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Recommendations for safety and sustainability measures of the EU FP7 Project UDRIVE

PLEASE CITE THE PUBLISHED VERSION

https://doi.org/10.26323/UDRIVE_D51.1

PUBLISHER

EU FP7 Project UDRIVE Consortium

VERSION

VoR (Version of Record)

PUBLISHER STATEMENT

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REPOSITORY RECORD

Tattegrain, Helene, Isabel Wilmink, Simone Wesseling, Laurette Guyonvarch, Alexander Frey, Ruth Welsh, Myriam Evegenou, et al.. 2019. “Recommendations for Safety and Sustainability Measures of the EU FP7 Project UDRIVE”. figshare. https://hdl.handle.net/2134/31924.



UDRIVE

European Naturalistic Driving Study

EUROPEAN COMMISSION

SEVENTH FRAMEWORK PROGRAMME
FP7-SST-2012.4.1-3
GA No. 314050

eUropean naturalistic Driving and Riding for Infrastructure and Vehicle safety and Environment

Deliverable No.	UDRIVE D51.1	
Deliverable Title	Recommendations for safety and sustainability measures	
Dissemination level	Public	
Written By	Hélène Tattegrain, IFSTTAR Isabel Wilmink, TNO, Simone Wesseling, SWOV Laurette Guyonvarch, LAB Alexander Frey, BASt Ruth H. Welsh, Loughborough Myriam Evegenou, IFSTTAR Daniel Letisserand, IFSTTAR Marianne Riouffreyt, IFSTTAR Anne Guillaume, LAB Nicole van Nes, SWOV	31-05-2017
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Approved by	Marika Hoedemaeker (TNO) QA manager Nicole van Nes (SWOV) Project Coördinator	30-06-2017
Status	Final	30-06-2017

Please refer to this document as:

Tattegrain H., Wilmink I., Wesseling S, Guyonvarch L., Frey A., Welsh R.H., Evegenou M., Letisserand D., Riouffreyt M., Guillaume A., Van Nes N. (2017) UDRIVE deliverable 51.1 Recommendations for safety and sustainability measures of the EU FP7 Project UDRIVE, (www.UDRIVE.eu)

Acknowledgement:

The author would like to thank Heike Hoffmann for the valuable comments on previous drafts and for performing the quality assurance on the final draft.

Disclaimer:



UDRIVE is co-funded by the European Commission, DG Research and Innovation, in the 7th Framework Programme. The contents of this publication is the sole responsibility of the project partners involved in the present activity and do not necessarily represent the view of the European Commission and its services nor of any of the other consortium partners.

Executive Summary

The aim of Task 5.1 is to identify and select, among the outcomes of SP4, the results that are relevant to infer recommendations for measures improving road safety and sustainability. Due to time constraint, the analyses and the recommendations have been done in less time that it was planned at the beginning of the project.

The key outcomes of the SP4 work with particular reference to crash risk, unsafe driving, and eco-driving will be studied and organized in terms of relevance to safety and sustainability policies and potential actions towards road users, vehicle and road. Recommendations have been developed to propose actions to stakeholders that can be implemented in the near future to increase safety and sustainability of road transport. This work integrates several reviews of different measures implemented previously in France, Germany, Netherlands and United Kingdom in terms of road safety measures. Then, the recommendations consider possible updates of existing measures and the development of new measures.

They will include four kinds of areas:

- Recommendations in terms of regulation and enforcement measures;
- Recommendations for awareness campaigns and training;
- Recommendations for design of road infrastructure;
- Recommendations for vehicle safety.

Looking at road fatalities statistics, we have identified ***vulnerable road users*** as a topic which is important to create recommendations for. We have also identified factors that can have an influence on fatality occurrence like age and infrastructure. A report by the World Health Organization in 2015 (WHO, 2015) identified some area's wherein there is a need for recommendations to improve road safety. We have selected from the by WHO recommended topics, 3 topics which could be explored by naturalistic studies: ***seat belt, speed, distraction***. Another topic that we are looking into is ***critical situations***. The difficulties with investigating critical situations with road fatalities data bases, is that these databases often do not provide fully detailed information about the dynamic of the accident. Naturalistic studies have the ability to explore incidents more in-depth. Another objective of UDRIVE is to improve sustainability by looking into ***eco-driving***. We will look at recommendations for this topic in this report as well.

Improving seat belt use

The analysis provided in SP4 describes how driver's seat belt are used and in particular what driver/trip characteristics influence seatbelt usage. Even though the driver sample is biased with drivers particularly sensitive to road safety and whom are therefore more likely to use seat belts properly, the results show a lower rate of trips with seat belt on than official numbers show. The main factor linked to this rate appeared to first be the country specific and then gender-related. The study also provides some specific results on driver characteristics linked to driving without seat belt as well as type of trips where seat belt is not used at all. Males are more likely to drive without a seat belt and very short trips at night represent a higher risk to drive without seat belt.

Seat belt use is very important to reduce the gravity of accidents. The European Road Safety Observatory (see appendix A.4 Seat belt wearing rate by car occupancy and road type) has published statistics on the use of seat belts in different countries showing that the French and Polish use the seat belts less, especially in urban areas. The recommendations are to improve the police enforcement, to create awareness campaigns for specific countries (France, Poland) and add seat belts topics in formation for specific population (young men).

Reduce driving above the speed limit

The analyse showed that the French and German participants made small speeding less (between 11 to

15%) than the Dutch and the English participants but in terms of high speeding (between 16 to 21 %), the French and German participants are on average while the English and Dutch are far below. On the other hand, Poles are still very above average for all speeding. The difference between the observed and calculated number of speeding is very high for the speed limits 0-30 km/h and 50-70 km/h. On the other hand, for the speed limits 110-130 km/h and 30-50 km/h, this difference is negative. Regarding the period of the day, the difference is very high during the evening and the night and is negative during the afternoon. Police control, awareness campaign and infrastructure development could be useful to reduce speed in 30 km/h areas. Awareness campaign can be useful to explain the risk during night.

Reducing critical situations

To analyse the critical situations three types of analysis were carried out : an analysis of abrupt braking, an interview experiment to reconstruct as precisely as possible the episode as seen by the driver using the classical techniques of the self-confrontation method, an interview experiment to allow the driver to propose recommendations to prevent critical situations. The hard braking analyse showed that the occurrences of hard braking are not the same for all operational sites and for all speed limit, that the drivers are aware of this weather risk, that the cruise control can be useful. The roundabouts appear as an infrastructure which generates a lot of hard braking and of lowest time headway. In the interview experimentation, most of driver recommendations concern infrastructure modifications and the potential contribution of informative and active driving assistance systems. The infrastructure modifications and the active driving assistance system are more often selected as the first choice than the other type of recommendations.

Improving vulnerable road user safety

The following measures are supported by the results of the UDRIVE studies on vulnerable road users (VRU). Advanced driver assistance systems like blind spot detection and warning systems and AEB that can detect vulnerable road users could prove to be additionally valuable for VRU safety, since car and truck drivers do not always check their blind spot. It could be beneficial to include the usage of ADAS in the training of new drivers. Creating trucks wherein direct vision is enhanced has the potential to contribute to VRU safety since the blind spot area is greatly decreased. Moreover, making cyclists aware of blind spots of large vehicles is important. Designing infrastructure in line with a Safe System approach aims at infrastructure that is able to accommodate for human error (ITF, 2016).This includes physical separation in time or place between drivers and VRU's. Most near-crashes identified in the UDRIVE study wouldn't have occurred if road users would have been physically separated. In the UDRIVE study on interactions with pedestrians it seems that the mere presence of pedestrians makes drivers more aware of other potential pedestrians. Creating a 'pedestrian environment' by the availability of sidewalks and using traffic calming and intuitive design has good potential to decrease driver-pedestrian conflicts.

Promote eco-driving

The analysis of the UDRIVE data in the context of eco-driving showed that behaviours regarding gear-changing, braking and speed choice were especially relevant as drivers showed large variation in those behaviours with associated substantial variations in CO2-emissions. These were thus starting points for recommendations to promote eco-driving, which should aim to reduce the amount of highly dynamic driving, driving at very low or very high speeds and inefficient gear-changing. Current measures such as eco-driving training and awareness campaigns can be updated to reflect modern vehicles and travel choices that support eco-driving (e.g. route and departure time choice). Recommendations for new measures include enforcement of speed limits with a view to reduce energy use, regulating the use of in-vehicle systems that contribute to eco-driving, further awareness campaigns promoting the use of vehicles

with gear shift indicator and automatic engine shutdown systems, promoting driving in the highest gear, and giving feedback to drivers about their eco-driving 'scores'. Another category of measures is the design of road infrastructure that supports eco-driving (e.g. grade separated intersections, improved network design, improved traffic light algorithms including communication with vehicles). Traffic management strategies can be adapted to achieve smoother driving (less stop-and-go traffic). And in the longer term, automation of the driving task offers possibilities for programming the vehicles to drive eco-friendly.

Reduce dangerousness of secondary tasks

The UDRIVE data was an opportunity to study in detail occurrence and impact of different secondary tasks on driving for cars as well as trucks. As a global observation, around 6% of the driving time was spent while a driver was performing visuo-manual secondary tasks (the more dangerous ones). Data showed a significant difference between countries. The most frequent secondary task is different between trucks (eating and using in-vehicle controls) and cars (mobile phone use). Even if phone related tasks are not allowed in the studied countries, driver still engage in such tasks. Nearly 39% of the phone time was spent performing visuo-manual tasks and 61% was spent performing auditory tasks in cars. In that sense, drivers seem to be aware of the risk and try to adapt their behaviour. Moreover, car drivers tend to perform mobile phone visuo-manual tasks either while standing still (56%) or at very low driving speed. Nevertheless, it still represents a risk since it tends to decrease driver performance (increase in standard deviation in lane position). Truck drivers feel more comfortable in initiating a task at low speeds (below 30km/h) or at very high speeds (more than 80km/h). Opposite to car drivers, the proportion of phone task initiations was lower at standstill than the overall proportion of standing still in the data. Awareness campaigns could therefore still be fruitful under the condition they are adapted to the real way people drive. It should provide discriminant estimation of risk and emphasis on the specific risks linked to visuo-manual tasks

It should be noted that many of the findings in UDRIVE cannot be generalised to all car drivers or all European countries. In-depth research for proposed specific measures is therefore needed. The proposed measures regarding vehicle safety, regulation and enforcement measures, awareness campaigns and training and design of road infrastructure are supported by the results of the discussed UDRIVE studies at the end of the project. The UDRIVE database will allow the researchers to make more studies for road safety.

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1 Introduction

1.1 Objectives

The aim of Task 5.1 is to identify and select, among the outcomes of SP4, the results that are relevant to infer recommendations for measures improving road safety and sustainability.
The key outcomes of the SP4 work with particular reference to crash risk, unsafe driving, and eco-driving will be studied and organized in terms of relevance to safety and sustainability policies and potential actions towards road users, vehicle and road. Recommendations will be developed to propose measures to stakeholders that can be implemented in the future to increase safety and sustainability of road transport. This work integrates several reviews of different actions done previously in France, Poland, Germany, Netherlands and United Kingdom in terms of road safety measures. Then, the recommendations allow to consider possible updates of existing measures and the development of new measures.
They will include four kinds of areas:

- Recommendations in terms of regulation and enforcement measures;
- Recommendations for awareness campaigns and training;
- Recommendations for design of road infrastructure, e.g. for vulnerable road users;
- Recommendations for vehicle safety.

1.2 Context

Each year, about 1.2 million people die in crashes on the world's roads and many millions are seriously injured (OECD/ITF (2016)). The International Traffic Safety Data and Analysis Group (IRTAD) composed by transport ministries, road safety agencies, research institutes, industry and non-governmental organisations gives us comparable statistic by country.

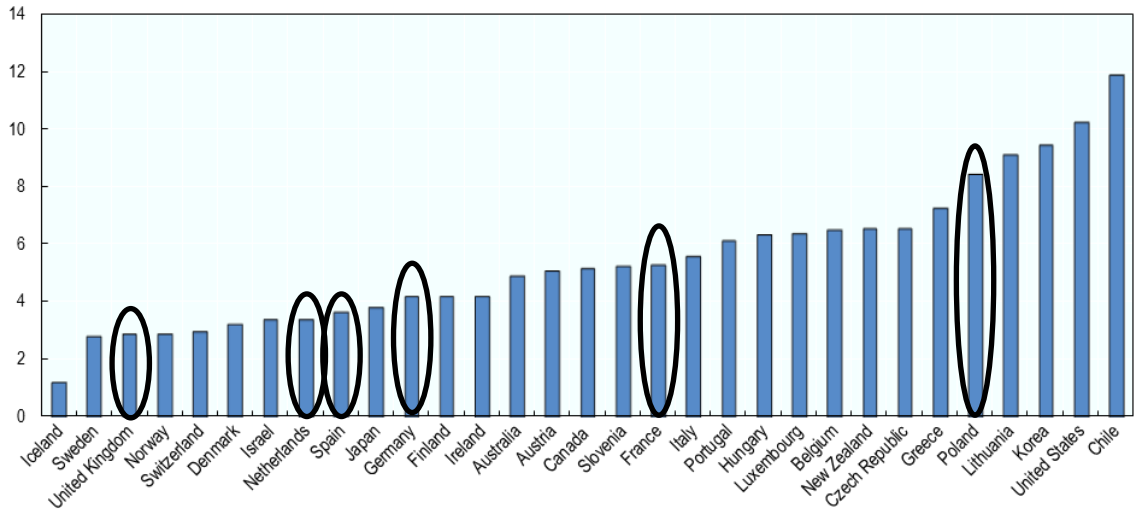


Figure 1: Road fatalities per 100 000 inhabitants, 2014 (extracted from OECD/ITF (2016))

We can see that the 6 operational sites of UDRIVE project have different values of road fatalities per 100 000 inhabitants which ranges from countries with low ratios like the UK (2.87 road fatalities) to Poland with a high ratio (8.42 road fatalities). Therefore, we hope to have good representativeness of the road safety problem across Europe.

Table 1-1: Road safety and traffic data for France (extracted from OECD/ITF (2016))

	1990	2000	2010	2013	2014	2014 % change from 2013	2014 % change from 2010	2014 % change from 2000	2014 % change from 1990
Reported safety data									
Fatalities	10 999	8 079	3 992	3 268	3 384	3.5	-15.2	-58.1	-69.8
Injury crashes	162 573	121 223	67 288	56 812	58 191	2.4	-13.5	-52.0	-64.2
Injured persons hospitalised			30 393	25 966	26 635	2.6	-12.4		
Deaths per 100 000 inhabitants	19.8	13.7	6.4	5.1	5.3	3.1	-16.8	-61.4	-73.3
Deaths per 10 000 registered vehicles	3.9	2.3	1.0	0.8	0.8	3.2	-19.8	-64.6	-78.1
Deaths per billion vehicle kilometres	25.2	15.8	7.1	5.8	5.9	2.7	-17.0	-60.9	-77.0
Traffic data									
Registered vehicles (thousands)	30 869	35 874	40 181	42 342	42 476	0.3	5.7	18.4	37.6
Vehicle kilometres (millions)	436 000	518 200	560 400	567 800	572 400	0.8	2.1	10.5	31.3
Registered vehicles per 1 000 inhabitants	546	609	640	665	665	-0.1	3.8	9.0	21.8

Between 2000 and 2014, the number of road fatalities decreased by 70.8% in Spain, 56% in the Netherlands, 55% in Germany, 58.1% in France 49.1% in Poland and 48% in the United Kingdom. The number of deaths per 1000000 inhabitants has been reduced in the same proportions. **Error! Reference source not found.** shows the road safety data for France. Road safety data for other countries data are presented in appendix **Error! Reference source not found.**.

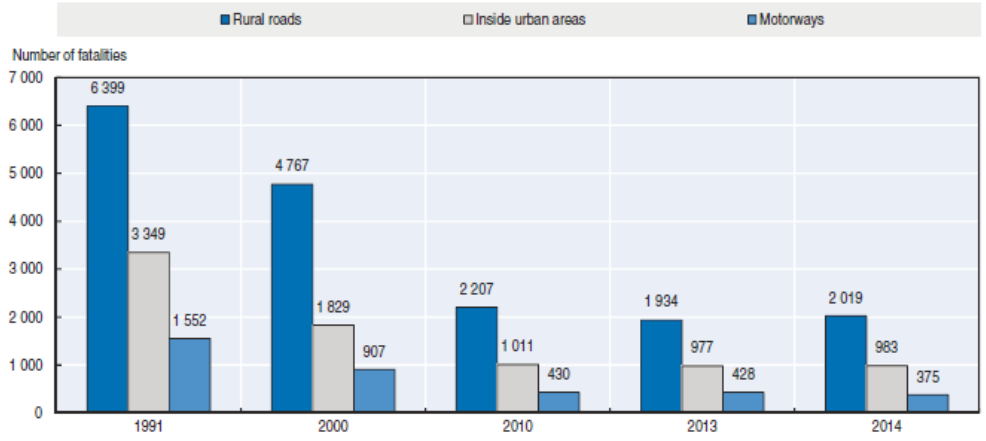


Figure 2: Road safety by road type for Poland (extracted from OECD/ITF (2016))

The distribution between the number of fatalities per road type is fairly similar in all countries studied in UDRIVE: few on motorways (<10%), about 60% in rural areas and 30% in urban areas. Only in Poland the number of fatalities is similar in rural and urban areas (see appendix A.3 Road fatality by road type).

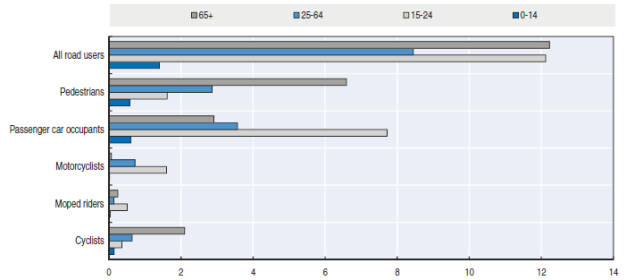


Figure 3 : Road fatalities by age and road users in Poland (extracted from OECD/ITF (2016))

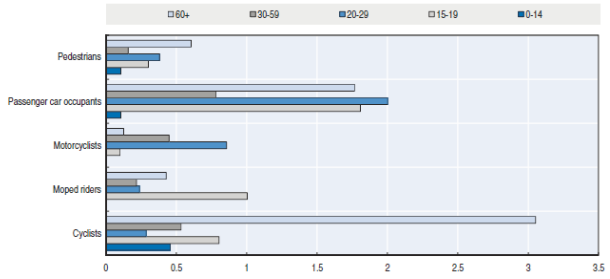


Figure 4 : Road fatalities by age and road users in the Netherlands (extracted from OECD/ITF (2016))

The distribution of fatalities per road user type in Poland (Figure 3 : Road fatalities by age and road users in PolandFigure 3) is representative of the number of fatalities in other countries (see appendix A.2 Fatalities by user group) except for the Netherlands (Figure 4). Young people are overrepresented in car accidents. More road fatalities occur amongst cyclists and especially elderly cyclists (60+) compared to other countries. This finding is related to the higher exposure to risk since the Netherlands is a cycling country.

Looking to road fatalities statistics, we have identified ***vulnerable road users*** as a topic which is important to create recommendations for. We have also identified factors which can have an influence on fatality occurrence like age and infrastructure. A report by the World Health Organization in 2015 (WHO, 2015) identified some area's wherein there is a need for recommendations to improve road safety. We have selected from the by WHO recommended topics, 3 topics which could be explored by naturalistic studies: ***seat belt, speed, distraction***. Another topic that we are looking into is ***critical situations***. The problem with investigating critical situations with road fatalities data bases is that these databases often do not provide fully detailed information about the dynamic of the accident. Naturalistic studies have the ability to explore incidents more in-depth. Another objective of UDRIVE is to improve sustainability by looking into ***eco-driving***. We will look at recommendations for this topic in this report as well.

To resume, we have identified 6 topics to be discussed in this report: ***vulnerable road users, seat belt, speed, distraction, critical situations and eco-driving.***

1.3 Structure of this report

The following topics will be discussed in this report per chapter:

- Improving seat belt use, since seat belt use shows to prevent fatalities
- Reducing driving above the speed limit, since high speed leads to more severe accidents
- Reducing critical situations, since less abrupt driving can reduce accident occurrence
- Improving vulnerable road user safety, since the fatality rate hasn't decreased as much as for other road users and they are the most vulnerable in traffic
- Reducing dangerousness of secondary tasks, since distraction is a important factor in accident occurrence
- Promoting eco driving, since pollution due to transport is too high

For each topic:

- Relevant results for research questions analysed in SP4 are described.
- Several reviews are done to identify existing recommendations in terms of regulation and enforcement measures, awareness campaigns and training, design of road infrastructure, vehicle safety.
- New recommendations based on the results of UDRIVE studies are given regarding regulation and enforcement measures; awareness campaigns and training; design of road infrastructure and vehicle safety.

2 Improve seat belt use

2.1 Analysis of SP4 results

The analysis provided in SP4 describes how driver's seat belts are used and in particular how driver/trip characteristics influence seatbelt usage.

Data set

The UDRIVE data were collected across 5 different countries in Europe: France, United Kingdom, Germany, Poland and the Netherland. 186 drivers volunteered to participate to this study focused on road safety and driver behaviour. Renault cars that were equipped for the study included 3 car models: Clio 3, Clio 4 and Megane. The available sample for the seatbelt study was therefore biased in different ways:

- Drivers willing to participate in such study were more likely to drive and behave safely
- No driver category of specific behaviour was included: young drivers, taxi drivers, truck delivery drivers known as having a lower rate of driver seat belt use.
- Due to the recorded signals, only driver seat belt use could be addressed.
- All Renault cars were equipped with seat belt reminder (SBR). The SBR included 2 sound level (increasing with time and speed)

All these parameters may lead to an overestimation of the seat belt usage compared to the real population in Europe.

Results

The seat belt wearing rate of the drivers in U-DRIVE is lower than the official numbers (-10% for France for example, ONISR 2014) even with this biased sample of drivers. It could be assumed that passengers even have a lower rate. The study also provides some specific results on driver characteristics linked to driving without seat belt as well as type of trips were seat belt is not used at all. Men are more likely to drive without seat belt and very short trips at night represent a higher risk to drive without seat belt.

These results must be linked to the exposure to fatality in case of frontal crash. In France for example more than 20% of the fatalities were not wearing their seat belt (including passenger) (VOIESUR, 2014), making all of the drivers without seat belt a potential dead victim in case of an accident

Awareness campaigns are therefore still needed to increase this rate. It would be interesting to study more in details psychological characteristics of drivers with a wrong use of the seat belt to target the campaign messages to the correct population. This kind of study could be achieved using focus groups and/or on line survey as well as driving style tests (available in the UDRIVE data). Specific population such as taxi drivers or young people should also be studied more in detail as they are more exposed to this behaviour

But even if they could be more targeted, awareness campaigns seem to have a limited potential in terms of changing the driver behaviour. For years, many of them tried to improve driver knowledge on the risk of driving without seat belt. The rate of drivers without seat belt is still not so high in other countries. The impact of local culture could be a factor explaining the difference between the rate for the Northern countries (Ge, UK, NL) with respectively a rate of 90,4%, 91.3% and 95,6% of the trips driven with seat belt on during the whole trips compared to France and Poland with respectively a rate of 82,9% and 76,1%. Italy and Spain may even have lower rate as southern countries and should be studied to enrich the analysis. For countries where offending the laws is often observed, awareness campaigns should be supplemented with

more controls and more penalties with a higher amount of fines in order to encourage compliance with the road safety rules. Furthermore it is known that some drivers wrap their seat belts behind their back in order to avoid the seat belt reminder. When caught by the police, they should be having a doubled fine for this irresponsible behaviour.

2.2 Recommendations

2.2.1 Review of existing measures

Table 2-1 Overview of vehicle safety measures in Europe related to seat belt

Topic	Existing measures in Europe
Regulation and enforcement measures	Seat belts are the easiest and cheapest way to prevent injuries in an accident. They do not require any special technology and are installed in all cars. Since 2006, the use of seat belts is mandatory in all EU vehicles. Under EU legislation, drivers and passengers must wear seat belts in any seat equipped with them. Non-wearing seat belts are the second biggest fatal cause on the road, after speed and before drunk driving. An EU study on road safety (2008) concludes that any incentive to use seat belts would save up to 7,300 lives per year in the EU. https://ec.europa.eu/transport/road_safety/topics/vehicles/seat_belts_en
Vehicle safety	The European Directive [2003/20/EC] on the compulsory use of seat belts has to be implemented into law by the Member States until 9 May 2006. Under the existing European legislation it was compulsory to use seat belts in vehicles below 3.5 tonnes fitted with restraints. This obligation has now been extended to all categories of vehicles. The Directive also requires the use of restraint systems specially adapted for children. (see http://europa.eu/rapid/press-release_IP-06-583_en.htm)

Table 2-2 Overview of vehicle safety measures in Germany related to seat belt

Topic	Existing measures in Germany
Regulation and enforcement measures	Seat belts, which are prescribed by law, must be used while driving (regarding Sec. 21a, para. 1 German Road Traffic Code (StVO)). There are only very few exceptions, like short drives in delivery traffic when leaving the vehicle frequently or while driving with walking speed (6 km/h). Furthermore, in buses, which are licensed to carry standing passengers in local transport, seat belt use is not required. Furthermore, passengers in buses (with a total mass more than 3.5 t) are allowed to unfasten their seat belt when leaving their seat briefly. Sec. 21a, para. 2 StVO regulates the duty to wear safety helmets when driving a motor cycle with a maximum design speed more than 20 km/h, except using prescribed seat belts. In case of violation, the law provides for fines according to Sec. 1, para. 1 BKatV).
Awareness campaigns and training	The DVR-Campaign "Hat's geklickt?" (Did it click?) aimed at an increase in seat belt use especially in trucks and other commercial vehicles since 2002. Therefore the campaign uses ads, posters, flyers, personal communication and crash- or flip over simulators at special events. A scientific evaluation was not yet carried out, but based on traffic observations by DEKRA and the German highway police, the seatbelt use by truck drivers rose between 2002 and 2013 from 10% up to 60%.

Table 2-3 Overview of vehicle safety measures in France related to seat belt

Topic	Existing measures in France
Regulation and enforcement measures	1964 Obligation for new vehicles to have 3 anchors for the installation of seat belts in the front seats 1970 Obligation for new vehicles to have front seat belts with three points. 1973 Obligation of use the seat belts in the front seats in no urban area. 1975 Obligation of use the seat belts in agglomeration during the night (22 hours to 6 hours) and on urban highways. 1976 Obligation for new commercial vehicle to have 3-point belts for the front seat. 1977 Mandatory installation of retractable belts in front seats of new vehicles. 1979 General obligation of seat belt use in the front seats in urban areas. 1989 General obligation of seat belt use in commercial vehicles under 3T500. 1990 Medical exemptions from seat belt use may be granted by the county medical boards. 1990 Obligation of use the seat belts in the rear seats of vehicles so equipped 1992 Implementation of penalty points. 1992 Obligation to carry children less than 10 years in approved devices. 1994 Loss of one point on the driver's license for the driver not using seatbelt. 2000 Road safety is declared a national priority. 2001 Duty of child carrier under 3 in a chair with a belt or harness. 2003 Loss of three points on the driving license for the driver not using seatbelt. 2013 Mandatory installation of seat belt in public transport.
Awareness campaigns and training	• Campaign 2016-2017 "Transport Attitude" In order to sensitize as many bus users as possible to the need for seat belt use, ANATEEP (National Association for Educational Transport of Public Education) has created a mobile, tablet or pc game: LUDOCAR.This game will be broadcast by the ANATEEP network in the context of security education events and by FNTV (National Federation of Passenger Transport), a partner in this campaign, which will broadcast in its member network more than one million flyers "By bus as by car, I buckle my belt" with the QR code to download the game. Https://www.anateep.fr/les-campagnes-transport-attitude/la-campagne-en-cours.html The campaigns of ANATEEP before 2016: • September 2015, "By bus as by car, I buckle my belt!" http://www.securite-routiere.gouv.fr/la-securite-routiere/actualites/en-car-comme-en-voiture-je-boucle-ma-ceinture-! • September 2009: The national road safety department create a campaign to increase the rear seat belt use. This film shows a woman who brings her daughter to school before going to work. It's a short trip; she does not take the time to tie her daughter. She drives quietly when a truck breaks in front of her. She brakes sharply, her daughter is ejected from the bench ... The message given is "During a violent shock, an unattached child incurs the same risks as if he were falling from the 4th floor. Before you get on the road, make sure all your passengers are tied up."

	• March 2005: a new communication campaign to remind everyone that the rear seatbelt is not an optional accessory which can be dispensed "Seat Belt the rear place, a vital gesture of your life". (Http://www.securite-routiere.gouv.fr/medias/campagnes/ ceinture-de-securite-al-arriere-un-geste-vital?) • April 2005, the road safety organizes a crash test at UTAC. http://www.securite-routiere.gouv.fr/medias/espace-presse/publications-presse/ceinture-de-securite-al-arriere-un-geste-vital?.

Table 2-4 Overview of vehicle safety measures in UK related to seat belt

Topic	**Existing measures in UK**
Regulation and enforcement measures	It is the law to wear a seatbelt, if it is fitted in the seat being occupied, as a driver or a passenger both in the front and the rear of a vehicle. Drivers caught without a seatbelt face on-the-spot fines of £100. If prosecuted, the maximum fine is £500. It is also the law to ensure that children being driven are: • In the correct car seat for their height or weight until they reach 135 centimetres tall or their 12th birthday, whichever is first • Wearing a seat belt if they're 12 or 13 years old, or younger and over 135cm tall The driver can be fined up to £500 if a child under 14 isn't in the correct car seat or wearing a seat belt while the vehicle is being driven. A civil order suit can also be brought against the diver in the case that they are transporting someone else's child. Good vehicle drivers are except from wearing a seatbelt if the journey is less than 50 m. On-spot enforcement is carried out regionally (e.g. https://www.lincs.police.uk/news-campaigns/news/2017/east-midlands-hgv-seatbelt-campaign/). For example, during March 2017 officers from the East Midlands Operational Support Service (EMOpSS) caught more than forty HGV drivers without seatbelts during a four day operation in the East Midlands. Full details of the seatbelt regulations (along with exemptions) are available on the UK government website (https://www.nidirect.gov.uk/articles/wearing-seat-belt-and-exemptions).
Awareness campaigns and training	The UK has a long standing governmental scheme 'Think' that covers many areas of road safety including raising awareness of seatbelt use. A combination of public information broadcasts, posters, on-line simulation and learning tools are used. In a recent release from the UK government (2016) they state that 'the 'THINK!' campaign has played a crucial role in reminding people of the importance of this safety measure. For the past 10 years the number of people wearing seatbelts has consistently been above 90%, with a high of 98% of car drivers recorded wearing a seatbelt in 2014 (https://www.gov.uk/government/news/britain-marks-50-years-of-seatbelt-safety). A recent initiative launched by a regional fire service is a campaign called 'The Fatal Four' which is aimed particularly at new and younger drivers (http://www.leicestershire-fire.gov.uk/your-safety/road-safety/the-fatal-four/). The fatal four refers to the four main causes of fatal accidents in the

	UK; inappropriate speed, mobile phone use, not wearing a seatbelt and drink/drug driving. In the UK, young drivers, aged between17-34, have the lowest seat belt-wearing rates combined with the highest accident rate. Training and educational materials available through the campaign include lesson plans with associated resources and also offers road show activities including virtual reality crash experience highlighting the consequences of actions such as not wearing a seatbelt.

2.2.2 New recommendations

Seat belt use is very important to reduce the seriousness of accidents. The European Road Safety Observatory (see appendix A.4 Seat belt wearing rate by car occupancy and road type) has published statistics on the use of seat belts in different countries showing the French and Polish using less the seat belts, especially in urban areas. UDRIVE analyse confirm this tendency and provides some specific results on driver characteristics linked to driving without seat belt as well as type of trips were seat belt is not used at all. Men are more likely to drive without seat belt and very short trips at night. Then, new awareness campaigns are needed targeted to specific populations and the strengthening of police checks is necessary to convince recalcitrant drivers to adopt more responsible behaviour.

Table 2-5: Recommendations for seat belt measures

Topic	**Measures**
Regulation and enforcement measures	• Improve the police enforcement: In the Stakeholders workshop, it was suggested to use the radars of red lights to give fines to the drivers who aren't wearing their seat belt
Awareness campaigns and training	• During driving training, create awareness particularly amongst young people in the necessity of using their seat belt, even for short trips and night routes. • Awareness campaigns are needed especially in France and Poland to improve seat belt use. In the Stakeholders workshop, it was suggested that crash tests could be used to show drivers the consequences of not using seat belt.
Vehicle safety	• Try to identify the misuse of seat belt (not using seat belt properly)

3 Reduce driving above the speed limit

3.1 Analysis of SP4 results

In the SP4 analyse the exposition are not taken into account to analyse the overspending events. Then we have used the number of event identified by the SP4 and we have calculated the number of events that should be present in each category if this number depended solely on exposure.

Table 3-1: Repartition of 11-15% over speeding by OS

	Observed	Calculated distribution proportional to distance travelled	Calculated distribution proportional to the exposure time
Germany	627	757	658
France	1743	2184	2268
The Netherlands	879	734	619
Poland	1267	983	960
UK	2155	2013	2166
Total	6671	6671	6671
chi2		0,000	0,000

For example, for the event over speeding between 11 and 15%, we can see that the German participants have done 627 events. If we consider the number of km, they should have done 727 events of this type. If we consider the driving time achieved, they should have done 658 events of this type. Then we can conclude that the German participants made less overs speed of this type than the average participants. Similarly, the French participants made less speeding of this type than the average participants. On the other hand, the Dutch and the Polish participants made more overs speed of this type than the average participants. The English participants have an average event number.

Table 3-2: Repartition of 16-20% over speeding by OS

	Observed	Calculated distribution proportional to distance travelled	Calculated distribution proportional to the exposure time
Germany	483	525	456
France	1595	1514	1573
The Netherlands	324	509	429
Poland	1044	682	666
UK	1180	1396	1502
Total	4626	4626	4626
chi2		0,000	0,000

For the events exceeding 16%, the German participants are still below average, the Polish participants are always above. However, the Dutch and English participants are below, while the French are in the average.

Table 3-3: Repartition of all over speeding by OS

	Observed	Calculated distribution proportional to distance travelled	Calculated distribution proportional to the exposure time
Germany	1110	1282	1114
France	3338	3698	3841
The Netherlands	1203	1243	1048
Poland	2311	1665	1626
UK	3335	3409	3669
Total	11297	11297	11297
chi2		0,000	0,000

If we consider the sum of all overtaking events, German participants do less than over speeding in relation to the number of kilometres but they do the same number according to the time they are traveling. Dutch participants do the same number than over speeding in relation to the number of kilometres but they do more according to the time they are traveling. The French and English participants do less the Polish ones do more. All these effects on the occurrence of over speeding are significant according to the chi2 test.

In conclusion, we can see that the French and German participants realize small speeding less than the Dutch and the English participants but in terms of high over speeding, the French and German participants are on average while the English and Dutch are far below. On the other hand, Poles are still very above average for all over speeding.

Table 3-4: Repartition of all over speeding by speed limit

	11-15%		16-20%		Sum of all events	
Speed limits	observed	calculated distribution proportional to exposure time	observed	calculated distribution proportional to exposure time	observed	calculated distribution proportional to exposure time
0-30	2256	997	1683	691	3939	1688
30-50	1382	2534	1085	1757	2467	4291
50-70	1287	680	823	471	2110	1151
70-90	1099	995	659	690	1758	1685
90-110	582	648	302	450	884	1098
110-130	65	817	74	567	139	1384
Total	6671	6671	4626	4626	11297	11297
chi2		0,000		0,000		0,000

The effect of limit speed on the occurrence of over speeding is significant according to the chi2 test. We can observe that the difference between the observed and calculated number of speeding is very high for the speed limits 0-30 km/h and 50-70 km/h. On the other hand, for the speed limits 110-130 km/h and 30-50 km/h, this difference is negative. Theses results are the same for the two type of speeding.

Table 3-5: Repartition of all over speeding by period of the day

	11-15% observed	11-15% Calculated distribution proportional to the exposure time	16-20% observed	16-20% Calculated distribution proportional to the exposure time	Sum of all events observed	All events Calculated distribution proportional to the exposure time
Morning	1328	1452	937	1007	2265	2459
Pre-Noon	769	755	565	524	1334	1279
Noon	392	506	292	351	684	858
Afternoon	1972	2304	1165	1598	3137	3902
Evening	324	230	259	159	583	389
Night	167	123	123	85	290	208
Late-Night	1719	1300	1285	902	3004	2202
Total	6671	6671	4626	4626	11297	11297
chi2		0,000		0,000		0,000

The effect of period of the day on the occurrence of over speeding is significant according to the chi2 test.

We can observe that the difference between the observed and calculated number of speeding is very high during the evening and the night and is negative during the afternoon. Theses results are the same for the two types of speeding.

3.2 Recommendations

3.2.1 Review of existing measures

Table 3-6 Overview of vehicle safety measures in Europe related to speed

Topic	Existing measures in Europe
Vehicle safety	Speed is at the core of the road safety problem. In fact, speed is involved in all accidents. In around 30% of the fatal accidents speed is an essential contributory factor. Firstly, speed affects the risk of being involved in an accident. At a higher speed, it is more difficult to react in time and prevent an accident. Secondly, speed affects the risk and severity of injury in an accident. At a higher (impact) speed, more energy is released when colliding with another vehicle, road user or obstacle. Part of this energy will need to be absorbed by the vulnerable human body. Very strong dependencies have been established between speed, accident risk and severity. New technologies enable in-vehicle systems that support drivers to comply with speed limits. These systems provide information about the speed limits in force; warn the driver when exceeding the limit; or make excess speed impossible or uncomfortable. Such systems are available and likely to be introduced progressively. New technologies also enable communication between road and vehicle, allowing for full dynamic speed limits, based on the actual traffic and weather conditions. These systems are still under development. (see https://ec.europa.eu/transport/road

Table 3-7 Overview of vehicle safety measures in France related to speed

Topic	Existing measures in France
Regulation and enforcement measures	1972: Decree of 5 July establishing an Interministerial committee for road safety and creating the position of Interministerial Delegate for Road Safety (DISR). 1973: Decree of 28 June fixing the speed limit at 110 km/h on 13 100 km of main roads and 100 km/h on other roads. 1974: Decree of 6 November fixing the speed limit, from 9/11/1974, to: 130 km/h on motorways; 110 km/h on expressways at 2 x 2 lanes; 90 km/h on the roads. 1975: Decree of 8 December fixing at 45 km/h by construction the maximum speed of mopeds. 1979: Decree of 16 October requiring, as from 1 January 1980, the use of helmets by moped users. 1982: Creation of the Directorate of Security and Road Traffic. (DSCR) Decree of 29 December, limiting, from 1 January 1983, the speed of passenger cars on wet roads to: 80 km/h on the roads; 100 km/h on expressways with 2 x 2 lanes; 110 km/h on motorways. 1983: Order of 26 August requiring the installation of speed limitation devices for heavy goods vehicles put into circulation from 1 October 1983: - 90 km/h for vehicles between 10 and 19 tonnes;

	- 80 km/h for vehicles of more than 19 tonnes, for public transport vehicles; - 100 km/h for vehicles equipped with anti-lock braking system; - 90 km/h for other vehicles not equipped. 1985 1 August: decision to mandate a minimum speed of 80 km/h for motorists using the left lane on highways. 1987: Implementation for 1988 departmental plans for road safety actions (PDASR). 1988 Generalization of accompanied driving in all departments. 1990: As of 1 December, generalized speed limitation in built-up areas at 50 km/h. Possibility, under conditions, of zones at 30 and 70 km/h. 1991: Decree of 28 August introducing the distinction between small and large speeding. 1992: July 1: implementation of the point license. Their number will be increased to 12 on 1 December. The decree of December 4 imposes a maximum speed of 50 km/h on all the networks in case of visibility less than 50 m. 1994: Decree of May 5 limiting speed for novice drivers to 80, 100 or 110 km/h depending on the roads. 2002 14 July: the President of the Republic decided to make road safety a project of his five years. 2003: October 27: Inauguration of the first speed camera. 2004 : 31 October: implementation of the automated sanction control system. 6 December: Decree providing for worsening penalties for excesses of Speed of 50 km/h and more and the reduction of penalties for speeding less than 20 km/h outside built-up areas. July: Removal of mobile radar announcements. 2006 - IRB meeting on November 9, 2006 5 January: law providing for worsening penalties for excesses Speed of 50 km/h and more by increasing the effectiveness of the vehicle confiscation penalty. 2008 - IRB meeting on February 13 Speed limits for passenger vehicles; 2009 - IRB meeting on January 13 Deployment of the first red light radars 2010 - IRB meeting on February 18 Decision to install 100 speed radars. 2011: Deployment of the first discriminating radars. 2012: Mars: installation of first level crossing radars. 20 June: installation of the first speed radars. 1st of July: progressive installation of bands of sound banks on the motorway network to fight against hypo vigilance. 2013: 4 March: commissioning of the first new generation mobile radars. 16 September: first licenses issued in accordance with the European format. 7 November: entry into force of the European directive facilitating cross-border exchanges of information on road safety. 2014: 12 December: first "double face" radar in experimentation in the Rhone. 2016: ION 2016 to 1547 of 18 November 2016 Modernization of Justice

	of the XXI century The government muscle to the rules of road safety: publication of the Law on the Modernization of Justice of the twenty ten new road safety measures, objective: to fight against fraud and bad driving behaviours; regarding speed: Immediate Entering the vehicle from the first excessive speeding,> 50km/h, over 1,500 euro fine, indented 6 points on their license or suspension for 3 years.
Awareness campaigns and training	Selection of road safety campaigns around speed by the DSCR: (Http://www.securite-routiere.gouv.fr/medias/campagnes) Communication of road safety on his Facebook page: https://www.facebook.com/routeplussure/ Communication of road safety on YouTube: Https://www.youtube.com/channel/UC6HBB1-4e6-6A54eB6ADXow Campaign # TousTouchés - Films Bruno Aveillan (Quad), music of Mirwais Realized for road safety Present on YouTube and available on the website http://www.routeplussure.fr/ - "Shockwave" - # TousTouchés, released January 28, 2016 Http://www.youtube.com/watch?v=OacNJm_mq2E "Behind every victim of the road, there are victims in life." An accident is a shock wave that impacts, for a long time, the lives of our families, our friends, our colleagues. This film calls for awareness, and to change our behaviour, in order to make the road safer, for our entourage as for us. - "Runaway" - # TousTouchés, released March 25, 2016 Https://www.youtube.com/watch?v=zZt7ijpj_zw As in the first film "Shockwave", Road Safety highlights the irreversible upheavals caused by a road accident in the entourage of the victims. "Loss of control" shows the accident of a motorcycle who carries in his fall all his relatives and recalls that "A motorcycle, the greatest danger is to think that there is none. " - "Highway of the Sun" - # TousTouchés aired July 5, 2016 Https://www.youtube.com/watch?v=y-vFRX6WvH8 In France, 1 fatal accident out of 4 is due to speed. Highway of the Sun "portrays the crash of a family man who will cause all his relatives with him because he was speeding on a driving holiday. The goal is to remember" that we Regrets to drive too fast than when it is too late ". Other Campaigns: - "When love is dead" the new film ... Erick Zonca , released in May 2015 Topics: Other hazards , speed - "How long, 100 seriously injured / day, mobilize us!" Released in February 2015 Road Safety is launching a major mobilization campaign to combat an unrecognized reality: the number of injured on the roads drops much less rapidly than the number of people killed. An accident can last a lifetime. This film, "How Long ...", is broadcast on television and on YouTube on the eve of the big holidays in winter holidays. Www.routeplussure.fr Topics: Alcohol and driving , Phone , Speed - " New speed campaign:" Too soon, too late " , released in July 2014 One regrets to drive too fast only when it is too late On the eve of the extended weekend of 14 July and the big starts, Road Safety calls on the French to take responsibility on the roads. A few km/h

	in addition to authorized speed limits can be fatal for yourself, your family ... and for others. Topics: Speed - "The faster you go, the more irreversible the consequences", released in February 2013 Road Safety launches on Saturday, February 9, a campaign to sensitize drivers to the dramatic consequences of speed. Seven radio spots explain through concrete scenarios how one endangers his life and that of others by driving too fast.

Table 3-8 Overview of vehicle safety measures in germany related to speed

Topic	**Existing measures in Germany**
Regulation and enforcement measures	Sec. 3 StVO regulates the driving speed on German roads. In general, drivers are only allowed to drive as fast as they can permanently control their vehicle. In built-up areas, the permissible maximum speed is furthermore limited to 50 km/h for all motor vehicles. Outside built-up areas, motor vehicles with a total mass below 3.5 t are at maximum allowed to drive with 100 km/h. This speed limit does not apply to motorways, or other roads with separated lanes (separation by means of construction). Drivers have also to adjust their speed to road-, traffic-, visibility- and weather conditions, and to reduce their speed / be ready to brake especially for children, needy and elderly people. In case of violation, the law provides a fine in accordance with Sec. 1, para. 1 BKatV).
Awareness campaigns and training	Speed is the central topic of the joint campaign "Runter vom Gas!" (Down with speed) of the Ministry of Traffic and Digital Infrastructure (BMVI) and the German Road Safety Council (DVR) since 2008. The Campaign uses a wide variation of measures like billboards on highways, video and audio spots, events and contests and of course internet and social media content. The motives change frequently and were at first focused on appeal to fear to enhance awareness of the consequences of accidents. Since 2011, the campaign pursues a more positive appeal based on advises, family, responsibility or joy of life motives. The latest evaluation took place 2013/2014 by BASt and showed high penetration rates, awareness levels and support for its contents. In addition, an increase of sensibility for traffic risks could be measured (Klimmt & Geber, 2017). Because it is difficult to calculate campaign's effect immediately depending on the number of accidents, indirect effects e.g. a medial and public discussion of road safety and safe driving will support the development of a cognitive base, on which a chance of attitude may take place (Klimmt, 2013). The German Road Safety Council promotes in the campaign "Bester Beifahrer" (Best co-driver) the use of driver-assistance-systems, like e.g. traffic-sign recognition, that support the compliance of the permitted speed or emergency-braking-assistance that reduce the results of excessive speed in the case of an accident. An evaluation of these campaigns is not available.
Design of road infrastructure	The general principles of Road Traffic Regulations for the speed in Germany: On Motorways the recommended speed is 130 km/h, the speed limit on rural roads is 100 km/h and on urban roads 50 km/h. Under special conditions, it is possible to apply lower speeds in limited zones, for example 30 km/h. These regulations apply to roads regardless without additional signage in accordance with the German Road Traffic

	Regulations (StVO) and the road's dedication in accordance with road law.

Table 3-9 Overview of vehicle safety measures in UK related to speed

Topic	**Existing measures in UK**
Regulation and enforcement measures	National speed limits per vehicle and road type are clearly identified and available on the UK government's website. In addition, local councils can set their own speed limits in certain areas, and these must be clearly signed. For example: 20 mph zone in a built-up area near a school / 50 mph (rather than 60 mph) limit on a stretch of road with sharp bends A speed limiter must be fitted on: vehicles with more than 8 passenger seats, e.g. buses, minibuses, coaches, stretch limousines and goods vehicles with a maximum laden weight of more than 3.5 tonnes. The minimum penalty for speeding is a £100 fine and 3 penalty points added to the driver's licence. (In the UK you can be disqualified from driving if you build up 12 or more penalty points within a period of 3 years, 6 points if within the first 2 years of driving). Currently, the maximum fine for breaking the speed limit is £1000, or £2500 if caught on a motorway and is related to how much the speed limit is exceeded. A new grading system that will increase the maximum fine and will be related to personal income is due to come in to place in April 2017. A variety of methods are used to enforce adherence to the speed limit: • Fixed location speed cameras • Mobile speed cameras • Police marked and unmarked patrol vehicles • Average speed checks through for example road works • Smart motorway variable speed limits and camera checks As an example, in 2015, 52,516 fixed speeding penalties were issued on 11 smart motorway sections compared to 2,023 on the same stretches in 2010-11, before they were upgraded to smart motorways. The smart sections use the hard shoulder and variable speed limits to control traffic flow and have come under some criticism as being essentially a 'revenue' generator.
Awareness campaigns and training	Speeding is another topic covered by both the 'THINK!' and the 'Fatal Four' campaigns. The 'THINK!' campaign has delivered hard hitting material including TV advertisement which shows the emotional consequences of killing a child while speeding (http://think.direct.gov.uk/speed.html). The 'THINK!' campaign also urges drivers to remember that the speed limit is not a target, and that you should drive at a speed that suits the conditions and the type of road. For example, if it's foggy or raining, then driving at the speed limit could be too fast The National Speed Awareness Course (NSAC) scheme is designed to allow the Police to divert low-end speeding motorists to a re-education course. The course content is designed to change the driver's behaviour with the aim of preventing the driver from re-offending. In 2015, according to Government statistics 1,207,570 drivers opted to complete a Speed Awareness Course (NSAC), as an alternative to receiving fixed penalty points and a fine. A theory test is taken before the practical driving test in the UK. The theory test covers aspects related to speed limits, stopping distances and also appropriate speeds in varying conditions

	(https://www.gov.uk/theory-test).

3.2.2 New recommendations

The analyse showed that the French and German participants realize small speeding less (between 11 to 15%) than the Dutch and the English participants but in terms of high over speeding (between 16 to 21 %), the French and German participants are on average while the English and Dutch are far below. On the other hand, Poles are still very above average for all over speeding. It is important for the Poland authorities to increase speed controls and to make awareness campaign on this topic. It may also be worthwhile to reduce the high over speeding by the French and German population.

The difference between the observed and calculated number of over speeding is very high for the speed limits 0-30 km/h and 50-70 km/h. On the other hand, for the speed limits 110-130 km/h and 30-50 km/h, this difference is negative. This effect could be due to actual police control on highway (automatic control) and on urban area on the street with high traffic. It could be worthwhile to enforce the police control on the area with 30 km/h limit and to make drivers aware of the risks incurred by VRUs in this type of area. Some infrastructure development could be done in these areas to reduce the speed.

Regarding the period of the day, the difference is very high during the evening and the night and is negative during the afternoon when the traffic is high. It is important to make the driver aware of the risk during the night. The traffic is low and the drivers see not the risk but in case of accident its gravity will be important.

Table 3-10: Recommendations for speed measures

Topic	**Measures**
Regulation and enforcement measures	• Increase police control in low speed limit areas, especially in the area with 30 km/h and 50-70 km/h limit. • Increase the number of speed control on Poland. • Increase the number of speed control during the night.
Awareness campaigns and training	• Most of the speeding are recorded in low speed limit areas. Awareness campaigns can explain to the drivers the consequences of over speeding in these areas especially to VRU injuries. • Explain the problem of over speeding during the night. • Increase the number of campaign for speed reduction on Poland and also for France and Germany for high over speed.
Design of road infrastructure	• Increase the speed bumper in very low speed limit areas.
Vehicle safety	• Give to the drivers of the advice onto the speed adapted to the infrastructure and to the traffic.

4 Reduce critical situations

4.1 Analysis of results

To analyse the critical situations three types of analysis were carried out.

- An analysis of abrupt braking,
- An interview experiment to reconstruct as precisely as possible the episode as seen by the driver using the classical techniques of the self-confrontation method
- An interview experiment to allow the driver to propose recommendations to prevent critical situation.

4.1.1 Interviews on critical situation to analyse risky situations

16 of the 30 participants of the UDRIVE French panel were individually interviewed during the UDRIVE equipment removal of their vehicle, in April 2017. Interviews lasted approximately 1.5 hours and were divided in three phases. The first, the longest, consisted in presenting to the driver at least 2 clips selected from the most recent available videos (dating back to January or February 2017): one presented a double task situation (typically a phone call), the other a hard braking event. The objective was to reconstruct as precisely as possible the episode as seen by the driver using the classical techniques of the self-confrontation method: introduce at present tense the global context ("Here, Thursday, 5: 00, you just quit your job"), launch the video a few seconds before the critical event– share the driver's field of interest (e.g. looking at what he/she is looking at) – then suspend it to let the memory take over, use empty content ("and here...") and echoes phrases. In short, this first phase was meant to stimulate the drivers' evocation of situations experienced by them as critical, whether these situations took place during or before the UDRIVE project. The interview ended with a questionnaire covering all the above issues (ex: "I rarely/sometimes/often/always write text messages while driving").

Methodological Issues: Results suggest that the use of the self-confrontation method is particularly successful in revealing and analysing risky situations. The revival of hard-braking sequences, if actually experienced as critical, was pretty effective. However, the method clearly reached its limits for the analysis of dual-task situations. In this case, the revival is much more difficult to obtain: it seems that the driver doesn't reconnect with a particular situation but that, instead, the video evokes a prototypical memory of the same type situations. The method should therefore be adapted for improving the study of such situations.

Driver knowledge: Interviews provided data concerning 3 crashes and describe, conversely, factors of intentional risk-takings in situations that remain safe. Reported crashes appear to be essentially related to complex infrastructure configurations, giving rise to an ambivalent behaviour, from the driver or from a third part: refusal of priority not anticipated in a roundabout and false start at a hairpin intersection to gain visibility.

Risk-taking factors were classified into 6 categories. Concerning secondary tasks, the study showed that the idea of "falling into" a second-task is not valid for all drivers. Participants seemed to be basically in a dual task mode, the question being then the characterization of those situations that require their full attention on the driving task.

4.1.2 Interviews on critical situation to propose recommendations

The experiment was conducted over 8 days over two weeks when participants come to the site to uninstall the UDRIVE hardware. As another experiment took place at the same time, lead by the LAB, we had to distribute the drivers. It was not possible for them to do both the experimentation, during the time of uninstallation. We therefore shared the participants and received 17 participants.

The first part of the questionnaire on the participants records their belonging to road associations, their driving habits regarding the use of GPS information systems and assistance systems such as regulators and speed limiters (see appendix A.6 Questionnaire for driver's interview on recommendations).

Three hard braking situations per participant have been selected from the videos of their journeys. Participants visualized two or three strong braking sequences. For each of them, they had to answer one questionnaire.

- First step, they had to give their degree of agreement on a Lickert scale in 5 points on adjectives or expressions describing the situation: critical, complex, manageable, responsibility of others, presence of warning signs, situation already lived.
- In second step, participants had to propose solutions to avoid this situation. When they did not have an a priori answer we proposed to them different possibilities:
    - By modifying the infrastructure
    - By providing support systems to provide information
    - By offering support systems to take control of
    - By proposing other improvements to vehicles
    - By making police checks
    - By changing driving training
    - By changing the highway code
    - By introducing new themes in awareness-raising campaigns

A complementary question was asked to all drivers who were present to uninstall the equipment on their vehicle, both those who participated in our experiment and those who participated in that of the LAB. We asked them to clarify their views on awareness campaigns and their definition of what an effective campaign should be.

Results

We interviewed 17 drivers, 11 principal and 6 secondary ones. There are 11 men and 6 women. None of drivers is a member of association in relation with road and only 3 people don't use information systems. Only 3 people have completed training courses.

The analysed situations consist of 43 situations of hard breaking: 22 following situations with short time headway, 14 situations with obstacle (car stopped or slowed down) and 7 situations with vulnerable users. The participants estimated that 70% of these situations were critical, 19% were difficult to manage, 35% had signs that would have allowed for better anticipation and 44% was generated by other road user's behaviour. 53% had signs that would have allowed for better anticipation. These situations were estimated as very rare (never), rare (onces/year) frequent (onces/month) or very frequent (onces/week)

Table 4-1: Type of recommendations given by the drivers

	Choices	First choice
Modify infrastructure	27	23
Add informative driving assistance system	12	1
Add active driving assistance system	13	9
Vehicle fittings	3	0
Police checks	4	1
Change traffic laws	1	1
Add topics in driving education	4	1
Create awareness campaigns	5	3
Nothing to do	4	4
Total	69	43

On the 43 situations, the divers propose 69 recommendations. Most of them concern infrastructure modifications (27) and for 12 situations informative driving assistance systems could be helpful and for 13 situations active driving assistance systems could be helpful. The infrastructure modifications and the active driving assistance system are more often selected as the first choice than the other type of recommendations.

The list of suggested recommendation is presented in appendix A.7 Comments of drivers during interview. For infrastructure modification, in urban area, the problem of lack of parking was often explained and fitting outs of pedestrian crossings are proposed. In rural area, the coherence between the attended driver behaviour and the infrastructure could be improve (speed bumper to have lower speed, expand road to turn left or to cross, remove pedestrian crossing on dangerous place, …); On highway, some changes could help to identify the exit or non attended pedestrian crossing. It could be helpful to prevent other road user dangerous behaviour (abrupt insertions). For driving assistance systems, most of them concerns hazards detection and systems to help the driver to maintain safe time headway. The most cited active system was the emergency braking. In terms of police checks, 4 drivers would like dangerous parking and dangerous behaviour to be sanctioned. The driving learning could add some topics like safety distance, insertions, arrival on slow vehicle. The awareness campaigns can addressee topics on indicator use, dangerous behaviour and roundabout crossing.

The last result concerns the driver preferences on awareness campaign type. At all drivers who participate at the two interviews (to analyse risky situations and to propose new recommendations), the following question was asked “A good prevention campaign should:”

Table 4-2 : Driver choice in terms of awareness campaign type.

	Choices	First Choice
Present risk in a scientific and quantified way	19	5
Present the risk emotionally and affectively	25	12
Suggest consequences more than show them	11	3
Present the risk in a raw and frontal way	24	11
Staying positive and valuing good behaviour	15	5
TOTAL	94	36

The Table 4-2 presents the driver preferences. Most of them prefer emotional awareness campaigns.

Participants showed a preference for campaigns that present real risks in a raw or emotional manner.

4.1.3 SP4 Analysis of braking events

In this analyse 3 events was used:

- High hard braking: The first event had accelerations less than -5m/s^2 (i.e. deceleration greater than 5m/s^2) for at least 0.3 seconds.
- Hard braking: The second event was used to detect hard braking which had acceleration of less than -3m/s^2 (i.e. deceleration greater than 3m/s^2) for at least 0.5 seconds.
- Normal braking: The third event was used to detect hard braking which had acceleration less than -1 m/s^2 (i.e. a deceleration greater than 1m/s^2) for at least 2 seconds.

The objective of this study was to investigate which factors are more often present in hard braking than in non-hard braking to better explain which factors may explain the hard braking presence.

The occurrences of hard braking are not the same for all operational sites. The German participants behave much calmer than the other panels. The most abrupt behaviour is observed for the French and Dutch. On the other hand, the time headway is lower at the beginning of very hard braking and hard braking than at the beginning of normal braking in all operational sites.

The driving on the road with speed limit upper the 62 km/h generate more Hard and very hard braking. This state of affairs is problematic because the velocities that are more elevated the severity of the accidents can be more important.

The drivers made less hard braking when it is raining. This result shows that drivers are aware of this weather risk.

The cruise control can be useful. The drivers made less hard braking when the cruise control is active. The use of cruise control could be encouraged to reduce abrupt driving.

The roundabouts generate two problems; (1) the hard braking occurs more often when approaching or crossing a roundabout, (2) the lowest time were found also on roundabout. Then, it could be better if the drivers have to be more quite when they cross a roundabout. They have to try to have longer time headway especially on roundabout.

4.2 New recommendations

Table 4-3: Recommendations for critical situation measures

Topic	**Measures**
Regulation and enforcement measures	• Increase police checks upstream of areas where traffic jams regularly occur. • Increase police checks to respect road marking with continuous lines to reduce unpredictable insertions. • Checking compliance with parking rules. • Fines for hazardous wire changes
Awareness campaigns and training	• Awareness of using turn signal when turning. • Risk sensing engendered by hazardous wire changes in the traffic. • Campaign to promote a better use of roundabouts • Show accidents to promote respect of safety distances
Design of road infrastructure	• During roundabout approach, a lot of hard braking occurs and the following distances decrease. The design of this type of infrastructure could be improve to reduce speed approach. • Improve parking especially when the road is bottleneck.

	• Widening narrow roads in order to be able to cross each other particularly in turns • Design a dynamic traffic sign that lights up when the pedestrian is ready to cross when the infrastructure in less readable (example pedestrian crossing at a motorway exit) • Lighting the pedestrian crossings at night, the pedestrians in the seeing dressed in black are absolutely not visible.
Vehicle safety	• System to inform the drivers on the leading distance. • Promote the emergency braking system • Promote system to alert when arriving in front of a slow or stopped vehicle • Improve the signalling of a vehicle for other users following it, when it is stopped in the middle of the track (example for a turn on the left) and to distinguish between normal and sudden braking. • use on cruise control could be encouraged to reduce abrupt driving

5 Improving vulnerable road user safety

5.1 Aim and background

In UDRIVE vulnerable road user safety was studied with the objective of gaining insight into how to improve the safety of vulnerable road users like pedestrians, cyclists and motorcyclists. The emphasis of the performed studies was therefore on interactions between drivers and vulnerable road users. The aim was to identify and understand the everyday behavioural patterns in these interactions as well as the circumstances of conflicts or safety critical events in these interactions.

In 2016 approximately 25 500 road users were killed on European roads (European Commission, 2017). Vulnerable road users accounted for 43 % of all fatalities; 21% of these fatalities were pedestrians, 8% of these fatalities were cyclists and 14% were motorcyclists. Over the years the amount of road fatalities in Europe has been decreasing, though the amount of fatalities among vulnerable road users hasn't decreased as much as among other road users. Besides the many fatalities that occur every year many more people are injured as a result of a crash and those involved suffer with the often severe consequences. It is estimated that 135 000 people get seriously injured as a result of a road crash in Europe. Especially vulnerable road users are at risk in traffic, since they are less protected compared to a driver in a car or truck.

In several European studies factors that contribute to crashes with vulnerable road users have been investigated. Studies into severe injured vulnerable road users (Aarts, et al. 2016) and research into fatalities amongst vulnerable road users (Habibovic & Davidsson, 2011) show that the most frequent contributing factors to crashes were failures of looking or in judgement, reduced visibility or reduced awareness; reckless driving; speed-related factors and psychoactive substances; loss of control of vehicle; and/or insufficient comprehension of the traffic situation. In these studies databases based on police reports on crashes have been analysed.

Research into interactions between vulnerable road users and other road users using a naturalistic driving method, like in UDRIVE, provides insight into everyday behaviour and everyday conflicts, and as such gives indications about potentially effective measures that can be taken to reduce fatalities amongst this vulnerable group.

In this chapter the results found by UDRIVE studies on vulnerable road users are discussed, as well as recommendations for measures to improve vulnerable road user safety in Europe.

5.2 Overview of UDRIVE results on vulnerable road user safety

The analysis of vulnerable road user safety was focused on interactions with cyclists, pedestrians and powered two wheelers. The studies consisted of research questions about:

- Blind spot shoulder checks and gaze behaviour of car drivers toward cyclists on urban intersections.
- Gaze behaviour of truck drivers towards cyclists on urban intersections.
- Cyclist overtaking manoeuvres by car drivers.
- Safety critical events involving cyclists.
- Interactions between drivers and pedestrians.
- Safety critical events involving powered two-wheelers.
- Everyday riding behaviour of power two-wheelers drivers in common urban traffic scenarios.
- Time headway between cars and powered two-wheelers.

A summary of the most relevant results is presented in this chapter. The aim of this chapter is to give an overview of the results of the studies and to provide a basis for the recommendations of measures that will be discussed in Paragraph 5.3.2.

Respectively results are described on interactions with cyclists, interactions with pedestrians and interactions with powered two-wheelers related to the potential contributing factors to crashes between drivers and vulnerable road users. The analyses of the studies were based on data from France, Poland, Germany, Spain the Netherlands and/or the United Kingdom. An extensive description of all studies can be found in Deliverable D44.1 (Jansen et al., 2017).

5.2.1 Interactions between drivers and cyclists

Interactions between drivers (car drivers and truck drivers) and cyclists were investigated by looking at under what circumstances and how often drivers check their blind spot, by investigating overtaking behaviour of drivers and by an in-depth analysis of safety critical events. Results on these studies are described in this paragraph.

5.2.1.1 What factors contribute to safety critical events involving cyclists?

The objective of the UDRIVE study on safety critical events (i.e. crashes and near-crashes) between cyclists and drivers was to investigate the contributing factors to crashes and near crashes. A near-crash was defined as a situation which was not planned and required an immediate, urgent evasive manoeuvre by at least one of the conflict partners to avoid a crash.

Results are based on driving behaviour by car drivers from the Netherlands, the United Kingdom, France and Poland and truck drivers from the Netherlands. For truck drivers 8 safety critical events were identified and for car drivers 3. Because of the small amount of near crashes found in the data, and no crashes, the results were analysed qualitatively. The results in this study give an indication to the contributing factors of crashes.

In this study the safety critical events seem to be caused by a combination of infrastructure (a curve or a road being too narrow), the manoeuvre (often overtaking), other oncoming traffic, an error by the cyclist, or a manoeuvre by the cyclist (slowing down). All events took place on a road with a speed limit of 50 km/h or less, about half of the roads had a designated bicycle lane, and none of the drivers were driving too fast at the start of their evasive manoeuvre. All of the drivers decreased their speed as an evasive manoeuvre.

5.2.1.2 Under what circumstances and how often do drivers check their blind spot?

A failure of a driver to check their blind spot before making a turn on an intersection can lead to serious crashes. These accidents typically involve vulnerable road users, such as cyclists. The number of blind spot fatalities may be reduced if there is a better understanding of blind spot checking behaviour.

In the UDRIVE studies on blind spot checking it was investigated which factors influence whether car and truck drivers check their blind spot before making a turn on an urban intersection or roundabout. Getting insight into how often and under what circumstances drivers check their blind spot can give an indication of how large the problem is and how to make sure less fatalities occur as a result of blind spots not being checked.

5.2.1.2.1 Main results on blind spot checking of car drivers

Results are based on driving behaviour of drivers located in the Netherlands, Poland, France and the United Kingdom. For right turn (for UK drivers left turn) intersections results were based on 961 turns by 69 drivers, for right turns on roundabouts results were based on 826 turns by 46 drivers (Polish drivers were excluded for the analysis on roundabouts since there weren't enough manoeuvres to be analysed). The factors analysed consisted of infrastructural, situational, and behavioural characteristics.

Prevalence In the study on gaze behaviour of car drivers towards cyclists on urban intersections and roundabouts it was found that drivers only check their blind spot actively prior to or during the right turn in

approximately 7% of the cases for intersections and 5% for roundabouts. Results show that drivers during the manoeuvre look most of the time at the future road towards the right turn, between 65% and 95% of the time on average. Other categories where drivers were looking involved elsewhere and sideways. During manoeuvres the proportion of looking sideways increased, this increase starts earlier for Dutch drivers (at 3 seconds before the turn) compared to French and British drivers (at 1 second before the turn). At roundabouts French and British drivers hardly performed any sideway checks, while Dutch drivers performed more frequently sideway and blind spot checks. The low average frequency of blind spot checks raises the question if this is problematic, and under what circumstances.

Infrastructure A large difference has been found amongst drivers between different countries. On average, the frequency of blind spot checks in the Netherlands was 5.5 times as high as in the other countries at intersections (in 27% of the cases), and 13 times as high at roundabouts (in 19 % percent of the cases). The most logical explanation for this difference is that the prevalence of cyclists and cyclist facilities in the Netherlands is higher than in the other countries. This is supported by the data; the average prevalence of cyclist facilities (i.e., adjacent lanes and separated tracks) across all manoeuvres is 10% at intersections, and 29% at roundabouts. However, in the Netherlands, these proportions are 37% at intersections and 67% at roundabouts.

Distraction Almost all drivers were at some time during and before the manoeuvre engaged in a secondary task. This could be either a visual task (e.g. looking at a navigation system), manual (e.g. texting), auditory (e.g. handsfree calling) or combined. In 17% of all right turns of intersections before the manoeuvre and 8% of all right turns at intersections drivers were engaging in *visual secondary task* behaviour at some point. At manoeuvres on roundabouts drivers were engaged a *visual secondary task* in 14% of the time just before and in 9% of the time during the manoeuvre. Being engaged in secondary tasks didn't have a significant influence on blind spot checking when looking at the average results at countries combined; drivers didn't increase or decrease their blind spot checking when they were engaged in another task.

5.2.1.2.2 Main results on blind spot checking of truck drivers

Results are based on driving behaviour of 10 Dutch truck drivers. Due to the low number of drivers and observations, no inferential statistical analyses have been performed.

Prevalence The main finding in the UDRIVE study on gaze behaviour of truck drivers towards cyclists on urban intersections is that drivers check their blind spot prior to the right turn manoeuvre in approximately 5% of the cases, both for intersections and roundabouts. When the right turn manoeuvre is included, the frequency of blind spot checks increases to 19% at intersections, and 15% at roundabouts.

Situational factors A striking finding is that in 10 cases across 6 drivers the presence of a cyclist coming from the truck driver's direction did not result in a blind spot check. Even though the number of observations is small, the consequence of such behaviour is potentially fatal.

Distraction 9 out of 10 truck drivers were at some point involved in secondary tasks at intersections, and at roundabouts. Since the profession of truck drivers gives rise to frequent secondary task involvement, such as checking an order status, and phone calls with the dispatcher, these findings might not be surprising. Secondary task involvement is related with an increased blind spot check frequency prior to making a manoeuvre on an intersection.

5.2.1.2.3 Conclusion

The findings on blind spot checking of car and truck drivers indicate that the drivers in the vast majority of right turns predicted that there would not be any encroaching cyclists from the right. Apparently drivers felt that the traffic did not necessitate blind spot checks in the majority of the manoeuvres. The prediction

of drivers might not always be accurate though, and their gaze behaviour could lead to serious accidents. The finding that drivers engage in secondary tasks just before and during a right turn is striking and could potentially lead to fatal crashes.

5.2.1.3 What factors influence driver behaviour while overtaking cyclists on rural roads?

When cars and cyclists share the same lane in traffic, cars typically need to overtake, potentially resulting in dangerous conflicts. In the UDRIVE study on overtaking cyclists' lateral distance between the car drivers and cyclists on rural roads was investigated as a result of factors such as car and vulnerable road user speed, presence of oncoming and leading traffic, driver, country and infrastructure factors.

Results are based on driving behaviour of drivers from Germany, France, Poland and the United Kingdom. 146 overtaking manoeuvres on rural roads were analysed.

Results show that the duration of a car driver overtaking a cyclist in the study was on average 9.3 seconds (± 3.5s) and driven speed by car drivers was on average 61km/h (± 15km/h). The average lateral distance 1.65 meters (± 0.64m). Most European countries have a recommendation of 1.5 meters for overtaking. Several factors influenced the lateral distance. Lateral distances were larger when the speed of the car was higher, when the speed of the cyclist was higher, and when the overtaking vehicle was following another vehicle. Lateral distances were found to be smaller when the cyclist was positioned further away from the edge of the road, and when there was an oncoming vehicle (in case of accelerative overtaking manoeuvres).

5.2.2 Interactions between drivers and pedestrians

In the study on interactions between drivers and pedestrians, interactions were explored on three main levels: (1) when there was a conflict, or expected conflict between drivers and pedestrians, (2) when pedestrians were present in the field of view of the drivers but not on a collision course, and (3) when drivers were driving in locations, in which conflicts occurred earlier on. These levels were measured by a smart camera, the Mobileye system, which was installed in every car. This system continuously measures the distance of pedestrians (and other road users) in front of the car.

The comparison of the three levels was meant to see if and how drivers adjust their behaviour and safety margins when they drive in the presence of pedestrians and/or infrastructure that contains vulnerable road user facilities.

5.2.2.1 How do car drivers behave in the presence of pedestrians?

Results were based on driving behaviour of drivers from the United Kingdom and France.

Results indicate that when pedestrians are present in the field of drivers (not necessarily on a collision course), drivers drive slower than when pedestrians are not present. This suggests that pedestrians' presence plays an important role in keeping drivers aware and alert towards potential conflicts with pedestrians. Furthermore, results showed that real dangerous interactions (real or expected conflicts) were associated with higher car speeds, and required more severe braking. Just over 400 conflicts were identified, that could be clustered into four subgroups linked to the car's speed profile.

1. Conflicts that involved the highest speed group mainly concerned a situation in which the pedestrian (still) was on the pavement.
2. Conflicts that involved a group of car drivers that had just increased their speed before the conflict occurred; again generally a conflict with a pedestrian who (still) was on the pavement.
3. Conflicts in which the high speed drivers probably had noticed the potential conflict well in advance, and had reduced speed to avoid a collision.

4. Conflicts in which the car driver had not reduced speed until very late, seemingly because he had not at all noticed the pedestrian. This group of conflicts was the largest.

Additionally, it was investigated qualitatively whether a pedestrian collision warning could have the potential to reduce the risk associated with conflicts between pedestrians and drivers. Certain cases, not too many, showed a pattern of potential benefit of an early alert by a pedestrian collision warning. These cases generally correspond to situations category 4, wherein car drivers hadn't reduced their speed until very late.

5.2.3 Interactions with and behaviour of motorcyclists

Little is known yet about normal, everyday riding behaviour of motorcyclists. The UDRIVE studies on powered two-wheelers investigate everyday riding behaviour and time headway between powered two-wheelers and cars.

5.2.3.1 Everyday riding behaviour of motorcyclists

This analysis focused on speed choice and acceleration by powered-two-wheeler riders in four common urban intersection scenarios: free flow followed by a right turn, free flow followed by a left turn, full stop followed by a left turn, and full stop followed by a right turn. The analysis was based on 7350 manoeuvres by 32 riders from Spain, where each rider featured at least 10 manoeuvres in at least one of the above scenarios.

There are two main findings in this study. First, significant differences have been found between the scenarios. Pair-wise comparisons showed that most scenarios were significantly different from each other on all measures, these being speed at the manoeuvre onset, speed at the manoeuvre offset, average speed, maximum speed, minimum speed, acceleration at the manoeuvre onset, average positive and negative acceleration, and maximum positive and negative acceleration.

The second main finding concerns a comparison between riders. Across riders significant differences have been found in speed choice and acceleration during manoeuvres, as well as in the time window surrounding full stops prior to the manoeuvres. Furthermore, riders appear to use a constant deceleration in the five seconds preceding a full stop, but the magnitude of this deceleration varies across riders. These findings suggest that riders have different preferences (i.e., riding styles) regarding speed choice and acceleration.

A UDRIVE study into safety critical events for powered two wheelers identified two safety critical events. In one event the motorcyclist was braking harshly on a one directional dual lane situation where the view off a pedestrian who started to cross at a zebra crossing was blocked by vehicles in the other lane. In the other event the motorcyclist was swerving due to a passenger car entering from a side road into the path of the motor rider.

5.2.3.2 Time headway between cars and powered two-wheelers

In this study time headway between cars and powered two-wheelers was compared to time headway between two cars and time headway between cars and trucks. Data from car drivers based in five countries was used for this analysis; Germany, France, the Netherlands, Poland and the United Kingdom.

The main findings of the study were that the distance between road users for three different categories (powered two-wheelers, cars, trucks) are very similar. In the data distances up to 3 seconds between vehicles were looked at. At lower driving speeds ($\leq$ 50km/h) the average time headways were around 1.7s, at medium speeds (60 - 80km/h) the average time headways varied somewhat between 1.4 and 1.6s. At speed over 80km/h the time headway in car-car situations remained around 1.4s, but the time headway in

car-truck situations tended to increase again to around 1.7s. Whereas the general picture showed very similar time headways for the different vehicle combinations there are two exceptions worth mentioning: cars followed trucks slightly closer than they followed other cars and PTWs, and at medium speed cars followed PTWs at a slightly longer distance than other cars or trucks. There were hardly any differences between the five countries.

5.2.4 Conclusion and limitations

Overall, the findings of the UDRIVE studies give an indication that driver behaviour (and vulnerable road user behaviour) is not always optimal and that infrastructural features have an influence on driver's behaviour. To improve vulnerable road user safety the next step is to identify measures that can be taken to influence the behaviour of drivers in a way that they will notice vulnerable road users sooner and more often.

The naturalistic driving method is a valuable technique to collect insights into road user behaviour. 'Real life' behaviour of drivers and vulnerable road users can be investigated. A drawback to this method is that analysing (video) data is rather time consuming. As a result for the UDRIVE project the sample size for some studies is relatively small and some findings are therefore qualitatively described. The data collected isn't necessarily representable for general driver behaviour in Europe. Results should therefore be interpreted as an indication into contributing factors to vulnerable road user safety and crashes. Extended research is needed with a larger and a more diverse sample size to be able to generate more solid assumptions.

5.3 Recommendations on improving vulnerable road user safety

A review of existing measures in Europe related to improving vulnerable road user safety is given first. Recommendation based on the described findings in the UDRIVE studies on vulnerable road users are described next.

5.3.1 Review of existing measures in Europe

Table 5-5 an overview is shown of existing measures in Europe and especially Germany, France, the United Kingdom and the Netherlands, related to vulnerable road users regarding vehicle safety, regulation and enforcement, awareness campaigns and training, and design of road infrastructure. These measures are based on information provided by UDRIVE partners in the respective countries.

Table 5-1 Overview of vehicle safety measures in Europe related to vulnerable road users

Topic	**Existing measures in Europe**
Vehicle safety	- European demands for motorcycle helmets are registered in European Regulation ECE R22-05. Minimum demands concerning shock absorption, penetration resistance, stiffness, protruding parts, surface friction, chin strap and risk of detachment in a crash are determined. - ABS is a system preventing the wheels from blocking when braking heavily. ABS for motorcycles has decreased the number of road accidents for motor cyclists (Rizzi et al., 2015). - Since 2002 so-called 'bull-bars' are prohibited in Europe. - Euro NCAP rates cars since 2006 on the protection of vulnerable road users. - Since 1995 new trucks, semi-trailers and trailers are equipped with open side underrun protection, protecting the vulnerable road user from sliding underneath the wheels. Since 2007 a front-view mirror and wide-angled mirror are compulsory for trucks, this makes the

	view on the blind spot corner wider.

Table 5-2 Overview of existing measures in Germany related to vulnerable road users regarding regulation and enforcement, awareness campaigns and training, and design of road infrastructure

Topic	**Existing measures in Germany**
Regulation and enforcement measures	- Every pedestrian has to use the pavement. If the road has no pavement or hard shoulder, pedestrians are allowed to use the road. If an intersection or a T-junction has traffic lights, pedestrians must use them when crossing the road (see Sec. 25, para. 1, StVO). Bicycles are defined as vehicles, so they must be used on roads (see Sec. 2, para. 1, StVO). - In addition, Sec. 2, para. 4, StVO regulates to ride bikes behind each other. It is only allowed to ride bikes next to each other, when other traffic is not affected. There is the duty to use cycle paths, if special traffic signs are applicable. Children, under eight, must use the pavement with their bikes; children, until reaching the age of ten, are allowed to use the pavement with their bikes (see Sec. 2, para. 5, StVO). - A bicycle helmet is recommended for all cyclists. - Motorcyclists use motor vehicles, which must have a licensing (see Sec. 1, para. 1, StVG). Additionally, the motorcycle must maintain an adequate insurance. Sec. 21a, para. 2 StVO regulates the duty to wear safety helmets, except when using prescribed seat belts.
Awareness campaigns and training	- Drivers of motorbikes and cyclists present another target group of campaigning, e.g. with motorbikes as one focal point in the 2009 "Down with speed!" campaign or on the topic of cyclists in the campaign "Rücksicht im Straßenverkehr" (Respect in traffic) since 2012 or especially on the use of bicycle helmets in 2016. In these campaigns, billboards, actions, events and online content were used. There is no evaluation available. - Additionally, the German Road Safety Council has developed and certificated different safety trainings on road safety centers and in real traffic dedicated to motorcyclists. Participants were taught in the right handling, braking and steering as well as hazard recognition. An evaluation of these trainings does not exist, but the evaluation of car-safety-trainings by Kiegeland/Kassel University for BASt in 1999 (Kiegeland, 2004) and Kerwin (2004) transferred to motorbikes, promises an improvement of braking, steering and hazard perception.
Design of road infrastructure	- Planning and design of urban streets must be based on objectives derived from the liveability and viability of the towns and communities concerned, seeking a balanced consideration of all claims for use of the local street space. In this process, it will frequently be necessary – especially in urban centres – to reduce the volume, or at least the prioritisation, of individual motorised traffic in terms of speed and convenience in favour of pedestrians, cycle traffic and local public transport. The German design guidelines provide the basis for planning, design and operation of roads. Further recommendations for cycle and pedestrian facilities specify these guidelines in greater detail.

Table 5-3 Overview of existing measures in France related to vulnerable road users regarding regulation and enforcement, awareness campaigns and training, and design of road infrastructure

Topic	**Existing measures in France**
Regulation and enforcement	- Police checks are increasing in number to verbalize cyclists who do

measures	not respect the red traffic lights.
Awareness campaigns and training	- " Mountain bikers ", released in May 2012 - A motorcycle, the greatest danger is to think that there is none. - "Runaway" - # TousTouchés, released March 25, 2016 - Https://www.youtube.com/watch?v=zZt7ijpj_zw - As in the first film "Shockwave", Road Safety highlights the irreversible upheavals caused by a road accident in the entourage of the victims. "Loss of control" shows the accident of a motorcycle who carries in his fall all his relatives and recalls that "A motorcycle, the greatest danger is to think that there is none."
Design of road infrastructure	- A large number of cycle lanes are being created in the major French cities.

Table 5-4 Overview of existing measures in the United Kingdom related to vulnerable road users regarding regulation and enforcement, awareness campaigns and training, and design of road infrastructure

Topic	**Existing measures in UK**
Regulation and enforcement measures	- Motorcyclists must wear a safety helmet by law that meets British safety standards when riding a motorcycle or moped on the road. There is no law requiring bicyclists to wear a helmet however bikes ridden at night require front and rear lights. - The UK highway code (https://www.nidirect.gov.uk/articles/rules-pedestrians-1-35) provides information relating to the use of footways and crossings for pedestrians and for the interaction between pedestrians and other road users.
Awareness campaigns and training	- A number of national campaigns and training initiatives exist in the UK. - A Hazard Perception Test is a key component of the diving theory test (both motorcyclists and other road users in respect of the VRU) (https://www.gov.uk/theory-test/hazard-perception-test). - The UK's long standing 'THINK!' campaign promotes the steps both drivers and riders can take to reduce motorcyclist / cyclist casualties on the roads. The latest in a series of cyclists TV campaigns reminds cyclists to 'hang back' at junctions to avoid getting caught between a lorry and left hand turn (http://think.direct.gov.uk/cycling.html). - Cycling proficiency tests are undertaken in many schools aimed at 9-11 year olds. The scheme recognizes that early road safety education is crucial in keeping children safe on the roads. It helps develop their skills, increase their confidence as cyclists and identify risks they may come across on the roads. - The UK government produces Road Safety Education Leaflets which include advice for pedestrians and cyclists (e.g. https://www.nidirect.gov.uk/articles/road-safety-leaflets) - BikeSafe (http://www.bikesafe.co.uk/) offers workshops across the UK where the main riding hazards faced by motorcyclists are explored. By delivering theory presentations and observed rides, the workshop helps motorcyclists understand their strengths and weaknesses. - Numerous local campaigns aimed at vulnerable road users are employed in the UK, for example: - The 'Share the Road' campaign aims to raise awareness about the safety issues faced by pedestrians, cyclists and motorcyclists. It aims at encouraging all road users to think about their attitudes on the road and to become a 'considerate' road user

	(https://tfl.gov.uk/campaign/share-the-road). - Heads-up distracted campaign (https://www.newcastle.gov.uk/parking-roads-and-transport/roads-highways-and-pavements/road-safety-initiatives/heads-distracted) aims to raise awareness of the dangers of not paying attention when crossing the road, following figures showing that the biggest cause of accidents in the city-centre is "failure to look properly when crossing the road" – usually through distractions such as mobile phones or listening to music through headphones. Targeted at young people aged 18-22 years, the age group most affected, the campaign is using a combination of social media and bus shelter advertising in hotspot locations across the city-centre.
Design of road infrastructure	- The following are examples of recent road infrastructure designs; - The London Cycle Superhighways plan has been developed to establish an improved infrastructure to give cyclists more space and security on the carriageway and to raise driver awareness of cyclists. A total of twelve Cycle Superhighways are planned in and around the London area. (https://www.london.gov.uk/sites/default/files/cycling-revolution-london.pdf) - Investment has also been made into a national network of cycle routes. The National Cycle Network is a series of safe, traffic-free paths and quiet on-road cycling and walking routes that connect to every major town and city. The Network passes within a mile of half of all UK homes and now stretches over 14,000 miles across the length and breadth of the UK. - The Department for transport, after a 2 year research project (2011), produced guidance for local authorities when designing 'shared space' roads. Shared space is a design approach that seeks to change the way streets operate by reducing the dominance of motor vehicles, primarily through lower speeds and encouraging drivers to behave more accommodatingly towards pedestrians. (https://www.gov.uk/government/publications/shared-space).

Table 5-5 Overview of existing measures in the Netherlands related to vulnerable road users regarding regulation and enforcement, awareness campaigns and training, and design of road infrastructure

Topic	**Existing measures in the Netherlands**
Regulation and enforcement measures	- The motorcyclists licence consists of three stages. Motorcyclists under the age of 20 years old can drive a light motorcycle with a cylinder capacity up to 125 cc (A1). When 20 years or older a driver can obtain a licence for a middle heavy motorcycle (A2). After having an A2 licence for 2 years a driver or when a driver is older than 24 years can obtain a licence for a motor with unlimited power (A). - Since 1972 wearing a helmet for motorcyclists in the Netherlands is obliged. - To improve cyclist safety mopeds were moved from the bicycle paths to the road when speed limit is lower than 70 km/h in 1999. Evaluation of this measure confirmed that less crashes involving mopeds and cyclists occurred (Van Loon, 2001). - As of 2003 all trucks in the Netherlands must have a blind spot mirror. This mirror only provides a bit more sight and didn't therefore didn't prove to be an efficient measure. - It is compulsory for drivers to stop for a stop signal by school crossing patrol officers helping children to cross the road on their way to school.

Awareness campaigns and training	- Several trainings are being offered to enhance motorcyclist safety. For a Dutch advanced rider training a positive effect on safety was determined by a study done by SWOV (Boele & Craen, 2014). This training was a one day course (given by KNMV) including a practical training on the road and the training of hazard perception. - There are multiple school education programs aimed at children between 4 and 12 years old, wherein children learn for example about blind spots or get a practical cycling test to test for proficiency. Some of these tests are evaluated and show significant improvement on behaviour, though some tests need to be studied for their effects (SWOV, 2012b). - There are multiple education programs for different types of vulnerable road users. For example education for elderly using e-bikes, education aimed at younger adults to be made aware of group pressure in traffic or education aimed at parents supporting their children in traffic. An overview of these programs can be found on the website of CROW: https://www.crow.nl/mobiliteit-en-gedrag/tools/toolkit. They list 58 programs aimed at cyclists, 7 programs aimed at motorcyclists, 19 programs aimed at moped riders, 38 programs aimed at pedestrians, 7 projects aimed at blind spot recognition. - The Dutch organisation VVN launched a campaign aimed at cyclists using their lights when it starts to get darker outside. Their aim is to make cyclists aware of how dangerous cycling without lights is since they are less visible to other road users. - When schools start again an awareness campaign is launched (by the Dutch organisation VVN) to alert drivers for school-going children. - Professional competence guidelines for truck drivers oblige bus- and truck drivers to follow post-training of 35 hours every 5 years. In the Netherlands this is called code95. Drivers can choose what training they want to follow, and they have an option to choose for blind spot education. - Blind spot checking is accounted for in truck driver examination. - Several awareness campaigns on blind spots of trucks aimed at vulnerable road users.
Design of road infrastructure	- Aiming at the separation of cyclists and motor vehicles like in the Dutch city Houten, by creating separated lanes for cyclists and faster motorised vehicles. - By creating 30 km/h zones in residential areas motorised traffic is discouraged to drive fast and to keep an eye out for vulnerable road users. Changing areas from 50 km/h to 30 km/h zones has a positive effect on the number of injuries; the decrease is approximately 25% (SWOV, 2010). - There are some initiatives in the Netherlands to make school routes safe for young children using special corridors to guide the young pedestrians to school, playgrounds or sport facilities (SWOV, 2012a). - In Amsterdam a road has been changed from a regular road into a cycling road aiming to enhance cyclist safety. Cars are ‘guests’ on the road and are allowed to drive a maximum speed of 30 km/h instead of 50 km/h and share the road with cyclists. Research by the city shows the project is successful; the new design results in a safer and faster traffic flow for cyclists. The city is planning to extend the project and implement the design to other streets.

5.3.2 Recommendations based on UDRIVE findings

The discussed UDRIVE studies focus on the behaviour of drivers and motorcyclists. Results show that driver's behaviour at times is risky regarding vulnerable road users. What recommendations can we propose based on the findings in the UDRIVE studies on improving vulnerable road user safety?

5.3.2.1 Main findings

An extensive overview of the findings in the studies on vulnerable road users can be found in chapter 5.2. The main findings in the described studies on vulnerable road user safety are:

Interactions between cyclists and car/truck drivers

- In this study the safety critical events seemed to be caused by a combination of infrastructure (a curve or a road being too narrow), the manoeuvre (often overtaking), other oncoming traffic, an error by the cyclist, or a manoeuvre by the cyclist (slowing down).
- Results indicate that drivers on average do not check their blind spot often when turning right (or left in the UK) at an intersection or when leaving a roundabout.
- In the Netherlands, drivers check their blind spot significantly more often compared to France, Poland and the United Kingdom. This is probably the result of the Dutch infrastructure and prevalence of cyclists.
- Drivers engage in secondary task behaviour regularly often during and before right turn manoeuvres (left turn in the UK).
- Average lateral distance for car drivers when overtaking cyclists was 1.65 meters (± 0.64m). Most European countries have a recommendation of 1.5 meters for overtaking
- Lateral distances were larger when the speed of the car was higher, when the speed of the cyclist was higher, and when the overtaking vehicle was following another vehicle.

Interactions between pedestrians and car drivers

- When pedestrians are present in the field of drivers (not necessarily on a collision course), drivers drive slower than when pedestrians are not present. This suggests that pedestrians' presence plays an important role in keeping drivers aware and alert towards potential conflicts with pedestrians.
- Results suggest that pedestrian collision warning for some safety critical events could be beneficial.

Interactions and everyday driving of powered two-wheelers

- The time headway between road users for three different categories (powered two-wheelers, cars, truck) is very similar. Depending on the driven speed by the driver average time headway was between 1.4s and 1.7s.
- Findings suggest that riders have different preferences (i.e., riding styles) regarding speed choice and acceleration.
- Two safety critical events were identified. One was caused by the view of the motorcyclist being blocked resulting in a pedestrian being seen late. In the other event a passenger car entered suddenly from a side road into the path of the motor rider.

5.3.2.2 Recommendations

Based on these findings we recommend a number of measures that could increase vulnerable road user safety. It should be noted that many of the findings in UDRIVE cannot be generalised to all car drivers or all European countries. In-depth research for proposed specific measures is therefore needed. The following measures regarding vehicle safety, regulation and enforcement measures, awareness campaigns and training and design of road infrastructure are supported by the results of the discussed UDRIVE studies:

Vehicle safety

- Research has shown that it is difficult to create *blind spot detection and warning systems* to support trucks turning right that work effectively (SWOV, 2015). Research into blind spot detection and warning systems in 2010 showed that to give the driver enough time to react when a signal is given when a vulnerable road user is too close, was difficult with the systems that were available at that time. New and improved technologies and smart cameras might give different results (Van Beeck, 2016; Silla et al., 2015), and more research is needed to determine the effects of such systems on vulnerable road user safety today.
- Some *Autonomous Emergency Braking (AEB)* systems can detect vulnerable road users. The car brakes automatically for vulnerable road users that aren't identified by the driver in time. Systems that are capable of preventing frontal to rear collisions are already becoming more and more commonly installed in new cars (SWD, 2016). Systems that are capable of detecting vulnerable road users are currently less common, but could prove to be additionally valuable for vulnerable road user safety.
- The results in this study on blind spot checking support the recommendation of enhancing direct vision for truck drivers. The high seating position of truck drivers impairs their direct sight of vulnerable road users. Creating trucks wherein direct vision is enhanced has the potential to contribute to vulnerable road user safety (SWD, 2016) since the blind spot area is greatly decreased.
- Results on powered two wheelers indicated that riders have different styles of decelerating at junctions. Warning systems could be more effective if adapted to personal riding style. Though not studied directly, it cannot be excluded that this also applies for warning systems for car and truck drivers.

Awareness campaigns and training

- The study on blind spot checking supports the recommendation from a previous study (Talbot et al., 2014) that *cyclists should be made aware of the blind spots* of large vehicles, and that they should not undertake large vehicles on the approach to a junction. Awareness campaigns, targeted training or warnings on trucks could help realising that.
- It could prove to be beneficial to include the usage of a*dvanced driver assistance systems* (ADAS) like AEB, intelligent speed adaption and warning systems in the training of new drivers and in their exam. ADAS can support the driver in identifying vulnerable road users and it is therefore desirable for drivers to get acquainted with such systems when learning how to drive.

Design of road infrastructure

- Designing infrastructure in line with a Safe System approach aims at infrastructure that is able to accommodate for human error (ITF, 2016). This includes *physical separation in time or place* between drivers and vulnerable road users. Research indicates that well-designed bicycle facilities, as well as physically separated lanes, improve cyclist safety (WHO, 2015; Schepers et al., 2015). This can be realised, for example, by designing junctions or arranging traffic lights so that turning vehicles cannot run into cyclists. Most near-crashes identified in the UDRIVE study wouldn't have occurred if road users would have been physically separated.
- *Traffic calming and designing infrastructure intuitively* results in an increasing level of cycling safety (Schepers et al., 2015). In the UDRIVE study on interactions with pedestrians it seems that the mere presence of pedestrians makes drivers more aware of other potential pedestrians. Creating a 'pedestrian environment' by the availability of sidewalks and using traffic calming and intuitive design has good potential to decrease driver-pedestrian conflicts. The effects of specific calming infrastructure design could be investigated for cyclists as well, for example by cycling streets where car drivers are 'guests'.

6 Promoting eco-driving

6.1 Analysis of SP4 results

6.1.1 Eco-driving research questions

For this study, we define eco-driving to be about (operational) strategies associated with low fuel consumption to reduce energy use while driving that is in this case: pressing and releasing the accelerator and brake pedals, and gear-shifting. There are some 'golden rules' for eco-driving:

- shift gear up as soon as possible, between 2000 and 2500 revolutions per minute;
- anticipate traffic flow (to minimise dynamics and limit braking);
- maintain a steady speed;
- decelerate smoothly by coasting;

Other actions that may influence energy use were not researched in UDRIVE, such as

- The use of air-conditioning or heater, or opening the windows.
- Travel choices such as destination choice and mode choice.

Choices regarding departure time choice, route choice and lane choice were also not researched, but have been considered in the paragraph with recommendations for policy measures as measures influencing these choices can have an impact on the possibilities to drive eco-friendly (in the sense of whether traffic allows the driver to drive eco-friendly). However, choices regarding destination and travel mode have not been targeted, as those choices have very little to do with driving behaviour. Also, measures promoting the purchase and use of clean and efficient vehicles are not discussed, and neither is regulation regarding the emission levels of vehicles. Also, we do not discuss low or ultra-low emissions zones that have been implemented in many European cities. Such measures are mainly for reducing pollutants (e.g. NO_x), and are about banning certain vehicles, rather than influencing driving style.

The analysis of the data in the context of eco-driving focused on several research questions regarding driving styles, the effects of driving styles on eco-driving and the potential effect of eco-driving. Table 6-1 lists the relevant research questions and the measures / data sources that were used to carry out the analyses (if not directly from the vehicle).

Table 6-1: Research questions and data sources

Research question	**Measures/variables used for the analyses and their sources**
When do drivers brake and is it necessary to brake in each instance?	• recognizing bends, junctions, traffic lights (map data) • headway, lane width (mobile eye) • braking energy, engine speed
How much do drivers deviate from the speed limit in free flow situations?	• velocity and acceleration • bends • junctions, speed limits (map data)
Why do drivers deviate from the speed limit in free flow situations?	• speed limits (map data) • headway distance (mobile eye)
Do drivers shift gear to avoid high engine speeds and high fuel consumption?	• engine speed
Is eco-driving an observable characteristic of	• Ecodriver parameter, driverID and characteristics

certain drivers?	(questionnaire)
Is eco-driving and safe driving correlated, through increased anticipation of road infrastructure and traffic situations?	• Ecodriver parameter

6.1.2 Results of the data analyses regarding eco-driving

The eco-driving analyses in SP4 have been reported in detail in [Bärgman et al., 2017]]. This paragraph summarises these results, with the aim to provide a starting point for the following section on recommendations for measures. The analysis was structured around the research questions regarding driving styles, the effects of driving styles on eco-driving and the potential effect of eco-driving.

6.1.2.1 Driving styles

The research questions related to driving styles were:

- How much do drivers deviate from the speed limit in free flow situations?
- Why do drivers deviate from the speed limit in free flow situations?
- When do drivers brake and is it necessary to brake in each instance?
- Do drivers shift gear to avoid high engine speeds and high fuel consumption?

The analyses of the UDRIVE data showed that drivers deviate from the speed limit by up to 20%, both below and above the limit. The dynamics show an even larger spread, up to 50%. Drivers that keep a larger time headway (either due to personal driving style or due to the absence of traffic), tend to lose less energy in braking. When selecting only straight roads without intersections and without a vehicle in front, the braking energy does not decrease, although the difference between individual drivers increases. This indicates a larger difference in personal driving style, independent of driving circumstances. However, the difference between better and worse eco-driving behaviour is most easily recognised in the gear shifting analysis. There is a large bandwidth in average engine speed at the gear shifting moment between drivers. The eco-driver advice is to change gear between 2000 and 2500 RPM, but drivers range from 1400 to 3000 RPM, depending on the vehicle type and the gear, but mostly on the driver behaviour.

Information about why drivers deviate from the speed limit could not be derived during the UDRIVE project. A more detailed study of driving circumstances, for example by looking at velocity behaviour in very specific traffic situations, could yield more information on the reason for the personal speed choice. A more reliable definition of free-flow (data excluding congested traffic conditions and infrastructural obstructions) would give a cleaner free-flow velocity distribution that better represents the driver's personal style. The information given by the drivers in the questionnaires may be used in the future to give insight in their reasons to over speed or to drive slower than the limit.

6.1.2.2 The effects of driving styles on eco-driving

The research questions related to driving styles were:

- How do the differences in driving style translate into differences in fuel consumption?
- Are eco-driving and safe driving correlated?

The analyses showed that braking, gear shifting and the velocity choice and dynamics on the motorway can all change the fuel consumption by 10% or higher for a vehicle with traditional technology. A generic

number was not given, as it would depend strongly on the vehicle technology.

An eco-driving score for each driver was obtained by looking at their braking energy at 50-60 km/h, the engine speed at the gear shifting moment from second to third gear, the most frequent (peak) velocity at speed limits between 95 and 120 km/h, the width of the peak around the most frequent velocity at speed limits between 95 and 120 km/h and the weighted mean of the absolute acceleration at speed limits between 95 and 120 km/h. The distribution of the eco-score per driver showed considerable variation around the average, with a bandwidth of minus 40 to plus 40% (worst to best eco-driver).

To analyse the possible correlation between eco-driving and safe driving, an estimate of safety was made through the variable velocity times positive acceleration. This variable is commonly used for validating the driving behaviour in emission testing, to distinguish between aggressive and tame driving profiles. This safe driving variable and the eco-driving score per driver are clearly correlated. An analysis of the correlation between the eco-driving score per driver and safety-critical events would be interesting in this context.

6.1.2.3 The potential effect of eco-driving

The research questions related to driving styles were:

- Is eco-driving an observable characteristic of certain drivers?
- What is the potential effect of eco-driving given the bandwidth in driving styles between drivers?

The eco-driving potential could be described as the difference between the scores of the worst and the best driver, after correcting for driving circumstances. The 80% difference between best and worst eco-drivers indicates that eco-driving, as defined by this score, is an observable characteristic of certain drivers. It should be noted however, that fuel consumption does not linearly depend on this eco-driving scoring.

There were differences in the average score between countries, but there was not enough diversity in the data to correct the data for underlying effects such as different road types, so it cannot be concluded that these differences are only due to personal driving style. Also, grouping the results with respect to country, driver age or gender did not yield strong correlations that can be said to be independent of infrastructure, vehicle type and other factors. The more general the results, such as the velocity distribution around the speed limits on the motorway, the more data can be combined. This yields more robust results which can be generalized to the European average with more confidence. The major drawback of these generalizations is the limited traffic information in the data set, which may cause an unknown bias. The main problem was the poor quality of the headway signal, which meant that it was not possible to adequately separate different traffic situations that can affect driving behaviour. The generalizations of the result to a European average are therefore partly blind for important aspects which can affect driving behaviour. Specifically, it is based on the assumption that the traffic situations are representative for the European average.

For more statistically significant results regarding eco-driving, in future naturalistic driving data collection one should include more different drivers and more different vehicle types, even if this means that less data is available per driver. Besides that, one has to ensure a well-calibrated and continuous headway signal is available, along with other crucial parameters such as road gradient, vehicle payload and road surface.

6.2 Recommendations

6.2.1 Review of existing measures

Eco-driving has been receiving attention for many years and several countries have set up programs to promote eco-driving. Also, there are measures that were implemented for other reasons (e.g. for safety, throughput, comfort) that may support an eco-driving style.

Table 6-2 lists existing measures in the Netherlands.

Table 6-2: Existing eco-driving measures in the Netherlands

Topic	**Existing measures in the Netherlands**
Regulation and enforcement measures	Specific eco-driving measures: none at the moment. Until recently, the 'Het Nieuwe Rijden' Programme ('The New Driving') promoted eco-driving by providing information about the golden rules of eco-driving. That programme was canceled. The New Driving was, however, mentioned in the 'Energieakkoord' (Energy Agreement for Sustainable Growth, from 2013) as a measure. No other eco-driving measures are mentioned in this Agreement. Other measures contributing to eco-driving: No measures aiming specifically to support eco-driving. However, reduced speed limits, especially combined with strict enforcement (for air quality, noise or traffic safety reasons) can be considered to some extent to support energy-efficient driving. In the Netherlands, several sections of urban motorways (e.g. in Amsterdam, Rotterdam, The Hague and Utrecht) have 80 km/h speed limits for air quality reasons. Also, some incentives to drive outside peak hours (financial rewards or higher tolls during peak hours) can help because traffic is smoother outside peak hours.
Awareness campaigns and training	There are currently no (public) awareness campaigns. However, there are many organisations that offer eco-driving training.
Design of road infrastructure	Eco-driving does not seem to be considered in the design of road infrastructure.
Vehicle safety	Not applicable.

Table 6-3 lists eco-driving measures currently deployed in France.

Table 6-3: Existing eco-driving measures in France

Topic	**Existing measures in France**
Regulation and enforcement measures	Specific eco-driving measures: During the initial driver training, young drivers receive advice to consume less. Furthermore, during the examination, if they have a thrifty driving, the note of the examination is increased by some points. Other measures contributing to eco-driving: Since 2014, the Parisian motorists have to slow down. The speed on the beltway of the capital is officially limited at 70km/h, against 80km/h previously. Furthermore, in most of the French cities, the speed limits on the fast axes are lowered

	every time the level of air quality overtakes a critical threshold. If pollution is very high, vehicles are only allowed to travel in some large cities on alternate days. On the other hand, a pollution car label (vignette) was created to qualify vehicles in terms of pollution and the least polluting vehicles that have a vignette of category of less than 2 can circulate. (https://www.crit-air.fr/en/information-about-the-critair-vignette/the-french-vignette-critair/critair-and-politics.html)
Awareness campaigns and training	The Environment and Energy Management Agency (ADEME) is involved in the implementation of public policies in the fields of environment, energy and sustainable development. This organization has created numerous guidelines including eco-driving ones. In 2009, a methodological guide was created (http://www.ademe.fr/guide-formation-a-leco-conduite) to facilitate the introduction of eco-driving training. It contains expert advice from ADEME as well as testimonials from the "La Poste group" . The organisation trained more than 60,000 employees and obtained 5 to 8% reductions Greenhouse gas emissions and fuel consumption. A lot of French insurances propose some recommendations and courses to promote eco-driving : • **Matmut:** https://www.matmut.fr/assurance/prevention-auto free driving courses, duration: 3 h 30 to discover techniques for economical driving in traffic and reduce fuel consumption and emissions. Program: Demonstration of eco-preventive techniques, : advice, analysis of consumption and balance sheet. • **MMA:** http://www.zerotracas.mma/news/4618/l-eco-conduite.htm. Supported by the Government and the ADEME (Environment and Energy Management Agency), which was welcomed by oil tankers and carmakers who organized mini-awareness-raising courses during the last World Motor Show. • **YOUNG Driver Assur:** https://www.jeune-conducteur-assur.com/eco-conduite.html • **AVIVA:** https://www.aviva.fr/conseils-en-assurance/mes-demarches/aviva-sengage-contrats-eco-responsables.html
Vehicle	A lot of smartphone applications exist to help the driver to save fuel : **French agency** : http://www.ademe.fr/particuliers-eco-citoyens/deplacements/choisir-voiture-adopter-lecoconduite/adopter-leco-conduite And the car manufacturers give fuel information to the driver in most of the car's models.

Table 6-4 discusses existing eco-driving measures in the United Kingdom.

Table 6-4: Existing eco-driving measures in the United Kingdom

Topic	**Existing measures in the UK**
Regulation and enforcement measures	Specific eco-driving measures: The UK driving theory test (revised 2015) now includes multiple choice questions related to ecosafe and economical driving. The aim is to encourage new drivers to learn how to get the most enjoyment from their driving with the correct skills, attitude and behaviour. Other measures contributing to eco-driving: Many cities operate a congestion charge in order to reduce the volume of

	traffic during peak times by encouraging people to take public transport into the city. (E.g https://tfl.gov.uk/modes/driving/congestion-charge)
Awareness campaigns and training	Some insurance companies promote 'green-driving' by offering reductions in insurance costs for drivers subscribing through green driving 'apps'. For example as well as considering the number of miles driven, 'Insurethebox' offers personalized insurance costs based on telematics information related to the speed driven at on different sorts of road and whether the driver brakes or accelerates sharply. The Driving Standards Agency commissioned a study (https://www.gov.uk/government/publications/eco-driving-what-determines-take-up-of-post-test-training) to find out how eco-driving training can be provided and promoted in a more engaging way and how take-up can be increased amongst existing car drivers. Many organisations offer 'green driving' training for private and commercial drivers (e.g. Automobile Association (AA), Royal Society for the Prevention of Accidents (RoSPA), Energy Saving Trust). The UK government also offers guidance on 'smarter driving' http://www.dft.gov.uk/vca/fcb/smarter-driving-tips.asp Tips included relate to driving smoothly, idling, over-revving and appropriate speed choice in order to promote fuel efficiency and emissions reduction.
Design of road infrastructure	Nothing apparent – linked however to congestion and emission zones.

Table 6-5 contains the existing eco-driving measures in Germany.

Table 6-5: Existing eco-driving measures in Germany

Topic	**Existing measures in Germany**
Regulation and enforcement measures	Specific eco-driving measures: According to Sec. 16 para. 1 FeV (driving licence regulation), candidates must prove in the theoretical exam that they have sufficient knowledge about environmentally adapted and energy-saving driving. Other measures contributing to eco-driving: In general, German traffic regulations determine road users' behaviour participating in road traffic. Sec.1, para. 1 StVO requires inter alia environmental awareness. An offence in the sense of Sec. 49 para. 1 Num. 25 StVO in combination with Sec. 30 para. 1 StVO is committed by any person, who causes unnecessary noise or pollution by using his vehicle. It is forbidden to run the engine unnecessarily. Useless driving in built-up areas is forbidden, if other people are disturbed by this behaviour. In case of violation, the law provides a fine in accordance with offence law (OWiG) regarding Sec. 1 StVO. Currently the government promotes the purchase of electric vehicles (starting in May 2016) with 4.000 Euros for a pure electric vehicle, 3.000 Euros for a plug-in hybrid. Only electric vehicles up to a net list price of 60.000 Euros are promoted. Overall, 600 million Euros will be available for this incentive measure. Vehicle manufactures are involved with 50 %. In addition, in total 300 million Euros will be invested for new charging stations.
Awareness campaigns and	Based on campaigns like "Spritsparstunde" (fuel-save-lesson) or "Fahr'

training	und Spar' mit Sicherheit" (Drive and save with safety) today the "Eco Safety Training" is offered by the DVR. It teaches the use of low rotational speeds, the use of momentum and the establishment of secure space for safe decisions in traffic. The evaluations of these campaigns reveal considerable savings on fuel, maintenance costs and a reduction of accident costs (Schulte & Fabian, 2009).

6.2.2 New recommendations

The naturalistic driving data analyses have resulted in a number of findings that can help to derive new policy recommendations. With regard to eco-driving, if the question is: "How can ND data be useful for road authorities for developing policies?" then the question is: what did we learn from the ND data about unsustainable driving? Unsustainable driving includes:

- Highly dynamic driving (in terms of speeds and gear changing):
    - Caused by **traffic conditions**: high density to congested traffic with a lot of interactions between vehicles and the need to accelerate/decelerate often
    - Caused by **road network design**: with many intersections or speed bumps where a large share of the vehicles needs to stop or slow down considerably.
    - As a consequence of **personal driving style** / preferences (driver always accelerates/decelerates strongly, and/or does not anticipate well). This can be unintentionally or intentionally.
- Driving at very low or very high speeds
    - Very low: can be unavoidable, because on residential streets (safety concerns), but can also be caused by traffic conditions (congestion) that may or may not be avoidable, e.g. by changing the route or by changing the speed, e.g. shockwave damping.
    - Very high: can be legal, on roads with (very) high speed limits (in NL: 120/130) – question is what share of km's is driven on roads with high speed limits. Drivers can also exceed the speed limit (driver style - unintentionally or intentionally).
- Inefficient gear-shifting (mostly personal driving style)

From this list, it is clear that unsustainable driving can be caused by the driving environment (infrastructure, traffic conditions) or by personal driving styles. Both were researched in SP4, although the influence of the infrastructure or traffic conditions could not be determined very well). The driving environment can, to some extent, be adapted by road authorities, but also by some travel choices (e.g. changing the departure time), although those can be argued to be outside the scope of this project. Personal driving styles can also be targeted, in various ways. It is also important to get a feeling for how often or for how long a certain type of unsustainable driving occurs. For instance, depending on the share of certain driving conditions in the km's driven, it can be more or less useful to target these km's with policy measures (e.g. driving on residential streets with 30 km limit or lower with or without speed bumps is generally only done for short distances at the beginning and end of trips). Congestion may take up a larger share of the km's driven, but most km's are still made in relatively low traffic volumes with high speeds.

With this in mind, Table 6-6 gives a list of possible eco-driving measures. These measures are, generally, not country-specific, although national and local policies and regulations may have an influence on the feasibility of the measures. Measures designed to reduce the amount of driving (mileage) have not been included, nor have measures related to climate control in the vehicle been included. In general, it can be

said that:

- Optimal gear-changing is important, so systems and tips to support optimal gear changing have been included.
- For urban roads, the energy inefficiency stems from the need to come to a stop often. Hence the measures aimed at reducing the amount of braking or at better anticipation, possibly with the driver being supported by in-vehicle systems to achieve this.
- On rural roads and motorways, high speeds and congestion contribute most to energy efficiency. Therefore, measures to reduce high speeds and alleviate congestions have been included.
- Feedback to the driver about their 'eco-driving score' can help the driver to learn how to drive more energy-efficiently. This should include tips regarding gear shifting, speed choice (at higher speeds) and anticipation of situations where deceleration will be required.
- Idling is interesting to address, as it is very often beneficial to shut down the engine –already when idling takes more than 2 seconds– but the ND data do not include the start of the trip, so only analyses of idling en-route are possible.

Table 6-6: Recommendations for eco-driving measures

Topic	**Recommendations for new measures**	**Link with UDRIVE data[1]**
Regulation and enforcement measures	Enforcement of speed limits. From an energy efficiency perspective, this is especially relevant for speed limits of 100 km/h and higher. At all speed limits, enforcement can help reduce speed variations.	UDRIVE data showed that drivers drive up to 20 km/h above and below the speed limit. The average of the distribution is now usually on the limit, but it could be lower with strict enforcement, as this leads to a reduction of the highest speeds.
	Regulating and enforcing several in-vehicle systems that reduce energy use through reduction of driving dynamics and non-optimal speeds.	UDRIVE data showed the effects of the use of Adaptive Cruise Control on the speed distributions (speeds stay at or are below the set speed).
Awareness campaigns and training	Promoting the purchase of vehicles with Gear Shift Indicator (GSI) Promoting the use of GSIs already present in vehicles	UDRIVE data showed substantial variation in gear shifting behaviour between drivers and that this leads to variation in energy consumption.
	Promoting the use of automatic engine shut-down (start-stop) systems and raising awareness of how quickly that can be beneficial.	UDRIVE data showed that idling takes up substantial amounts of time (in urban areas; approximately 15% of the time).
	Promoting the application of eco-driving tips, especially those regarding gear shifting and anticipation.	UDRIVE data confirmed that there is considerable variation between personal driving styles and that this leads to variation in energy consumption.
	Promoting the use of the highest gear, at least when driving on roads with speed limits of 70 km/h or higher.	UDRIVE data showed that some drivers shift to the highest gear at very high speeds (e.g. 90 km/h)
	Promoting the purchase of (plug-in) hybrid electric vehicles ((P)HEVs), as these are designed to recover braking energy.	Not based on UDRIVE data (no (P) HEVs in the dataset).
	Measuring the eco-driving score of drivers and providing feedback and (financial) incentives	UDRIVE data confirmed that there is considerable variation between

[1] See chapter 6 of deliverable 41.1 [Bärgman et al., 2017] for UDRIVE analysis results regarding eco-driving.

	for improvement of the eco-driving score to the driver, for instance drivers of company/lease cars and professional drivers.	personal driving styles and that this leads to variation in energy consumption.
	Update of awareness campaigns and eco-driving training (during the initial driving training, or perhaps more effectively after about 2 years of driving experience). This could include driver choices beyond the actual driving task (e.g. route choice and departure time choice) to encourage driving in optimal conditions. Positive choices could be rewarded; negative choices could be discouraged (e.g. by a congestion charge).	Only indirectly based on the UDRIVE data (which shows a wide variety in eco-driving scores between drivers and suggests that there is an influence of road design and traffic conditions on driving behaviour).
Design of road infrastructure	Where possible, implement grade-separated intersections. This is, however, an expensive measure that may only be feasible in a limited amount of locations.	See above.
	If grade separated intersections are not feasible, carefully considered intersection designs can help to make it easier for the majority of vehicles to pass the intersection without having to brake and to (almost) come to a stop. Note that a balance between energy-efficiency and safety has to be found here (e.g. roundabout vs. give way intersection).	See above.
	At signalised intersections: Improve the algorithm and/or settings. Add communication with the vehicles to optimise the green light allocation and the speed patterns.	See above.
	In cities, road networks can be designed to resemble a tree structure rather than a grid structure. This may reduce the number of stops. (see: neighbourhoods in older cities vs. newer neighbourhoods)	See above.
	30 km/h roads are often implemented from a safety perspective, but should be limited to access roads (in residential areas or business parks) and should, from an energy efficiency perspective, not be extended to distributor and through roads, so that only short distances are driven on 30 km roads. See the Dutch Sustainable Safety principles for the description of road function vs. lay-out/geometry[2].	See above.
	Redesign local road networks to avoid heavy traffic through town centres, instead building by-passes.	See above.
Vehicle safety or other	Driver support systems that facilitate smooth driving and optimal speed choice, where	UDRIVE data showed the effects of the use of Adaptive Cruise Control on the

[2] See the Sustainable Safety factsheet at https://www.swov.nl/sites/default/files/publicaties/gearchiveerde-factsheet/uk/fs_sustainable_safety_background_archived.pdf

	possible based on local dynamic maps: • Adaptive cruise control. • Functions such as curve speed warning, Green Light Optimal Speed Warning, SpeedAlert. • Other speed advice functions promoting optimal speed choice and lane choice (and possibly route choice).	speed distributions (speeds stay at or are below the set speed). Other functions were not present in the data set but could be used to support anticipation.
	While penetration of in-vehicle systems is still low: More guidance using road signs, for instance when there is a need to reduce speed (e.g. signs 70-50 when going from a speed limit of 100 or 90 to 50 km/h)	UDRIVE data showed some drivers brake less than others, which could be supported by the appropriate signs.
	Traffic management strategies to support eco-driving, such as smoothing traffic flows, resolving congestion (e.g. C-ACC, shockwave damping, smart routing).	Not analysed specifically in UDRIVE, however such strategies result in less braking which is associated with lower energy consumption.
	In the long run: eco-friendly driving strategies in automated vehicles.	UDRIVE data could be used to derive the most eco-friendly behaviour under different circumstances, which could be used to enhance driving algorithms in automated vehicles.

7 Reduce dangerousness of secondary task

7.1 Analysis of SP4 results

The analysis provided in SP4 is based on a first extraction of the data. At the time the study was provided, no data from the Netherlands was available. The data set included unbalanced samples from each of the other countries (in terms of distance driven, total time and number of drivers). Results would therefore need to be consolidated with further analysis.

Only internal distractions where studied in this analysis whereas external distractions are also a key factor for road safety (advertisement, interaction with vulnerable road users …). Concerning internal distraction, two different categories are often used: visual manual task and auditory tasks. Both include a cognitive load but visuo-manual task are considered as more dangerous: as soon as a secondary task competes with primary driving task (vision), a significant part of attention is dedicated to the secondary task and therefore, accident risk increases. Visuo-manual task include the use of electronic devices, reading and writing, smoking, drinking and eating.

On the other hand, Phone related tasks include very different process in terms of distraction. To be relevant for road safety and focus on the more dangerous phone task, visuo manual task should be studied separately. For example, texting on a phone increases by 23 crash risk whereas phone conversation is done. Hands free interaction (such as Hands free conversation and interaction) can be considered as having a lower impact on safety. On the contrary, searching, reading or phoning hand held (visuo manual tasks) are known as being particularly dangerous.

As a global observation for cars, 52% of the trips included a secondary task. Around 6% of the driving time was spent with visuo-manual secondary tasks when looking at all countries together. 12% of the driving time in Poland was spent doing potentially dangerous tasks (visuo-manual) whereas it was only 4,3% in France and 5,1% in UK. This observation is compliant with the higher number of death on road in Poland (7,7/100 000 inhabitant) than in France, 5,4 / 100 000). For trucks, the two most common tasks where eating (22%) and control (20%) (typically interacting with the truck buttons and levers).

Phone is the most frequent type of secondary tasks for cars (4%). The percentage of visuo manual tasks for German drivers appeared very low but due to the nature of the sample, the significance would have to be studied in more details. It is also one of the most frequent tasks for trucks, and also one with longer-durations, and therefore a high exposure task.

Concerning phone related tasks for cars, in the sample, nearly 39% of the phone time was spent with visuo-manual tasks and 61% was spent with auditory task. In that sense, drivers seem to be aware of the risk and try to adapt their behaviour. Women seem particularly motivated for hand free conversation instead of hand held (38.6% of the time spend phoning compared to 6.72% for men) and France as a very high rate of Hands free conversation (55.12%) compared with the other countries (9.13 for Poland and 12.32 for UK). Even if UK had a quite low range of engagement in mobile phone tasks (2.87%), this country had still the higher rate of engagement into visuo-manual tasks (68.54%). On the contrary, France had a rate of engagement into visuo-manual phone related tasks of only in 21% of the time.

Even if phone related tasks are not allowed in the studied countries, the study showed that the driver engage himself in such tasks anyway. For cars, they tend to do it either while stand still (56%) or at very low speed but they still represent a risk since they tend to decrease driver performance (increase in Standard deviation in lane position). For trucks, drivers feel more comfortable in initiating a task at low speeds

(below 30km/h) or at very high speeds (more than 80km/h). Opposite to cars, the proportion of phone task initiations was lower at standstill than the overall proportion of standstills in the data.

Concerning the drivers, general attitudes towards safety in driving influence the choice of whether or not to use a mobile phone. In particular, drivers with higher rate of phone use have a poorer attitude toward road safety. This population may therefore be more reluctant to awareness campaign.

7.2 Recommendations

7.2.1 Review of existing measures

Table 7-1 Overview of vehicle safety measures in Europe related to secondary task

Topic	**Existing measures in Europe**
Vehicle safety	The human-machine interface (HMI) of in-car information systems and telephones should be designed as ergonomically as possible to allow for safe use such as automatic postponement of incoming calls and designing complex HMI that would regulate driver use of in-vehicle systems. Attempts are being made to develop technology through GPS and other means to block mobile phone ("hand-held") use while driving in the same way as interlocks have been used to reduce speeding as well as drinking and driving. (see https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/car_telephone_use_and_road_safety.pdf) In the iMobility Forum HMI Working Group report (2015), a series of detailed recommendations are made concerning the technical content for an European Statement of Principles on HMI (ESoP) revision, and the need for continued research and maintenance. Further recommendations are made concerning the process through which an ESoP revision could be achieved with the aim of establishing a new EC Recommendation. (see iMobility Forum HMI WG Final Report 2015).

Table 7-2 Overview of vehicle safety measures in Germany related to secondary task

Topic	**Existing measures in Germany**
Regulation and enforcement measures	In general, German traffic regulations determine road users' behaviour participating in road traffic. Sec.1, para. 1 StVO requires inter alia drivers' caution and consideration. Sec. 23, para. 1a, StVO regulates the use of mobile phones. Drivers are not allowed to use a mobile phone or car phone, if there is the need to pick up the phone or hold it in the hand (ban of "hand-held" use of mobile phones). This does not apply, if the vehicle stands still and the engine of motor vehicles is turned off. Referring to Sec. 23, para. 1b, StVO.
Awareness campaigns and training	Drivers of motorbikes and cyclists present another target group of campaigning, e.g. with motorbikes as one focal point in the 2009 "Down with speed!" campaign or on the topic of cyclists in the campaign "Rücksicht im Straßenverkehr" (Respect in traffic) since 2012 or especially on the use of bicycle helmets in 2016. In these campaigns, billboards, actions, events and online content were used. There is no evaluation available. Additionally, the German Road Safety Council has developed and certificated different safety trainings on road safety centers and in real traffic dedicated to motorcyclists. Participants were taught in the right handling, breaking and steering as well as hazard recognition. An evaluation of these trainings does not exist, but the evaluation of car-safety-trainings by Kiegeland/Kassel University for BASt in 1999 (Kiegeland, 2004) and Kerwin (2004) transferred to motorbikes,

	promises an improvement of breaking, steering and hazard perception.

Table 7-3 Overview of vehicle safety measures in France related to secondary task

Topic	**Existing measures in France**
Regulation and enforcement measures	The use of a hand held telephone while driving is prohibited. It is also prohibited, as of July 1, 2015, that any device capable of emitting sound, with the exception of electronic hearing-correcting devices, be borne by the driver of a vehicle in circulation. This prohibits in particular the earphones for making phone calls or listening to music. Driving with a phone by hand or by wearing an audio device such as earphones, earpieces or headphones is liable to: • a fine of € 135; • a 3-point withdrawal from the driver's license. On 1 July 2015: prohibition to wear any device capable of emitting sound to the ear while driving or cycling. **Official texts of the Highway Code: www.legifrance.gouv.fr** Art. 221-6-1.-Where clumsiness, carelessness, carelessness, negligence or failure to comply with a legislative or regulatory obligation of prudence or security prescribed by section 221-6 is committed by the driver, A land motor vehicle, manslaughter is punishable by five years' imprisonment and a fine of 75,000 euros. The penalties shall be increased to seven years' imprisonment and a fine of € 100,000 where: 1 ° The driver committed a manifestly deliberate violation of a particular obligation of prudence or security provided for by law or regulation …..
Awareness campaigns and training	**Topics Phone** Campaign to explain the prohibition to carry any device capable of emitting sound to the ear while driving, even when riding a bicycle. http://www.securite-routiere.gouv.fr/medias/campagnes/au-1er-juillet-2015-interdiction-de-porter-tout-dispositif-susceptible-d-emettre-du-son-al-oreille- en-driving-even-a-bike. The use of the telephone at the wheel has become a commonplace practice, but it is still dangerous. Only 51% of drivers feel that the phone is a real hazard, yet it is responsible for one in every 10 accidents. It has also been proven that the driver has 30 to 50% less information on the road when It is on the phone then causing a negative impact on the proper performance of tasks required for driving. Some other campaigns were diffused before : • "At the wheel, when you look at your smartphone, who looks at the road?",October 2013, http://www.securite-routiere.gouv.fr/conseils-pour-une-route-plus-sure/dossiers-thematiques/smartphone-au-volant-attention-danger/smartphone-au-volant-attention-danger/ understand it-safe • Road Safety - Driving Telephone (16: 9), November 2008, http://www.securite-routiere.gouv.fr/medias/campagnes/le-telephone-au-volant • Telephone and Conduct - A Global Concern, Road Safety - 13 videos,https://www.youtube.com/playlist?list=PLKAhYoOVYE-GjnTHo-6n6zY5X9CVi4WJY **Topics: Alcohol and drivi**ng , other dangers , fatigue , Phone

	" The manifesto of women ", released in March 2012 **Topics: Alcohol and driving , other dangers , fatigue , Phone , Speed** " The dangerous drivers ", released in June 2011

Table 7-4 Overview of vehicle safety measures in UK related to secondary task

Topic	**Existing measures in UK**
Regulation and enforcement measures	The main focus is upon the use of mobile phones. There are on the spot fines for drivers caught using a phone whilst driving. From March 2017 the penalties for those caught using a mobile phone while driving double to six points and a £200 fine. The rise in penalty points will mean an immediate ban for newly-qualified drivers who have a ceiling of six points for the first two years after passing the test.
Awareness campaigns and training	The use of mobile phones is included in the governments 'THINK!' campaign which also points out that whilst using phone hands free (e.g. for navigation) is not illegal, if this distracts the driver and affects their ability to drive safely, the driver can still be prosecuted by the police. (http://think.direct.gov.uk/mobile-phones.html). Distraction is one of the topics covered in the 'Alertness' section of the UK driving theory test: 'Distraction - making sure you focus on your driving and avoid distraction' Road safety campaigners provide fact sheets related to 'distracted driving' e.g. the Royal Society for the Prevention of Accidents (RoSPAA)http://www.rospa.com/road-safety/advice/drivers/distraction/fact-sheet/. The charity BRAKE note that distractions can involve any one, or more, of the below (http://www.brake.org.uk/rsw/15-facts-a-resources/facts/1131-distractionfacts): i) Visual (reading infotainment screens and sat navs, looking at objects and people outside the vehicle unrelated to the driving task); ii) Mental (thinking about something else, conversations with passengers and phone calls); iii) Auditory (listening to someone on the phone, music and noises outside the vehicle); and iv) Physical (typing, smoking, eating and drinking). They advise that any road user can become distracted, including vulnerable road users emphasizing the importance for drivers to watch out for people on foot and bicycles doing unpredictable and dangerous things.

7.2.2 New recommendations

The results described previously show that even if drivers are aware of the dangers of secondary tasks (such as mobile phone use), they still need to be informed about the risks of such behaviours.

Awareness campaigns could be fruitful under the condition they are adapted to the real way people drive. It should provide discriminant estimation of risk.

- It should be adapted to the countries since the driver behaviour could be very different from one country to the other.

- It should also be adapted to the drivers more likely to perform such tasks. A sociological study could provide more detailed ideas on the target drivers to adapt as much as possible the campaign message.
- The risk of visuo manual tasks related to phone should be stressed: drivers should decrease as much as possible that kind of interaction.

Generally speaking, drivers should be advised to completely disconnect while driving and to prefer using their Bluetooth connexion since it is compatible with driving.

8 Conclusions

Based on these findings we recommend a number of measures that could improve road safety. It should be noted that many of the findings in UDRIVE cannot be generalised to all car drivers or all European countries. In-depth research for proposed specific measures is therefore needed. The following measures regarding vehicle safety, regulation and enforcement measures, awareness campaigns and training and design of road infrastructure are supported by the results of the discussed UDRIVE analyses.

Improve seat belt use

The seat belt wearing rate of the drivers in UDRIVE is lower than the official numbers (-10% for France for example, ONISR 2014) even with this biased sample of drivers. It could be assumed that passengers have an even lower rate. The study also provides some specific results on driver characteristics linked to driving without seat belt as well as the type of trips where a seat belt is not used at all. Men are more likely to drive without a seat belt and very short trips at night represent a higher risk of driving without using a seat belt.

Regulation and enforcement measures

The strengthening of police checks is necessary to convince recalcitrant drivers to adopt more responsible behaviour. The European Road Safety Observatory (see appendix A.4 Seat belt wearing rate by car occupancy and road type) has published statistics on the use of seat belts in different countries which show that the French and Polish use the seat belts less, especially in urban areas. Therefore, improvement in the enforcement by the police is needed: In the Stakeholders Workshop, it was suggested to use the radars of red lights to identify and award fines to the drivers who aren't wearing their seat belt.

Awareness campaigns and training

Awareness campaigns are therefore still needed to increase seat belt use, especially in France and Poland. In the Stakeholders workshop, it was suggested that crash tests could be used to show drivers the consequences of not wearing a seat belt. During driving training, awareness could be raised particularly amongst young people in the necessity of putting their seat belt on, even for short trips and night routes. It would be interesting to study in more detail the psychological characteristics of drivers miss-using the seat belt in order to target the campaign messages to the correct population. This kind of study could be achieved using focus groups and/or on line surveys as well as driving style tests (available in the UDRIVE data). Specific populations such as taxi drivers or young people should also be studied more in detail as they are more exposed to this behaviour.

Reduce driving above the speed limit

In urban areas, in most countries, the default speed limit for passenger cars is 50 km/h, lower speed limits (typically 30 km/h) are often enforced in residential areas or around schools. Speed limits on roads outside built up areas typically vary between 80 and 100 km/h. On motorways speed limits vary between 90 to 140 km/h. In Germany, there is no general speed limit. Instead there is a recommended speed limit of 130 km/h and local speed limits apply on a large part of the motorway network. Speed is particularly controlled in most European countries. A lot of automatic control is done but in accident analyses, the speed appears as a main factor to explain the fatalities. in the UDRIVE data, some factors were identified to explain where and when speeding occurs.

Regulation and enforcement measures

A significant amount of speeding occurs in areas with a 30 km/h limit. It could be worthwhile enforcing the police control in areas with 30 km/h limit and making drivers aware of the risks incurred by VRUs in this type of area.

Vehicle safety

It can be challenging for the driver to be aware of the current speed limit when travelling on routes where the speed limit varies during the course of the journey. Moreover, in case of distraction it is possible that the driver does not see a reduction of speed. Some informative driving assistance systems could be helpful to inform the driver about the current speed limit.

Awareness campaigns and training

The operational site which provides a high number of instances where vehicle speed is over the speed limit is the Poland site. It is important for the Poland authorities to increase speed controls and to make awareness campaigns on this topic. It may also be a worthwhile intervention in order to reduce the incidences of speeding more than 15% by the French and German population.

Design of road infrastructure

To improve the safety in areas with a 30 km/h limit, some infrastructure development could be done to reduce the speed. For example, traffic calming measures are an effective way of reducing speed in the areas highly populated by pedestrians or in the vicinity of schools.

Reduce critical situations

To analyse the critical situations three types of analysis were carried out : an analysis of abrupt braking, an interview experiment to reconstruct as precisely as possible the episode as seen by the driver using the classical techniques of the self-confrontation method and an interview experiment to allow the driver to propose recommendations to prevent critical situations.

Regulation and enforcement measures

In terms of police checks, some drivers would like dangerous parking and dangerous behaviour to be sanctioned.

Vehicle safety

In terms of vehicle safety, systems to inform the drivers on the leading distance and to alert when he/she is approaching a slow vehicle seem to be helpful for the driver. In terms of active systems, it would be interesting to promote the emergency braking system and the cruise control use.

Awareness campaigns and training

The driving learning could add some topics like safety distance, insertions, arrival on slow vehicle. The awareness campaigns can address topics on indicator use, dangerous behaviour and roundabout crossing.

Design of road infrastructure

For infrastructure modification, in urban areas, the problem of lack of parking was often noted; in addition, during roundabout approach, a lot of hard braking occurs and the following distances decrease. The design of this type of infrastructure could be improved to reduce approach speed. A lot of situations analysed with the driver during the interview experiment concern problems at pedestrian crossings. It is important to

design pedestrian crossings in places where the driver can anticipate their presence. If a pedestrian crossing is located in an unexpected area, some dynamic sign should be added to alert the driver when a pedestrian is present. In the same way, the presence of a pedestrian could be better detected by the driver if the areais illuminated.

Improving vulnerable road user safety

Vulnerable road user safety was studied in UDRIVE to identify and understand everyday behavioural patterns in interactions between pedestrians and cyclists with drivers as well as the circumstances of conflicts or safety critical events during these interactions. Based on these results measures are identified that can be used for policy making. The following measures are supported by the results of the UDRIVE studies on vulnerable road users:

Vehicle safety

Advanced driver assistance systems (ADAS) like blind spot detection and warning systems and automatic emergency braking systems that can detect vulnerable road users could prove to be additionally valuable for vulnerable road user safety, since car and truck drivers do not always check their blind spot to see whether a cyclist is approaching. Newer and more advanced technologies and smart cameras, compared to a few years ago, are possibly able to identify vulnerable road users more efficiently. Differences are identified between countries for blind spot checking. In the Netherlands blind spot checking amongst car drivers is higher (but still only in 27% of the cases) compared to other countries (on average 7%) for right turns, probably resulting from the cycling infrastructure and prevalence of cyclists in the Netherlands. Truck drivers check their blind spot in 19% of the right turns. Creating trucks wherein direct vision is enhanced has the potential to contribute to vulnerable road user safety since the blind spot area is greatly decreased (SWD, 2016).

Awareness campaigns and training

It could be beneficial to include the usage of ADAS as a part of new driver training, so that drivers get acquainted with using these systems early on. Moreover, making cyclists aware of blind spots of large vehicles and the risk of undertaking them when approaching junctions is important as previously stated by Talbot et al. (2014). Awareness campaigns, targeted training or warnings (for example by using stickers) on trucks could help realise this.

Design of road infrastructure

Designing infrastructure in line with a Safe System approach aims at infrastructure that is able to accommodate for human error (ITF, 2016).This includes physical separation in time or place between drivers and VRU's. Research indicates that well-designed bicycle facilities, as well as physically separated lanes, improve cyclist safety (WHO, 2015; Schepers et al., 2015). Most near-crashes identified in the UDRIVE study wouldn't have occurred if the road users had been physically separated.

In the UDRIVE study on interactions with pedestrians it seems that the mere presence of pedestrians makes drivers more aware of other potential pedestrians. *Traffic calming and designing infrastructure intuitively* results in an increasing level of cycling safety (Schepers et al., 2015). Creating a 'pedestrian environment' by the availability of sidewalks and using traffic calming and intuitive design has good potential to decrease driver-pedestrian conflicts. The effects of specific calming infrastructure design could be investigated for cyclists as well, for example by cycling streets where car drivers are 'guests'.

Promoting eco-driving

For this study, we define eco-driving to be about (operational) strategies associated with low fuel consumption to reduce energy use while driving that is in this case: pressing and releasing the accelerator and brake pedals, and gear-shifting. Choices regarding departure time choice, route choice and lane choice were also not researched, but have been considered in the paragraph with recommendations for policy measures as measures influencing these choices can have an impact on the possibilities to drive eco-friendly (in the sense of whether traffic allows the driver to drive eco-friendly).

Regulation and enforcement measures

From an energy efficiency perspective, enforcement of speed limits is especially relevant for speed limits of 100 km/h and higher. At all speed limits, enforcement can help reduce speed variations.

Vehicle or other

Driver support systems that facilitate smooth driving and optimal speed choice, where possible based on local dynamic maps: Adaptive cruise control, Functions such as curve speed warning, Green Light Optimal Speed Warning, SpeedAlert, other speed advice functions promoting optimal speed choice and lane choice (and possibly route choice). While penetration of in-vehicle systems is still low, more guidance using road signs, for instance when there is a need to reduce speed (e.g. signs 70-50 when going from a speed limit of 100 or 90 to 50 km/h) could be useful. A solution to motivate the driver could be by measuring the eco-driving score of drivers and providing feedback and (financial) incentives for improvement of the eco-driving score to the driver, for instance drivers of company/lease cars and professional drivers. This could include driver choices beyond the actual driving task (e.g. route choice and departure time choice) to encourage driving in optimal conditions. Positive choices could be rewarded; negative choices could be discouraged (e.g. by a congestion charge). In the long run, eco-friendly driving strategies in automated vehicles could be a solution to optimize fuel consumption.

Awareness campaigns and training

The purchase of vehicles with Gear Shift Indicator (GSI) and the use of GSIs already present in vehicles, the use of automatic engine shut-down (start-stop) systems and raising awareness of how quickly that can be beneficial can be promoted as well as the purchase of (plug-in) hybrid electric vehicles ((P)HEVs), as these are designed to recover braking energy.

The training can help promote the application of eco-driving tips, especially those regarding gear shifting and anticipation, the use of the highest gear, at least when driving on roads with speed limits of 70 km/h or higher (during the initial driving training, or perhaps more effectively after about 2 years of driving experience).

Design of road infrastructure

Where possible, implement grade-separated intersections. This is, however, an expensive measure that may only be feasible in a limited amount of locations. If grade separated intersections are not feasible, carefully considered intersection designs can help to make it easier for the majority of vehicles to pass the intersection without having to brake and to (almost) come to a stop. Note that a balance between energy-efficiency and safety has to be found here (e.g. roundabout vs. give way intersection). At signalised intersections: Improve the algorithm and/or settings. Add communication with the vehicles to optimise the green light allocation and the speed patterns. In cities, road networks can be designed to resemble a tree structure rather than a grid structure. This may reduce the number of stops (see: neighbourhoods in older

cities vs. newer neighbourhoods); 30 km/h roads are often implemented from a safety perspective, but should be limited to access roads (in residential areas or business parks) and should, from an energy efficiency perspective, not be extended to distributor and through roads. Redesign local road networks to avoid heavy traffic through town centres, instead building by-passes.

Reduce dangerousness of secondary task

Only internal distractions where studied in this analysis whereas external distractions are also a key factor for road safety (advertisement, interaction with vulnerable road users …). Concerning internal distraction, two different categories are often used: visual manual task and auditory tasks. Both include a cognitive load but visuo-manual tasks are considered more dangerous: as soon as a secondary task competes with primary driving task (vision), a significant part of attention is dedicated to the secondary task and therefore, accident risk increases. Visuo-manual tasks include the use of electronic devices, reading and writing, smoking, drinking and eating.

Regulation and enforcement measures

The visual manual tasks are particularly dangerous in terms of road safety and police control can reduce this use. Phone is the most frequent type of secondary tasks for cars. The percentage of visuo manual tasks for German drivers appeared very low but due to the nature of the sample, the significance would have to be studied in more details. It is also one of the most frequent tasks for trucks, and also one with longer-durations, and therefore a high exposure task.

Vehicle safety

Generally speaking, drivers should be advised to completely switch off their mobile while driving and to prefer using their Bluetooth connection since it is compatible with driving.

Awareness campaigns and training

It is important to make the driver aware of the danger of using his telephone while driving, not only in convective mode but especially when handling it.

These recommendations have to be completed after new analyse on UDRIVE data. Due to time constraints and delays in the data availability, not all the data were analysed. These current results show how this type of data can be used and the wealth of lessons learned. The discussions in the various workshops carried out at the end of the project highlighted a number of stakeholders' needs that could be addressed by new analyses.

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9.3 References

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Appendix A Road safety Statistic

A.1 Fatalities

Table A. 1 : Road safety and traffic data for France (OECD/ITF (2016))

	1990	2000	2010	2013	2014	2014 % change from 2013	2014 % change from 2010	2014 % change from 2000	2014 % change from 1990
Reported safety data									
Fatalities	10 999	8 079	3 992	3 268	3 384	3.5	-15.2	-58.1	-69.8
Injury crashes	162 573	121 223	67 288	56 812	58 191	2.4	-13.5	-52.0	-64.2
Injured persons hospitalised			30 393	25 966	26 635	2.6	-12.4		
Deaths per 100 000 inhabitants	19.8	13.7	6.4	5.1	5.3	3.1	-16.8	-61.4	-73.3
Deaths per 10 000 registered vehicles	3.9	2.3	1.0	0.8	0.8	3.2	-19.8	-64.6	-78.1
Deaths per billion vehicle kilometres	25.2	15.8	7.1	5.8	5.9	2.7	-17.0	-60.9	-77.0
Traffic data									
Registered vehicles (thousands)	30 869	35 874	40 181	42 342	42 476	0.3	5.7	18.4	37.6
Vehicle kilometres (millions)	436 000	518 200	560 400	567 800	572 400	0.8	2.1	10.5	31.3
Registered vehicles per 1 000 inhabitants	546	609	640	665	665	-0.1	3.8	9.0	21.8

StatLink http://dx.doi.org/10.1787/888933385435

Table A. 2 : Road safety and traffic data for the Netherlands (OECD/ITF (2016))

	1990	2000	2010	2013	2014	2014 % change from 2013	2014 % change from 2010	2014 % change from 2000	2014 % change from 1990
Reported safety data									
Fatalities	1 376	1 082	537	476	476	0	-11.4	-56.0	-65
Deaths per 100 000 inhabitants	9.2	6.8	3.2	2.8	2.8	-0.3	-12.7	-58.5	-69
Deaths per 10 000 registered vehicles	2.2	1.3	0.52	0.44	0.44	-0.1	-14.8	-65.6	-79
Deaths per billion vehicle km	13.1	9.0	4.0	3.6	3.6	0.3	-10.6	-60.0	-72
Injury crashes	44 916	37 947	19 378[2]						
Traffic data									
Registered vehicles[1] (thousands)	6 382	8 385	102 96	10 698	10 712	0.1	4.0	27.8	68
Distance travelled (million km)	105 400	119 700	132 800	132 100	131 700	-0.3	-0.8	10.0	25
Registered vehicles per 1 000 inhabitants	429	529	621	638	637	-0.2	2.5	20.4	49

1. Including mopeds.
2. Following 2009 the reporting of minor crashes sharply dropped. No information on progress in safety can be derived from the numbers.

StatLink http://dx.doi.org/10.1787/888933385599

Table A. 3 : Road safety and traffic data for the Germany (OECD/ITF (2016))

	1991	2000	2010	2013	2014	2014 % change from 2013	2014 % change from 2010	2014 % change from 2000	2014 % change from 1991
Reported safety data									
Fatalities	11 300	7 503	3 648	3 339	3 377	1.1	-7.4	-55.0	-70.1
Injury crashes	385 147	382 949	288 297	291 105	302 435	3.9	4.9	-21.0	-21.5
Injured persons hospitalised	131 093	102 416	62 620	64 057	67 732	5.7	8.2	-33.9	-48.3
Seriously injured (MAIS3+)					14 645				
Deaths per 100 000 inhabitants	14.2	9.1	4.5	4.1	4.2	0.8	-6.2	-54.2	-70.5
Deaths per 10 000 registered vehicles	2.5	1.4	0.7	0.6	0.6	0.2	-12.0	-56.5	-75.6
Deaths per billion vehicle kilometres	19.7	11.3	5.2	4.6	4.6	-0.9	-11.9	-59.7	-76.8
Traffic data									
Registered vehicles[1] (thousands)	44 925	53 106	52 289	54 480	55 011	1.0	5.2	3.6	22.5
Vehicle kilometres (millions)	574 100	663 302	704 800	725 700	740 500	2.0	5.1	11.6	29.0
Registered vehicles per 1 000 inhabitants	563	646	639	677	681	0.7	6.6	5.4	20.9

1. Registered vehicles including mopeds.

StatLink http://dx.doi.org/10.1787/888933385449

Table A. 4 : Road safety and traffic data for the United Kingdom (OECD/ITF (2016))

	1990	2000	2010	2013	2014	2014 % change from 2013	2014 % change from 2010	2014 % change from 2000	2014 % change from 1990
Reported safety data									
Fatalities	5 402	3 580	1 905	1 770	1 854	4.7	-2.7	-48.2	-65.7
Injury crashes	265 600	242 117	160 080	144 480	152 407	5.5	-4.8	-37.1	-42.6
Deaths per 100 000 inhabitants	9.4	6.1	3.0	2.8	2.9	3.9	-5.4	-52.8	-69.6
Deaths per 10 000 registered vehicles	2.4	1.2	0.5	0.5	0.5	3.0	-6.8	-58.2	-76.5
Deaths per billion vehicle kilometres	12.8	7.4	3.8	3.5	3.6	2.2	-5.2	-52.0	-72.2
Traffic data									
Registered vehicles (thousands)	25 191	29 629	35 170	36 101	36 715	1.7	4.4	23.9	45.7
Vehicle kilometres (millions)	422 840	482 951	507 814	508 584	521 188*	2.5	2.6	7.9	23.3
Registered vehicles per 1 000 inhabitants	440	503	560	563	568	0.9	1.4	13.0	29.1

* Estimation.

StatLink http://dx.doi.org/10.1787/888933385707

Table A. 5 : Road safety and traffic data for Spain (OECD/ITF (2016))

	1990	2000	2010	2013	2014	2014 % change from 2013	2014 % change from 2010	2014 % change from 2000	2014 % change from 1990
Reported safety data									
Fatalities	9 032	5 776	2 478	1 680	1 688	0.5	-31.9	-70.8	-81.3
Injury crashes	101 507	101 729	85 503	89 519	91 570	2.3	7.1	-10.0	-9.8
Injured persons hospitalised (police data)		27 764	11 995	10 086	9 574	-5.1	-20.2	-65.5	
Seriously injured person (MAIS3+)		12 766	7 331	6 613					
Deaths per 100 000 inhabitants	23.3	14.4	5.3	3.6	3.6	0.9	-31.9	-74.8	-84.4
Deaths per 10 000 registered vehicles	5.1	2.2	0.7	0.5	0.5	0.4	-31.2	-77.3	-90.0
Traffic data									
Registered vehicles (thousands)	17 615	25 715	33 375	33 024	33 037	0.0	-1.0	28.5	87.6
Registered vehicles per 1 000 inhabitants	454	642	718	707	710	0.5	-1.1	10.6	56.6

StatLink http://dx.doi.org/10.1787/888933385676

Table A. 6 : Road safety and traffic data for Poland (OECD/ITF (2016))

	1990	2000	2010	2013	2014	2014 % change from 2013	2014 % change from 2010	2014 % change from 2000	2014 % change from 1990
Reported safety data									
Fatalities	7 333	6 294	3 908	3 357	3 202	-4.6	-18.1	-49.1	-56.3
Injury crashes	50 532	57 331	38 832	35 847	34 970	-2.4	-9.9	-39.0	-30.8
Deaths per 100 000 inhabitants	19.3	16.4	10.2	8.7	8.4	-3.3	-17.7	-48.8	-56.3
Deaths per 10 000 registered vehicles	8.1	4.5	1.8	1.4	1.3	-7.4	-28.3	-71.6	-84.4
Traffic data									
Registered vehicles[1] (thousands)	9 041	14 106	22 115	24 521	25 255	3.0	14.2	79.0	179.3
Registered vehicles per 1 000 inhabitants	238	369	579	636	664	4.4	14.6	80.2	179.5

1. Registered vehicles including mopeds.

StatLink http://dx.doi.org/10.1787/888933385620

A.2 Fatalities by user group

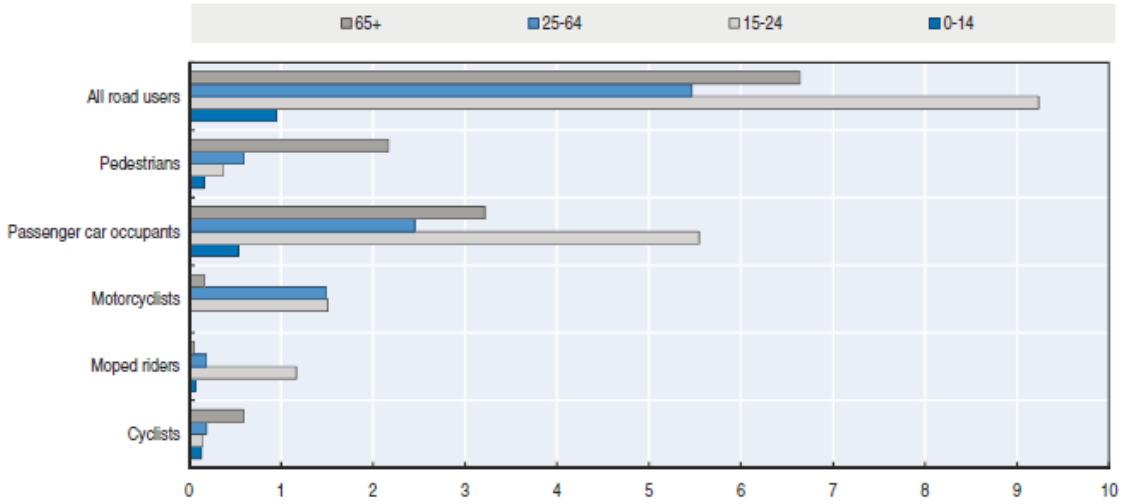


Figure A. 1 : Road fatality by age and road usergroup for France per 100 000 inhabitants in 2014 (OECD/ITF (2016))

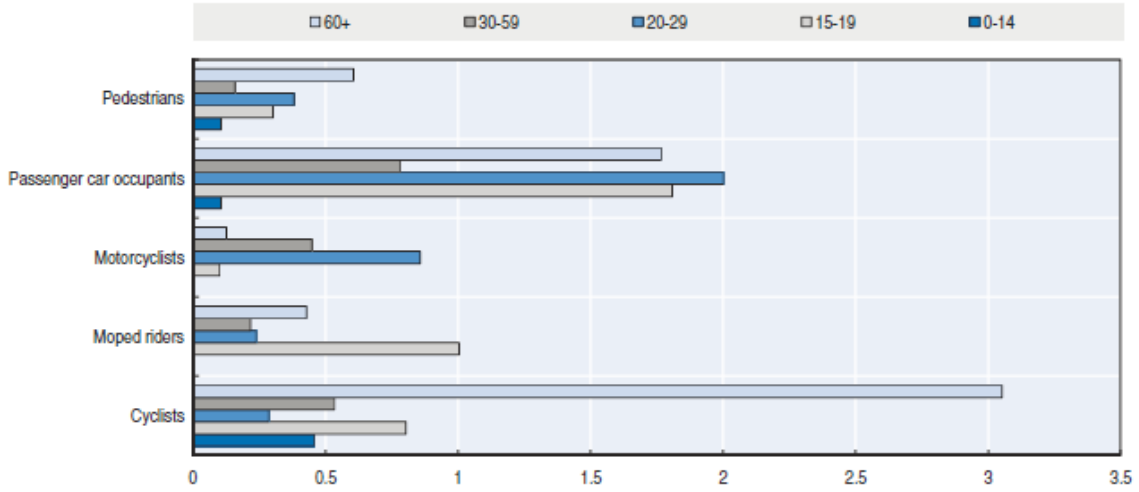


Figure A. 2 : Road fatality by age and road usergroup for the Netherlands per 100 000 inhabitants in 2014 (OECD/ITF (2016))

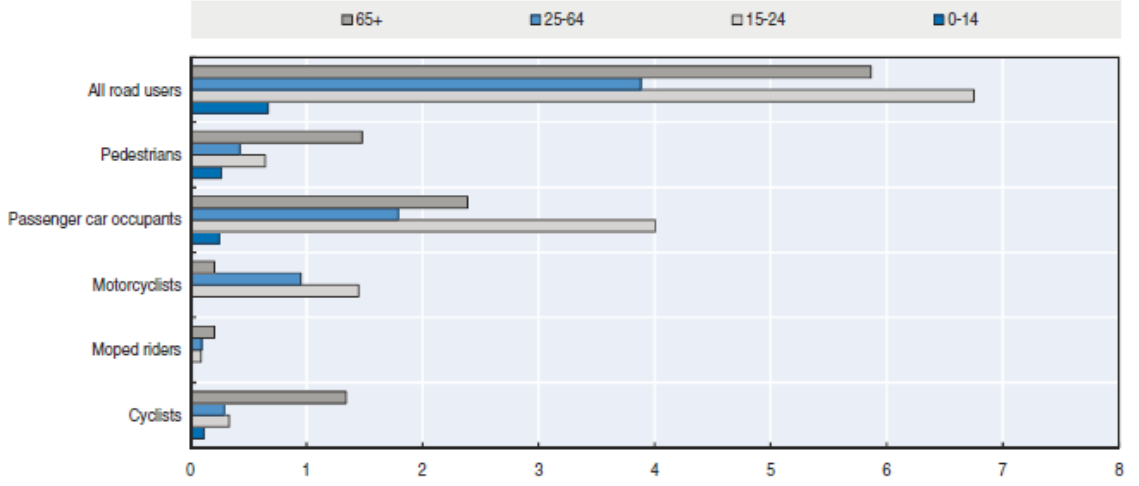


Figure A. 3 : Road fatality by age and road usergroup for Germany per 100 000 inhabitants in 2014 (OECD/ITF (2016))

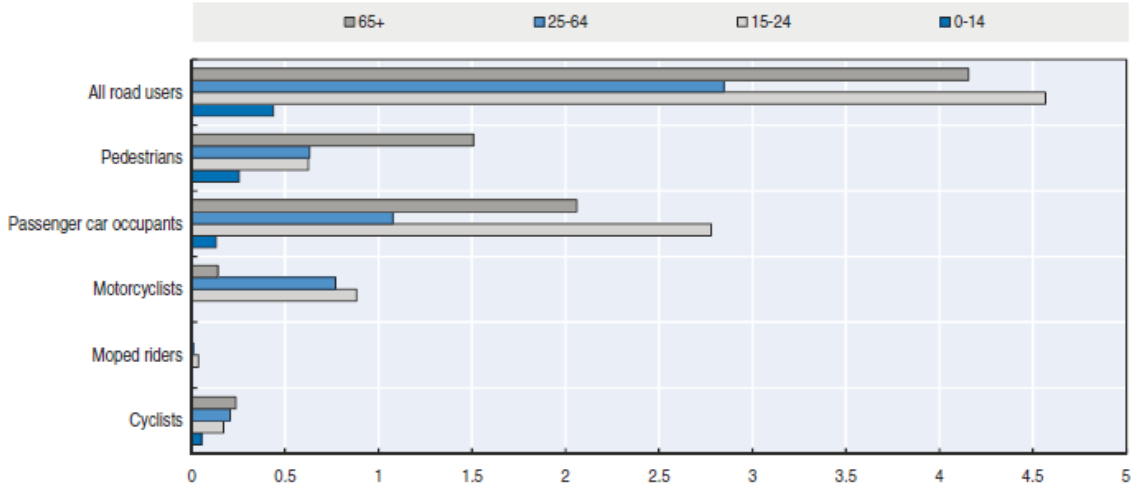


Figure A. 4 : Road fatality by age and road usergroup for the United Kingdom per 100 000 inhabitants in 2014 (OECD/ITF (2016))

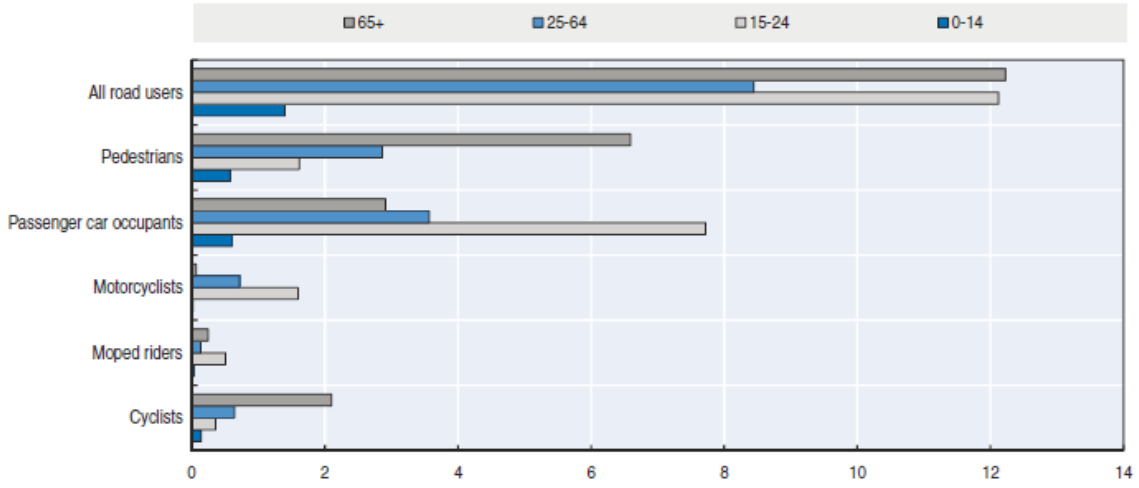


Figure A. 5 : Road fatality by age and road usergroup for Poland per 100 000 inhabitants in 2014 (OECD/ITF (2016))

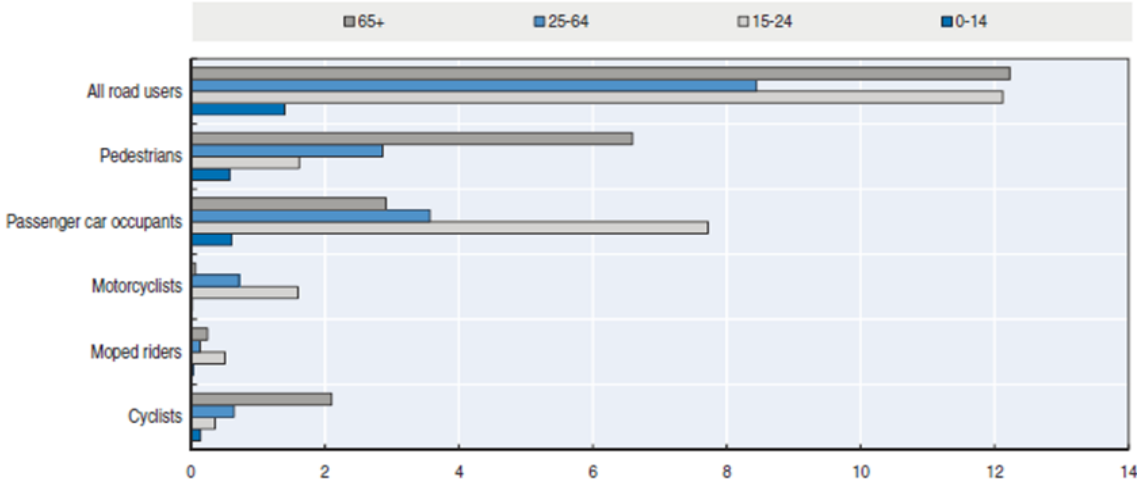


Figure A. 6 : Road fatality by age and road usergroup for Spain per 100 000 inhabitants in 2014 (OECD/ITF (2016))

A.3 Road fatality by road type

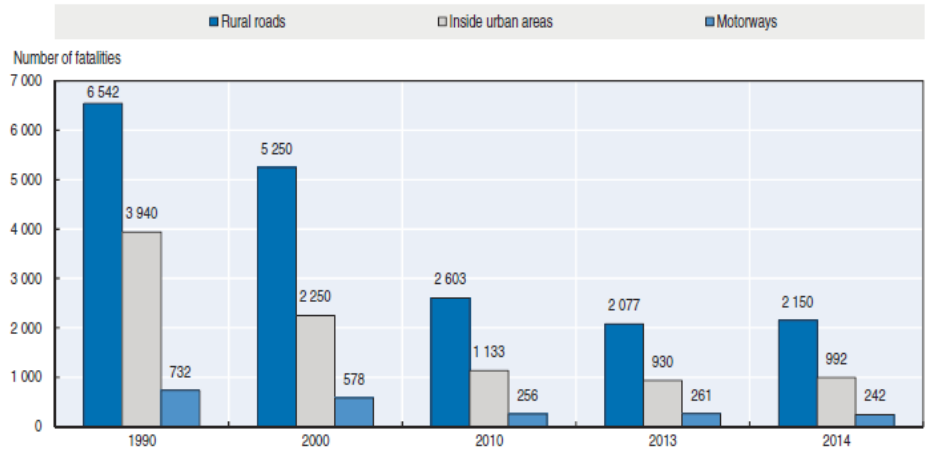


Figure A. 7 : Road fatality by road type for France (OECD/ITF (2016))

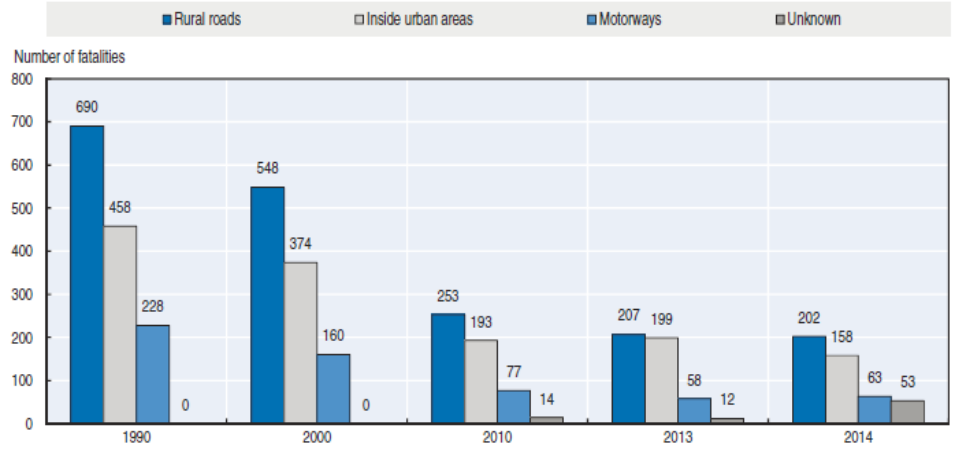


Figure A. 8 : Road fatality by road type for the Netherlands (OECD/ITF (2016))

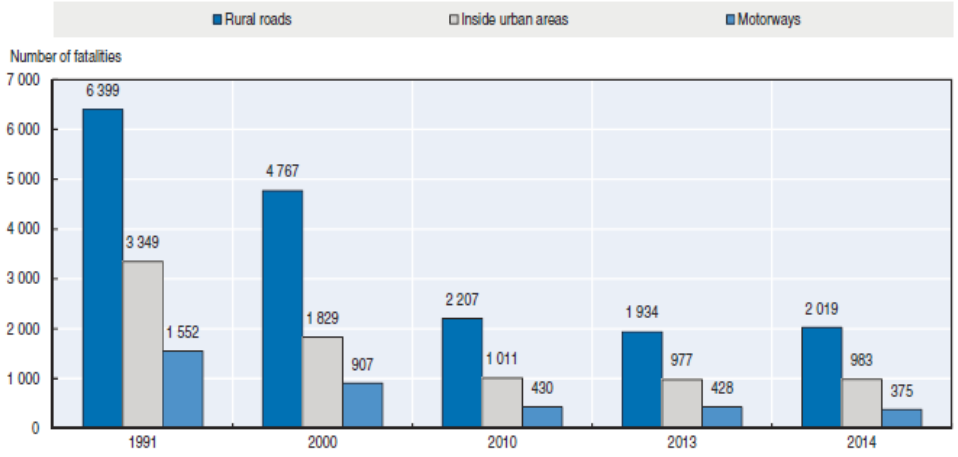


Figure A. 9 : Road fatality by road type for Germany (OECD/ITF (2016))

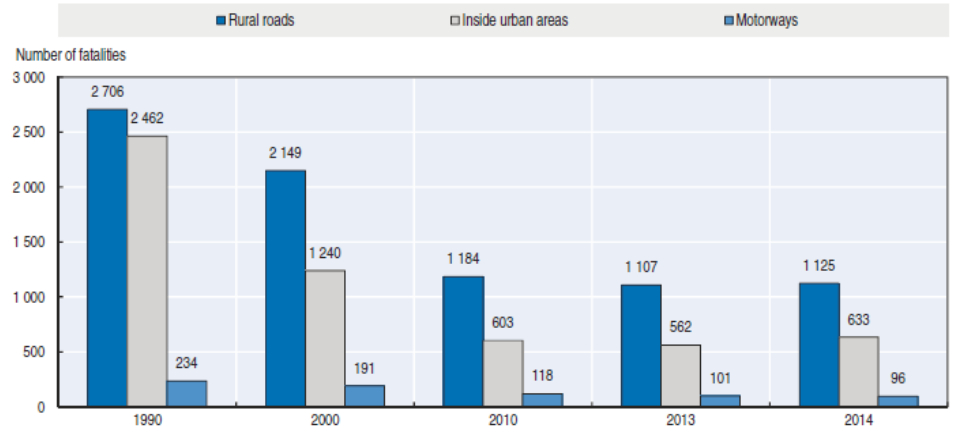


Figure A. 10 : Road fatality by road type for the United Kingdom (OECD/ITF (2016))

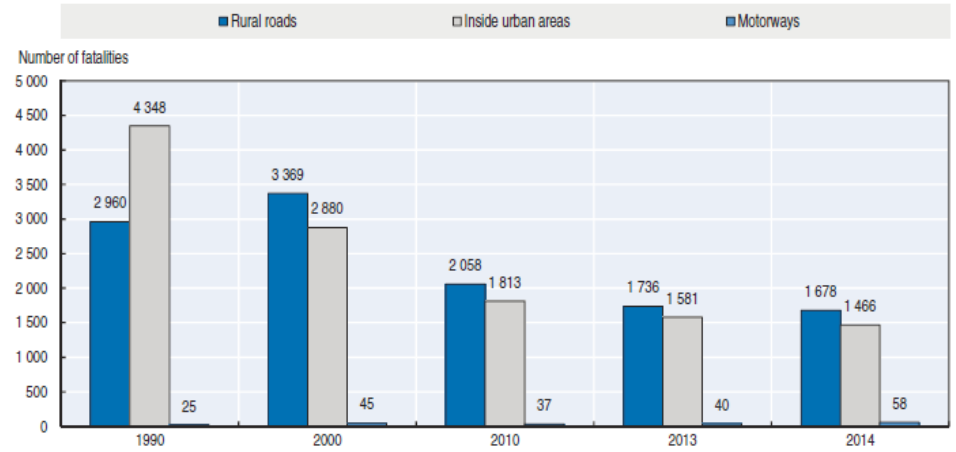


Figure A. 11 : Road fatality by road type for Poland (OECD/ITF (2016))

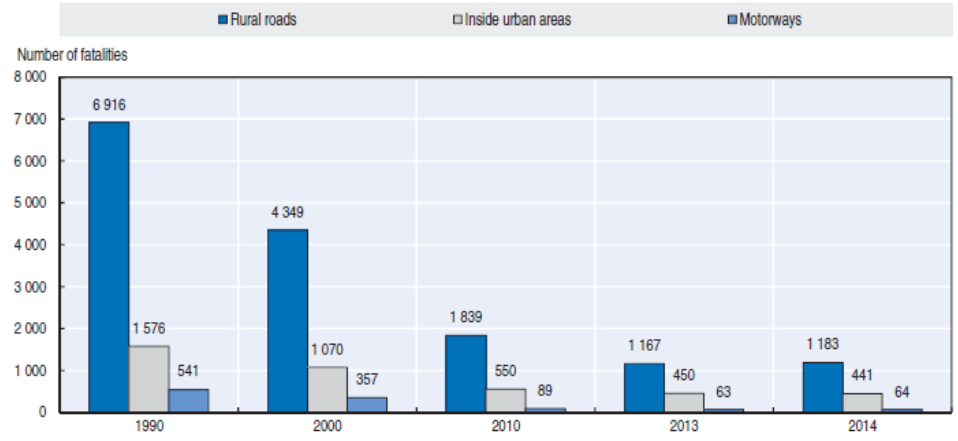


Figure A. 12 : Road fatality by road type for Spain (OECD/ITF (2016))

A.4 Seat belt wearing rate by car occupancy and road type

Table A. 7 : Seat belt wearing rate by car occupancy and road type for France (OECD/ITF (2016))

	2005	2012
Front seat		
Urban roads	94.2	95.8
Motorways	98.3	98.6
Rear seats		
Adults – Urban roads	66	71
Adults – Motorways	73	84
Children (use of child restraint) – Urban roads	85	89
Children (use of child restraint)– Motorways	82	94

Table A. 8 : Seat belt wearing rate by car occupancy and road type for Germany (OECD/ITF (2016))

	2000	2013	2014
Front seat			
General (driver + passengers)			
Driver	94	97	98
Passenger	95	98	98
Urban roads (driver)	90	96	98
Rural roads (driver)	95	97	98
Motorways (driver)	98	98	99
Rear seats			
General	82	97	98
Children (use of child restraint)	94	98	99

Table A. 9 : Seat belt wearing rate by car occupancy and road type for Poland (OECD/ITF (2016))

	2014	2015
Front seat		
Driver	93	
Passenger	94	
Urban roads (driver)	92	
Rural roads (driver)	92	
Motorways (driver)	96	
Rear seats		
General	71	
Children (use of child restraint)	89	93

Source: Motor Transport Institute.

Table A. 10 : Seat belt wearing rate by car occupancy and road type for the United Kingdom (OECD/ITF (2016))

	2009	2014
Driver	95	97.9
Front seat passenger	95	96
Rear seat passenger	89	87.1
Child rear seat passenger (aged < 14)	96	90.7
Adult rear seat passenger (aged 14 and over)	79	81.1

A.5 Road safety attitudes and behaviour of drivers

Table A. 11 : Road safety attitudes and behaviour of drivers for France (ERSO (2017))

French drivers are less supportive for stricter legislation on speeding and drink-driving compared to drivers in other countries.

	France	ESRA average
Self-reported driving behaviour	**% of drivers that show behaviour at least once**	
In the past 12 months, as a road user, how often did you drive without respecting a safe distance to the car in front?	67%	60%
In the past 12 months, as a road user, how often did you talk on a hand-held mobile phone while driving?	31%	38%
In the past 12 months, as a road user, how often did you drive faster than the speed limit inside built-up areas?	68%	68%
Supporting stricter legislation	**% of drivers that disagree with the following**	
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: for speeding**	46%	61%
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: alcohol**	85%	87%
Do you support the following measure?: **Zero tolerance for alcohol (0,0‰) for all drivers**	50%	41%
Perceived probability of being checked	**% of drivers with answers in following categories**	
In the past 12 months, have you been stopped by the police for a check? **(once or more)**	30%	31%
On a typical journey, how likely is it that you (as a driver) will be checked by the police for respecting the speed limits (including checks by police car with a camera and/or GoSafe cameras)? **(Very (big) chance)**	56%	37%
In the past 12 months, have you been checked by the police for alcohol while driving a car (i.e., being subjected to a Breathalyser test)? **(once or more)**	23%	19%

Source: ESRA 2016

Legend
(comparison of country attitude in relation to average attitude of other SARTRE countries):

- 2-9% better
- 10-19% better
- ≥ 20% better
- 2-9% worse
- 10-19% worse
- ≥ 20% worse

Table A. 12 : Road safety attitudes and behaviour of drivers for Germany (ERSO (2017))

German drivers are more supportive for stricter legislation on speeding and drink-driving compared to drivers in other countries.

	Germany	ESRA average
Self-reported driving behaviour	**% of drivers that show behaviour at least once**	
In the past 12 months, as a road user, how often did you drive without respecting a safe distance to the car in front?	67%	60%
In the past 12 months, as a road user, how often did you talk on a hand-held mobile phone while driving?	36%	38%
In the past 12 months, as a road user, how often did you drive faster than the speed limit inside built-up areas?	78%	68%
Supporting stricter legislation	**% of drivers that disagree with the following**	
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: for speeding**	70%	61%
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: alcohol**	90%	87%
Do you support the following measure?: **Zero tolerance for alcohol (0,0‰) for all drivers**	40%	41%

Perceived probability of being checked	**% of drivers with answers in following categories**	
In the past 12 months, have you been stopped by the police for a check? **(once or more)**	17%	31%
On a typical journey, how likely is it that you (as a driver) will be checked by the police for respecting the speed limits (including checks by police car with a camera and/or GoSafe cameras)? **(Very (big) chance)**	25%	37%
In the past 12 months, have you been checked by the police for alcohol while driving a car (i.e., being subjected to a Breathalyser test)? **(once or more)**	8%	19%

Source: ESRA 2016

Legend
(comparison of country attitude in relation to average attitude of other SARTRE countries):

- 2-9% better
- 10-19% better
- ≥ 20% better
- 2-9% worse
- 10-19% worse
- ≥ 20% worse

Table A. 13 : Road safety attitudes and behaviour of drivers for Poland(ERSO (2017))

Polish drivers are more supportive for stricter legislation on speeding and drink-driving compared to drivers in other countries.

	Poland	ESRA average
Self-reported driving behaviour	**% of drivers that show behaviour at least once**	
In the past 12 months, as a road user, how often did you drive without respecting a safe distance to the car in front?	47%	60%
In the past 12 months, as a road user, how often did you talk on a hand-held mobile phone while driving?	48%	38%
In the past 12 months, as a road user, how often did you drive faster than the speed limit inside built-up areas?	64%	68%
Supporting stricter legislation	**% of drivers that disagree with the following**	
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: for speeding**	67%	61%
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: alcohol**	90%	87%
Do you support the following measure?: **Zero tolerance for alcohol (0,0‰) for all drivers**	30%	41%
Perceived probability of being checked	**% of drivers with answers in following categories**	
In the past 12 months, have you been stopped by the police for a check? **(once or more)**	55%	31%
On a typical journey, how likely is it that you (as a driver) will be checked by the police for respecting the speed limits (including checks by police car with a camera and/or GoSafe cameras)? **(Very (big) chance)**	53%	37%
In the past 12 months, have you been checked by the police for alcohol while driving a car (i.e., being subjected to a Breathalyser test)? **(once or more)**	48%	19%

Source: ESRA 2016

Legend
(comparison of country attitude in relation to average attitude of other SARTRE countries):

- 2-9% better
- 10-19% better
- ≥ 20% better
- 2-9% worse
- 10-19% worse
- ≥ 20% worse

Table A. 14 : Road safety attitudes and behaviour of drivers for the United Kingdom (ERSO (2017))

British drivers are more supportive for stricter legislation on speeding and drink-driving compared to drivers in other countries.

	United Kingdom	ESRA average
Self-reported driving behaviour	**% of drivers that show behaviour at least once**	
In the past 12 months, as a road user, how often did you drive without respecting a safe distance to the car in front?	49%	60%
In the past 12 months, as a road user, how often did you talk on a hand-held mobile phone while driving?	22%	38%
In the past 12 months, as a road user, how often did you drive faster than the speed limit inside built-up areas?	56%	68%
Supporting stricter legislation	**% of drivers that disagree with the following**	
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: for speeding**	69%	61%
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: alcohol**	89%	87%
Do you support the following measure?: **Zero tolerance for alcohol (0,0‰) for all drivers**	38%	41%
Perceived probability of being checked	**% of drivers with answers in following categories**	
In the past 12 months, have you been stopped by the police for a check? **(once or more)**	9%	31%
On a typical journey, how likely is it that you (as a driver) will be checked by the police for respecting the speed limits (including checks by police car with a camera and/or GoSafe cameras)? (**Very (big) chance)**	21%	37%
In the past 12 months, have you been checked by the police for alcohol while driving a car (i.e., being subjected to a Breathalyser test)? **(once or more)**	5%	19%

Source: ESRA 2016

Legend
(comparison of country attitude in relation to average attitude of other SARTRE countries):

- 2-9% better
- 10-19% better
- ≥ 20% better
- 2-9% worse
- 10-19% worse
- ≥ 20% worse

Table A. 15 : Road safety attitudes and behaviour of drivers for the Netherlands (ERSO (2017))

Dutch drivers are less supportive for stricter legislation on speeding, but more for drink-driving compared to drivers in other countries.

	Netherlands	ESRA average
Self-reported driving behaviour	**% of drivers that show behaviour at least once**	
In the past 12 months, as a road user, how often did you drive without respecting a safe distance to the car in front?	58%	60%
In the past 12 months, as a road user, how often did you talk on a hand-held mobile phone while driving?	24%	38%
In the past 12 months, as a road user, how often did you drive faster than the speed limit inside built-up areas?	67%	68%
Supporting stricter legislation	**% of drivers that disagree with the following**	
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: for speeding**	43%	61%
What do you think about the current traffic rules and penalties in your country for each of the following themes?: **The penalties are too severe: alcohol**	91%	87%
Do you support the following measure?: **Zero tolerance for alcohol (0,0‰) for all drivers**	30%	41%
Perceived probability of being checked	**% of drivers with answers in following categories**	
In the past 12 months, have you been stopped by the police for a check? **(once or more)**	20%	31%
On a typical journey, how likely is it that you (as a driver) will be checked by the police for respecting the speed limits (including checks by police car with a camera and/or GoSafe cameras)? **(Very (big) chance)**	36%	37%
In the past 12 months, have you been checked by the police for alcohol while driving a car (i.e., being subjected to a Breathalyser test)? **(once or more)**	17%	19%

Source: ESRA 2016

Legend
(comparison of country attitude in relation to average attitude of other SARTRE countries):

- 2-9% better
- 10-19% better
- ≥ 20% better
- 2-9% worse
- 10-19% worse
- ≥ 20% worse

A.6 Questionnaire for driver's interview on recommendations

Before presenting the situations:

1) **Are you part of an association**:
   - ☐ cyclists
   - ☐ bikers
   - ☐ motorists
   - ☐ in relation to road safety

2) Do you use a system or ems information: GPS, traffic information, navigation? If you use more than one, please report the frequency of use of the one you use the most.
   - ☐ I do not have
   - ☐ I have but I do not use
   - ☐ This happens to me a few times a year.
   - ☐ I used about once a month
   - ☐ I used at least once a week
   - ☐ I used almost daily

3) Do you use one or more driving assistance systems: **cruise control, limiter, lane keeping, blind spots …?** If you use more than one, please report the frequency of use of the one you use the most.
   - ☐ I do not have
   - ☐ I have but I do not use
   - ☐ This happens to me a few times a year.
   - ☐ I used about once a month
   - ☐ I used at least once a week
   - ☐ I used almost daily

4) What is your overall view of the effectiveness of road safety awareness campaigns?
   - ☐ I avoid watching
   - ☐ I look but I do not find it interesting
   - ☐ I look at them and it helps me to be aware of problems
   - ☐ I find it interesting for others to do more careful

5) **If you had to give your opinion on the question, what would be a good prevention campaign for you?**
Thank you for classifying three proposals from the most important to the least important.

A good prevention campaign should:

-A- Present risk in a scientific and quantified way
-B- Present the risk emotionally and affectively.
-C- Suggest consequences more than show them
-D- Present the risk in a raw and frontal way
-E- Staying positive and valuing good behavior.
Choice 1 : ……. Choice 2 : ……. Choice 3 : ……

6) Have you ever completed a driving development course?
   - ☐ yes, which one : .....
   - ☐ no

For each situation:

In the following questions, we will ask you to give your opinion on sentences that describe the situation.
You have the option to modulate your opinion from "Strongly Disagree" to "Strongly Agree".

1) **Proposal: The brake has marked a passage ed Quick with a "normal" situation to a "critical" situation potentially dangerous.**
   - ☐ Totally disagree
   - ☐ Disagree
   - ☐ Neither disagree nor agree
   - ☐ Agreed
   - ☐ Strongly agree

2) **This situation was complex for you to manage. (Complex situation: lots of information to take)**
   - ☐ Totally disagree
   - ☐ Disagree
   - ☐ Neither disagree nor agree
   - ☐ Agreed
   - ☐ Strongly agree

3) **This situation was due especially the behavior of other road users.**
   - ☐ Totally disagree
   - ☐ Disagree
   - ☐ Neither disagree nor agree
   - ☐ Agreed
   - ☐ Strongly agree

   Could you be more precise? .....

4) **This situation was easily controlled.**
   - ☐ Totally disagree
   - ☐ Disagree
   - ☐ Neither disagree nor agree
   - ☐ Agreed
   - ☐ Strongly agree

5) **There were warning signs that could help you anticipate this situation.**
   - ☐ Totally disagree
   - ☐ Disagree
   - ☐ Neither disagree nor agree
   - ☐ Agreed
   - ☐ Strongly agree

6) **Have you ever encountered this type of situation?**
   - ☐ This had never happened to me before this time.
   - ☐ This happens to me a few times a year.
   - ☐ This happens to me about once a month
   - ☐ This happens to me at least once a week
   - ☐ This happens to me almost daily

7) In your opinion, to avoid ed to be in this situation, how is there any way to act ?

☐ By changing the infrastructure (road marking, signs ...) → (Q10)
☐ adding assistance system in the vehicle to give information (Exceeding speed, GPS ...) → (Q11)
☐ adding assistance system in the vehicle to take control (Cruise Control, Emergency Brake ...) → (Q12)
☐ proposing other vehicle improvements (yours, that of others) → (Q13)
☐ by Police Controls → (Q14)
☐ changing the driver training (initial training, advanced training courses) → (Q15)
☐ modifying the code of the road → (Q16)
☐ introducing new themes in awareness campaigns → (Q17)

Specify below each of the proposals you have checked.

8) Can you clarify how you would consider <u>infrastructure changes</u>?

☐ Change marking, how: .....
.....
☐ Delete all or part of signaling, which one: .....
.....
☐ Add one or more types of signage or new signage, specify:
.....
☐ Reallocate routes differently, how: .....
.....
☐ Change the road completely, how: .....
.....
☐ Other: .....
.....

9) Would an <u>information system</u> be useful?

☐ In my car. Description of what the system could do: .....
.....
☐ in the other cars. Description of what the system could do: .....
.....

10) How could an <u>active assistance</u> system, taking control of the vehicle, be useful?

Description of what this system might do: .....
.....

11) What improvements could be made in <u>vehicles</u>?

Description of what this system might do: .....
.....

12) To avoid this situation, what types of <u>police actions</u> could be useful?

☐ Awareness, describe: .....
.....
☐ Fines, specify: .....
.....
☐ Other actions: .....
.....

13) Specify the types of <u>driving training</u> that may be useful to avoid this situation.

☐ When licensing.
☐ Advanced course
☐ Other: .....
Description of what this training could learn: .....
.....

14) In your opinion, how could the Road Code be amended to avoid this situation?

Description : .....
.....

15) What could these <u>awareness campaigns</u>?

Description of what this campaign could deliver as message and public target: .....
.....

16) In which order of priority would you classify the actions you envisaged in the following list?

A. By Infrastructure Changes
B. Providing Vehicle Assistance Systems to provide information
C. Providing In-Vehicle Assistance Systems to take control
D. By proposing other improvements to the vehicles (yours and others)
E. Making Police Checks
F. By amending the Highway Code
G. By changing driving training
H. By introducing new themes in awareness-raising campaigns

Priority 1 : ……. Priority 2 : ……. Priority 3 : ……..

A.7 Comments of drivers during interview

List of comments with proposals for infrastructure changes

- Lack of parking poses problem. Consider single-track traffic, add sidewalks, rethink traffic and need parking.
- Design a dynamic traffic sign that lights up when the pedestrian is ready to cross. High-rise signage to be seen from afar.
  Light pedestrian crossings at night: pedestrians in the dark, dressed in black are absolutely not visible.
- Upstream coherence between the typology of the infrastructure (wide road, good visibility and authorized speed, only 50.
  Round dangerous point, prevent further upstream.
- Better identify highway exits
- Turn with a mound on one side and a hole on the other. Car in front with brambles on the side of the road so that she is forced to deport. Plan the slope so that the road is wider. Narrow road forbidden to heavy goods vehicles. Not want the road to be widened to run faster. It is limited to 50 but the limitation is poorly respected.
- Off-street parking to facilitate the avoidance of people turning left. But so little used, not necessarily necessary.
- More insertion pathways, or longer
- Continuous line to prevent last minute insertions.
- Install speed bumps to slow drive
- Remove the pedestrian crossing. A speed limitation would not be respected at this point.
- Remove the central medians, failing that put plastic studs.
- Audio and visual alert to signal the presence of a pedestrian on a passage.
- Left lane forbidden to heavy lorries on the urban highway
- Widening the road
- Announce traffic light further upstream
- Better indicate crossing
- Add pedestrian light
- Put a stop or give way, it is a subdivision exit. Mirror to anticipate arrival of a car
- Put the way in one direction
- Widening the road
- Downside on the road to plan to park without biting on the track.
- Better indicate the bus route.
- Announce the traffic jam upstream.
- Dynamic sign to signal that a pedestrian crosses or wants to cross, or a traffic light to protect the passage, or bridge for pedestrians. Despite the fixed signs, and as there is virtually no one, there is no expectation of pedestrians, too close to the exit of the curve.
- Lack of marking, not seen the street on the left.
- Modify the input of the store so that it is more visible
- Indicate when a pedestrian enters the passage

List of comments with suggestions for informative assistance system

- Long range obstacle detection
- Imagine radar that analyzes everything that is moving in the environment to detect pedestrians and animals.
- Environmental sensors to detect the presence of traffic lights
- Info on the distance with the vehicle you are following
- Imagine a sensor that detects the presence of oil plate on the track
- Emergency brake lights that should be different from normal braking
- Alert behavior non-standard to red traffic light
- Information on arrival too fast on the front car.

List of comments with suggestions for active assistance system

- Self-braking
- Emergency braking
- System to retake control of the vehicle in the event of loss of grip.
- Automatic emergency system when it brakes before.
- Emergency braking
- Button that could be activated or deactivated to engage or not an emergency assistance and brake system, just when desired. The assistance reduces the pleasure of driving or a system that would detect signs of fatigue and activate the assistance system.
- Emergency braking. Traffic jam assist. A friend has it, but it puts too much space between the front vehicle and people fit.
- Braking adapted to the situation if not as usual.
- Emergency braking
- Emergency braking
- Emergency braking
- Emergency braking

List of comments with system proposals on other vehicles

- Kit to see in front of vans or trucks.
- Indicate if vehicle stopped in the middle of the track even if it does not brake or not.

List of comments with proposals for police actions

- Compliance with the parking rules.
- Speed controls on a wide road upstream of a place where you have to slow down.
- Fines for dangerous wire changes
- Prevent trucks from getting on the emergency stop strip to wait
- Radars

List of comments with proposals for driving training

- Courses to review the code
- Trainings on the rules of insertion in the tracks, how far we must fit.
- Learn safety distances
- Learn the arrivals on slow or stopped vehicle.

List of comments with proposals for the modification of the highway code

- Heavy trucks should not park on the emergency stop band, problem of rest time.

List of comments with proposals with ideas for awareness campaigns

- Awareness of the use of the turn signal when turning.
- Raise awareness of the risks engendered by zig-zig in traffic.
- Prevention campaign on the proper use of roundabouts
- Respect safety distances and show accidents.

Appendix B Review report template; checklist for reviewers

B.1 Overall judgement: readibility, structure and format

		Yes	No	N/A
	Does the deliverable reflect the content described in the Description of Work?	X		
Comments				
	Is the deliverable sufficiently understandable: did you fully understand it (even if slightly off topic for you)?	X		
Comments				
	Does the deliverable include learning from mistakes/challenges encountered and does it stimulate to further research?	X		
Comments				
	Is the document template applied properly?		X	
Comments	See font size chapter 4! Comments 6 to 8!			
	Is the structure of the deliverable easy to follow? Do you suggest any changes to the structure to make the deliverable more accessible?		X	
Comments	The structure of chapter 5 differs from other chapters.			
	Is the English in the deliverable good? Is it clear and accessible?	X		
Comments				
	Are the figures and tables understandable and refered to in the text?		X	
Comments	Table markings in chapter 5.3 and chapter 6.2ff are in not right order. Furthermore it's unclear why the recommendations are displayed in tables without numbers.			

B.2 Scientific judgement

		Yes	No	N/A
	Is the issue which is being researched clearly and simply stated?	X		
Comments				
	Are the objectives as described in the deliverable in line with the Description of Work (description of the Task)?	X		
Comments				
	Is the quality of the study design sufficient, are the methods/procedures as well as their actual application appropriate/correct?	X		
Comments				
	Do the results match the objectives as described in the Description of Work?	X		

Comments				
	How are the findings and results of the work described in the deliverable? Does the conclusion chapter reflect all described main important issues in the report and are the conclusion well based? Are the conclusions clearly stated? Are the conclusions relevant and applicable?	X		X
Comments	According to the conclusions: The chapters are not fully processed (e.g. chapters 3, 4, 7 and 8) to give a complete answer.			
	Does the report include the relevant and necessary references? If relevant, is the necessary wider view on the field of work properly given?	X		
Comments				
	Other comments	X		
	See comments in full text!			