup	2.08
Company car	1.18
Emergency vehicle	0.90
Taxi/minicab	0.70
Bus/PSV	0.56
All work-related drivers	1.39

Work-related drivers, when considered as a whole, were seen to have an elevated blameworthiness ratio, i.e. they were more likely to actively cause accidents than become involved as blameless or passive participants. However, splitting the sample into groups by concentrating on vehicle types reveals that there were important differences between different driver groups. Only the top three classes of vehicle had drivers that were coded as being at least partly to blame in more than 50% of the accidents that they were involved in. The last three classes of vehicle suffered proportionally more accidents primarily caused by other road users.

4.3 Accident severity

An initial examination of the severity of accidents in the sample showed that LGVs were more likely than other vehicle groups to be involved in fatal and serious accidents. To examine the effect of vehicle class, $O-E/\sqrt{E}$ was computed for cells in a table, where 'O' is the observed figure and 'E' the expected figure. This can be treated as a standard normal residual. This measure is based on the χ^2 statistic and attempts to provide an induced exposure measure by finding combinations of a 'row' feature and 'column' feature which are considerably over-represented in the data, even when mere coincidences have been allowed for (Colgan and Smith, 1978). For each cell, $O-E/\sqrt{E}$ is calculated and the resulting figure is evaluated against the square root of the upper 5 percentile point of the appropriate χ^2 distribution divided by the number of cells in the table. Here, a figure exceeding ± 1.01 is approximately equivalent to a significance level of $p < 0.05$, and the null hypothesis is that there is no interaction, i.e. differences between accident severity are unaffected by vehicle type, and vice versa. Figure 5 shows the clear over-representation of LGVs using this analysis.



Such a finding is hardly surprising and could be expected to occur as a result of LGVs’ large mass increasing the severity of any crash they are involved in. However, when blameworthiness is taken into account, a different picture emerges. In fatal accidents where LGV drivers are considered at least partly to blame, the majority of cases appear to occur as a result of poor observation and distraction. The most common result is running into the rear of other vehicles, causing either a fatal crushing injury to another vehicle occupant or to the LGV driver themselves. Such accidents occur mostly on motorways or dual carriageway A class roads. About a quarter of fatalities caused by LGV drivers involve breaking the speed limit; these include cases where the driver is breaking the applicable limit for a vehicle of that class, as well as those ignoring posted speed limits. There was evidence of fatigue or illness in around a fifth of fatalities caused by LGV drivers. Two fatalities were caused by overloading or insecure loads. One fatal case showed the lengths to which some drivers will go, in terms of perceived time pressure and willingness to circumvent safety protocols.

Accident account

It was a fine mid-June evening. It was dark and the streetlights were lit; visibility was good although there was spray being thrown up from the wheels of vehicles from an earlier rainfall. The road surface was wet but in a good state of repair. The driver (M, 35) of a Ford Iveco Lorry (1) was travelling along an A class bypass with three lanes in his direction, which was subject to the national speed limit of 70 mph. Traffic flow was light and the driver was on a journey to make a delivery to a commercial address. His truck was partially laden. He had travelled approximately 80 miles towards his destination, and had made a very brief stop (4 minutes) at a service station on the motorway, approximately 20 minutes after starting his journey. It is believed he disabled his speed limiter, which also disabled his ABS braking system, at this point. He also removed the number plate fixed to the trailer to avoid speed detection.

On joining the A road he pulled in behind another heavy goods vehicle and he started travelling too close behind it, slipstreaming. This restricted his view of the road ahead and when the road joined another A class dual carriageway where the road split into three lanes, his view of the nearside lane ahead was obscured by the lorry in front. He moved over into the nearside lane to join the new road and was taken by surprise when he saw ahead of him the driver (M, 59) of a stationary Vauxhall Cavalier (2). Driver 1 braked heavily to take evasive action at 50 metres from the Cavalier, but with his disabled ABS his front wheels locked on the wet road surface and the driver lost control of the steering. The lorry then skidded and swerved between lanes 1 and 2. The driver released his brakes momentarily to regain control of his vehicle then reapplied them at a distance of 40 metres; again the lorry skidded before colliding extremely heavily with the rear offside of the Cavalier.

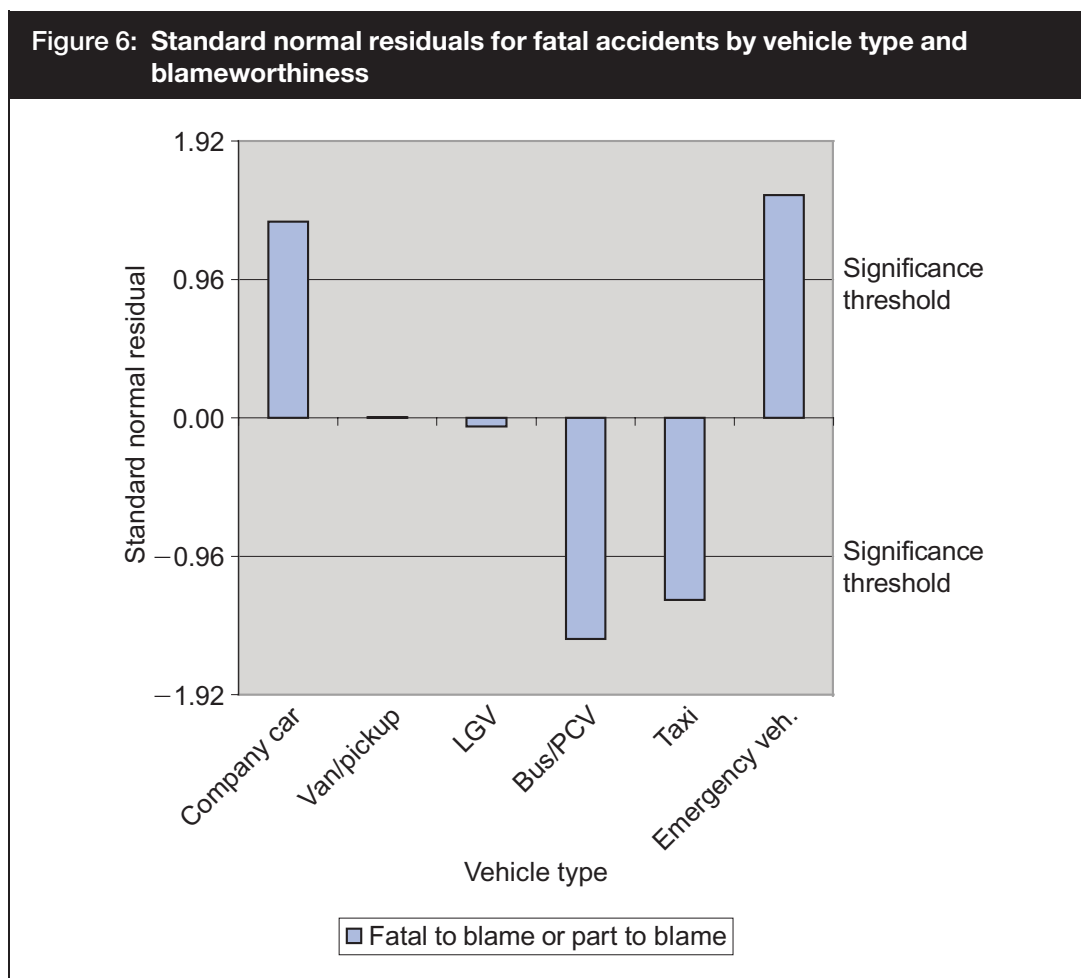
The driver of the Cavalier received fatal injuries and died several days later in an intensive care unit. His wife who had been a passenger in the vehicle sustained multiple injuries but none life threatening. It is not known why the vehicle was stopped on the clearway as the passenger had been asleep at the time of the accident, and as far as she knew there had been no problems with the car prior to the accident.

The police vehicle examination revealed that had the ABS system been working at the time of the accident the driver would have had control of his vehicle and been able to take effective avoiding action as his wheels would not have locked up. Had the driver been adopting the speed limit required for his type of vehicle the outcome might also have been different (he was travelling at 58 mph at the commencement of braking). Under interview/detention the driver denied all knowledge of the speed limiter

being disabled. He was not believed by investigating police. The driver was charged with causing death by dangerous driving.

Driver 1 was paid for working a 45 hour week, so it was in his interest to finish his work as quickly as possible. A seizure of his past tachograph records found 65 other speeding offences.

However, over half of the fatal LGV accidents were found to be cases where the LGV driver was *not* to blame. Running the standard normal residual analysis again on fatal cases alone, and taking blameworthiness into account, showed that there were only two groups of drivers significantly more likely to have a hand in causing fatal road accidents, rather than becoming involved as blameless participants: company car drivers and emergency vehicle drivers. Figure 6 shows the standard residual analysis.



It is important to realise that (fortunately) overall numbers of fatal accidents are quite small, so these results should be treated with some caution. Nevertheless, an examination of common patterns in company car fatal accidents shows that over half of them involve excessive speed on the driver’s part. There was only one case of

excessive alcohol consumption; two cases where driver fatigue played a part; and one case where a driver was distracted by using a hands-free mobile phone.

With drivers of emergency vehicles, the majority of the fatal accidents caused involved excess speed, as might be expected. In half of them, another driver's behaviour had also contributed to the accident in some way, including a driver who had clearly failed to observe a speeding police car using emergency lights that was about to overtake her vehicle as she turned.

4.4 Explanatory factors in work-related accidents

An explanatory factors list with 64 items was used to categorise each accident in the sample. This list was summarised further into seven 'background' factors and eight major 'behaviour' factors. Table 2 shows the results of a standard normal residual analysis of these factors in all 'at fault' accidents across the six major vehicle types. Significant figures ($p < 0.05$, threshold value ± 1.07) are shown in bold.

Table 2: Explanatory factors in accidents: standard normal residuals across six vehicle types						
	Company car	Van	LGV	Bus	Taxi	Emergency vehicle
Background						
Slippery roads	1.07	0.16	-1.45	-0.57	-2.22	0.32
Vehicle defects	-1.44	-0.70	1.50	0.08	0.10	-0.39
Unusual handling	-2.07	-1.80	3.96	-0.04	-1.01	-1.29
Load problems	-2.53	0.89	2.55	-1.25	-1.23	-1.58
Alcohol	1.35	0.46	-1.19	-0.20	-0.17	-1.39
Fatigue/illness	0.18	-0.12	2.36	-1.67	-0.43	-2.10
Time pressure	-2.94	-2.50	-3.51	-1.74	0.04	15.63
Behaviour						
Close following	-0.23	-1.04	1.67	1.83	-2.21	-3.44
Excess speed (limit & conditions)	1.32	-0.22	-1.90	-2.70	-1.21	1.79
Poor observation (all categories)	1.94	3.52	2.20	3.00	4.50	-1.68
Failure to signal	0.13	-1.43	-0.08	3.06	-0.30	-0.81
Gap judgement	0.91	0.00	-1.48	-0.53	1.30	-0.75
Distance to stop judgement	-3.24	-2.79	-3.45	-1.10	-2.04	-2.23
Failure to check load	-1.09	-0.34	1.75	-0.54	-0.53	-0.68
Deliberate recklessness	-0.78	0.30	-0.62	-0.72	3.50	-0.91

Company car drivers had more of their accidents on slippery roads, or while under the influence of alcohol, or while speeding, than would be predicted by chance when compared with drivers of other vehicles used for work purposes. Over half of the accidents on slippery roads also involved excessive speed, so there appeared to be a large overlap in these two groups.

Lorry drivers, in contrast, had a higher proportion of close following, fatigue/illness accidents, and accidents resulting from the type of load/handling problems one might expect with this type of working vehicle.

Bus drivers showed a higher proportion of close following and failure to signal accidents. In the failure to signal group, however, another driver shared blame with the 'at fault' bus driver in the majority of cases.

Taxi drivers were the only group that showed over-involvement in accidents caused by deliberate recklessness or failure to correctly judge gaps in traffic before making a manoeuvre. However, the 'reckless' sub-group was very small, and contained such anomalies as a taxi driver having his vehicle stolen after a violent dispute (i.e. the reckless driver was actually the former passenger).

Emergency vehicle drivers were the only group that showed over-involvement in accidents involving time pressure and excess speed, but this is hardly surprising given the type of driving this sub-group has to engage in out of necessity.

Every group of drivers, with the exception of emergency drivers, showed an over-involvement in accidents with an observational failure component. It was decided to examine this factor further to see if there were any specific differences in more detailed sub-types of observational failure among the six groups.

Some evidence of differences in observational failures among the driver groups was found. Van and pickup drivers were found to have had significantly more ($p < 0.05$) accidents where they failed to take account of a restricted view. When the cases were examined, the largest category proved to be cases where heavy or queuing traffic had somehow contributed to blocking a driver's view of other traffic, as in the case below.

Accident account

It was the middle of the morning on a fine day in winter. The driver (M,32) of a Leyland DAF pickup (1) was waiting to turn right across two lanes of opposing traffic on a busy urban A road with a 30 mph limit. He saw a bus in the outer lane in the opposite direction flash headlights to indicate that he could turn in front of it. He did so, but turned right into a minor road straight into the path of a Vauxhall Astra (2), driven by (M,24) that was proceeding normally in the inside lane down the side of the stationary bus. The two vehicles collided and were badly damaged. Driver 1 blamed driver 2 for the accident because 'he shouldn't have been overtaking on the inside' (even though the road was marked into two lanes). Driver 1 was also attempting to turn into a one-way street past 'No Entry' signs, but he thought that this was acceptable because he was going to park on the pavement just inside the junction. He was also abusive to the driver he

had hit. Driver 1 was charged with driving without due care and attention and fined.

Van and pickup drivers were also found to be more likely to have had accidents where they failed to notice another driver's signal. These cases tended to involve either running into the rear of a vehicle that the van/pickup driver had failed to notice was slowing and/or indicating to turn, or alternatively attempting to overtake such a vehicle and subsequently colliding with it.

Bus/PCV drivers were found to be more likely than drivers of other vehicles to have had accidents relating to a failure in continuity of observation. This typically occurred in right of way violations (ROWVs), for example where a bus pulled out in front of other vehicles without the driver re-checking the road in a particular direction. An excerpt from a police interview with an accident-involved driver illustrates this:

Police: 'At what point did you see the vehicle?'

Driver: 'I didn't see it until she hit me; I was concentrating on the traffic coming the other way. I assumed the road was clear and I carried on then next thing I hear a bang.'

It is possible that bus drivers have a higher than average exposure level to this kind of collision, given that they often drive set routes around cities during which they must perhaps make many more junction manoeuvres than, say, a company car user, so perhaps this finding is not overly surprising.

Taxi drivers had a disproportionate number of accidents where they failed to look in the relevant direction at all. Most commonly this involved U-turning in the road in front of a vehicle that is about to pass them, or reversing without enough rear observation and hitting pedestrians or other vehicles. This finding is (again) probably related to the type of manoeuvring (U-turns and reversing) that taxi drivers are most likely to do more of in their regular driving than drivers of other vehicles.

Although emergency vehicle drivers did *not* show an overall over-involvement in observational errors as a causal factor in comparison with other groups of driver with observational errors as a sub-group, they did seem to be over-represented in two accident groups with an observational error component. The first of these was classified as 'failing to take account of a restricted view'. Nearly all these cases also involved travelling through a red light at a traffic light controlled junction while on an emergency call and failing to see a vehicle using the junction at the time, most commonly as it would have been masked by a vehicle that had already stopped and given way for the emergency vehicle. The second of the accident groups comprised cases where a driver had failed to notice another driver's signal. However, all these cases were 'combined fault' accidents, and the observational failure had been on the

part of another accident-involved driver rather than the emergency driver, even though the emergency driver had been determined to be at least partly at fault in addition.

4.5 Other involved vehicles in collisions

There is evidence of a type of ‘global exposure effect’, i.e. at-fault drivers are significantly more likely to hit other vehicles which are the same class/type as their own – lorry drivers are more likely to hit other lorry drivers, company car drivers hit other company car drivers, etc. This might be expected to occur in most vehicle types as there may be a commonality of use with vehicles of various types that leads to such an exposure effect.

However, some surprising results of the vehicle type-to-type crash analysis were revealed. Company car drivers, for example, were found to hit cyclists more often than chance would predict. Nearly all these cases involved a driver who had completely failed to see a cyclist prior to collision, including this shocking fatal case below.

Accident account

It was the middle of the evening on a fine night in late spring. The driver (M,36) of a Ford Mondeo (1) was travelling along a rural B road with a 60 mph limit. The road was on the outskirts of a village, and was lit with streetlamps, although these did not provide very good illumination due to overhanging trees and undulations in the road.

The driver was travelling along the road at around the speed limit, and was approaching a cyclist (M,32) who was riding ahead. The cyclist was displaying lights front and rear. Despite this, driver 1 completely failed to see him, and hit the rear of the cycle with the nearside front corner of his car. The first thing the driver claimed to know about the collision was hearing a bump and then seeing both the cyclist and his bike cartwheeling down the road in his rear view mirror. The side of the car’s windscreen was damaged, the nearside headlight was smashed, and a portion of the bumper snapped off. Despite this damage, driver 1 failed to stop at the scene, and carried on his journey. He claimed to have panicked, and only stopped to examine the damage to his car some five miles later. Even though there was a telephone near where he stopped, he still didn’t report the accident.

The cyclist had, meanwhile, died of the severe injuries he had received, and was discovered by another motorist, who alerted the police.

Driver 1 elected to continue on his journey. He was attending court the

next day, charged with a speeding offence. He elected to travel down and stay with his girlfriend for the night, as the town where he was due in court was a fair distance from his home and the accident location. (Driver 1 travelled many miles in his company car each year due to the nature of his employment.)

He didn't mention the accident to anyone, and had the windscreen on his car replaced while staying with his girlfriend. He then took the car to another friend's, and left it there with a note, hoping that the friend would arrange to fix the remaining damage to the car during the following week. However, the police had by now worked out from the debris at the accident scene that his car might have been involved. When driver 1 had travelled home in another vehicle, door to door enquiries were going on in the street where he lived. He didn't answer the door to the police, and later went out with a friend for the evening. After a few drinks, he finally broke down and thought it best to turn himself into the police the next morning.

In his interview(s), driver 1 could not account for why he had completely failed to see the cyclist, or why he had failed to stop and report the accident, or why he had apparently appeared to try and conceal the fact that his car was involved at all. He and people who knew him mentioned that he had been under a lot of stress, working twelve to fourteen hour days, and having personal problems with his ex-wife and family. He was never able to explain how he had not seen the cyclist, or why he didn't stop or report the accident, and was jailed for five months, with a driving ban of four years.

Drivers of buses/PCVs also appeared to be more likely than drivers of other vehicles to hit cyclists. On examination, these cases appeared roughly evenly split between cases where a bus driver had pulled out of a junction and failed to see an approaching cyclist, and cases where a bus driver had misjudged the gap needed when overtaking a cyclist and thereby cause them to be knocked from the bike.

Drivers of vans/pickups appeared to be significantly more likely to be involved in collisions with motorcyclists. There seems to be no obvious vehicle-related reason for this; it is merely that these cases involve van/pickup drivers making the same typical failure(s) of observation that were shown in ROWV accidents detailed in Clarke *et al.*'s (2004) study of motorcycle accidents. The typical pattern was that such drivers failed to give way to a motorcyclist, even when the motorcyclist may be clearly visible to others in the area and using conspicuity aids. This is often referred to as a 'Looked But Did Not See' (LBDNS) accident, for example by Brown (2002).

4.6 Road type and rural/urban areas

Buses, taxis and emergency vehicles were found to be over-represented in accidents on urban roads of all classifications (A, B or unclassified).

LGVs were found to be over-represented in accidents that occur on rural A class roads and motorways. The top three error/violation types for rural A roads were: (1) rear-end shunts (including avoidance accidents) (36%); (2) ROWVs (21%); and (3) loss of control on bends/other (20%). Insecure loads also appeared in 8% of these accidents.

In contrast, motorway LGV accidents showed a higher comparable percentage of loss of control accidents (25%), the majority of which were caused by driver fatigue (which did not prove to be the case in loss of control accidents on rural A roads). Again, there was a large proportion of ROWV accidents, but these mainly involved lane changing. There was evidence of vehicles being unseen in lorry drivers' blind-spots, which was a particular problem with foreign-registered left-hand drive trucks. Of the small number of verifiably foreign-registered trucks in the database, 60% of accidents they became involved in (driver at least partly at fault) show this observational problem. There was a lesser, although still quite high, proportion of rear-end shunt LGV accidents on motorways. Around half of these occurred in heavy/slow moving traffic, and roughly a quarter of them involved an element of driver fatigue.

Company car drivers were found to be over-represented in accidents on only one class of road: rural unclassified roads. When these cases were examined, it was found that the majority of these accidents involved excessive speed (limit and conditions), sending vehicles out of control on bends. Such accident-involved drivers were found to be significantly younger (mean age 30 years) than 'at fault' company car drivers as a group (mean age 36 years) ($t = 1.99$, $p < 0.05$). This result is in accordance with previous work (Clarke *et al.*, 2002) that showed younger drivers in general were over-represented in loss of control bend accidents on rural roads.

Van and pickup drivers were over-represented on three different classes of road when compared with other drivers. These were: urban unclassified roads; rural B class roads; and rural unclassified roads.

Around half of the accidents on urban unclassified roads involved ROWVs, most usually turning right in front of a vehicle that has right of way. Around a quarter were rear-end shunts, and the remainder were a mixture of pedestrian accidents, reversing accidents and insecure loads, all of which might be expected in this vehicle class in an urban environment.

On the two classes of rural road (B class and unclassified), the top violation category was again ROWVs. The second most common violation was loss of control, most

usually on a bend, and most usually involving excessive speed. Unlike the over-represented group of drivers in company cars, van drivers in loss of control accidents on rural roads showed no significant difference in their average age from the average age of all ‘at fault’ van drivers in the sample.

4.7 Time of day analysis

‘At blame’ company car drivers showed two peak times for accident involvement. The first was between eight and nine o’clock in the morning, i.e. corresponding to the morning rush hour. The second was between eight and nine o’clock in the evening. The first sub-group of cases (08:00–08:59) contained mostly urban slight accidents; ROWV accidents involving misjudgement of another vehicle’s approach speed or observational failures; and rear-end shunt accidents involving distraction and close following. The second sub-group (20:00–20:59) contained lower proportion of urban rear-end shunt accidents, but a much higher proportion of serious accidents in rural areas that involved excess speed and risk-taking.

Lorry/LGV drivers that were at fault showed two peak times for their accident involvement: these were between eight and nine o’clock in the morning, and twelve midday to one o’clock in the afternoon. Both these sub-groups featured rear-end shunt accidents as the most common accident type, particularly the midday group. There was evidence of close following as a causal factor and most of the injuries were slight, though there were some much more serious or fatal cases that occurred on faster roads like motorways. There was also a high proportion of ROWV accidents. These were split about equally between rural and urban areas. They were slightly more likely to be serious or fatal than the rear-end shunt accidents, and involved poor observation and ‘blind-spot’ errors. There was also some evidence of a sub-group of ‘loss of control’ cases in the 08:00–08:59 group. These cases mainly involved lorries overturning on rural A roads; although some cases of this type also showed evidence of driver fatigue as a causal factor.

Van and pickup drivers that were at fault had a peak in their accidents slightly earlier in the morning than the equivalent group of company car drivers – between seven and eight o’clock. They showed the same sort of accident type proportions and primary causes as occurred in company car accidents, being primarily urban ROWV or rear-end shunt slight accidents. There was also a small sub-group of ‘loss of control’/overtaking accidents, which again were typically more serious, involved excessive speed and tended to occur in rural areas.

Bus and emergency vehicle drivers failed to show any particular time bias in their ‘at fault’ accidents (or, where they do, the data set is far too small to draw meaningful comparisons). Taxi drivers seemed to have more accidents caused by other parties between midnight and three in the morning, but showed no such peak in their ‘to blame’ accidents. On examination, most of these accidents between midnight and three o’clock in the morning involved either pedestrians (usually

intoxicated) attempting to cross the road in front of taxis, or taxi drivers becoming the victim of the drunk and dangerous drivers who tend to be on the roads in the early hours of the morning.

4.8 Fatigue as a factor in accidents

Driver fatigue is often found to be a major cause of work-related road accidents (e.g. RAC, 2001), but only 2.6% of the whole sample showed fatigue as a possible causal factor. An attempt was made to find sleep-related cases by use of Horne and Reyner's list of sleep-related criteria for accidents (as detailed in Flatley *et al.*, 2003), but no more cases were found. However, the blame ratio for fatigue accidents in the sample was 3.6, i.e. work-related accident-involved drivers appeared more than three times as likely to cause a fatigue-related accident than become the passive victim of another driver's fatigue. The largest vehicle category in fatigue accidents was lorries (LGVs). There was some evidence of a peak in LGV fatigue accidents in the early hours of the morning, and early in the afternoon. 'Early hours' accidents occurred most often on motorways, perhaps because low traffic densities and monotonous driving could be contributing to boredom and associated fatigue at these times (Flatley *et al.*, op.cit).

4.9 Vehicle defects

Accidents resulting from vehicle defects were quite rare, and only accounted for around 1.5% of the sample. The two main categories of vehicle that were prevalent in this group were LGVs and vans/pickups. The most common defect found was with braking systems. A typical case prose account is reproduced below.

Accident account

It was late in the afternoon on a fine day in spring. The driver (M,25) of an ERF articulated HGV (1) was travelling along a rural A road with a 60 mph limit. He was heading back to base, and was at the limit of his maximum working hours. He headed towards a crossroads junction ahead, where there was a build-up of stationary traffic. Driver 1 failed to notice this in time, and when he did, he braked sharply. This caused the front driven wheels of the tractor unit to break into a skid, and the truck jack-knifed, skidding out of control into the opposing lane where it hit an oncoming Astra (2), driven by (M,40). The car was a write off and its driver received serious injuries. Driver 1 was charged with driving without due care and attention, and using a vehicle with defective brakes. The load-sensing valve of the braking system had been set wrongly, and maximum air braking had been applied to the tractor unit wheels as if the truck were laden when it was not. This was felt to have contributed to the loss of control and jack-knifing of the truck and trailer. Though the driver*

* ERF is the name of a truck manufacturer. The initials date from 1933 and relate to the initials of the founder, Edwin Richard Foden.

and company were reported for offences disclosed, no charges ended up being made due to an administrative error.

There was also evidence in some cases of confusion as to who exactly was responsible for vehicle maintenance, as occurred in the tragic case below.

Accident account

It was early in the morning on a fine day in winter. It had not yet got light, the road was damp, and there was no street-lighting. The driver (M,33) of an Iveco tipper lorry (1) was travelling along a rural A road with a 60 mph limit. He and the traffic ahead of him were travelling reasonably slowly, having just come through a village, and going uphill. Driver 1 then saw traffic slowing to a halt ahead for an unknown reason. He braked quite sharply to slow the truck to a standstill, but the back wheels on the truck locked and caused it to veer into the opposing carriageway, where it became stationary. Driver 1 was just about to reverse the truck back onto its correct side of the road (the driver of the car behind him had stopped and left room for him to do this) when a Leyland box van (2), driven by (M,53) suddenly came from the opposite direction, saw the stationary truck across his lane, and braked hard. His van skidded, hit the lorry and the car behind it, and then hit a tree. The van driver was killed and all vehicles were badly damaged.

Police discovered that the brakes on the Iveco truck were defective – a load sensing valve had been set wrongly, and this would cause the vehicle to go out of control under moderate to heavy braking. The truck was a rental unit; the driver was not responsible for its maintenance, and neither was the company renting it. Due to a legal technicality, all charges against the driver or any of the companies involved were dismissed.

There were also accidents in this small group of cases that showed more obvious signs of a lack of maintenance including wheel sheer-off, worn brake linings and failures of brake air lines. The two examples above, however, both show that poor maintenance can also include the way brakes are adjusted for vehicle load, even though they may be working efficiently in other respects. Other accidents in this group included one remarkable case where an LGV had no trailer brakes at all, as the trailer air lines were not connected, and another where an LGV was involved in an accident while being used in contravention of a prohibition notice.

4.10 Miscellaneous work-related accidents

In this research project, we were also keen to identify all the possible ways of being injured on the roads while using them in a work capacity. Though we have found drivers of six types of vehicle accounted for 88% of work-related road traffic

accident involvement, this of course still leaves 12% (over 250 cases) of the sample to be accounted for.

4.11 Minibuses and tractors

These classes of vehicle were common in the 'miscellaneous' section of the sample, although not in large numbers in the sample as a whole. 'At fault' minibus drivers appeared to have very similar accident characteristics to the drivers of vans or pickups detailed earlier. However, one tragic case in particular showed the result of combining poor working practices with fatigue.

Accident account

It was early in the morning on a wet day in autumn. It was raining and was still dark with no street-lighting. The driver (M,42) of a Renault Master minibus (1) was travelling along a rural A road with a 60 mph limit. The driver worked for a foreign company, and had finished taking a group of workers to a power station. He was now on his way home. He was on the wrong side of the road when he entered a right-hand bend ahead. He was then confronted by an oncoming Ford Escort (2), being driven in the opposite direction. The Escort driver braked and skidded on seeing the minibus on his side of the road. Driver 1 apparently attempted to drive up the grass verge on the offside, but had a head-on collision with the Escort, killing both the driver and passenger of the Escort.

Driver 1 claimed that the car had been on his side of the road and he'd been trying to avoid it. Accident investigation disproved this. It was discovered that driver 1 had only been back in the country from his home in mainland Europe for two days, and in this work shift he had driven over 350 miles without a break having had only 5 hours sleep the night before. Police thought the most likely explanation for the accident was that he'd been tired and had absent-mindedly started driving on the wrong side of the road, still thinking he was in continental Europe. The driver denied this. He was charged with causing the death by dangerous driving of the Escort driver and passenger.

About two-thirds of tractor accidents were caused by other drivers. Overtaking slow-moving tractors while not noticing that they were indicating to turn right into a field or farm entrance was quite common. There was little evidence of obscured or non-working indicators being a contributory factor in such accidents, as might have been expected.

'At fault' tractor drivers themselves seemed also to have some degree of difficulty with the slow-moving nature of their vehicles. Some cases showed that a driver could take quite effective estimates of visibility and/or the speed/distance of

approaching vehicles and yet still come to grief in a right of way accident, as their tractor proved unable to accelerate quickly enough to complete a turn or manoeuvre safely.

4.12 Other miscellaneous vehicle types

Other types of vehicle found in the sample included: private cars used for business purposes; motorcycles; delivery floats; and recovery vehicles. The frequencies of all these vehicles appeared to be very small. However, it is possible that we are missing a number of accidents involving drivers using their own vehicles on business who fail to declare this fact to the police, perhaps due to a lack of insurance cover for the vehicle if it is being used for commercial purposes. It is impossible to tell from available data how widespread this practice is.

Though numbers are too small to make any analysis regarding typical accidents in these cases, all but one of the above vehicle classes showed a blame ratio of 1.0 or less, which suggested that drivers/riders of these vehicles were no more likely than any other driver to cause an accident. The exception was drivers of private cars being used for business, who appeared to be at least somewhat to blame in the majority of accidents they became involved in. Two cases revealed the kind of insurance violation described above, and both these cases showed that drivers had a poor knowledge of the legal requirement to be insured for using their vehicle in a commercial setting. There was some evidence of time pressures and excessive speed in these cases; examples of which included a salesman rushing to a meeting; a reserve fire-fighter driving fast to a call-out at his station; and a delivery driver rushing to deliver takeaway food.

4.13 'Non-driving' work-related accidents

Twenty-one cases in the database involved workers who were not driving themselves at the time of the accident, but who were working on or near the road. Two-thirds of these accidents involved workers who were run over or otherwise injured by other drivers while performing the various duties that their jobs require. Most of these cases involved carelessness on the part of the other road user, but a minority also showed a reckless disregard by road users for people working on the highway, as in the following two cases.

Accident account 1

It was the middle of the afternoon on a fine day in early summer. A female crossing attendant (or 'lollipop' lady) (1) (F,55) was working in the road. Some children had just crossed and she was just leaving the road when the driver of a Rover 214 started forwards and almost collided with the lollipop lady. The lollipop lady shouted at the driver (F,50), who shouted back, and the lollipop lady approached the car to talk to the driver. As she

got near, the driver slapped her face and then drove off. Even though the lollipop lady stood in front of the car and was pushed out of the way by the car, the driver didn't stop and left the scene. She was traced and charged with dangerous driving and assault.

Accident account 2

It was early in the afternoon on a fine day in winter. A uniformed police officer (M,42) was on foot and out of his patrol car when he approached what he knew to be a recently stolen car with a number of occupants. The car was stationary as he got to the driver's open window and attempted to remove the keys from the ignition in order to stop the offenders getting any further with the car. The driver (M,31) deliberately drove off and steered towards the officer, knocking him into the road, running over him, and dashing his head on a nearby piece of traffic furniture. He received a head injury from which he died soon after. The driver was apprehended and convicted of manslaughter.

Cases that involved carelessness rather than recklessness tended to involve drivers failing to see stationary vehicles such as delivery or recovery vehicles in time to stop, or drivers who failed to give sufficient clearance to workers unloading or loading vehicles at or near the side of the road. Some drivers' lack of knowledge of basic traffic law was also quite surprising, as in the following case.

Accident account

It was the middle of the morning on a wet day in winter. The driver (F, age unknown) of a curtain-sided delivery van (1) had pulled up her vehicle and was delivering to a pub. The van was parked half on the pavement and half on the road because traffic was very busy and she didn't want to block off the whole lane. After she finished her delivery, she had to walk around the offside of the van and close the side covers. While doing this, a Rover (2), driven by a female driver of unknown age, passed her vehicle at about 5 mph in queuing traffic and caught her a blow with its nearside wing mirror, causing minor injury. The mirror was pushed inwards and sprang out again with a noise, and the delivery driver chased the car down the road and wrote down its registration number. Despite this, the driver of the car didn't stop and continued on her journey. She was traced and charged with failing to stop at the scene of an accident. She said that she thought that the incident didn't qualify as an accident because there was no damage to her car, and the woman she had hit had run after her, and so therefore couldn't have been injured. She was charged with leaving the scene of an accident, but the results of these charges were not recorded.

4.14 Countermeasures

A list of 23 possible behavioural strategies for avoiding typical accidents was drawn up using established texts such as *Roadcraft* and *The Highway Code*, together with prior knowledge of the data. The countermeasures were concerned solely with simple driver behaviours and did not extend to road/vehicle engineering factors that were outside the scope of this study. Each case in the database was coded for the countermeasures that might have either prevented the accident or reduced the severity of it. Countermeasures were not meant to be either exotic or counter-intuitive, and they dealt with mainly obvious measures that would be understood by most competent drivers. (A detailed list of countermeasures can be found in the Appendix of this report.) The top five countermeasures for the three classes of vehicle and driver with peak blameworthiness are shown in Figures 7–9. In each of these figures, the top five countermeasures are shown by cumulative percentage in order to show their effectiveness on a particular class of vehicle-related accidents, considered as a whole. (NB. Figure 7 appears to show six in the top five, as the final two items share joint fifth place.)

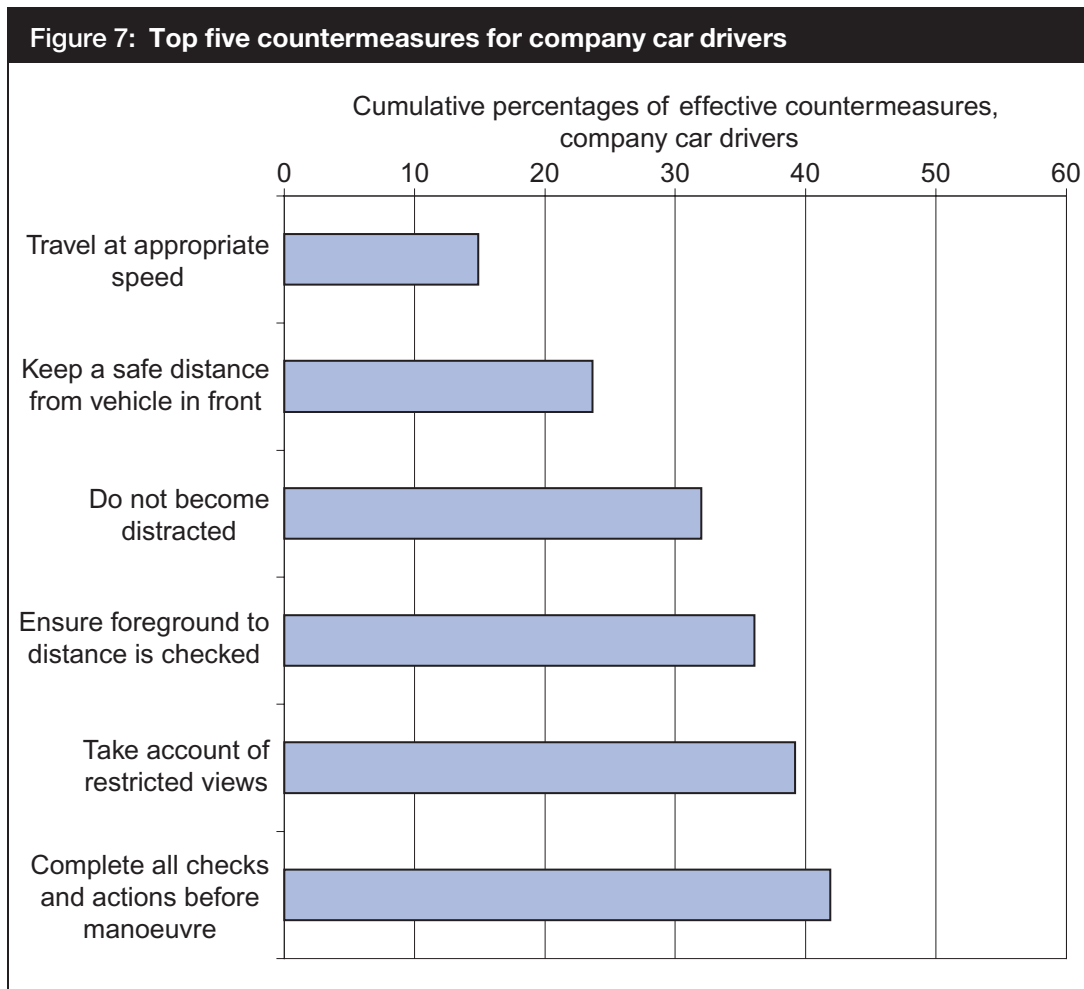


Figure 8: Top five countermeasures for van/pickup drivers

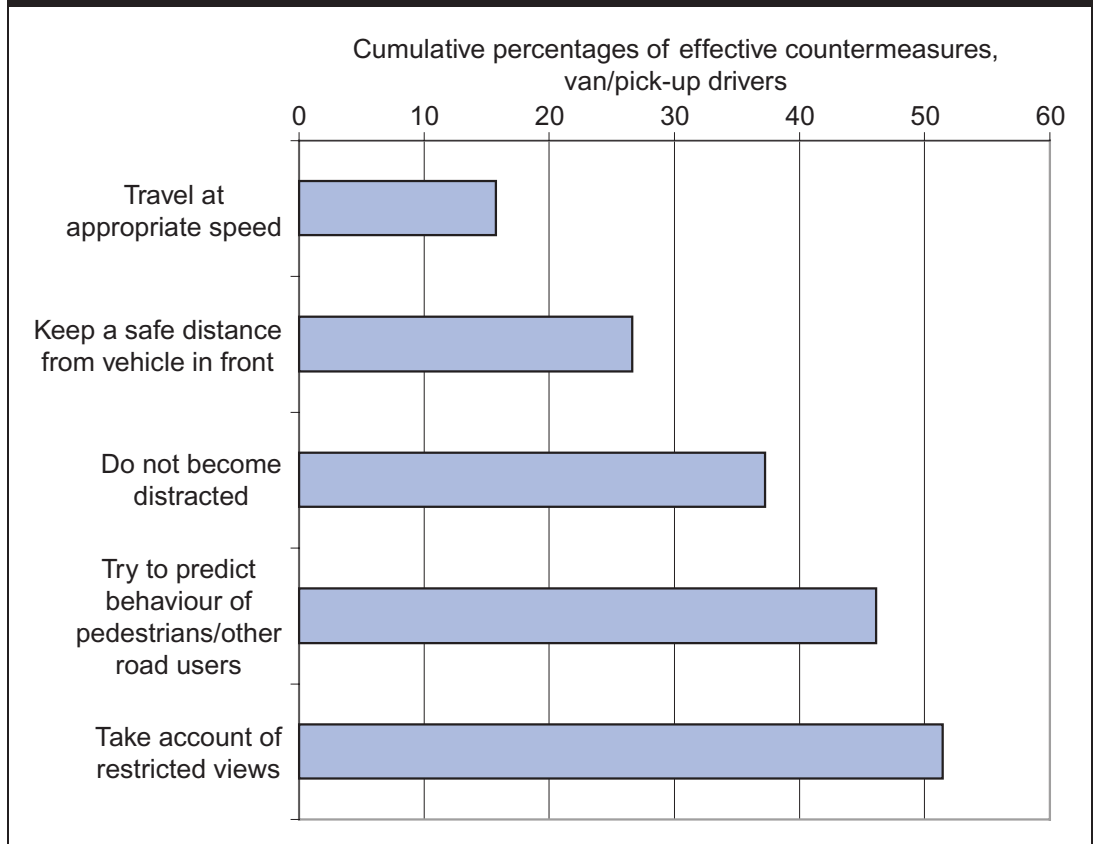
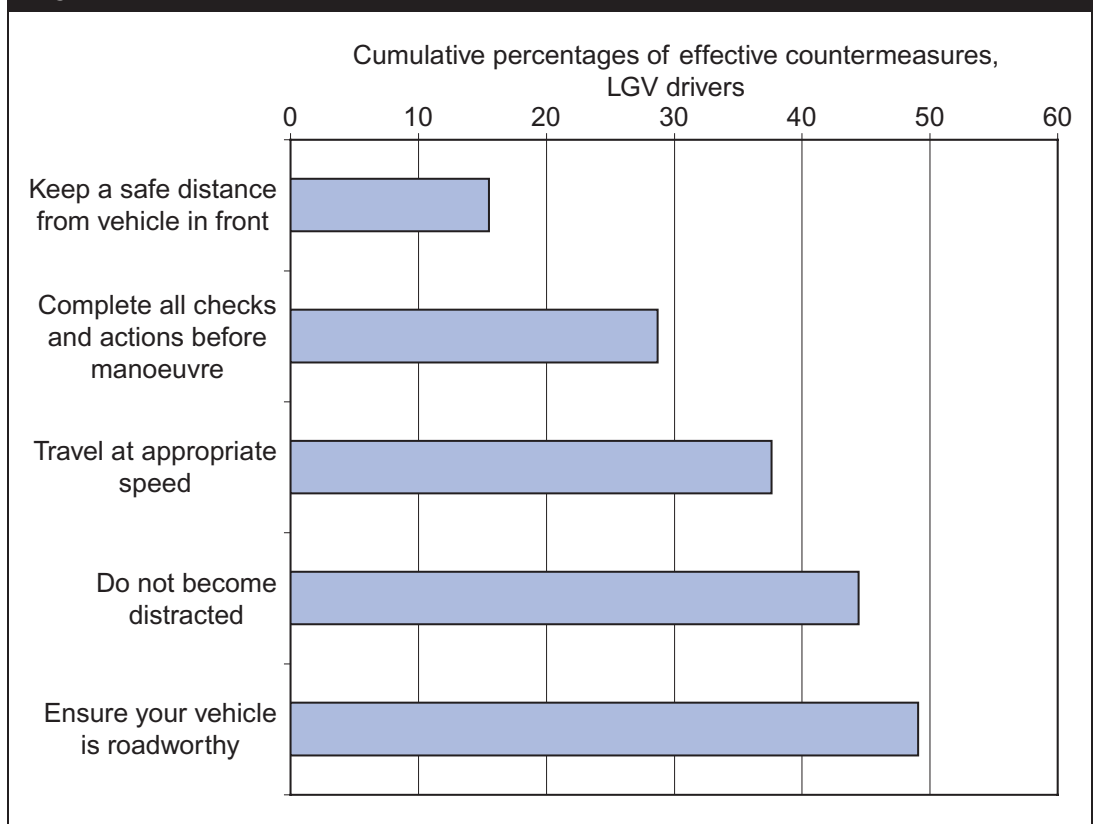


Figure 9: Top five countermeasures for lorry/LGV drivers



It can be seen that the top five effective countermeasures vary between the three vehicle types in the way that might have been predicted by the errors and violations that were shown for each class of driver earlier. Key themes that would improve safety in all these driver groups are speed control, maintaining safe following distances, and avoiding distraction. The scope for improvement, however, differs quite widely between vehicle types, before diminishing returns set in.

5 SUMMARY AND DISCUSSION

5.1 Vehicle types in work-related accidents

The majority of work-related road traffic accidents involved the drivers of six main types of vehicle. These were: company cars; vans/pickups; lorries (HGV/LGVs of all weights); buses (PCVs); taxis (including Hackney carriages and minicabs); and emergency vehicles (EVs). These accident-involved drivers were almost all male; the only significant number of female drivers occurred in the company car sub-group. The characteristics of work-related road traffic collisions in general are therefore similar to those of male road accidents in general.

Peak numbers of accidents occurred in the 25–35-year-old age group for the sample as a whole, though there were some marked differences in the age distribution according to vehicle type: van and pickup drivers showed their peak number of accidents in a younger age band than other drivers (21–25 years); lorry/LGV and bus/PSV drivers showed a peak that extended through a wide age range compared with drivers of other vehicles (25–50 years).

The results from blameworthiness ratios showed that work-related vehicle driving seemed in many cases to involve drivers having accidents caused by other motorists. Three of the vehicle groups (taxi, bus and emergency vehicle) had blameworthiness ratios below 1.0, which implied that these drivers were more likely to be passive victims of other road users' mistakes and violations than they were to be perpetrators of such mistakes and violations.

This form of analysis proved particularly pertinent when examining various sub-groups of accidents. With fatal accidents, for example, we found that lorries/LGVs were significantly more likely to be involved in fatal collisions, and showed factors such as distraction, fatigue, speed and time pressure. However, over half of LGV-related fatalities were actually caused primarily by other drivers. When overall fatalities were analysed using blameworthy cases only, the group most likely to cause fatal accidents appeared to be company car drivers. These cases most often involved excessive speed as a causal factor.

There were a variety of findings across the vehicle sub-groups. Table 3 summarises the main points.

Table 3: Summary of work-related road accidents by vehicle type

	Blame	Age/sex	Severity	Location – over-represented on...	Over-represented contributory factors
Company cars	More to blame than not	Peak at 31–35 years, mostly male, some females	More fatalities than other vehicle types, if driver to blame	Rural unclassified (60 mph limit)	Excess speed; poor observation; excess alcohol; slippery roads
Vans/pickups	More to blame than not	Peak at 21–25 years, mostly male, few females	No effect	Urban unclassified roads; rural B class roads; and rural unclassified roads (mixed limits)	Poor observation (restricted views and other drivers' signals)
LGV/lorry	More to blame than not	Peak at 26–30 years, nearly all male	More fatalities than other vehicle types, regardless of blame	Rural A roads (60 mph) and motorways (70 mph)	Poor observation; close following; fatigue; load problems; vehicle defects
PCV/bus	Other parties more to blame	Peak at 46–50 years, nearly all male	No effect	Urban roads, all classifications (30 and 40 mph)	Poor observation (at junctions); close following; failure to signal
Taxi/minicab	Other parties more to blame	Peak at 26–30 years, nearly all male	No effect	Urban roads, all classifications (30 and 40 mph)	Poor observation (U-turns and reversing); gap judgement
Emergency vehicle	Other parties more to blame	Peak at 26–30 years, nearly all male	More fatalities than other vehicle types, if driver to blame	Urban roads, all classifications (30 and 40 mph)	Excess speed; time pressure

5.2 Company cars

It can be seen (from Tables 2 and 3) that company car drivers had different background and behavioural factors appearing in their accidents when compared with drivers of virtually any other vehicle. They were the only group (aside from emergency drivers) where excess speed was over-represented significantly as a causal factor. LGV drivers (as an example of a comparison group) showed more 'background' factors such as load problems, vehicle defects and driver fatigue.

Excess speed can be considered as a behavioural or 'attitudinal' failure (e.g. by Clarke *et al.*, 2002). Unfortunately, driver interview quotes from this study were found to be generally unrevealing with regard to attitudes. It may be, for example, that the 'perk' or 'sales' cars referred to by Chapman *et al.* (2000) are driven differently due to the reduced personal cost of any predicted accident. As one company car driver explained in a rare moment of candour to another driver who had shunted his car, and who wished to exchange details: 'Why? It's a company car – I don't give a s**t.'

Unfortunately, there is a lack of information about the exact type/use of company car involved in these excess speed collisions, so it is difficult to comment further. The sub-group of vehicles in these cases mostly contains average mass-market saloon cars, with the occasional luxury high-capacity model, but we have no further information beyond the fact that their drivers say they are company cars.

5.3 Fatigue, safety culture and vehicle defects

Although only a relatively small number of cases with driver fatigue as a causal factor were found, it is possible that a large number of such accidents have been logged as being caused by distraction or other observational failures. This would lead to an unquantifiable level of underestimation of the fatigue factor. Drivers are seldom willing to admit to having fallen asleep at the wheel, perhaps because they are unlikely to recollect having done so (Horne and Reyner, 1995). In addition, there are other ways in which fatigue can affect driving which are beyond the remit of this study. For example, shift workers who use their own car to commute are not (by the definitions used in this report at least) driving in a work-related capacity. Nevertheless, their work may be affecting their chances of having a fatigue-related accident. A study by Folkard (1999) showed that the risk of being in a single-vehicle accident at 3 o'clock in the morning was 50% above the baseline after four successive night shifts, for example. We cannot comment on this phenomenon any further as we only have evidence of such drivers hitting other work-related drivers, which proves to be a very small pool of cases. This small number does include one fatal accident involving a night-shift worker killed when he fell asleep at the wheel on his journey home and was hit by an LGV, after drifting out of control into the path of the lorry.

Some attitudes towards working time and fatigue were shown by various drivers in the sample, which gave a limited insight into this aspect of safety culture. There is, for example, a case on record where the tachograph of an LGV showed that the driver had only had 5.5 hours rest in the last 33.5 hours, and the vehicle had also covered 149 km with no records being made in the preceding week. The driver also admitted that he had disabled the speed limiter on the truck to enable it to go faster. Another case involved a driver who caused an accident after becoming fatigued and ill through working a regular 75-hour week. He was not covered by driving hours regulations as he was a company car driver.

More seriously there is evidence, albeit in a minority of cases, that drivers can perform such actions as deliberately falsifying tachograph records, disabling safety equipment such as speed limiters and ABS systems, and removing trailer registration plates when they think it will be financially advantageous to do so. The driver in the case described in Section 4.3 of this report claimed that removing trailer plates to evade safety cameras was common practice, for example. He was paid for working a 45-hour week only, so his motivation could be assumed to be financial in that it was in his interest to finish his work as quickly as possible. The seizure of his past tachograph records appeared to bear this out, as 65 other speeding offences were revealed.

Vehicle defects are likewise not a common cause of accidents overall, but where they are a factor, a worrying failure of safety culture in some organisations is revealed. One case in particular highlighted the 'grey areas' that can exist with regard to which company is liable for aspects of vehicle maintenance.

5.4 Other types of work-related accidents

Accidents that involved drivers of other vehicles not included in the groups above did not reveal any particularly surprising findings. However, drivers using their own cars in relation to work seemed to have an elevated blame ratio when compared to other drivers in the miscellaneous group. It is also likely that we underestimated the number of such drivers, as drivers may have attempted to conceal the purpose of their journey from the police, perhaps because they are not insured to drive for commercial purposes. The need for proper insurance cover should be impressed on such drivers; the examples in the database showed a poor understanding of the need for such cover.

People working in the road seemed to come to grief in road accidents primarily due to a lack of care shown by other road users, who sometimes seemed fairly ignorant of basic road traffic law (or, alternatively, were aware of it but chose to ignore it). The perception seemed to be that pedestrians were not expected to be in the road, and some drivers would do little to ensure their safety when they were.

6 CONCLUSIONS

To a striking degree, this sample of work-related accidents shows the same characteristics as a general sample of all accidents. In other words, we find that work-related accidents are not fundamentally different in their causal structure to any other road accidents, except in certain tightly defined conditions; an example would be the risks engaged in of necessity by emergency drivers.

Some work-related drivers, principally those driving company cars, vans/pickups or LGVs, appeared to be more to blame in their accidents: these are drivers who drive above average mileages and who are exposed to a variety of internal and external stressors and motivations that may explain this finding. Their errors and violations did not appear markedly different from those of the general driving population; they may merely have had more opportunities for committing them. The solution here may involve driver training, but consideration must also be given to altering organisational and work structures that may be shaping these drivers' attitudes and behaviour.

Perhaps more surprisingly, other work-related drivers, principally those driving buses, taxis and emergency vehicles, suffered more accidents primarily caused by other road users. Their problem was therefore predominantly one of exposure to dangerous environments. This was very marked, for example, in the case of taxi and minicab drivers, whose work puts them on the road at the same time as young, reckless and intoxicated drivers, intoxicated pedestrians, and even customers that sometimes assault them. Defensive driving techniques may be a partial solution with this kind of driver, but can only go so far in accident prevention terms if the behaviour of other road users is not also addressed.

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APPENDIX

Countermeasures list

- 1 Come to a stop at junctions when view is in doubt
- 2 Re-check to the right before pulling out
- 3 Ensure that foreground to distance is checked properly with a sweeping gaze
- 4 Take account of restricted views (*e.g. hillcrests, corners, buildings, parked or stationary cars, vegetation etc.*)
- 5 Give yourself enough time to be sure of the speed and path of approaching traffic
- 6 Ensure the approaching vehicle is not masking other close following traffic
- 7 Travel at an appropriate speed for road conditions (*i.e. it may be necessary to travel below the speed limit in certain circumstances when, for example, traffic is especially heavy, there are adverse weather conditions or travelling round a severe bend in the road*)
- 8 Avoid braking on bends
- 9 Complete *all* necessary actions and checks before making a manoeuvre (*i.e. check mirrors and blind spot, and signal in good time*)
- 10 Ensure that all traffic signs and signals are adhered to
- 11 Be aware of the possibility of pedestrians or other road users entering the road without due care
- 12 Ensure your vehicle is positioned effectively in the road so that other road users can see you
- 13 Keep a safe distance from the vehicle in front
- 14 Look ahead of the vehicle in front for any hazards or signals that may cause it to slow down or stop
- 15 Do not let your mind wander or allow yourself to be distracted by anything inside or outside of the vehicle (*e.g. passengers, mobile phones, events outside the vehicle*)
- 16 Ensure your vehicle is roadworthy (*e.g. tyres, brakes, lights etc. are regularly checked*) and any loads are securely fastened
- 17 Avoid driving if you are physically or mentally unable to do so safely (*e.g. if you are ill, tired, under the influence of drink or drugs, or using medication that can affect your concentration and/or reaction time*)

- 18 When a vehicle is slowing down to make a turn or stop, be aware of the possibility of other road users overtaking the vehicle
- 19 Before overtaking vehicles that are slowing down, ensure they are not about to turn
- 20 Avoid overtaking in the vicinity of junctions or in areas where emerging traffic is a strong possibility
- 21 Avoid crossing solid white lines during a manoeuvre
- 22 If you need to slow down or stop your vehicle, do so in a safe location
- 23 Move cautiously through traffic when filtering/passing stationary or slow-moving vehicles

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