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Characteristics And Causes Of Heavy Goods Vehicles And Buses Accidents In Europe

Petros Evgenikos[a]*, George Yannis[b], Katerina Folla[c],
Robert Bauer[d], Klaus Machata[e], Christian Brandstaetter[f]

[a]*Research Associate, National Technical University of Athens, Iroon Polytecheiou 5, Athens, 15773, Greece*
[b]*Professor, National Technical University of Athens,Iroon Polytecheiou 5, Athens, 15773, Greece*
[c]*Researcher, National Technical University of Athens,Iroon Polytecheiou 5, Athens, 15773, Greece*
[d]*Senior researcher, Austrian Road Safety Board, Schleiergasse 18, Vienna, 1100, Austria*
[e]*Senior researcher, Austrian Road Safety Board, Schleiergasse 18, Vienna, 1100, Austria*
[f]*Senior researcher, Austrian Road Safety Board, Schleiergasse 18, Vienna, 1100, Austria*

Abstract

While Heavy Goods Vehicles (HGV) and buses account for just a small proportion of the vehicle fleet or the total vehicle kms travelled in the EU, they are over-involved in severe road accidents, creating a significant need to better understand the characteristics specific to this vehicle group. In 2013, more than 4.500 persons were killed in road traffic accidents involving HGVs or bus/coach in EU, constituting almost 18% of all road accident fatalities for that year. The objective of this research is the analysis of basic road safety parameters related to HGV and buses/coaches in European countries, by the use of the EU CARE database with disaggregate data on road accidents, as well as of other international data sources. Time-series data on road accidents involving HGVs and buses/coaches for 27 EU countries over a period of 10 years are correlated with basic safety parameters, such as area type, season of the year, casualty age and gender, as well as the day of the week. Additional insight into accident causation is offered through analysis of a set of in-depth accident data from the EC SafetyNet project Accident Causation System. The results of the analysis allow for an overall assessment of the HGV and buses/coaches safety level in Europe in comparison to other modes of transport, thus providing useful support to decision makers working for the improvement of safety in the European road network.

Keywords: heavy goods vehicles;buses; EU CARE database; road accident causation; road safety; European countries

* Corresponding author. Tel.: +30-6945877578; fax: +30-2107721454.
E-mail address: pevgenik@central.ntua.gr

1. Introduction

Heavy Goods Vehicles (HGVs) are defined as goods vehicles of over 3,5 tons maximum permissible gross weight (vehicle and load). Heavy goods vehicles are over-involved in severe road accidents, since their high mass leads to severe consequences for other road users involved in the accidents. In view of this and the growth in heavy good vehicle traffic internationally over the last twenty five years, the safety of heavy goods vehicles continues to be strictly regulated in the best performing countries in road safety and work-related road safety action encouraged (DaCoTA, 2012[1]). Buses and coaches are also normally relatively large and even though transport by bus and coach is considered as the safest mode of road travel, every year, around 20.000 European buses and coaches are involved in crashes causing injury or death producing approximately 30.000 casualties (DaCoTA[1], 2012).

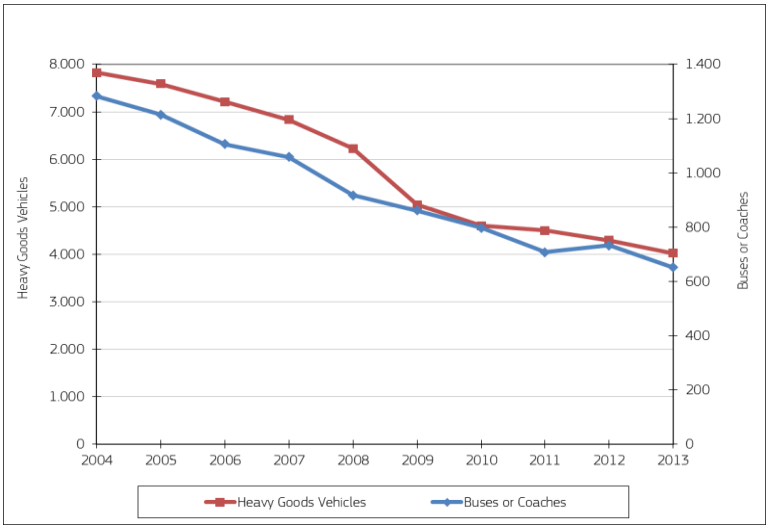
Heavy goods vehicles and bus transport is of economic importance in most areas of the developed world. In the USA, for example, the commercial trucking sector has annual revenues of more than US$500 billion and employs nearly 10 million people. Trucks transport over 11 billion tons of goods annually, about 60% of the total domestic tonnage shipped (Schwartz et al., 2007). Additionally, North American intercity and charter buses carry an estimated 860 million passengers annually, which is more than those transported by commercial air carriers or rail (Knipling, 2007). Interestingly, although HGVs and buses account for just a small proportion of the vehicle fleet or the total vehicle kms travelled in the EU, they are associated with almost 18% of the total road accident fatalities in 2013 (European Commision, 2015). The particular characteristics of these vehicles strongly influence – in a positive or negative way – the occurrence of road accidents and these characteristics relate to the vehicle itself (different traction characteristics, increased dimensions and weight), to the driver (professional drivers spend more time driving tan a typical driver) and the vehicle use for HGVs (commercial use must meet several efficiency criteria, regulations and restrictions and policy-related issues) (Christoforou et al., 2010).

The objective of this research is the analysis of basic road safety parameters related to Heavy Goods Vehicles (HGV) and buses/coaches in European countries, by the use of the EU CARE database with disaggregate data on road accidents and the SafetyNet Accident Causation System (SNACS). More specifically, time-series road accident data involving HGVs and buses/coaches from CARE for 27 EU countries over a period of 10 years (2004-2013) are correlated with basic safety parameters, such as area type, season of the year, casualty age and gender, as well as the day of the week and the time of the day. Additional insight into accident causation recorded for HGV and buses/coaches drivers is offered through analysis of a set of in-depth data, collected for the period 2005 – 2008, using a common methodology for samples of accidents that occurred in Germany, Italy, The Netherlands, Finland, Sweden and the UK. The data, on which this analysis is based, along with much of the analysis and the way that the different types of databases were combined, is obtained through the Traffic Safety Basic Facts 2015 – Heavy Goods Vehicles and Buses (European Commision, 2015), as well as through SAFETYNET and DaCoTA EC co-funded research projects and the European Road Safety Observatory (ERSO - http://ec.europa.eu/transport/wcm/road_safety/erso/index-2.html).

The results of the analysis allow for an overall assessment of the HGV and buses/coaches safety level in Europe in comparison to other modes of transport, thus providing useful support to decision makers working for the improvement of safety in the European road network.

2. Overall road safety trends for HGV and Buses in the EU

In 2013, 4.021 people were killed in road traffic accidents involving HGVs and 652 people in accidents involving buses or coaches in the 27 EU countries for which CARE accident data are available. In order to monitor the evolution of the HGVs and buses/coaches' safety level in Europe, accident trends for the decade 2004 - 2013 were considered. According to the following Figure 1, the number of fatalities in accidents involving HGV, buses or coaches has fallen by nearly 50% over this period in these countries, whereas the overall number of road accident fatalities had a lower decrease (reduction by 45%). Especially for HGV related fatalities their annual reduction was continuous within the decade, with a considerable decrease by 19% noted between 2008 and 2009. For Buses/coaches related fatalities though, an increase by 3,5% was recorded between 2011-2012. Generally, the reduction for both trends was parallel within the decade with approximately five times as many people killed per year in accidents involving HGVs as in accidents involving buses or coaches.

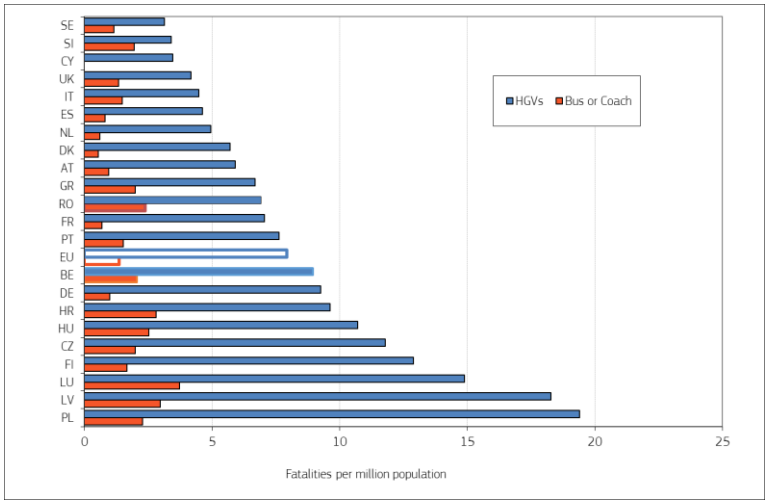


Source: CARE database, data available in May 2015

Fig. 1. Number of fatalities in accidents involving HGVs and buses/coaches in the EU, 2004-2013.

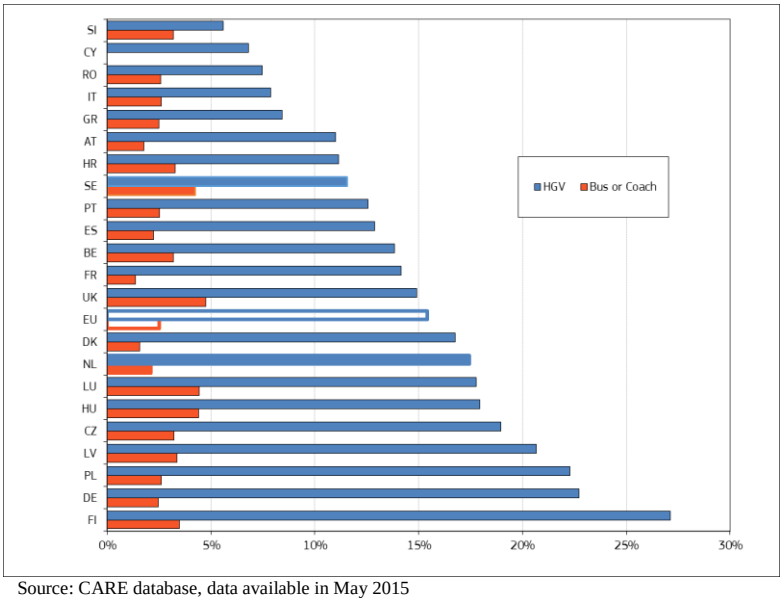
In road safety analysis exposure data is often used to calculate risk estimates, those being defined as the rate of the number of accidents (or casualties) divided by the amount of exposure of a population over a time period (Hakkert and Braimaster, 2002, Hauer, 1995), on that purpose data from other international databases such as OECD/IRTAD, Eurostat etc. were also used. Since there is no reliable and comparable data available about vehicle kilometres or person kilometres travelled by HGVs and buses/coaches in each of the above countries, the population is used as exposure data. The calculated risk figures may be used for different purposes, but their main objective is to enable the comparison of safety performance among different units, populations or countries.

Although in absolute figures in 2013 most HGVs fatalities occurred in Germany and Poland (759 and 748 people killed respectively), Germany has only the eighth higher fatality rate (9,3), with Poland having the highest risk of being killed in a road traffic accident involving a HGV (19,4). As indicated in Figure 2, the EU-average fatality rate in accidents involving HGVs is about 8 per million population, whereas for accidents involving buses or coaches the EU-average fatality rate is 1,4 per million population, ranging from 0,5 in Denmark to 3,7 in Luxembourg.



Source: CARE database (EUROSTAT for population data), data available in May 2015

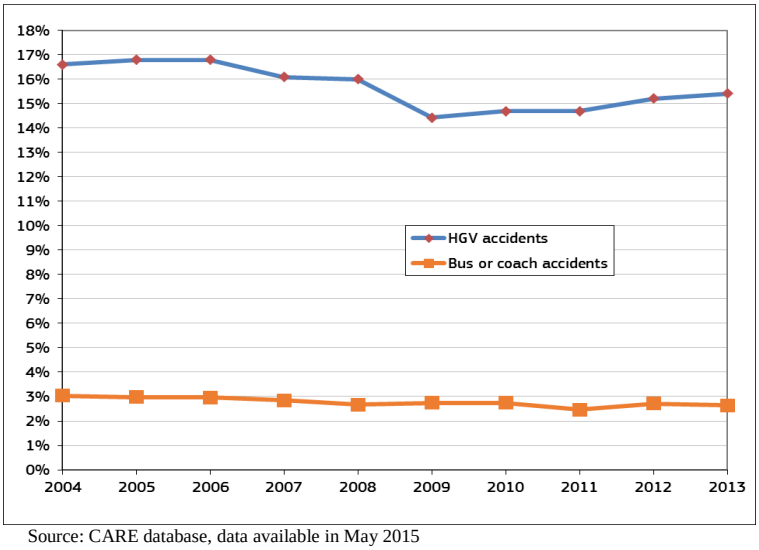
Fig. 2. Fatality rates in accidents involving HGVs and buses or coaches by country in the EU, 2013.



Source: CARE database, data available in May 2015

Fig. 3. Proportion of fatalities in accidents involving HGVs and in accidents involving buses or coaches by country in the EU, 2013.

Figure 3 shows that in the EU countries more than 15% of people who died in road traffic accidents in 2013 died in accidents involving HGVs and almost 3% in accidents involving buses or coaches, with considerable variation around these averages in individual countries. The respective trends for the decade 2004-2013 are also presented in the following Figure 4, indicating that the decreasing trend of fatalities involving HGVs during the last years has been inverted in 2010 continuing ever since.

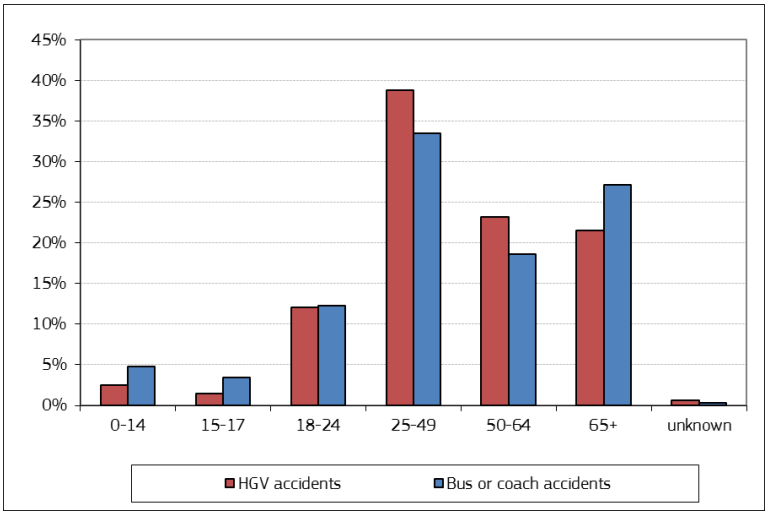


Source: CARE database, data available in May 2015

Fig. 4. Proportion of fatalities in accidents involving Heavy Goods Vehicles and buses or coaches in the EU, 2004-2013.

According to the results of a more detailed analysis by age groups and gender more than three quarters of the fatalities in accidents involving HGVs are males (76%), however, with a considerable variation between countries (i.e. 50% in Denmark and over 90% in Cyprus and Croatia). On the other hand, almost one third (33%) of fatalities in accidents involving buses or coaches are females, a higher percentage than the one in the HGVs accidents.

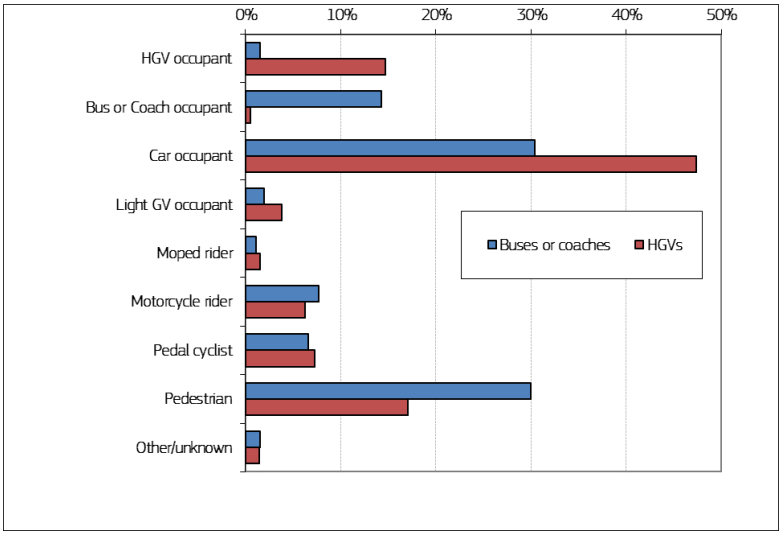
Additionally, as shown in Figure 5, in 2013, almost 40% of persons who died in a traffic accident involving HGVs in the EU were between 25-49 years old, with the respective proportion for fatalities related to buses/coaches accidents being 32%. However, it is worth noting that more people are killed in accidents with buses/coaches in all age groups except 25-49 and 50-64 years old.



Source: CARE database, data available in May 2015

Fig. 5. Distribution of fatalities in accidents involving HGVs and in accidents involving buses/coaches by age in the EU, 2013.

Due to the mass of the HGVs and the buses/coaches, persons involved in such accidents suffer the most severe consequences in collisions regardless they're occupants or outside the vehicles. In Figure 6 the distribution of fatalities in accidents involving HGVs and buses/coaches by road user type in presented, indicating that nearly half of those who died in 2013 in road traffic accidents that involved HGVs were travelling by car (47%). Across the EU, 15% of the fatalities in accidents with HGVs were HGV occupants with the same proportion being also for the occupants of buses or coaches in the respective accidents. It is worth noticing though that more than 30% of persons killed in 2013 in accidents that involved buses or coaches were pedestrians, the same as for car occupants.

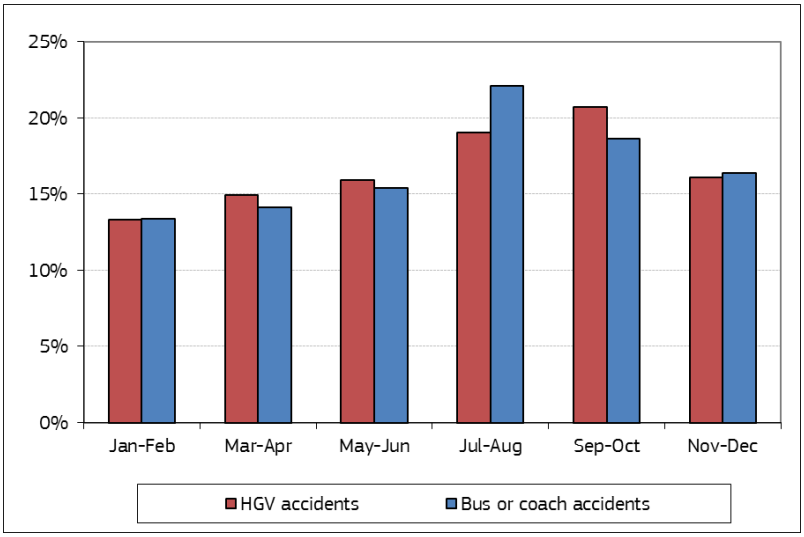


Source: CARE database, data available in May 2015

Fig. 6. Distribution of fatalities in accidents involving HGVs and in accidents involving buses/coaches by road user type in the EU, 2013.

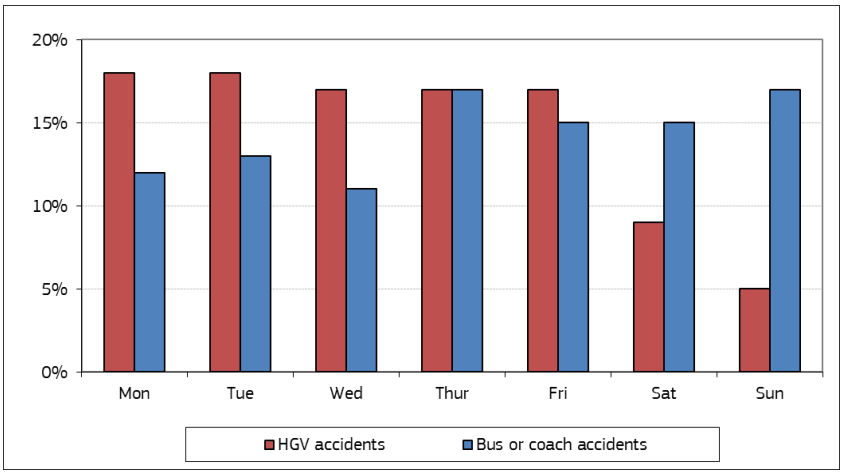
3. Road safety parameters of the HGV and Buses in the EU

In order to answer the question when most HGVs and buses/coaches' accidents occur, the analysis of the fatalities seasonal distribution showed that there is no clear trend in the incidence of HGV and buses/coaches fatalities by month among individual countries. In 2013, the peak for the HGV related fatalities in the EU countries occurred in September and October (21% of HGV fatalities) and the fewest fatalities occurred in January and February (13% of HGV fatalities). Figure 7 compares the distribution by month of HGV and buses/coaches fatalities and shows that the rate for accidents involving buses or coaches in 2013 peaked in July and August. However, for both transport modes the lowest proportion of fatalities are recorded in January and February, around 13%. As the slippery wet conditions of many European winters are conducive to high severity accident injuries, these analysis outcomes are likely to be associated with the actual number of people on the road during these seasons rather than an indication of risk of injury per person involved in accidents with HGVs or buses/coaches.



Source: CARE database, data available in May 2015

Fig. 7. Distribution of fatalities in accidents involving HGVs and in accidents involving buses/coaches by seasonality in the EU, 2013.

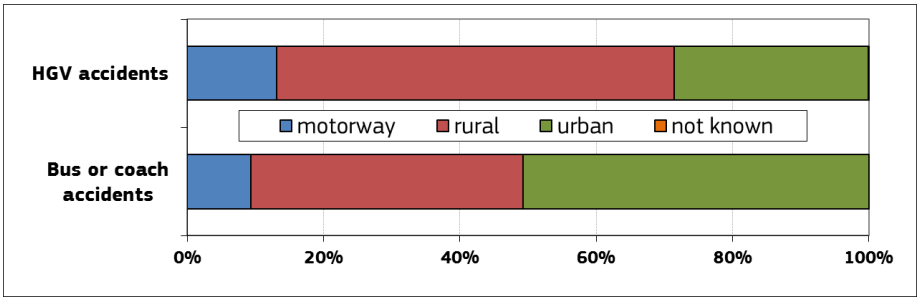


Source: CARE database, data available in May 2015

Fig. 8. Distribution of fatalities in accidents involving HGVs and in accidents involving buses/coaches by day of week in the EU, 2013.

Day of week and time of the day were also considered. The distribution of the fatalities in accidents involving HGVs is almost the same during the week days (around 18%) in EU, with significantly less people being killed during the weekend (9% on Saturdays and 5% on Sundays) and Monday and Tuesday being the most dangerous days of the week. This can be attributed to the fact that circulation of HGVs is mostly related to commercial activities which are reduced during the weekend in most countries due to driving bans (ASTERYX, 2003). In Slovenia though, 43% of the HGV related fatalities occur on Saturdays, probably because weekend driving bans are not in force. A high proportion of fatalities in accidents with buses/coaches is recorded from Thursday to Sunday with the peak being on Thursdays and Sundays (17%), as indicated in the above Figure 8.

According to the analysis carried out, in 2013, 58% of the fatalities in HGV accidents in the EU countries occurred inside rural areas, as follows from Figure 9. In Finland, Latvia and Sweden, more than 70% of persons were killed in accidents with HGVs outside urban areas, whilst in the Netherlands less than 40% (Luxembourg has small figures). Moreover, 45% of the fatalities in bus/coach accidents were recorded inside urban areas.



Source: CARE database, data available in May 2015

Fig. 9. Distribution of fatalities in accidents involving HGVs and in accidents involving buses/coaches by road type in the EU, 2013.

The share of fatalities on motorways is similar for both the accidents involving HGVs (15%) and buses/coaches (14%) in 2013 in the EU.

4. Accident causation analysis

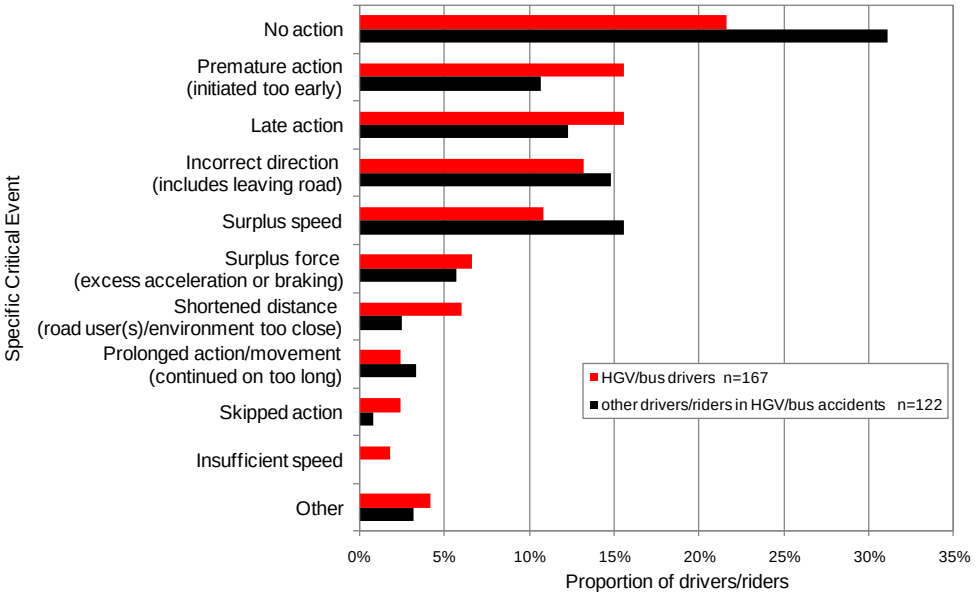
Additional insight into accident causation can be offered by in-depth data, such as those collected during the EU co-funded SafetyNet project. During that project, in-depth data were collected using a common methodology for samples of accidents that occurred in Germany, Italy, The Netherlands, Finland, Sweden and the UK (Bjorkman et al., 2008; Reed and Morris, 2008). The SafetyNet Accident Causation Database was formed between 2005 and 2008, and contains details of 1.006 accidents covering all injury severities. A detailed process for recording causation (SafetyNet Accident Causation System – SNACS) attributes one specific critical event to each driver, rider or pedestrian. Links then form chains between the critical event and the causes that led to it. For example, the critical event of late action could be linked to the cause observation missed, which was a consequence of fatigue, itself a consequence of an extensive driving spell. Links are established by trained personnel directly involved in the investigation according to the SNACS coding system, with full case evidence available to them.

These data have been analysed to compare the causation recorded for HGV or bus drivers and other drivers/riders in HGV or bus/coach accidents. Of the accidents in the database, 16% (158 cases) involve HGV or bus drivers. Minibuses are included in the bus category in the database. HGV drivers account for 79% of this group and bus drivers 21%, with 94% being male. Figure 10 compares the distributions of specific critical events for HGV or bus drivers against the distribution for other drivers or riders in HGV/bus accidents.

Of the specific critical events under the general category of ‘timing’, premature action and late action are both more frequent for HGV and bus drivers. ‘Premature action’ describes a critical event with an action started too early, before a signal was given or required conditions established. In combination with prolonged distance and prolonged action/movement - movements taken too far and manoeuvres that last for too long (for example, not returning to correct lane) - scenarios start to emerge of conflict between bicycle riders and other road users when sharing road

space. 'No action' is prelevant in the other drivers/riders group, describing those drivers/riders who have not reacted at all (or at least in an effective time frame) to avoid a collision, for example, to avoid an oncoming vehicle.

The next two specific critical events of incorrect direction and surplus speed are both higher for the other drivers/riders, although only slightly more for incorrect direction. Incorrect direction refers to a manoeuvre being carried out in the wrong direction (for example, turning left instead of right) or leaving the road (not following the intended direction of the road). Surplus speed describes speed that is too high for the conditions or manoeuvre being carried out, travelling above the speed limit and also if the driver is travelling at a speed unexpected by other road users. In general, in-depth analysis of SNACS data showed specific critical events related to 'timing' for more than 50% of HGV or bus drivers involved in road accidents.



Source: SafetyNet Accident Causation Database 2005 to 2008 / EC;N=289.Date of query: 2010.

Fig. 10. Distribution of specific critical events – HGV or bus drivers and other drivers/riders in HGV/bus accidents.

The following Table 1 gives the most frequent links between causes for injury accidents involving HGV or bus drivers/riders. For this group there are 195 such links in total. How often causes appear in the chains indicates their importance for the road users selected. Here, only the most common links are presented but further interpretation can take place by following the chains from critical event back to the first cause in the chain, as demonstrated by Talbot et al. (2009) for inattention and distraction.

Table 1. Ten most frequent links between causes – HGV or bus drivers.

Links between causes	**Frequency**
Faulty diagnosis - Information failure (driver/environment or driver/vehicle)	43
Observation missed - Permanent sight obstruction	23
Observation missed - Distraction	13
Equipment failure - Unpredictable system functions/characteristics	10
Observation missed - Faulty diagnosis	8
Observation missed - Permanent obstruction to view	7
Observation missed - Inadequate plan	6
Equipment failure - Maintenance failure - condition of vehicle	6
Observation missed - Inattention	5
Observation missed - Temporary obstruction to view	5
Others	69
Total	195

Source: SafetyNet Accident Causation Database 2005 to 2008 / EC. Date of query: 2010

Like the car driver group, faulty diagnosis (22% of the links) and observation missed (19% of the links) are the two dominant causes. 'Faulty diagnosis' is an incorrect or incomplete understanding of road conditions or another road user's actions. It is linked to both information failure (for example, a driver thinking another vehicle was moving when it was in fact stopped and colliding with it) and communication failure (for example, pulling out in the continuing path of a driver who has indicated for a turn too early). Unlike the car driver group, the most frequent cause leading to observation missed is 'permanent sight obstruction'. This refers to vehicle blind spots on these larger vehicles, where drivers cannot see part of the road infrastructure or other road users. Also observed for these larger vehicles are causes leading to equipment failure, both 'unpredictable system functions/characteristics' (covering problems with vehicle load) and 'poor maintenance'.

5. Conclusions - Discussion

The various road safety parameters examined revealed that the occupants of HGVs and buses/coaches are a special group of road users, with different safety needs and characteristics than other road users, mainly due to their specificities, but also to their different mobility behaviour. The safety problem for HGVs and buses/coaches vary systematically by region, reflecting different climates, cultures and behavioural characteristics, intensity of traffic, modal shares, regulations and policies applied, and vehicle technology readiness levels.

Analysis of the HGVs and buses/coaches' road accident data derived from the EC CARE database for the decade 2004 – 2013, showed that the number of fatalities in accidents involving HGV, buses or coaches has decreased by nearly 50% over this period in the EU countries, whereas the overall number of road accident fatalities had a lower decrease (reduction by 45%). Especially for HGV related fatalities their annual reduction was continuous within the decade, whereas for buses/coaches an increase by 3,5% was recorded between 2011-2012. CARE accident data were also combined with exposure data (population), allowing the more accurate comparison of the calculated rates between EU countries. According to the results of the analysis, nearly half of persons killed in 2013 in road traffic accidents that involved HGVs were travelling by car (47%). Across the EU, 15% of the fatalities in accidents with HGVs were HGV occupants and more than 30% of persons killed in 2013 in accidents that involved buses or coaches were pedestrians, the same as for car occupants. Additionally, almost 40% of persons who died in a traffic accident involving HGVs in the EU were between 25-49 years old, with the respective proportion for fatalities related to buses/coaches accidents being 32% and also significantly less people are killed during the weekend, with Monday and Tuesday being the most dangerous days of the week.

The analysis of other types of data such as in-depth accident data, allowed for additional insight into accident causation recorded for HGVs and buses/coaches. Specific critical events relating to 'timing' are recorded for 52% of HGV or bus drivers examined in the sample and 'faulty diagnosis' and 'observation missed' are the two dominant causes for injury accidents involving HGV or bus drivers/riders.

The results of the analysis allow for an overall assessment of the HGVs and buses/coaches safety level in the European road network relative to other modes of transport, providing thus useful support to decision makers working for the improvement of safety in the European road network. Certainly, the effort of data-collection is an on-going challenge and there are additional data that could help shed light to the problem of the HGVs and buses/coaches' road safety. Of particular interest are exposure data related to the mobility of these vehicles (vehicle fleet, veh-kms, passenger-kms travelled), but also data on the vehicle technological equipment and driving fatigue one of the most important accident factors related to the long distance lorry driving (DaCoTA, 2012[2], Maycock, 1997). Furthermore, the macroscopic analysis presented in this paper could in the future be combined with more detailed analysis using statistical models, which is necessary for the identification of the combined correlation of the parameters with an impact on HGVs and buses/coaches' road safety and the underlining reasons behind their casualties.

Acknowledgements

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Appendix A - Country abbreviations

Belgium	BE
Bulgaria	BG
Czech Republic	CZ
Denmark	DK
Germany	DE
Estonia	EE
Ireland	IE
Greece	EL
Spain	ES
France	FR
Croatia	HR

Italy	IT
Cyprus	CY
Latvia	LV
Lithuania	LT
Luxembourg	LU
Hungary	HU
Malta	MT
Netherlands	NL
Austria	AT
Poland	PL
Portugal	PT

Romania	RO
Slovenia	SI
Slovakia	SK
Finland	FI
Sweden	SE
United Kingdom	UK