UDRIVE

European Naturalistic Driving Study

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Executive Summary

Each week, around 500 people die and around 30.000 become injured on roads in the European Union. Also, road transport is one of the main sources of air pollution, which remains the number one environmental cause of death in the EU, leading to about 400.000 deaths each year. Human behaviour is directly or indirectly an important determinant of these negative consequences. Accordingly, an in-depth understanding of road user behaviour is needed to identify the main causes and the most promising approaches to mitigate the negative consequences of road transport.

Naturalistic Driving is a relatively new research method, allowing us to increase understanding in road user behaviour in a way that traditional research methods such as surveys, driving simulators or instrumented vehicles were never able to.

Objectives

The UDRIVE project aimed to increase our understanding of road user behaviour by systematically studying road user behaviour in real life conditions. First and foremost it focused on the identification of relevant measures to improve road safety up to the Horizon 2020 and beyond. Secondly, it focused on the identification of promising approaches for reducing harmful emissions and fuel consumption in order to make road traffic more sustainable.

Naturalistic data on cars, trucks and motorcycles across Europe

UDRIVE is the first large scale European Naturalistic Driving study, providing unique behavioural data on car driving, truck driving ánd riding powered two-wheelers. In 6 European countries, cars, trucks and powered two wheelers were fitted with camera's, sensors and dedicated equipment allowing us to, unobtrusively, record an impressive amount of footage on natural driving behavior. All participating vehicles were equipped with the same UDRIVE Data Acquisition System which was especially developed for the project and all data was stored in one central database. The final sample included 192 car drivers, 47 motor cyclists and 48 truck drivers.

Main Results

The UDRIVE project has generated several types of results: technical developments, The UDRIVE database and the new behavioural insights .

Technical developments were needed as part of the data collection and analysis workflow. Three tools have been developed in UDRIVE: a Data Acquisition System to collect data, an Online Monitoring Tool to monitor data collection, and a Data analysis tool to analyze the collected data. As the project is dealig with personal information that needs to be protected throughout the data chain, a Data Protection protocol has been developed within the project.

The UDRIVE database is another major result of the UDRIVE project: a rich European Naturalistic Driving database that has been developed. The uniqueness of this database stems from the variety of vehicles that have been used, the range of participant nationalities and ages, and the wide array of collected variables.

New Behaviour Insights were obtained by analyzing the collected data. UDRIVE has generated insights in driving and riding behaviour related to four main topics: everyday- and risky driving, secondary task engagement, interactions with vulnerable road users, and eco-driving.

Data analyses within UDRIVE and beyond

The UDRIVE database offers nearly infinite opportunities for data analysis. Within the timeframe of the UDRIVE project, quite a few of these analyses have been conducted. The end of the UDRIVE project does not mean the end of the exploitation of the UDRIVE database, on the contrary. The database will remain available for subsequent analyses for the UDRIVE partners, and within the bounds of privacy-related legal and ethical restrictions, also for other organisations.

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1 Introduction

UDRIVE was the first large-scale Naturalistic Driving study in Europe. By systematically studying road user behaviour in real life conditions, it aimed to identify building blocks for relevant and efficient measures for reducing road traffic casualties as well as harmful emissions.

This report provides an overview of the UDRIVE project through four main sections. Chapter 2 covers the context, objectives, and approach of UDRIVE. Chapter 3 summarizes the main project results in terms of technical development, legal development, the UDRIVE database, research results, and insights on technology for future for Naturalistic Driving studies. Chapter 4 discusses the impact of the current UDRIVE results, as well as the potential impact of future studies using the UDRIVE database. Finally, Chapter 5 provides contact information for follow-up questions.

2 Context, objectives and approach

This section summarizes the rationale for the UDRIVE project by describing the project context, its objectives, and its approach.

2.1 UDRIVE context

Road transport is indispensable for the exchange of goods and persons within the European Union and between neighbouring countries. Unfortunately, road transport also has several major negative consequences, in particular those related to road safety and environment. Human behaviour is directly or indirectly an important determinant of these negative consequences. Accordingly, an in-depth understanding of road user behaviour is needed to identify the main causes and the most promising approaches to mitigate the negative consequences of road transport.

2.1.1 Challenges for road traffic safety

In 2016, in the European Union just over 25,500 people were killed in traffic (Adminaite et al., 2017), equalling 70 people each day again. In addition, the European Commission estimates that in 2014 135,000 people, equalling 370 people each day, were seriously injured on EU roads (EC, 2016). Not only does this lead to immense costs in terms of human suffering and sorrow, it also leads to enormous monetary costs, estimated to add up to, on average, around 2% of EU countries' gross domestic product (Wijnen et al., 2017). Human behaviour is directly or indirectly an important determinant of road crashes.

Road safety has been a longstanding major concern for the European Commission, as can be concluded from the many documents and activities that have been published and undertaken in the past decades. It has, for example, set ambitious targets of reducing the number of road fatalities to a maximum of 15,500 fatalities in 2020 (EC, 2010a) with a longer-term vision of "moving close to zero fatalities in road traffic by 2050" (EC, 2011). Recently, the EU Transport Ministers agreed to set a target of halving the number of serious injuries on roads in the EU by 2030 from their 2020 level (EU, 2017). However, looking at the current figures and the developments in the last few years (Adminaite et al., 2017), it requires very serious efforts to bring these targets into reach.

2.1.2 The environmental burden of road traffic

Road transport not only results in many casualties, it also puts a severe burden on the environment. Various vehicle emissions contribute to the greenhouse effect and as such to the climate change. Several emissions also affect the quality of air. Moreover, road transport is still largely realized by consuming non-renewable fossil fuels. Also for the environment, the European Union has set targets, e.g., the target of a 20% cut in carbon emissions as compared to 1990 levels to be achieved in 2020 (EC, 2010b). The urgency of this type of targets was further emphasized by the Paris Climate Agreement of December 2015.

The last few decades emission legislation (e.g., EURO standards and CO2 legislation) have become much stricter, and cars much cleaner. However, it has been found that the real-world emissions of cars have not decreased at the same rate as the emissions measured on the type approval tests (Kadijk et al., 2016; Tietge et al., 2016). This indicates the increasing importance of driver behaviour, driving style as well as traffic circumstances, when evaluating real-world emissions of cars.

2.1.3 Human behaviour as a central determinant

Features of the vehicle as well as road and traffic circumstances are important determinants of both road safety and the environmental burden of our road transport system. Central to the system, however, are its users and the way they respond to the vehicle, the road and other road users. In-depth detailed knowledge about human behaviour in everyday traffic situations is needed to get a better representation of factors that affect road safety and road traffic emissions than currently available. This is where UDRIVE comes in.

2.2 UDRIVE objectives

The UDRIVE project aimed to increase our understanding of road user behaviour. First and foremost it focused on the identification of relevant measures to improve road safety up to the Horizon 2020 and beyond. Secondly, it focused on the identification of promising approaches for reducing harmful emissions and fuel consumption in order to make road traffic more sustainable. UDRIVE aimed to contributed to the following more specific scientific and technical objectives:

- Describe and quantify road user behaviour in different European regions, in regular conditions and (near-)crashes, with special attention to:
  - the prevalence and conditions of drivers involvement in secondary tasks such as distraction and inattention;
  - interactions between drivers and vulnerable road users: pedestrians and cyclists;
- Describe and quantify road user behaviour in relation to emission levels and fuel consumption with special in-depth attention to the effects of:
  - driving style;
  - road and road network characteristics;
  - traffic conditions such as congestion, impaired visibility or adverse weather.
- Identify new approaches, measures and tools to make the traffic system safer and more sustainable, with special attention to:
  - definition of measurable safety and environmental performance indicators for monitoring developments over time;
  - improving existing models of driver behaviour to be used for e.g. predicting effect of safety and environmental measures, and traffic flow simulations;
  - applications in commercial transport, including driver support systems and targeted training for safer and more fuel efficient driving.

2.3 UDRIVE approach

In order to meet the objectives and collect in-depth behavioural data, the UDRIVE project applied the Naturalistic Driving method. In previous studies both in Europe (PROLOGUE, Van Schagen & Sagberg, 2012) and in the United States (SHRP2, Campbell, 2012), the approach had proven its potential to contribute substantially to the understanding of road user behaviour.

2.3.1 In-depth behavioural information by Naturalistic Driving

A Naturalistic Driving (ND) study can be defined as a study undertaken to provide insight into driver behaviour during everyday trips by observing in detail the driver, the vehicle and the surroundings through unobtrusive data gathering equipment and without experimental control. Typically, in an ND study vehicles are equipped with several small cameras and sensors. For several weeks or months, these devices inconspicuously record vehicle manoeuvres (like speed, acceleration and deceleration, direction), driver behaviour (like eye, head and hand movements), and external conditions (like road, traffic and weather characteristics).

An ND study was considered most appropriate as this method provides insight into the actual real-world behaviour of road users, unaffected by experimental conditions and related biases. ND as a research method was developed in the late nineties of the previous century, and has been developed and refined continuously since then. The method has become technically possible because of the tremendous developments in information and communication technologies, improvements in storage capacities, data-mining, image processing, low-cost camera technology, etc. in the last couple of decades.

2.3.2 Car, truck and motorcycle data across Europe

For UDRIVE, data was collected in six countries: Germany, France, Poland, The Netherlands, United Kingdom and Spain. The final sample included 192 car drivers, 47 motor cyclists and 48 truck drivers (Castermans et al., 2017). All participating vehicles were equipped with the same UDRIVE Data Acquisition System which was especially developed for the project. All data was stored in a central database.

2.3.3 Data analyses within UDRIVE and beyond

The UDRIVE database offers nearly infinite opportunities for data analysis. Within the timeframe of the UDRIVE project quite a few of these analyses have been conducted. They focused on features of everyday driving, on distraction, on vulnerable road users, on the effects of road infrastructure, and on driving style and eco-driving. The next section gives an overview of the main results of UDRIVE‘s data analyses.

The end of the UDRIVE project does not mean the end of the exploitation of the UDRIVE database, on the contrary. The database will remain open for subsequent analyses for the UDRIVE partners, and within the bounds of privacy-related legal and ethical restrictions, also for other research organisations (see also Section 3.2).

3 Main results

The UDRIVE project has generated several types of results. Several tools have been developed as part of the data collection and analysis workflow and a legal structure has been developed to ensure that ethics are respected by all stakeholders. A large ND database has been delivered with unique variables. Several research results were obtained by analyzing the collected data. And finally, an evaluation of UDRIVE technology offers insights for future ND studies.

3.1 Technical development

Three tools have been developed in UDRIVE: a Data Acquisition System to collect data, an Online Monitoring Tool to monitor data collection, and a Data analysis tool to analyze the collected data. As the project is dealing with personal information that needs to be protected througout the data chain, a Data Protection protocol has be developed within the project.

3.1.1 Data Acquisition System

One of the main achievements of UDRIVE is the development of a state of the art Data Acquisition System (DAS). UDRIVE was the first large-scale naturalistic driving study in Europe, collecting data in six European countries (i.e., Germany, The Netherlands, United Kingdom, Spain, Poland, and France). One of the main goals was to collect data in the same format across countries, and to have the same set of variables available. Through this approach, it is possible to combine results of the different countries, and also to comparise between countries. For this reason, a detailed overview of technical specifications for the UDRIVE DAS has been drafted (Augros et al., 2013), based on the research questions developed within UDRIVE, as well as based on expectations for future, post-project, analysis. This deliverable was the basis for the Request for Proposal that UDRIVE distributed. Together with a manufacturer, UDRIVE developed one data logger suitable for installation in three different vehicle types: cars, trucks and powered two-wheelers (PTW). Having the same data logger for the three different vehicle types, ensured consistency and thereby comparability of data collected between the vehicle types and improved efficiency of development. The DAS was designed to collect data from various sensors and data sources, as illustrated in Figure 3.1 (and see Section 3.2.2 for an overview of the collected variables).

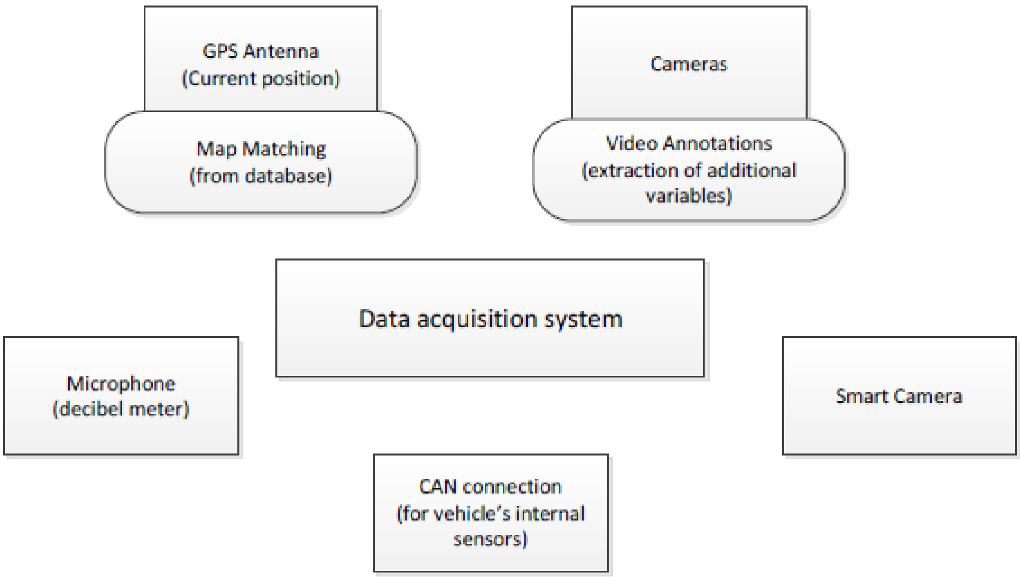


Figure 3.1: Overview of the data acquisition system, utilized sensors, and data sources.

Three UDRIVE vehicle adaptation teams (cars, trucks and PTW) worked together with the DAS manufacturer to design and develop the vehicle integration of the data logger, camera's and sensors. As most vehicles equipped with the UDRIVE DAS were owned by participants or transport companies, an important design criterion was that no permanent damage should be caused to the vehicle by installing the UDRIVE DAS. Another determining criterion for design was ease of installation and (related) the required installation time. Figure 3.2 gives an impression of the UDRIVE DAS integration in the different vehicle types.

Figure 3.2: Illustration of UDRIVE DAS and the integration in different vehicle types.

The UDRIVE DAS was homologated by the vehicle manufacturers to ensure that the UDRIVE DAS did not interfere with the normal functioning of the vehicle. All tests related to the homologation process were passed. Typical installation, configuration and calibration time of the DAS for all vehicle type was always less than one working day for one person which is very little for the unobtrusive integration of a system as complex as the UDRIVE DAS.

3.1.2 Online Monitoring Tool

The UDRIVE data flow involved three main stakeholder categories for collecting and managing the data: operation site (OS), local data centre (LDC) and central data centre (CDC). The six OSs (Germany, France, Netherlands, Poland, Spain, and UK) were responsible for installing and de-installing data acquisition systems(DAS) in vehicles, regularly replacing hard drives (HD) in vehicles during data collection, and monitoring data collection. The three LDCs (France, Germany, and Sweden) were responsible for data pre-processing: decryption, conversion, synchronization, harmonization, and (to some extent) data enrichment—adding road features from map matching. Finally, the CDC hosted the complete UDrive dataset and made the data available to analysts using a remote desktop service.

This whole process (data collection, transfer, and processing) was monitored by the UDRIVE On-line Monitoring Tool (OMT). This UDRIVE result is a new way to have complete control over how many data have been recorded, where they are located and where they are in the data-processing chain (illustrated in Figure 3.3). The OMT has helped OS teams to detect and solve technical issues swiftly, thus to ensure data quality and minimize loss of data.

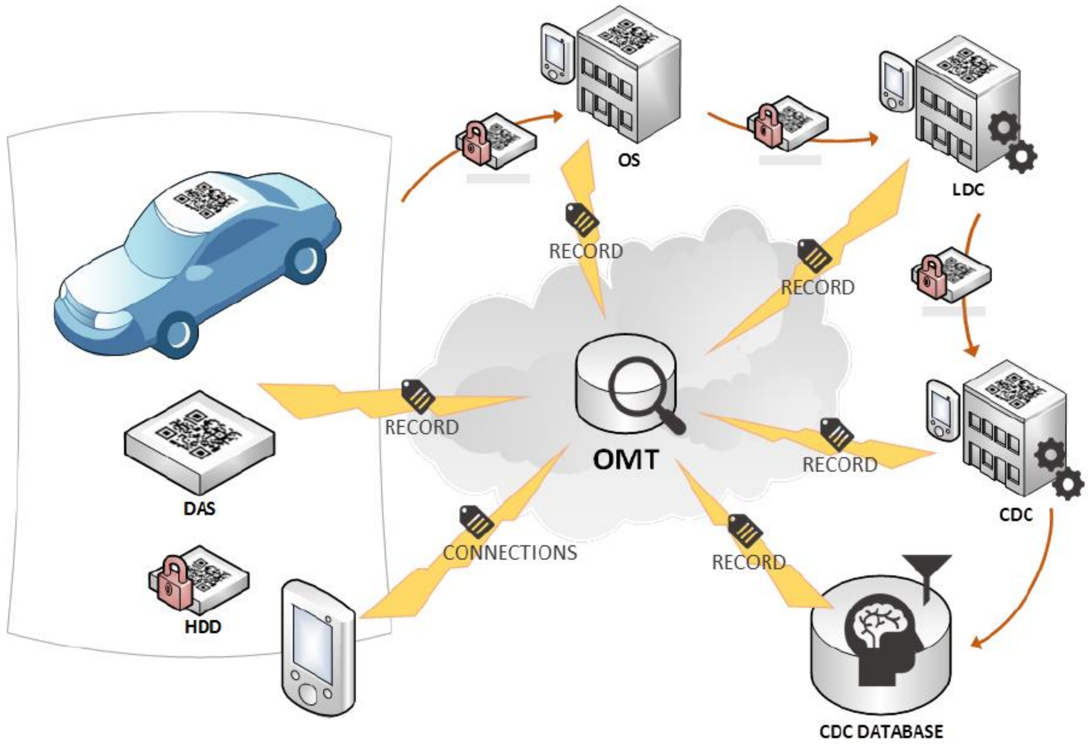


Figure 3.3: A visualization of the OMT, vehicles, LDC, and LDC. The red arrows show the data flow. The yellow flashes represent status uploads for each individual record throughout the data chain. Finally, the QR codes show where/when hardware (e.g., vehicles, DASs and hard-drives) was explicitly QR-scanned to update its status in the OMT.

3.1.3 Data analysis tool

In UDrive, data analysis was performed concurrently with data uploading and management. Annotators were manually coding attributes on a set of events, data processing might be running, transformed data might be extracted for analysis, several analysts might be developing new scripts to be included in the next processing, and new data might be in the process of being imported. Additionally, the process evolved over time. New derived measures had to be calculated and new annotations performed as the analysis progressed.

This complexity, added to the scale of the dataset itself (millions of kilometres with very rich data), called for the development of a dedicated tool, SALSA (Smart Application for Large Scale Analysis), based on previously existing developments in previous projects. UDRIVE developed the SALSA tool to manage the data and the complete data-reduction process (derived measures calculations, events detection and characterisation, and manual annotation), see Figure 3.4. This tool is a significant effort and result from UDRIVE.

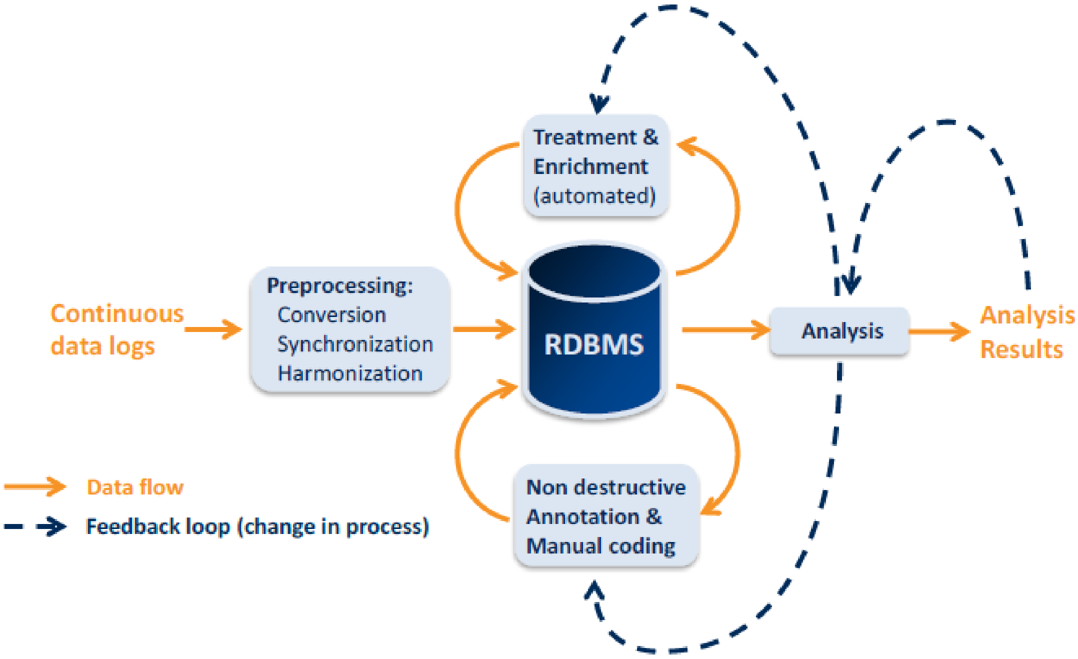


Figure 3.4: The process supported by SALSA. NOTE: RDBMS = Relational database management system.

Alongside multiple secondary functionalities, SALSA implements six main features: data querying, visualization (see Figure 3.5), annotation, interactive algorithm development, automated database management, and automated data processing.

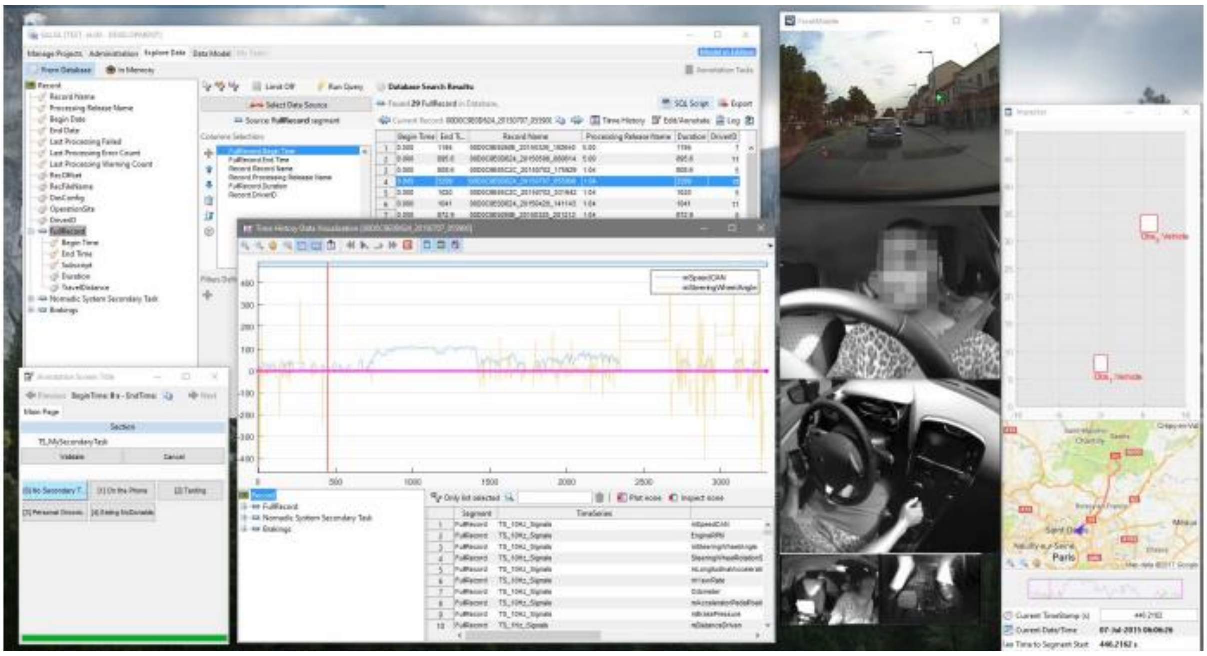


Figure 3.5: SALSA user interface in a typical visualisation and annotation scenario. NOTE: the driver's face has been blurred for this report, but is visible for analists.

The features are integrated together with a unified approach, rather than juxtaposed. SALSA provides analists with "building blocks" which they can combine together, the way they desire, to describe a model of the data and the associated calculations, data segmentations, or annotations. The behaviour of the tool is entirely based on this data model, i.e. with all the definitions iteratively made by users. The tool itself is integrated within MATLAB, and users can define their own algorithms using the MATLAB language to create derived measures (see Section 3.3).

3.1.4 Data protection

The set-up of a Naturalistic Driving Study (NDS) is affected by a number of different legal and ethical considerations and subsequent requirements (see Westhoff, 2013). Personal data is collected and handled for use in research, and the distributed nature of the project poses some unique challenges for the data management. The UDRIVE project has therefore developed a Data Protection Concept (DPC), where the constraints and requirements for the handling of data throughout the project are described (Gellerman et al., 2013). For example, the DPC covers legal requirements for Operation Sites (OS) to collect data, as well as for Analysis Sites (AS) to access the data.

3.2 The UDRIVE database

Another major result of the UDRIVE project is a rich database filled with ND data. The uniqueness of this database stems from the variety of vehicles that have been used, the range of participant nationalities and ages, and the wide array of collected variables.

3.2.1 Overview of vehicles and participants

Data collection took place between October 2015 and May 2017. In this period, well over 88,000 [1]hours of vehicle data was collected on 186 cars drivers, 48 truck drivers and 47 scooters riders. Collected data includes GPS, speed data and CAN data, as well as video data from a number of views including the driver's face, hands and feet, and covering both inside and outside the vehicle (see Figure 3.6).

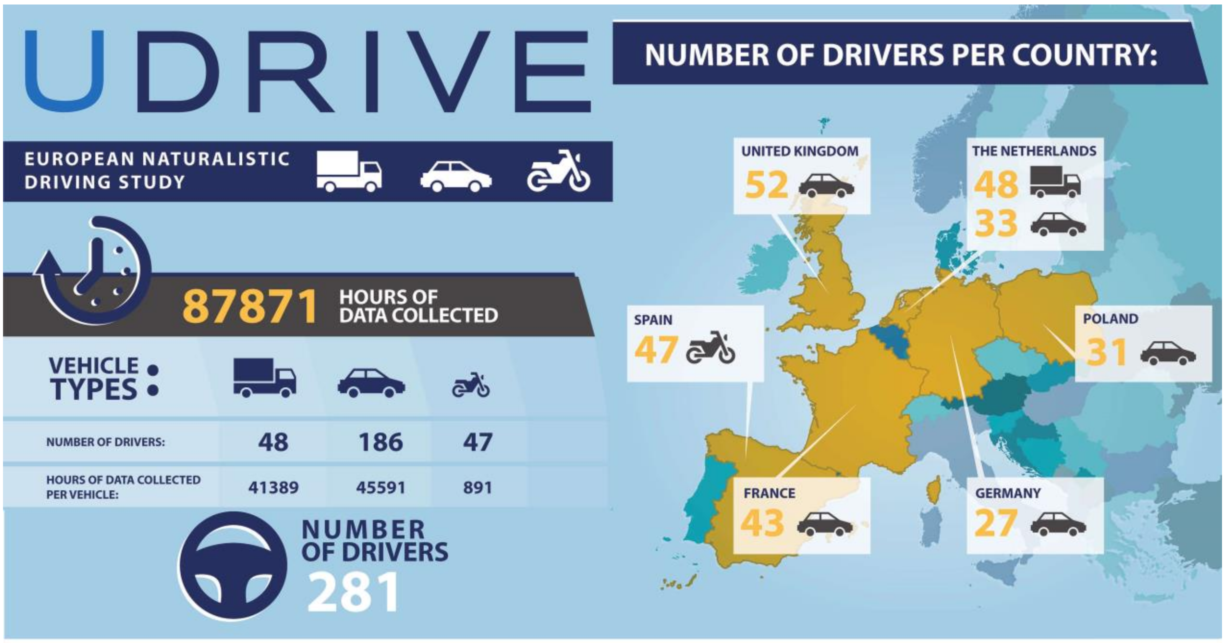


Figure 3.6: Data collected across the three modalities.

[1] At the end of the UDRIVE project, a part of the data was still being processed. At the time, the data received at the Central Data Centre was 87871 hours. At the time of writing this report, we know the final statistics and the actual hours of data collected is 98.000 hours. In order to keep consistency between this final report and the UDRIVE deliverables, we've used the number of 88.000 hours in the main text.

The recruitment strategy of each OS is described in deliverables D31.1 (Lai et al., 2013) and D33.1 (Quintero & Val, 2016). An important recruitment criterion for participation in the study was the make and model of vehicle: Renault Clios and Méganes, Volvo Trucks and Piaggio Liberty Scooters were included (illustrated in Figures 3.7-3.15) in order to achieve homologation agreements and access to vehicle-based data.

Figure 3.7: Renault Megane III

Figure 3.8: Renault Clio III

Figure 3.9: Renault Clio IV

Figure 3.10: Piaggio Liberty 125

Figure 3.11: Piaggio Liberty 125 side view

Figure 3.12: Volvo FM exterior

Figure 3.13: Volvo FM interior

Figure 3.14: Volvo FL exterior

Figure 3.15: Volvo FL interior

According to the study plan, it was aimed to reach a 50-50 split of male and female drivers. Age groups were also defined as well as the number of participants per age group. These numbers needed to be adjusted throughout the project due to external constraints. For example, it was more difficult to recruit truck drivers than initially anticipated. In Germany, it was also difficult to recruit enough Renault drivers, so that another car site was opened in the Netherlands. The extent of challenges of recruitment faced within the project could not be foreseen completely from the beginning of the project. Throughout the project, the study plan in terms of participant selection needed to be adjusted to find the optimal balance between effective data collection and desired sample characteristics. The final sample figures of recruited participants are summarized in Table 3.1.

Table 3.1: Summary of participants across vehicle types and operation sites.

Veh. Type OS	Participants	Gender		Age			
		Male	Female	20-29	30-39	40-49	50-65
Cars Total	192	55%	45%	11%	31%	25%	33%
France	45	47%	53%	9%	27%	31%	33%
Germany	30	63%	37%	17%	24%	7%	52%
Netherlands	33	55%	45%	9%	30%	27%	33%
Poland	31	71%	29%	6%	48%	39%	6%
UK	53	49%	51%	15%	28%	19%	38%
Trucks (NL)	48	98%	2%	6%	13%	32%	49%
PTWs (ES)	47	74%	26%	9%	55%	34%	2%
Grand Total	**287**	**66%**	**34%**	**10%**	**32%**	**27%**	**31%**

3.2.2 Overview of collected variables

Table 3.2 summarizes demographic variables as well as the collection of questionnaires used in UDRIVE. These variables were collected before the participants started their first trip. As with the collection of objective data within UDRIVE, selection of participants and acquisition of subjective data was defined uniformly in each country. This approach not only allows for combining data and creating clusters across European countries, but also to investigate differences in driving between European countries.

Table 3.2: Overview of subjective data, questionnaires, and additional tests

Category	Item
Personal details	Name
	Address (home, work)
	Contact details (phone, email)
	Gender
	Date of birth
	Driving experience
Vehicle details	Make and model
	Engine size
	Ownership of vehicle
	Access to vehicle
	Proportion of car usage
	Likelihood to change vehicle during data collection period
Travel details	Likelihood to move out of the area
	Likelihood to change travel patterns
	Typical weekly journey
Questionnaires	Driver attitude questionnaire (Parker et al., 1996; speeding and close-following items only)
	Driver behavior questionnaire (Lajunen et al., 2004; error and violations items only)
	Driving style questionnaire (French et al., 1993; full items)
	Traffic locus of control scale (Özkan & Lajunen, 2005; full items)
	Arnett inventory of sensation seeking (Arnett, 1994; full items)
	Crash and traffic violations history
Other tests	Video-based hazard perception test

In addition, data was collected during trips by means of the DAS. Table 3.3 provides an overview of the number of camera's and different sensors installed in the vehicles. The high number of camera views and the video quality of the camera views are unique for a large scale Naturalistic driving study. They provide a good look around and inside the vehicle for the trucks and cars and a view of the driver for the scooters (see Figures 3.16 and 3.17).

Another unique feature of the UDRIVE is the smart camera (Mobile Eye system). The smart camera recognises objects that are in the view of the camera such as other vehicles, trucks, motorcyclists, cyclists, pedestrians and road markings. A vast amount of information is available for all the objects recognised such as position relative to the vehicle, speed and travel direction of the moving object, distance to lane markings etcetera. The smart camera provided over 200 variables continuously measured.

Table 3.3: Overview of UDRIVE DAS characteristics by vehicle type

Car	Truck	PTW
7 cameras	8 cameras	5 Cameras
IMU sensors	IMU sensors	IMU sensors
GPS	GPS	GPS
Mobil Eye	Mobil Eye	X
CAN data	CAN data	X
Sound level	Sound level	X

Figure 3.16: Overview over camera perspectives in cars.

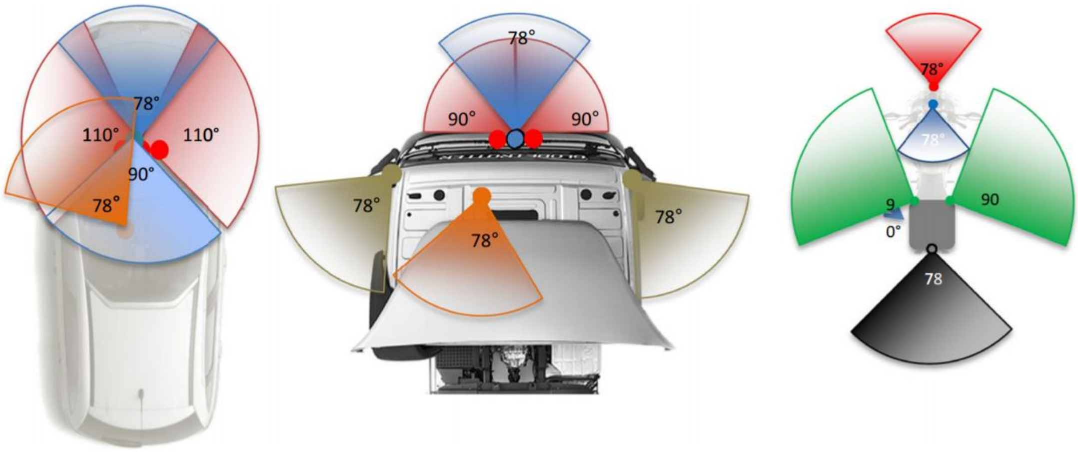


Figure 3.17: Overview of the camera views for cars, trucks and vehicles. For cars the foot-camera and passenger camera are not shown, for trucks the foot-camera is not shown.

The UDRIVE DAS also collected CAN (Controller Area Network) data from trucks and vehicles. As UDRIVE collaborated with Volvo and Renault, access was given to a wide range of information that is available in the in-vehicle network. Over 50 were variables were continuously collected from the vehicle CAN bus. The variables included (but were not limited to): seatbelt use, status of safety systems, emission related variables and status of vehicle controls. Furthermore, the GPS data collected by the UDRIVE DAS was map matched and enriched with road characteristics during the post-processing of data. This step enriched the UDRIVE data with information such as road type, local speed limit, passing intersection or roundabout, one-way streets.

Finally, a significant effort was spend processing the data after it had been collected and pre-processed. This effort consisted of the development and application of algorithms to create derived measures from the raw data. Those derived data will be a legacy of UDRIVE, likely to be used by researchers performing analyses after UDRIVE. More than 500 derived measures (e.g., attributes and time-series) were created through the SALSA tool, and/or through manual annotation of video data (see Section 3.3.1). Table 3.4 illustrates the massive effort carried out by the project to analyse the data.

Table 3.4: The amount of model elements which were defined by SALSA users during the data reduction effort in UDRIVE.

	Raw measures	Nodes			Time Series	Derived measures	Segment types	Attributes	Other	Total
		Scripts	*Inputs*	*Outputs*						
Cars	302	509	1968	1385	261	407	92	1617	829	**7370**
Trucks	306	79	583	303	134	130	24	405	386	**2350**
PTWs	60	22	109	114	19	41	8	131	75	**579**

3.3 Research results

UDRIVE has generated research results related to four main topics: everyday- and risky driving (Dotzauer et al., 2017), secondary task engagement (Carsten et al., 2017), interactions with vulnerable road users (Jansen et al., 2017), and eco-driving (Heijne et al., 2017). A recurring component in many of the corresponding analyses was the need for manual annotation of video data. Therefore, this activity which will be described first, followed a summary of the main findings in each research topic.

3.3.1 The UDRIVE annotation codebook and resulting annotations

Much of the analyses in UDRIVE have required manual annotations of videos to provide information about both the driver behaviour and the traffic context. A key result from UDRIVE is the codebook for manual annotation of video that was developed during the project. The codebook is provided as an appendix to UDRIVE Deliverable *D41.1 The UDRIVE dataset and key results* (Bärgman et al., 2017).

One major requirement for the UDRIVE codebook was that it be harmonized and comparable to other standard codebooks—most importantly, the one developed and used for many years at VTTI, which was used for the US SHRP2 Naturalistic Driving Studies (SHRP2, 2010; VTTI, 2015). That is why all variables in the UDRIVE codebook refer to variables in VTTI's 'Researcher Dictionary for Safety Critical Event Video Reduction Data' version 4.1 of October 5, 2015 (a.k.a., 'VTTI codebook'). Definitions, categories and related coding procedures were developed during conference calls and meetings, taking the needs of different analysis tasks into consideration.

3.3.2 Insights in everyday- and risky driving

Naturalistic Driving Studies give us an unique opportunity to observe drivers and riders during everyday driving and in risky conditions or behaviour. Although almost hundred thousand hours of driving and riding have been recorded, this was not sufficient to find (enough) crashes to calculate actual risks. Further, in UDRIVE time constraints made it unfeasible to identify and classify safety-critical events (e.g., near-crashes) for use in risk calculation. Therefore, analysis was refocussed on everyday driving (for example, overtaking on rural roads, speeding, and close following). UDRIVE also focussed on hard braking, the use of advanced driving assistance systems (ADAS), and seatbelts—and investigated contributing factors to seatbelt (non-) use. In addition, the self-confrontation technique was applied to investigate risky events in more detail. In UDRIVE , the technique consisted of showing videos of critical or risky situations (such as secondary task engagement) to the drivers who had experienced them during the UDRIVE Naturalistic Driving observations, and following up with interviews and targeted questions. With this technique, the driver's own recollection of events can provide more information about drivers understanding of near-crash and secondary-task engagement situations.

Results of the analysis of everyday- and risky driving include:

- the development of methods for identification of safety critical events candidates (that needs to be reviewed on video to evaluate relevance for safety),
- how drivers choose to speed and time head-ways (example of results are shown in Figure 3.18),
- how cars and trucks are overtaken by cars,
- how drivers can recall critical situations (near-crashes) and secondary tasks engagements when confronted with videos of such situations post-hoc (self-confrontation technique).

The results partially confirm results from previous studies, and partially provide us with new insights into everyday- and risk-driving aspects of traffic safety. This is true across all the driver behaviour analysis in UDRIVE.

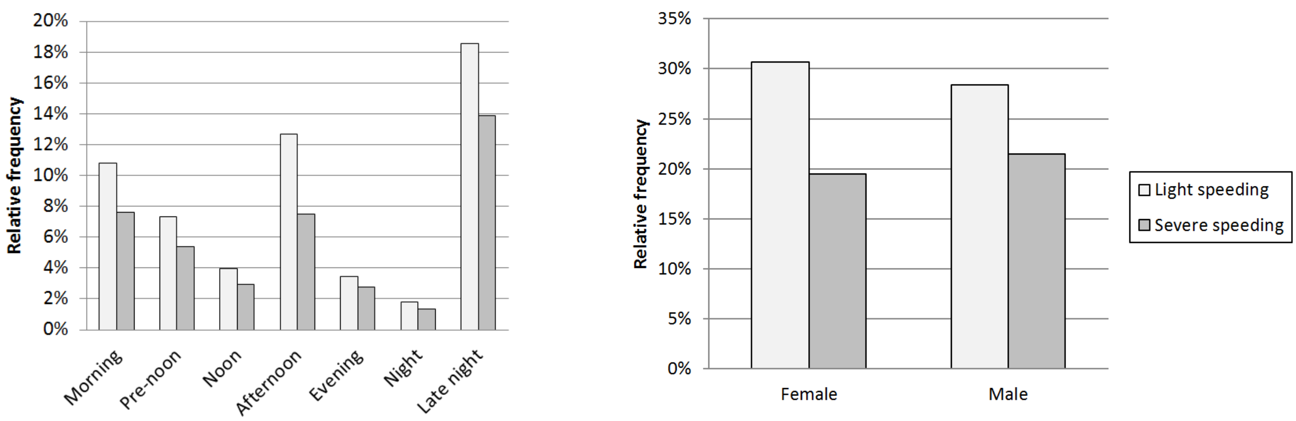


Figure 3.18: Relative frequency of speeding events by time of day (left) and gender (right). NOTE: Frequencies are weighted by exposure of time driven during a specific time of day and gender, respectively. Light speeding is defined as driving 11-15% above the speed limit, and severe speeding as 16-20% above the speed limit.

3.3.3 Insights in drivers' engagement in secondary tasks

The major focus of the work on driver inattention and distraction has been on obtaining a better understanding of drivers' engagement in secondary task activities. When do drivers choose to engage, what tasks do they select, whether they adjust their activity to different situations, and whether they are willing to surrender secondary task activities when the primary task of driving becomes more demanding. In other words, the focus was on self-regulation: how drivers manage their secondary task activity in the context of the dynamics of the traffic and road situation. That management includes deciding not to engage in such tasks in the first place or only to engage in some particular activities. Naturalistic Driving Studies are particularly suited to such an investigation, unlike experimental studies in driving simulators and even on test tracks, which tend to suffer from an instruction effect (participants are typically instructed to carry out an activity at a given moment). Although such experimental studies provide insight into how driver attention, driver information, and driving performance are affected by secondary tasks, they are less useful when research is focussed on drivers' management of task activity.

Results of the analysis of drivers' engagement in secondary tasks include:

- the proportion of time spent engaged in secondary tasks, for example by task and gender (Figure 3.19), and across countries (Figure 3.20),
- truck drivers engagement in secondary tasks,
- how car drivers attitudes relate to engagement in secondary tasks,
- how driving task and secondary task complexity influence the decision to engage in secondary tasks,
- how drivers adapt their safety margins for performing secondary tasks, and
- the potential of automated video analysis to support or replace manual annotation of video of secondary task engagement.

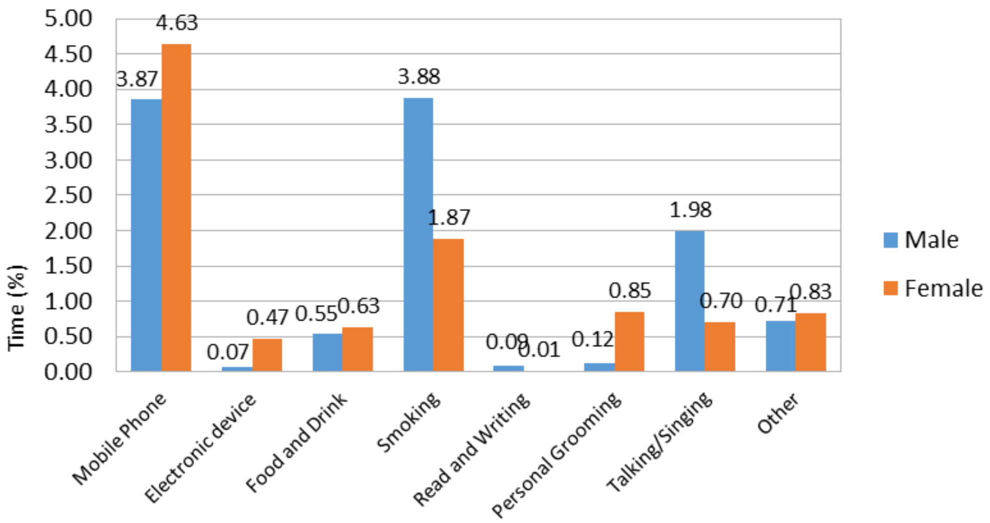


Figure 3.19: Proportion of driving time engaged in secondary task behaviour by task type and gender.

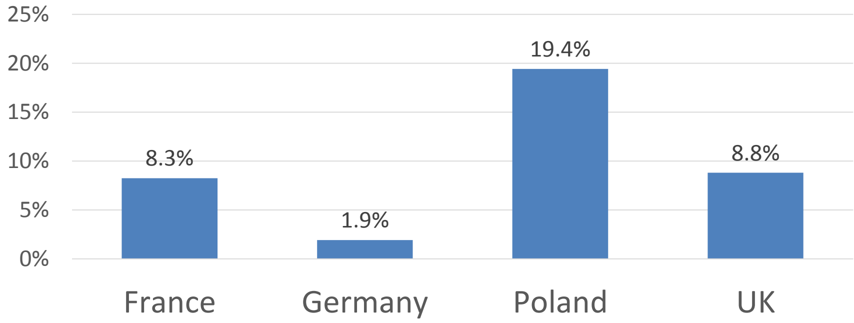


Figure 3.20: Proportion of driving time engaged in secondary task behaviour by country.

3.3.4 Insights in behaviour towards vulnerable road users

Within UDRIVE there has been a specific focus on pedestrians, cyclists, and powered two wheelers (PTW). These groups of road users are particularly vulnerable in traffic because they lack the protective shell provided by an automobile that helps those involved in a collision avoid serious injury. In addition, these transport modes have several features that make them more prone to being involved in a crash—features related to reduced conspicuity and, for the two-wheelers, the difficulty of maintaining balance, either or not in combination with high speeds. These features mean that pedestrians, cyclists, and PTW users have a high risk of getting fatally or seriously injured in traffic. Through UDRIVE , a large amount of naturalistic data was collected in order to get more in-depth insight into the interactions of these groups with passenger cars and trucks. The aim was to identify and understand not only the everyday behavioural patterns in these interactions, but also the circumstances behind conflicts and safety-critical events that occur.

Results of the analysis of vulnerable road users include:

- drivers interacting with bicyclists with respect to safety-critical event interactions, everyday interactions at intersections and roundabouts (e.g., blind spot checks, see Figure 3.21), and drivers overtaking of bicyclists on rural roads,
- drivers interacting with pedestrians with respect speed profiles around critical situations, and
- time headway between cars and PTWs, and other characterizations of everyday PTW riding behaviour.

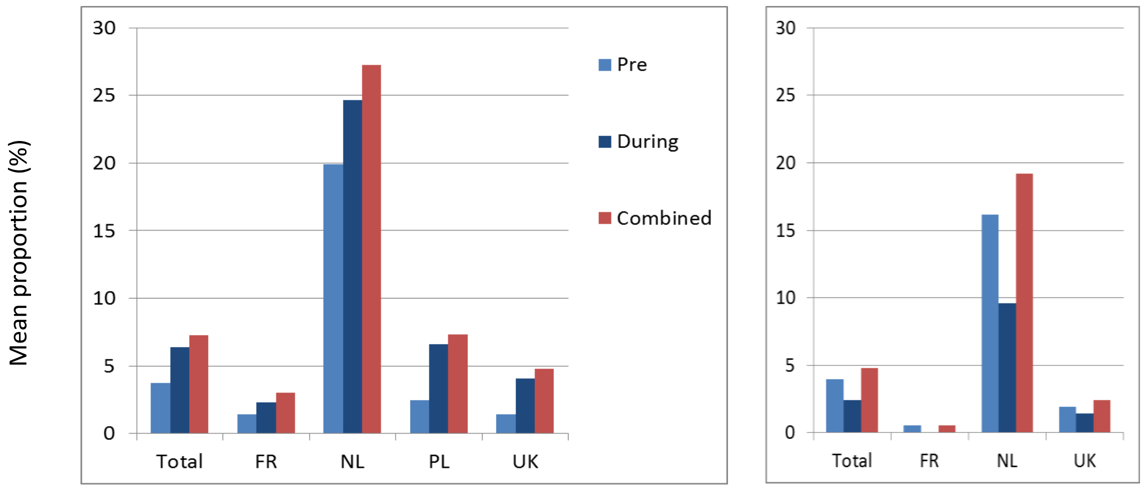


Figure 3.21: Mean proportion of right-turn manoeuvres with at least one blind spot check across car drivers, stratified per country (left: intersections, right: roundabouts). Note: FR = France, NL = Netherlands, PL = Poland, UK = United Kingdom (left-turn). Pre = time window 6 seconds prior to the manoeuvre onset, During = during the manoeuvre, Combined = time window of 6 seconds prior to the manoeuvre onset until the end of the manoeuvre. Roundabout manoeuvres have not been examined in Poland.

3.3.5 Insights on eco-driving behaviour

Eco-driving denotes a driving style associated with low fuel consumption. Unique to UDRIVE (unlike a generic collection of velocity data from random drivers such as the WLTP database, a worldwide, unified, light-duty test-cycle database with, for example, speed and acceleration information) is the augmentation of the velocity data with driving circumstances, like road type, speed limits, headway, and in-vehicle information. This allows driving behaviour to be placed in context, and personal driving style to be distinguished from behaviour imposed by traffic conditions. The UDRIVE analysis used the continuous signals of the full dataset for cars, consisting of 13,500 hours of driving by 154 drivers.

To assess the fuel consumption reduction potential, it is crucial to separate personal driving style from infrastructure and from congestion while driving. The range of personal driving style is the range of eco-driving. Infrastructure and congestion will be the main influences on fuel consumption during a trip. In this analysis, the challenge has been to uncover other influences which can be manipulated to encourage a fuel-economising driving style.

Results of the analysis of eco-driving include:

- velocity distributions across drivers and speed limits (example results, see Figure 3.22),
- the effect of driving styles on eco-driving, and
- potential effects of eco-driving.

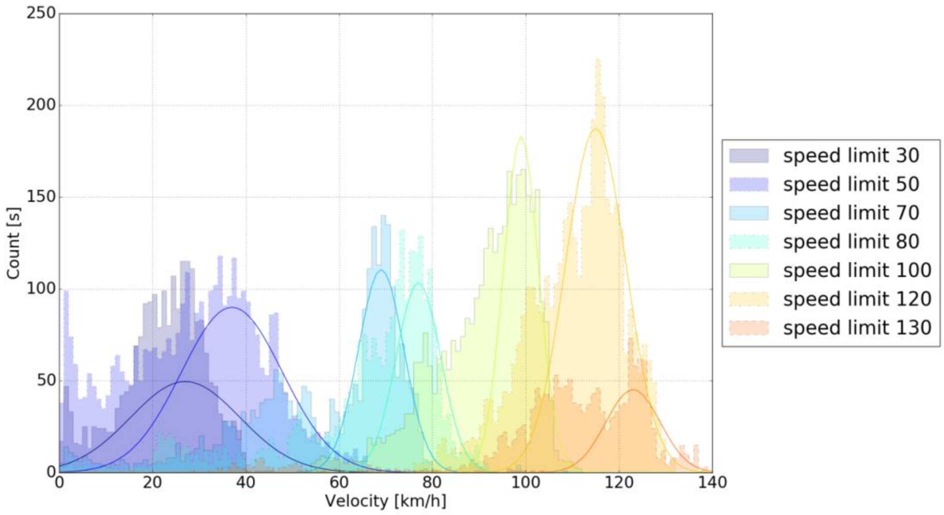


Figure 3.22: Velocity distributions per speed limit for one driver in The Netherlands, with a fit of the most frequent velocities.

3.4 Technology for future Naturalistic Driving studies

The resources and efforts associated with big naturalistic studies, such as the American SHRP II and the European UDRIVE, are tremendous and cannot be repeated and supported frequently, or even more than once in a decade (or a life time). Therefore, the potential of simple and low-cost technologies was investigated to address research questions such as the ones dealt with in UDRIVE. Naturally, the wealth and richness of the integrated data, gathered by such substantial studies and elaborated DAS, cannot be compared to data collected via simpler, nomadic data collection technologies. The question that needs to be asked is how many research questions can be addressed, at least to some extent, by other low-cost and simple technologies? This discussion is important, not only in order to replace naturalistic studies as UDRIVE and decrease their costs, but also to complement and enable their continuity after their completion.

Technology is rapidly evolving and almost any attempt to provide a comprehensive and complete state of the art of existing technologies (as well as their features and cost) is doomed to fail. Therefore, the 'Framework for Naturalistic Studies' (FNS; for more information see Lotan et al., 2017) was created. The FNS is a generic framework for presenting data collection technologies was created, on which the various important parameters associated with the question at hand, are illustrated, positioned and discussed. Due to its conceptual nature, categories and presentation mode of the FNS can be adjusted to new features and new technologies as they become available. The framework is built on two main dimensions: data collection technology type and sample size (see Figure 3.23).

The various technologies for data collection were mapped on the FNS. The technology groups include: mobile phone location services, mobile phone applications, telematics devices, built-in data loggers, dash cameras and enhanced dash cameras, wearable technologies, compound systems, and eye trackers. Most of the simple systems relate to specific behaviour that is monitored (e.g., speeding, lane keeping). Additionally, certain thresholds or triggers are used to automatically identify risky situations, which are related to that behaviour. However, once those instances are detected, no information on the circumstances leading or accompanying this behaviour are available. Typically, visual information (discrete or preferably continuous) is needed in order to fully understand the circumstances. Hence, upgrading simple (single-task oriented) technologies by other technologies (most typically by cameras), can significantly improve researchers' ability to obtain information on the circumstances, which accompany the detected risky behaviour.

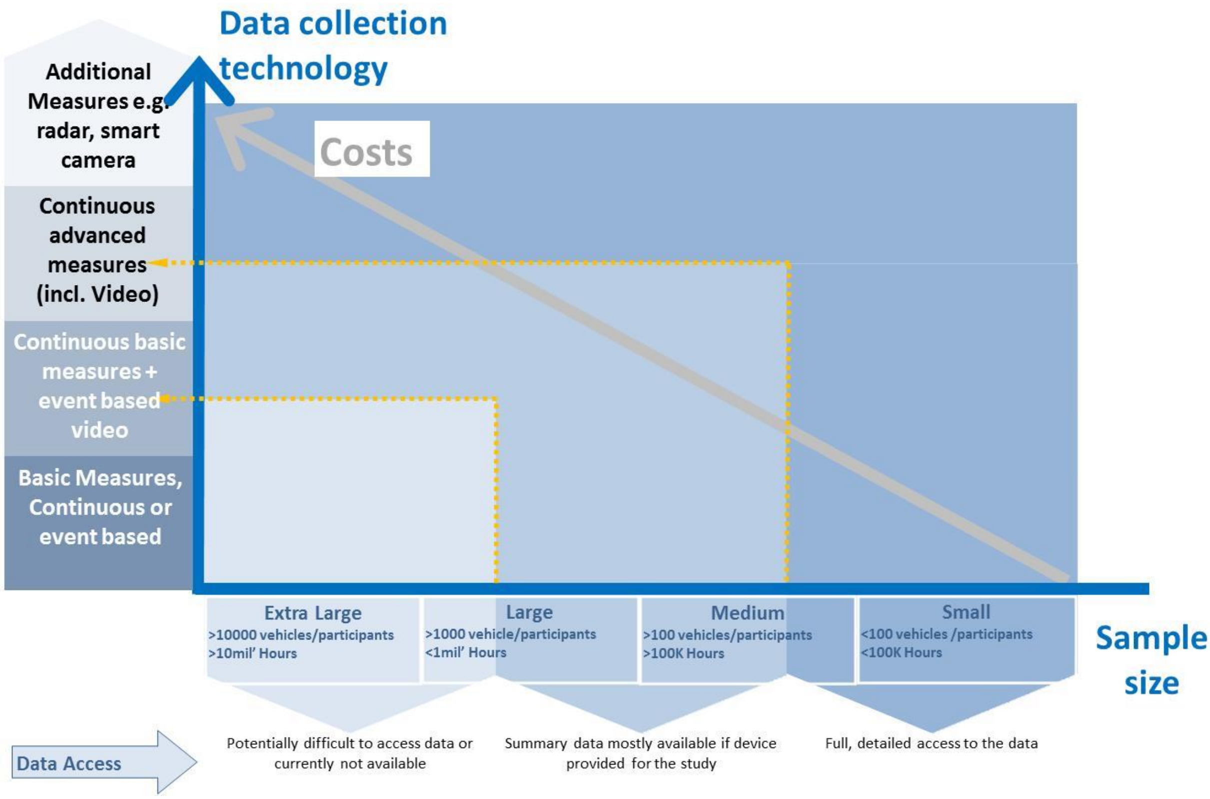


Figure 3.23: The Framework for Naturalistic Studies.

There is no real substitute to a car equipped with seven cameras and ample data loggers and sensors, all integrated into a workable platform. Still, given the rapid advancement of technology, a vast amount of interesting and relevant research questions can be addressed with much less sophisticated and costly systems. When going one-by-one over the research questions of UDRIVE, almost all of them could be addressed, at least to some extent, by simpler technologies (or by a combination of few). In addition, many of the research questions could be addressed to a greater extent if upgraded by cameras and/or CAN access.

For future ND studies, it is important to keep in mind that an upgrade of the technological features requires integration and the establishment of a unified platform for researchers. The compound systems and configurable automotive data loggers, mentioned in Section 3.1, provide examples for such systems.

4 Impact

Within the UDRIVE project the focus was on building a unique and rich European Naturalistic Driving data base. Within the project some first analyses on the data have been done, focusing on four key topics: everyday- and risky driving, secondary task engagement, interactions with vulnerable road users, and eco-driving. Those analyses are showcases that illustrate the huge potential of the database. The UDRIVE database has a huge potential for further use to improve our understanding of driving behaviour and to support industry and policy. This section explores such potential in terms of exploitation of results, societal implications, and socio-economic implications. Finally, an overview is presented of the main dissemination activities of UDRIVE.

4.1 Exploitation of results

The end of the UDRIVE project does not mean the end of the exploitation of the UDRIVE database. On the contrary. The database will remain available for subsequent analyses for the UDRIVE partners, and within the bounds of privacy-related legal and ethical restrictions, also for other organisations (see also Section 3.2).

A questionnaire (Wilschut et al., 2017) among industry and research centres on how they value and use Naturalistic Driving data indicated a highest interest for in-vehicle data from CAN, radar and cameras (outside and driver views). There is a growing interest to access (historic) probe data, which is considered to be highly valuable to understand traffic bottlenecks or mobility patterns. The potential is perceived by the parties, and will be explored below. Barriers mentioned were legal and practical hurdles to access such data as well as lack of expertise to analyse the data. The impression during interviews was that the majority of the potential users preferred the option of paying for what they ask for rather than having to develop all skills to analyse the data.

4.1.1 UDRIVE data for driver support functions

The Naturalistic Driving data collected within the UDRIVE project is of great value for the vehicle manufacturing industry to facilitate the development of driver support functions.

For function development, ranging from passive to more advanced driver-assistance systems (ADAS) as well as higher levels of automation functions, capturing both normal driving as well as accidents and incidents through collected Naturalistic Driving data can be used in combination with statistical crash data. Examples of where function developers have a strong need for naturalistic driving data were given, e.g., for basic tuning of the automated driving functions. Naturalistic Driving data can be used in order to define target scenarios and to select appropriate countermeasures and for sketching use cases in early development phases. Information captured in Naturalistic Driving data can serve as input when developing proper driver-, system-, vehicle- and environmental models for pre-crash and crash simulations evaluate the safety performance of a specific driver support function.

Furthermore, simulation tools for virtual testing will benefit from Naturalistic Driving data. For example, to assess the benefits of an ADAS it’s necessary to know how drivers behave in specific situations and how drivers react to the interventions by their vehicle. Naturalistic Driving data (with or without systems) can be used to provide the relevant data to develop, test and validate the behaviour models. The PEARS network and OPENPASS are initiatives that harmonise simulation tools and create a new software framework for simulation and evaluation of active safety and different types of automated functions in an integrated manner. Naturalistic Driving data plays an essential role in there developments.

<u>Impact</u>: The automotive industry will be able to improve the safety level of cars which consumers consider a major issue in their choice of car to purchase. This will give the European industry a leading edge worldwide.

4.1.2 UDRIVE data for behaviour-based safety programmes

The UDRIVE data is of great value for transport providers to reduce costs and casualties. In order to shape custom-made behaviour-based driver coaching, in-depth behavioural knowledge is required. A major part of this in-depth knowledge is to comprehend the mechanisms of driver behaviour. One example of the reason why it is necessary to comprehend specific behaviour is to successfully avoid a precipitating event, in other words understand behaviour in safety critical events that do not lead to a crash event. Thus far, the results retrieved from the analysis of the short time-span before a precipitating event has been often used for understanding crash causation and less for tailor-made driver coaching and training. Two specific use cases showing the value of Naturalistic Driving data for enhancing coaching strategies for driver coaching programmes are coaching teen drivers and coaching commercial truck drivers. Driver coaching can be aimed at safety, fuel consumption, vehicle care, driver health, costumer communication, stress management and other driving behaviours. For successful safety programs and coaching programs, it is necessary to track reliable Naturalistic Driving data to provide timely and effective feedback to the driver. The intended results of coaching programs are the formation of new habits. If successful, this can be accompanied by a change in attitude, feelings, stress level, and self-perceived performance on the coaching targets.

Impact: Transportation providers will use the enhanced knowledge on driver behaviour to implement behaviour-based safety programmes with the goals to promote safer and more efficient driving styles.

4.1.3 UDRIVE data to improve driver models on safety and sustainability

UDRIVE has investigated how Naturalistic Driving data and results can be used to improve existing driver models, particularly those related to safety and sustainability. To achieve that, ‘driving in horizontal curves on rural and motorways roads’ has been selected as a specific example case, with the criteria being that is should be highly relevant both for safety and sustainability. This case is relevant as inadequate advance speed adjustment by drivers is an elevated risk of loss of control and also unnecessary energy consumption.

Driving in the approach to and through curves requires adjustment of both longitudinal vehicle control — speed adaptation to the curve prior to curve entry — and lateral control such that steering input must guide the vehicle through the curve smoothly enough that there are no harsh corrections which could precipitate a loss of control. And of course longitudinal and lateral control are interlinked, in that driving too fast reduces the safety margin for lateral vehicle control, and makes it more likely that harsh steering will cause loss of control, potentially with serious consequences. Single-vehicle crashes, often occurring on curves, account for approximately one-third of fatalities across Europe.

Speed choice on curve approach has significant environmental implications, in that early use of engine braking can reduce energy wastage. Harsh deceleration just prior to curve entry is wasteful of fuel. Existing traffic micro-simulation models, designed to give road operators insight into how traffic flow and speed is influenced by roadway features, do not consider horizontal road alignment at a detailed level. To examine drivers’ lateral control and how it is related to curve radius, a model of driver steering behaviour that operates at a far higher level of granularity than the micro-simulation models, has been applied. To investigate energy wastage, a very detailed analysis of driver longitudinal vehicle control in curve approach and in curve negotiation has been carried out. Also investigated has been whether driver behaviour in this longitudinal control can be related to driver attitudes as revealed by the questionnaire administered to the participants in the project.

The results obtained by applying the detailed steering model showed that problematic steering by the UDRIVE participants could be related to curve radius: the tighter the curve, the higher was the incidence of high-amplitude steering input. The resulting distribution showed a negative exponential relationship that is remarkably similar to the known distribution of crash risk for curves of a given radius, where there is a far higher risk for small-radius curves (see Figure 4.1). The insight obtained can not only enhance driver-vehicle simulation models, but also suggests the development of new countermeasures to stimulate greater safety margins in curve driving.

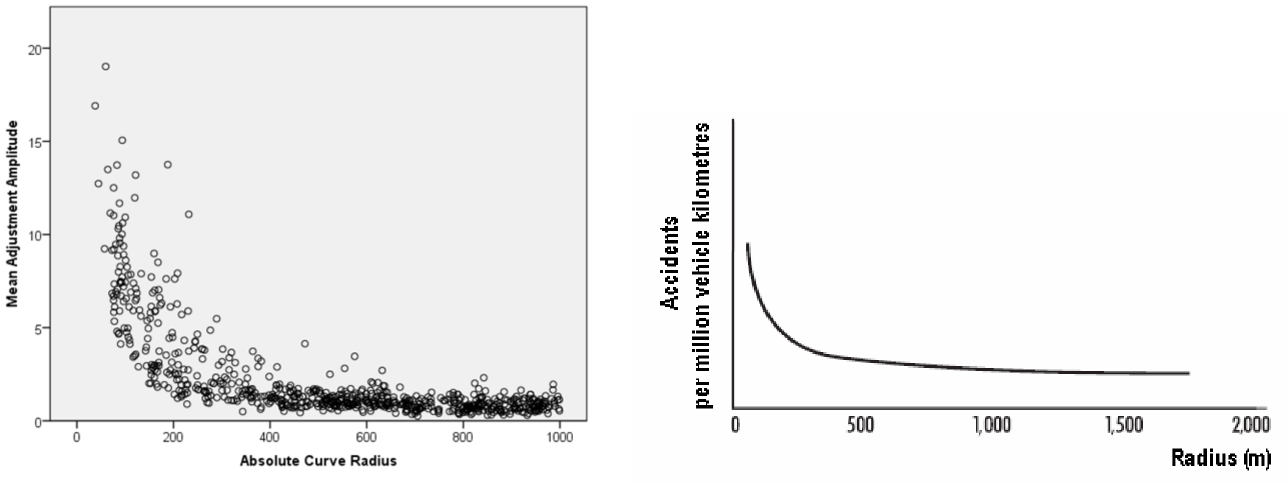


Figure 4.1: Mean amplitude of steering adjustment by curve radii smaller or equal to 1000 (left), and effect of horizontal curve radius on accident risk (right; ERSO, 2007, based on Hauer, 2000).

From an eco-driving perspective, the analysis has reinforced the conclusion that energy is being wasted by drivers in the approach to and passage through curves by lack of anticipation of the need to slow down and therefore by over-harsh deceleration. The consequent wastage of energy has been shown to be related to safety-related attitudes and behaviour in the form of self-reported tendency to commit traffic violations. From a more general perspective, the example case shows the potential of using UDRIVE data to improve driver models.

4.2 Societal and socio-economic implications

The UDRIVE results are relevant to infer recommendations for measures improving road safety and sustainability.[2] The key outcomes of the UDRIVE project are organized in terms of relevance to safety and sustainability policies and potential actions towards road users, vehicle manufacturers and road infrastructure and policy. Recommendations for developing new measures of updating of existing measures are given for the following 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.

Six main topics were identified to focus on for the development of the recommendations, being: seat belt use, speed behaviour, critical situations, distraction, vulnerable road users, eco-driving. For each topic a short summary of the key recommendations is given below. Finally, the impact of these measures is discussed on a larger, socio-economic scale.

4.2.1 Improve seat belt use

The analysis of UDRIVE data showed how drivers' seat belts 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

[2] Due to time constraint, the analyses and the recommendations have been done in less time than what was planned at the beginning of the project.

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 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 target through campaigns or enforcement specific populations (young men).

4.2.2 Reduce speeding

The French and German drivers in UDRIVE had less occurrences than average of small exceedances of the speed limit (between 11 to 15%) while the Dutch and English drivers were above average. However, in terms of high speeding (between 16 to 21 %), the French and German participants were on average while the English and Dutch are far below. On the other hand, Polish drivers were 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. Meaning that there is more speeding on lower speed limits. Regarding the period of the day, the difference is very high during the evening and the night and is negative during the afternoon. Recommendations relate to increase enforcement, awareness campaign and infrastructure development to reduce speeding especially on lower speed limits (30 km/h areas). Awareness campaign can be useful to explain the risk during night.

4.2.3 Reduce critical situations

For analysing the critical situations three types of analysis were carried out:

- an analysis of abrupt braking,
- interviews were carried out to reconstruct as precisely as possible the episode as seen by the driver using the classical techniques of the self-confrontation method,
- interviews were carried out 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 limits, 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. The interview showed that most of driver recommended infrastructure modifications and the potential contribution of informative and active driving assistance systems. These were more often selected as the first choice than the other type of recommendations.

4.2.4 Improve safety of vulnerable road users

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.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.

4.2.5 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 CO_2-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 the aim 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.

4.2.6 Reduce danger 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 visual-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 visual-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 visual-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 visual-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 dig deeper in relation to road safety.

4.2.7 Socio-economic impact

Implementation of the above measures, and the measures that will likely result from follow-up research (e.g., see Section 4.1), has the potential to create a large-scale socio-economic impact:

- Insurance companies will benefit because they will get a better insight in risk causation factors;

- The automotive industry will be able to improve the safety level of cars which consumers consider a major issue in their choice of which car to purchase. This will give the European industry a leading edge worldwide;
- Transportation providers will use the enhanced knowledge on driver behaviour to implement behaviour-based safety/efficiency programmes with the goal to promote safer and more efficient driving styles;
- Employers will see a decreased loss of production due to road crashes, now some 10-15% of total costs of road crashes in Europe (20-25 billion Euro);
- Road users will benefit because of lower accident risk and lower insurance contributions and medical expenses;
- Government and road authorities will profit from lower settlement costs.

Some of the measures based on UDRVE output will be implemented soon, others could take decades. All in all, they will save lives, contribute to a cleaner world and save €'s for our European society.

4.3 Main dissemination activities

The project consortium has been engaged in various dissemination activities during the course of the UDRIVE project. These activities have led to extensive visibility of the project locally, nationally and internationally for professionals and the general public, during the project as well as after the project.

4.3.1 General public

The main focus of the project dissemination has shifted over the project duration. In the beginning of the project, a lot of communication and dissemination was focused on recruiting participants to the study in different operation sites in Europe. Partners have engaged with different local media ranging from newspapers to radios in order to recruit a decent number of participants willing to take part in this naturalistic driving study.

At the end of the project the project results have been released to the general public. There was a big interest from the media and many activities in several countries contributed to communicate the results to the general public. Activities included interviews with the national and regional television, radio interviews and articles in national and regional newspapers.

4.3.2 Professionals

Most of the dissemination activities targeted the professional stakeholders (e.g., industry, academia, policy makers). Activities included:

- Several meetings have been organised to interact with stakeholders. At the start of the project stakeholder meetings were used to discuss and shape the research questions of the project. Towards the end the preliminary analyses results have been shared in webinars, and the feedback from the stakeholders have shaped the final analyses. Furthermore, the development of the countermeasures and the investigation of the value of the Naturalistic Driving data was done in close cooperation with stakeholders. Regional workshops have been organised at the data collection sites to inform national stakeholders in their local language about the project results and the value of the UDRIVE data for further analyses.

- The project has been presented at several stakeholder meetings. The project has been presented at several meetings in different stages of the project, including Naturalistic Driving 'Teach-inn's for the European Commission, EUCAR meetings of the Strategic Pillar Group Safe and Integrated Mobility Program Board and a Debating Mobility Breakfast on Road Safety and Infrastructure at the European Parliament.
- The project has been presented on various meetings, fellow project events and conferences ranging from small workshops to bigger conferences, in Europe as well as the USA and Australia. The UDRIVE project was often presented in relation with the FOT Net Data project and SHARP2. Conferences included the Driver Distraction and Inattention conference, ITS World Congress (audience of 10 000 people), the Naturalistic Driving Research Symposia in Blacksburg, Virginia, and the Naturalistic Driving Research Symposium 2017 in the Netherlands.
- Several articles have been published about the project, ranging from interviews for the EC website, articles in specific industry-oriented journals as well as scientific conference proceedings and journals.

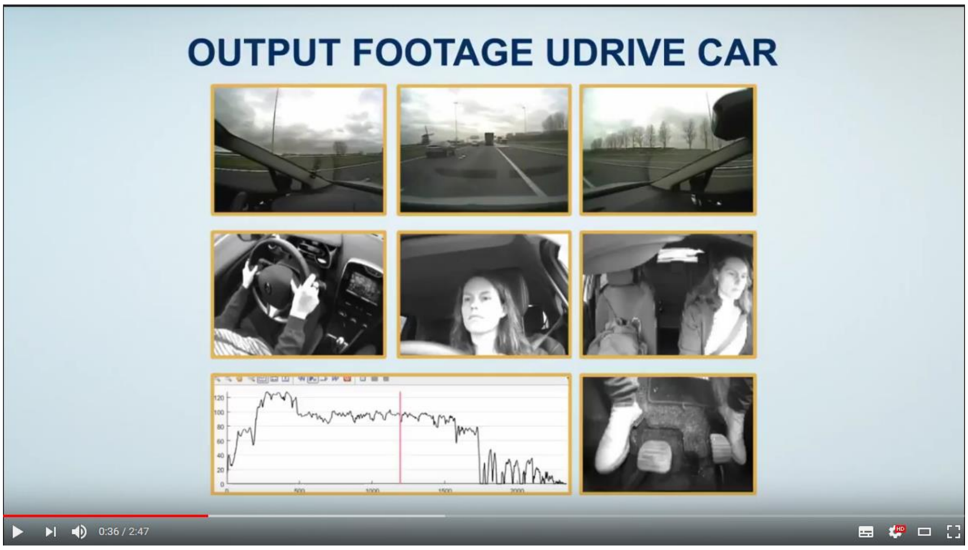
4.3.3 UDRIVE experience

A very successful and significant event has been the UDRIVE Experience – the UDRIVE final event which took place on 7 June 2017 in the Hague, the Netherlands. The UDRIVE Experience attracted over 150 delegates from all over the world. A series of interactive sessions were held to show and discuss the main results and methodology to/with the general public and all professional stakeholders. The UDRIVE experience was organised in conjunction with the 6th International Naturalistic Driving Research Symposium, which targeted the academic stakeholders. Figure 4.2 give an impression of the UDRIVE Experience, incluring presentations of the Project Officer Bill Bird, the project coordinator Nicole van Nes (SWOV) and the demonstration of the UDRIVE instrumented vehicles.

Figure 4.2: Impression of the UDRIVE Experience.

4.3.4 UDRIVE video trilogy

The finalisation of the project also enabled the creation of a detailed UDRIVE video trilogy[3], which also serves as a digital alternative for the final results brochure. Given the richness of the collected data and its dynamic nature (i.e., continuous video and sensor signals, see Figure 4.3), the opportunity to create a video instead of a printed brochure will significantly contribute to further dissemination and will increase circulation of the results after the project life.



[3] The UDRIVE video trilogy can be found at: http://www.udrive.eu/index.php/news/146-watch-the-latest-udrive-video-series

Figure 4.3: Screenshot of the UDRIVE video trilogy.

4.3.5 UDRIVE online compendium

The UDRIVE online compendium[4] contains the most important highlights and main results of the project (see Figure 4.4). The decision of making an online version of the main results instead of a printed book improves navigation of the results directory as well as the accessibility of the main results. The main results are displayed as highlights, and additionally, in-depth descriptions and scenarios including the relevant deliverables are supporting each of the highlights. For those looking for more in detail than the compendium, all UDRIVE deliverables will be available at the UDRIVE website after approval by the EC. Given that all the UDRIVE deliverables will be registered with a DOI number[5] by the end of 2017, the UDRIVE compendium will not only become the main reference point to the UDRIVE results but also a scientific catalogue.

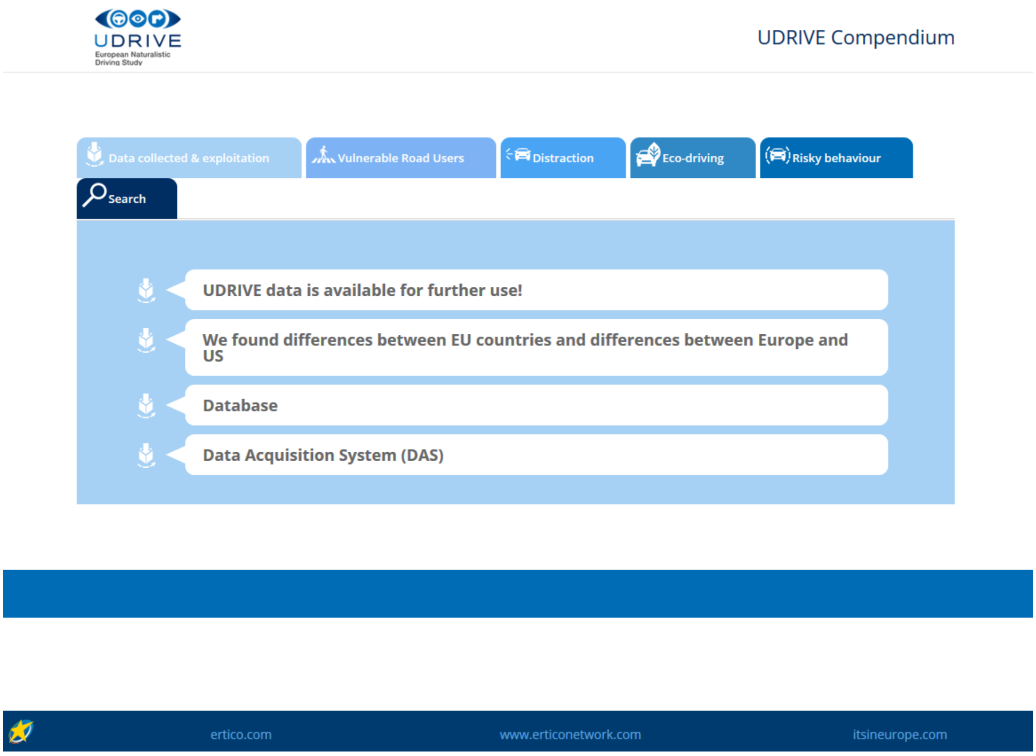


Figure 4.4: Screenshot of the UDRIVE online compendium.

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[4] The UDRIVE online compendium can be found at: http://results.udrive.eu/

[5] The Digital Object Identifier (DOI), is a standard used to permanently identify a piece of intellectual property, e.g. an article or document, and link to it on the web.

5 Contact information

5.1 The consortium

5.1.1 Coordination

The project was coordinated by the Dutch Road Safety Research Institute SWOV.

Project coordinator:

Dr. Nicole van Nes

Nicole.van.Nes@SWOV.nl

5.1.2 Partners

5.2 Website

The project website: http://www.udrive.eu/

The project website provides the UDRIVE video to give a short introduction of the project, the compendium of results for more information and the deliverable for all details. It also provides up to date information about the availability to use the data after the project.

5.3 Project logo and other information

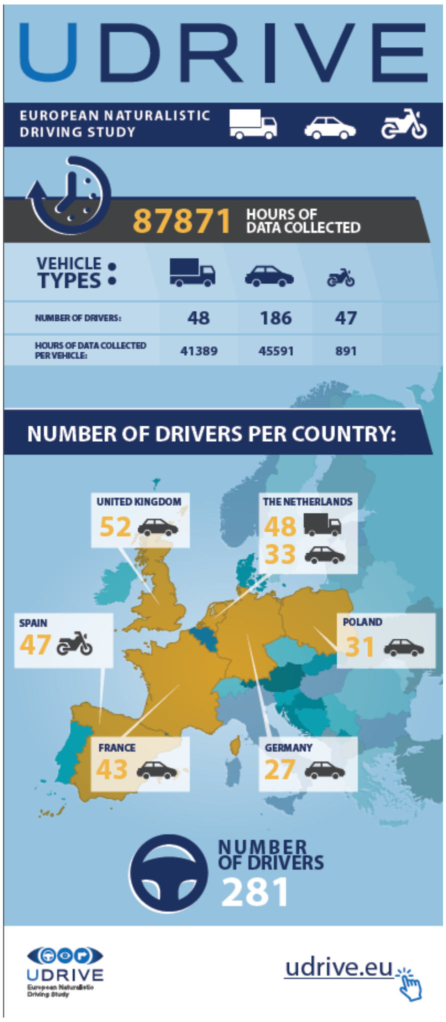
Below illustrations of the UDRIVE logo, the infografic on data collection and the UDRIVE films to disseminate the project results.

UDRIVE
European Naturalistic
Driving Study

Introducing UDRIVE (Part 1)

Collected data (Part 2)

Key results (Part 3)



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List of abbreviations

ADAS	Advanced Driving Assistance Systems
AS	Analysis Site
CDC	Central Data Centre
DAS	Data Acquisition System
HD	Hard Drive
LDC	Local Data Centre
ND	Naturalistic Driving
NDS	Naturalistic Driving Study
OMT	Online Monitoring Tool
OS	Operation Site
PTW	Powered Two-Wheeler
UDRIVE	eUropean naturalistic Driving and Riding for Infrastructure and Vehicle safety and Environment
VRU	Vulnerable Road User

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