UDRIVE

**European Naturalistic
Driving Study**

Lessons learnt from OS preparations

Deliverable 35.1

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Executive Summary

This report focuses on the specific lessons learnt from the data collection in UDRIVE, derived from the difficulties encountered by the operation sites and the solutions applied to mitigate the problems where possible. These lessons learnt concern all aspects of the data collection. Such lessons learnt will provide useful insights for any future naturalistic driving study or field operational test.

During the project, the operation sites provided three feedbacks related to their lessons learnt. These reports covered the pilot phase, the first six months of data collection and the last one at the end of the data collection. This iterative process gathered 71 lessons learnt. After the data collection, the final questionnaire was filled in by the participants and they provided with some interesting feedback.

Most important lesssons learned were: Selecting only one or two vehicle types contributed to easier instrumentation of the Data Acquisaition System to the vehicles. However, this decision put some constraints in the recruitment of participants due the different fleet of vehicles across the European countries, especially some models were not very common in certain countries.

One of the common problems across the Operation Sites (OS) was the participants' drop-outs. The main lesson learnt was that it is important to maintain a set of replacement participants until the end of the project to cover any eventual drop out.

Data protection was one of the most challenging aspects of the project. Dealing with images and personal data create some difficulties between the partners and their country data protection agencies.

From the participants' questionnaires, it was noted that even if they felt comfortable, their driving behaviour was somehow affected. Hide the equipment, and especially the cameras, the best it can be will help the participants drive normally. They also were pleased to have all the information beforehand and happy when dates, deadlines, incentives, etc., were respected as explained to them.

When involving any external supplier (e.g. rental vehicle company, garage, equipment supplier, etc.). the role, responsibilities, response time, liability, etc., of every supplier have to be defined in more detail to avoid misunderstandings, delays or ambiguities.

Developing as early as possible a very detailed and realistic plan of action allows to avoid delays, overspending, save resources and to achieve the project objectives.

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1   Introduction

UDRIVE ("European naturalistic Driving and Riding for Infrastructure & Vehicle safety and Environment") is the first large-scale Naturalistic Driving Study in Europe, which aims to collect and analyse naturalistic data on passenger cars, trucks, and powered two-wheelers, in six European regions over a period of 21 months.

UDRIVE is a 56-month research initiative co-funded by the European Commission (7th EU Framework Programme).The objective of UDRIVE is to analyse the naturalistic data on passenger cars, trucks, and powered two-wheelers (PTWs), collected in six European regions[1] (France, Germany, Poland, The Netherlands, Spain, United Kingdom) over a period of two years (Figure 1).
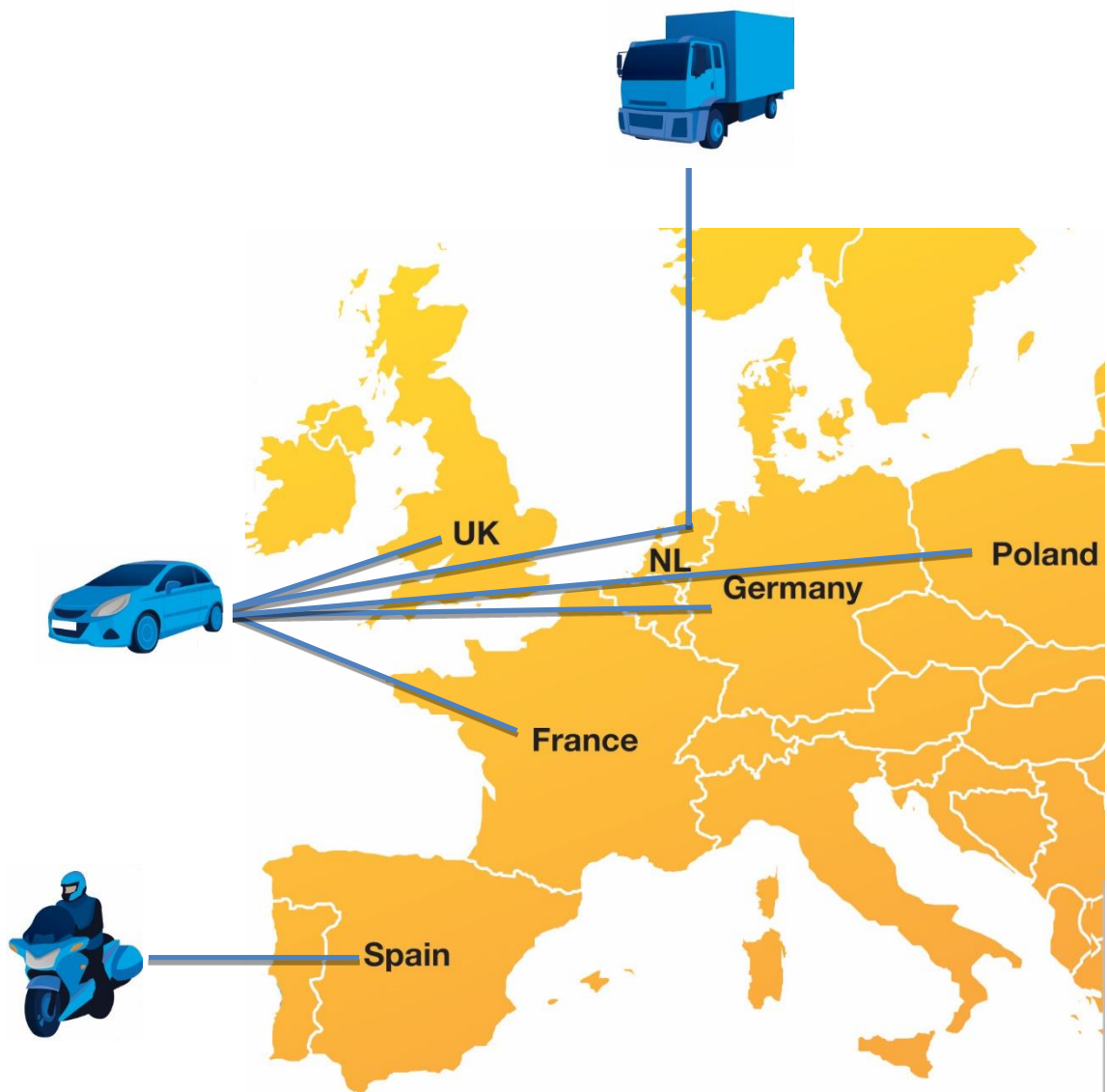

Figure 1 UDRIVE Operation sites and vehicle types

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[1] Initially there was an additional PTW OS in Austria (Vienna) but the DAS weight led to conclude that only the Piaggio Liberty 125 model (delivery services-type, with strong luggage rack) would be suitable for instrumenting; as this model does not exist in Austria, it was decided to shift the full target fleet to Spain.

For up to 21 months, 120 cars, 32 trucks and 40 scooters in France, Germany, Poland, The Netherlands, United Kingdom and Spain have been collecting vehicle data, GPS and speed data, as well as video data from a number of views, which varies depending on vehicle type: 5 for PTWs, 7 for cars and 8 for trucks (that have an additional blind spot camera), including the driver's face, hands and feet, and covering both inside and outside the vehicle. The purpose is to monitor aspects such as acceleration, lane position, speed, eye movement, traffic density and road condition.

UDRIVE will provide new insights to drivers' behaviour and crash causation factors such as distraction but also interactions with vulnerable road users and eco-driving, with the aim to provide recommendations for safety and sustainability measures.

1.1   Operation sites

The choice of operation sites (OS) was motivated by aiming at having a good spread over countries with different characteristics in terms of road safety records, road user behaviour, road infrastructure characteristics, the presence of vulnerable road users, climate, traffic density, etc., as well as the experience of the OS leaders with Naturalistic Driving tests (Table 1).

Table 1 Operations Sites characterisation

OS	Main location	OS Leader	Vehicle type	Characteristics
France	Lyon	CEESAR	Passenger cars	Mixture of urban roads, rural roads and highways. Varied traffic conditions
Germany	Braunschweig (though some participants were based in Berlin)	DLR	Passenger cars	Middle-sized city; mixture of urban roads and highway traffic.
Netherlands	Alphen aan den Rijn, Almere, Culemborg, Heeg	TNO	Trucks	Netherlands-wide short haul truck driver observation, both highway usage and local distribution.
			Passenger cars[2]	Middle-sized city; mixture of urban roads and highway traffic.
Poland	Warsaw	IBDiM	Passenger cars	City traffic as well as sub-urban and rural traffic; road infrastructure under-developed with many construction sites.
Spain	Valladolid	CIDAUT	PTWs	Middle-sized city traffic, many interactions between different types of road users; extra-urban ring-road with intersections low traffic density.
UK	Two locations: Loughborough and Leeds	Loughborough and Leeds universitie	Passenger cars	Operations in two distinct UK regions representing large and small urban areas and rural areas. Relatively high congestion.

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[2] The Dutch car OS was not initially planned and was established due to the difficulties met by the German OS to recruit the set target of 30 participants. 10 participants were thus shifted away to the Netherlands, which leased the cars.

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The UDRIVE Operation Sites (OS) have managed all aspects of the project's data collection phase: from the recruitment of drivers and vehicles (passenger cars, powered-two wheelers and trucks) to the transfer of the collected data to the local data centres (LDC), through the installation of the data acquisition systems (DAS) in the vehicles and monitoring of the participants, their vehicles and the data collection progress.

Following validation and configuration of the DAS in SP2, each OS had to recruit the required participants and perform a pilot implementation, i.e. a small scale, but representative preliminary installation and data collection.

The main recruitment criterion for participation in the study was the make and model of vehicle: Renault Clios and Méganes, Volvo Trucks and Piaggio Scooters were included in order to achieve homologation agreements and access to vehicle-based data. The project also laid out a sampling strategy, primarily according to driver age and gender.

After validation of the pilot implementation, the instrumentation of all participants' vehicles and the actual data collection could start.

During the collection of data period, the Operation Sites (OS) were asked to provide with their lessons learnt, and when the data collection was over, an exit questionnaire was given to the participants to obtain their feedback of the project.

1.2   Relation to the project structure

This deliverable provides the collection of lessons learnt from the OS during the preparation for data collection period as well as the data collection time. This report belongs to the SP3 Data collection, but its impact goes beyond the SP3 and the project trying to give insight for future Naturalistic Driving Studies or Field Operational Tests. The structure of the project is shown in Figure 2.
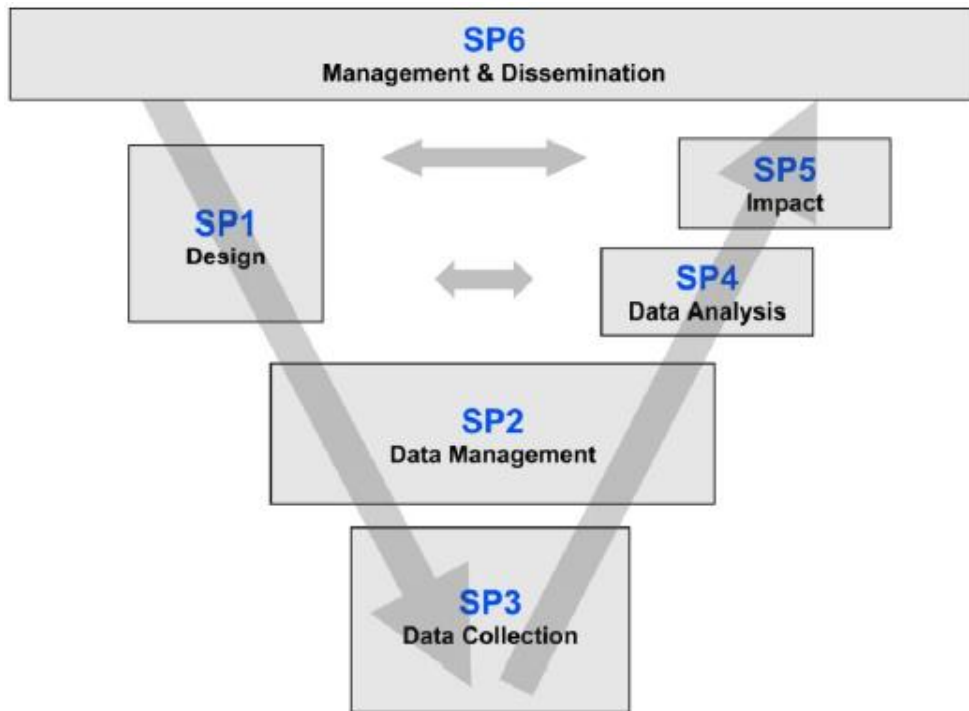
Figure 2 The overall structure of the UDRIVE project

1.3 Objective

This report focuses on the specific lessons learnt from the data collection in UDRIVE, derived from the difficulties encountered by the operation sites and the solutions applied to mitigate the problems where possible. These lessons learnt concern all aspects of the data collection, from the recruitment process, including participants' drop out, and vehicles' instrumentation process, to the data acquisition system and other equipment parts, the online monitoring tool, the supplier's after-sales services & support and data protection & data handling, but also specific ones related to vehicle type.

Incorporating the views from the participants gives an objective point of view and enriches the lessons learnt. Such lessons learnt will provide useful insights for any future naturalistic driving study or field operational test.

2   Methodology

For up to 21 months, 120 cars, 32 trucks and 40 scooters in France, Germany, Poland, The Netherlands, United Kingdom and Spain are collecting vehicle data, GPS and speed data, as well as video data. Several views are collected for video data, which vary depending on vehicle type: 5 for powered two-wheelers, 7 for cars and 8 for trucks (which have an additional blind spot camera), including the driver's face, hands and feet, and covering both inside and outside the vehicle. The different sensors and cameras allow to monitor aspects such as acceleration, lane position, speed, eye movement, traffic density and road condition.

The choice of these six operation sites was guided by the consideration to have a good spread over countries with different characteristics in terms of road safety records, road user behaviour, road infrastructure characteristics, the presence of vulnerable road users, climate, traffic density, etc.

During the project, the operation sites provided three feedbacks related to their lessons learnt. These reports covered the pilot phase, the first six months of data collection and the last one at the end of the collection phase.

The first feedback was requested after the participants pilot phase. The pilot test enabled to optimize the operations, briefing meeting, the administration of the questionnaires and comunication process with the participants. This phase was a learning process to improve the upcoming operations, that is the reason why the Operations sites were requested to give their feedback on what they had learnt during that phase. That period also covered the participants' recruitment and the definition of the operations procedures (e.g. installation of equipment, communication channels with participants, incentives strategy, etc.)

After six months collecting data, when the operations had been normalized and after a long enough period of collecting data, the OS were requested for a second feedback on their lessons learnt. It was important to collect the information from the ramping up phase, but also from the first few months of data collection, when the OS faced the real problems from carrying out such a study.

The last feedback report was submitted by the OS at the end of the data collection period. It covered most of the data collection and the de-installation of the equipments phase.

All the information gathered was analysed and classified into 5 main categories:

1. Methodology/ study plan versus actual sample criteria
2. Recruitment and re-recruitement (participant drop out)
3. Technical
   a. Vehicle instrumentation (installation/ deinstallation & piloting phase)
   b. Data collection phase
   c. Equipment-related
   d. OMT
   e. Pre-processing
4. Other non-technical issues
   a. Supplier's after-sales services & support
   b. Personal resources
   c. Participant handling & support
   d. Data protection & data handling
5. Vehicle-type specific

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The other pilar of this report is the participants' views. When the data collection was finished, during the deinstallation debriefing, the participants were requested to fill an exit questionnaire. This questionnaire collected the opinion of the participants regarding their experience and asked about aspects that could be improved (See Annex II). Their answers gave an objective point of view to the lessons learnt and have to be considered as the most enriching knowledge for future similar projects.

3   Results

During the iterative process of gathering the lessons learnt from the OS, 71 lessons learnt were reported. Some of the recommendations are very specific to one subject or some equipment, but others are general and very useful for future Naturalistic Driving studies. A detailed description of these observations is presented below. To better understand the lessons learnt and their impact, they have been grouped into 5 main categories.

3.1   Methodology/ study plan versus actual sample criteria

The decision of selecting only one or two vehicle makes and models, i.e. Renault Clios and Méganes, Volvo Trucks and Piaggio Scooters contributed to making easier the adaptation of the DAS to the vehicles. However, this decision put some constraints on the recruitment of participants due the different fleet of vehicles across the European countries, especially some models are not very common in certain countries. It also made impossible to have a second PTWs Operation site in Austria and created some problems with the recruitment of truck participants due to need for EURO 5 type and Volvo trucks. It turned out not to be possible to have a fully representative sample for the whole driver population in Europe. The same is applicable for cars. Indeed ownership of Renaults varies hugely amongst the participating countries. Consequently the project focused its efforts on finding sufficient numbers of participants and relaxed the requirements on age or gender demographics. The final sample includes more Clios than Meganes, more male than female drivers, not so many secondary drivers, except in the UK and populations between OS are not very comparable.

Most of the operation sites recruited participants who lent their private car to be instrumented. However, the PTWs and the Dutch cars were rented, which made recruitment much easier and allowed to have several consecutive waves of participants of shorter study periods. Even that it might be more expensive, this option saves time and permits to adjust the participants to a representative sample.

In future study it will be better to focus on vehicle types that are common in the study region. This, however, might require more investment in getting homologation from different car manufacturers.

3.2   Recruitment and re-recruitement (participant drop out)

The participants' recruitment was challenging in most of the OS's and caused delays and subsequently resulted in fewer data collected than anticipated. Delays in the project postponed the start of piloting, hence original recruitment efforts had to be repeated as there were dropouts in initially recruited drivers who had lost interest in the meantime, changed car, etc. Recruiting interested young drivers who fitted the criteria was found particularly difficult.

For trucks, the recruitment was especially difficult because there are different entities in the process that needs to agree to join the project. Firstly, the main contact person of the fleet has to agree, after the company management, the union and finally the truck driver himself has to accept. And also because it was needed to have EURO 5 type and Volvo trucks, which are very specific truck models, not so common in the Netherlands, which was the only truck OS.

Moreover one of the barriers to recruitment was the duration of the study itself, i.e. the perceived inconvenience for the participant of having one vehicle immobilized for instrumentation first and consecutive interventions (e.g. for debugging or replacement of equipment as necessary). Hence the importance of the incentive: if not high enough; the ratio monetary benefit / duration of the study won't be positive enough to convince potential participants.

It is important to anticipate and secure in advance efficient recruitment channels that can deliver enough interested contacts at the time the actual recruitment takes place: e.g. motorists association database, fleet owners or volunteers from own organisation, etc. Other recruitment channels used in UDRIVE include flyers at car dealerships, universities and shops car parks, as well as advertisements in traditional, online and social media. In France, access to the Database of private car owners from Auxiliary Automotive Association (AAA) – France allowed to match the sample strategy

Another lesson learnt is that it is needed to start early the recruitment process and explain carefully all the aspects of the project and their participation, especially the data protection and privacy.

However, if one OS cannot meet its recruitment quota, a backup plan with enough flexibility is needed not to penalize the project. In UDRIVE, 10 cars were shifted from Germany to The Netherlands and the 15 Austrian PTWs were shifted to Spain.

One of the common problems across the OS was the drop-outs. It was found very important to give a good briefing interview to provide detailed information to potential participants and clarify expectations on both sides but also to explain the overall purposes and benefits of study, as it makes people more receptive. It is essential to comply with the dates given to the participants. So a very detail realistic plan action has to be developed in order to avoid delays which can cause participants' drop outs. A set of replacement participants has to be maintained until the end of the project to cover any eventual drop out.

There were many reasons for the drop-outs. Indeed anticipating recruitment too early before the data collection start date bears the risk of participants losing interest or changing vehicle in the meantime. This was the case with some OS which had to re-recruit participants due to the starting delays.

Some of the reasons for drop-outs were a vehicle collision, vehicle mechanical failure, large number of technical interventions, lost of interest and moving to another city. Despite every effort at recruitment to ensure that participants are committed to completing the project, there are circumstances that cannot be helped or anticipated.

Having old vehicles increased the risk of mechanical failures and if they happened too often the participants will lose interest i.e.: PTWs.

The main lesson learnt is the importance of having a reserve pool of participants to anticipate any possible drop out. The 24-hour hotline is a necessity and should be monitored at all times in case of emergency and to give support to the participants.

3.3   Technical

3.3.1   Vehicle instrumentation (installation/ deinstallation & piloting phase)

The aim of piloting was to assess that each OS was properly trained and able to carry out OS operations. As a result, the pilot plan should be based on a precise description of the operations to be performed at an OS, based on requirements.

The fact that the pilot plan was created from scratch made it very difficult and time consuming. The process started by developing all procedures, centralizing information from all the partners within the project, consisting of 86 use cases describing each actor, operation, the role of each tool plus based on questions raised and answered. The next step was to define prerequisites that each OS had to fulfil before considering piloting, like assigning responsibilities, selecting a proper data transfer operator and installation team. CEESAR also identified critical documents that had to be developed/ adapted by each OS. These included questionnaires, briefing material, but also all instruction manuals and guidelines to instrument vehicles, pick-up and ship hard-drive, use the online monitoring tool, etc.

The result was a very detailed "handbook" for OSs. The document also comprised recommendations for piloting each step of the OS operation and a thorough checklist aiming at making sure that each OS didn't overlook any detail and giving them a clear list of their responsibilities before their starting collecting data.

During the first week of instrumentation, certain problems were encountered in terms of the logistics of managing participants. It is necessary to plan and organise the logistics of managing participants carefully, including planning enough personnel to handle them or receive not too many at the same time, making sure that there are enough computers/tablets for the online questionnaire.

For the pilot, three different vehicle types were instrumented: Clio III, Clio IV, and Megane III. Only the model Clio IV was equipped with the pre-series material matching the final equipment. The 2 other types were equipped with prototype material. Series material and prototype material validated by SECTRONIC was not identical, hence, the problems encountered by some OS's.

One of the main problems during the installation phase was the delays in the updated version of the software. This delay did not allow the OS's to perform many tests of the entire system. Also, software re-installment lacked robustness and there were ghost partitions that needed to be removed from the compact flash. This caused that the software had to be re-installed in many vehicles with the subsequent disruptions.

There were some mistakes with imcomplete and/or wrong system delivery by the DAS provider. The lesson learnt was to check all the materials before installing them in the vehicles. However, the fact that there was no status reports on the OMT yet at the time, made more difficult to check the functioning of the equipment.

A few devices (GPS antenna, cameras, cabling) were broken during the installation. Having spare equipments should be necessary.

3.3.2   Data collection phase

The scooters electric installation had to be re-installed because the cables section sent by the provider was smaller than the required. This added to the fact that some participants did not use the vehicle very often caused that some scooters run out of battery and did not record any data until repaired. Though this issue originates from installation time, the problem emerged when data collection had already started and was spotted at pre-processing. The lesson learnt itself concerns how the piloting phase should have detected this at an earlier stage to avoid data loss/not recorded. Check all the equipment received to ensure that meet the specifications required. It is keen to dimension the system that is going to be used, do enough technical tests and that the providers comply with the specifications given.

For the cars, there were not many issues. Some small adjustments to cameras were performed.

And for the trucks there were problems with HDD change. The leassons learnt were to instruct fleet owner very carefully, checked by own staff and make instruction as clear as possible. It would be helpful if they could be checked in realtime in the OMT.

3.3.3   Equipment-related

The most important problem related to the equipment were the broken DAS's. Some of them could be fixed at the OS's by re-instaling the software or reconfiguring the DAS. However, there were some DAS's that had to be sent to the provider or manufacturer. The process to fix them was very slow due to liability issues with the subsequent delays and that some participants did not collect data during that period. This problem can be mitigated by having spare DASes that could be shared around OS's as needed.

Some other technical issues with other components of UDRIVE system including cameras, cables, GPS antenna, etc. These problems were mainly detected with technical inspections and on-site repairs. In few cases fixing them required new component (e.g. power cable, GPS antenna). Establishing a centralised reserve of spare components as well helps to reduce the fixing delay.

Moreover to minimise the software problems and to save time it would be good to have a spare card ready with updated firmware to conduct re-configuration of data logger on the vehicle.

The DAS should be adapted to each type of vehicle. For the scooters, the fact that the DAS was the same than for cars created a problem. The DAS weight (15kg) exceed the maximum weight permitted for a normal PTW support bracket (5kg-8kg) which made change the vehicle model, the top case and the whole equipments installation. For the trucks, the technical system was too sensitive for heavy use trucks which cause that part of the time for some of the trucks data are not complete. In naturalistic driving studies with trucks, the systems have to be extra robust to prevent broken systems.

3.3.4   On-Line Monitoring Tool (OMT)

The On-line Monitoring Tool and pre-processing were essential tools for data quality control. One of the issues found was that there was no status reports on the OMT during the piloting phase, so there was no possibility to check the functioning of the equipment.

The snapshots from the cameras of the vehicles sometimes were in black. This could be caused by technical defect as well as by button pressed by participant (or non-participant driving the vehicle) to turn all cameras off, but this could not be checked on the OMT. It would have been very useful to see snapshots for all trips (one snapshot was available every 3-4 trips).

There was no possibility to check if the HDD exchange was successfull while the staff were at the vehicle place. In case it went wrong they had to go back, which meant taking a new appointment with the participant and could take at least a week time. That could have been a good feature for a future project.

In the OMT, the data coming from the Phidget was sometimes missing or corrupted; therefore the decoding could not be done for a few trips. Also, Information file (.inf) for data files was missing for some trips.

Connecting the piloting vehicle to the DAS using QR codes proved to be difficult. In order to replace a disc, firstly the disc has to be removed and detached from the DAS with the QR codes, check that it has been successful and attached to the Local Data Center (LDC) which was sent to. On the other hand, the new disc had to be attached to the DAS through the QR codes.

3.3.5   Pre-processing

There was a problem in decoding additional speed signal from PTWs as a speed sensor was added. The decoding of such signal had not been done and was not trivial and delayed the pre-processing. Procedures and code documentation are essential and allow continuity of the work.

One of the partners suffered an IT problem during a period of a month approximately. It was particularly difficult to get an overall assessment and solution from the company responsible for providing the services. The lesson learnt is that if these services are provided by an external company, from the beginning, they should engage on what their strategy will be exactly in case of system malfunction with no loopholes or ambiguities.

The OS did not have access to decoded data, so they could not check the synchronisation or the incoherence of the signals.

3.4   Other non-technical issues

3.4.1   Supplier's after-sales services & support

As mentioned before, the timing of receiving the broken DAS's back repaired from supplier was extremely long; from time to time the equipment sent back had missing pieces. This resulted in data loss as vehicle were not recording data while awaiting equipment back from supplier (delay was 6 to 7 weeks on average but most time even more) and also because no spare DAS's were foreseen per OS. Spare DAS's would have been needed.

Everyone involved in the project should be much implicated. Especially the participants and any external supplier (e.g. rental vehicle company, garage, equipment supplier, etc.). In each contract with the suppliers, their responsibilities, response time, penalization clauses, etc., have to be defined, so that they have to engage on what their strategy will be exactly in case of system malfunction.

3.4.2   Personal resources

Carrying out this type of project is very time demanding. And if the systems are not working properly or the participants are not fully implicated with the project even more. Any extra job not planned required extra efforts, e.g. creating the Installation manual, the re-recruitment process, dealing with the administrative paperwork (insurances, dealing with participants fines, etc.), the whole Data Protection Concept, and some other operations should not be underestimated when planning this type of project.

3.4.3   Participant handling & support

One of the problems was that participants did not drive as much as indicated in their original driving questionnaire. In some cases not all the information was provided since they would either be in a hurry or due to human induced error by the recruiters (e.g. forgetting to ask or document the answer to a particular question). This was the case for the mileage for example, the criteria was to take participants counting on doing a minimum mileage per year. This however did not reflect the actual mileage they estimated to do in a year. The result was less data collected and for the worst cases, it was needed to re-recruit new participants to replace them. The OMT was so important to regularly check and to identify such occurrence early and follow-up with participants.

There were two vandalized vehicles due to the visibility of the cameras installed in the vehicle. Some cameras and some of the DAS equipments were stolen and this increased the risk to deter participants to continue participation in study. It could be important to allocate resources to compensate participants on these types of incidents and thus not to neglect insurance for the damages caused to the vehicle.

Other lessons learnt from the OS's regarding the participants handling and support are:

- A clear procedure should be in place for handling driver complaints.
- It would be good to have technicians who can go to the drivers home or work place and fix the vehicle there.
- The 24-hour hotline is a necessity and should be monitored at all times in case of emergency and to give support to the participants.

3.4.4   Data protection & data handling

European data protection laws made challenging the project and the data collection. Dealing with images and personal data created some conflicts between the partners and their country data protection agencies. Due to perceived ethical and legal issues, the national data protection authorities can delay the authorisation for the data collection, so these issues should be checked at the project beginning or even in the proposal phase when considering a pilot location for study, trying to anticipate contacts with responsible authority as soon as possible to avoid unnecessary delays or cancellations. This issue created delays in the recruitment and thus data collection start in France. It also jeopardizes data from French OS being used for analysis by non-public bodies.

DPC (data privacy concept) documentation drafting and collection from partners, cross-checking their inputs is very time-consuming and affects use of personnel resources initially not planned for that task.

3.5   Vehicle-type specific

3.5.1   Trucks

The trucks had some specific problems and challenges throughout the project. This and the following issues are linked to commercially running fleet and the problems of distrust linked to challenging recruitment in the first place.

The trucks suffered camera sabotages: the driver camera was turned away or broken. In most cases this was probably done by drivers who drove in the participating trucks but did not participate in the UDRIVE project and were not happy about being recorded. Actually the face camera was used to filter out non-participants, but this was not well understood by all drivers. Even after again instructing the companies and drivers, cameras were still sabotaged. This led to many repairments.

The fleet owners and the drivers received new instructions in order to mitigate the problem and driving schedules were asked for so that participants and non-participants could be identified in the data. This might also have to do with the payment procedure. If drivers receive the money individually they remain more willing to participate.

For quite some data, identification is still not possible. These data cannot be used. For a future project, it is needed to instruct participants and non-participants very carefully. Make sure that non-participants know that the video-data are used to filter them out of the data and that all of their data will be excluded. And ensure that drivers are participating voluntarily.

For the companies in which one driver was assigned to one truck the above problems arose to a much lesser extent.

The trucks also have some problems with recruitment of participants due to:

- Fleet owners not seeing any commercial interest in participation and thus not willing to put efforts in it
- Workers' unions beingsuspicious about the privacy issues of their drivers. These unions have to approve changes in the worker's working environment and in some of the contacted fleets these unions refused participation.
- The EURO 5 Trucks that were needed in the project were changing into EURO 6. In quite some companies this change had been initiated before the end of the project which made it impossible to participate.
- More DAF than Volvo trucks in Dutch fleets

A way to mitigate this problems would be to use all possible relations to attract fleet owners, start early, make sure that the truck types included are the ones that many fleets are driving with, explain carefully that privacy will always be protected and convince parties of value of participation in project (PR, knowledge).

Recruitment of trucks is a very time consuming process. This is because there are different entities in the process that you need to convince to join the project. First, there is the main contact person of the fleet. Then there is the company management and only in the end there is the truck driver himself. Compared to just recruiting a person and one's car, this takes much more time and much more effort.

There were some problems with HDD change. Trucks had to be out of operation to have them available for repair. Sometimes it took quite a while before an appointment could be made between the installation company and the fleet owner. Changing of HDD's is a complicated task with a number steps that have to be taken in a specific order. We experienced that this HDD changing went wrong quite often because of this. It could only be checked on the OMT at the OS Leader premises if a HDD change was successful or not, there was no possibility to check it at the truck company location. In case it went wrong, the team had to go back there, which meant taking a new appointment and extra delays before it could be fixed.

For the trucks, the technical system was too sensitive for heavy use trucks which cause that part of the time for some of the trucks data are not complete. In naturalistic driving studies with trucks, the systems have to be extra robust to prevent broken systems.

Something similar happened with the questionnaires. They had to be adjusted for truck drivers because they were thought for car drivers.

3.5.2   PTW

Initially, SP3 of UDRIVE should have included naturalistic research on 40 powered two-wheelers (PTW), of which 25 should have been operated in Spain and 15 in Austria. Early analysis in the course of the data acquisition system (DAS) development showed that the DAS's would not be device easy to mount on every vehicle. It would be necessary to define a clear and precise procedure of installation followed by an even more precise assessment on data plausibility and data quality. This would be impossible for a large number of different vehicles. Hence, it was decided that only two different vehicles should be included in the study. Piaggio Liberty 125 and BMW R1200GS.

It later turned out that the DAS including the top-case and a battery would be more than twice as heavy as the maximum load of the Piaggio Liberty 125 luggage carrier. Hence, the vehicle was changed to a Piaggio Liberty 125 Delivery model, which has only one seat, but a strong luggage rack (often used for mail or pizza delivery services). This model does not exist in Austria, there are only a couple of vehicles, but a) with the 50ccm engine and b) operated by Austrian Mail Service, which would not comprise a representative sample of subject (beside all additional problems caused by the subjects being professional riders). Buying the vehicles and selling them after the study would not have fitted any strategy of having EC funding for the operation. KFV would have had to pay for the full price of all scooters. In addition, these vehicles cannot be sold in Austria after the project. This also made any other procedure of renting them impossible. There is no market for these vehicles there. So finally, we tried to rent the vehicles from Piaggio in Spain, but they did not agree.

The decision taken was that, considering all these issues, it was not possible to run an operation site in Austria and to shift the 15 PTWs to the Spanish OS.

Regarding the scooters, if a smaller DAS would have been used, which it could be mounted in any PTW, the recruitment process would have been easier and the Austrian OS could have run its operation. The DAS should be adapted to each type of vehicle. For the scooters, the fact that the DAS was the same than for cars created a problem. The DAS weight (15kg) exceed the maximum weight permitted for a normal PTW support bracket (5kg-8kg) which made change the vehicle model, the top case and the whole equipments installation. Each type of vehicle has different needs and having one DAS for each

type of vehicle could help to prevent some of the previous issues mentioned for trucks and PTWs. However, this will increase the costs of the in-vehicle adaptation and the personnel because specialists in each type of vehicle will be required.

Other issue for the PTW was that the provider did not supply the support brackets, which caused some delays. As a solution, the Spanish OS manufactured and procured them.

The fact that the scooters were rented from a second hand provider, and they were not in very good shape it caused many scooters mechanical failures. They had to be fixed in a garage concerted by the provider, however the reparations took very long even for a puncture. The vehicles should be new or the provider contract should have a clause stating that during the days when the vehicle is in the garage, no payment for the rental of the vehicle is due.

4   Questionnaires

The participants were asked to give their feedback regarding some aspects of the project (See Annex I) in a final questionnaire. This questionnaire was administrated during the finalization debriefing.

At the question if their behaviour had been altered during the participantion of the study, 55% of the participants said that it did not affect them, and another 40 % said that altered them sligthly. The main reason of this alteration was that the participants tried to drive more carefully or slower because they knew that they were being recorded.

However, when the participants were asked if they were aware that they have been recorded when driving, less than 10 % said that they weren't aware (Figure 3). The lesson that can be learnt is that somehow the equipment should be installed even more hidden if possible not to make participants change their behaviour.
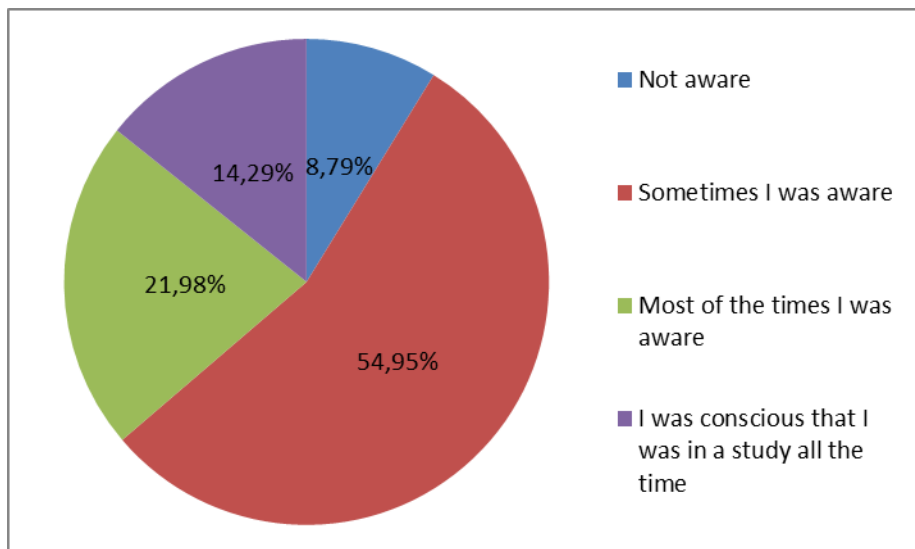
Figure 3 Awareness of the equipment

An observation pointed by some participants is that they would like to receive some feedback regarding their driving during the study, some analysis which could help them to improve their driving skills. Also that maybe monthly questionnaires to collect all the safety critical events could have been helpful.

The most positive feedback from the participants was that 95% would participate in a similar project, and in the observations, some participants congratulated the OS's teams, their organisation, communication and disposal.

5   Conclusions

The fact of selecting only one or two vehicle makes and models, i.e. Renault Clios and Méganes, Volvo Trucks and Piaggio Scooters contributes to making easier the adaptation of the DAS to the vehicles. However, this decision put some constraints in the recruitment of participants due the different fleet of vehicles across the European countries, especially some models are not very common in certain countries. It also made impossible to have a second PTWs Operation site in Austria and created some problems with the recruitment of truck participants due to need for EURO 5 type and Volvo trucks. It turned out not to be possible to have a fully representative sample for the whole driver population in Europe. Consequently the project focused its efforts on finding sufficient numbers of participants and relaxed the requirements on age or gender demographics.

The participants' recruitment for trucks was difficult because there were different entities in the process that needs to be agree to join the project. Firstly, the main contact person of the fleet has to agree, after the company management, the union and finally the truck driver himself has to accept. For trucks, the influence of the Unions shouldn't be underestimated and they need to be approached from the start and informed on all aspects of the study, to reassure them on how privacy aspects are to be dealt with, and through them win over drivers more easily. Ideally the truck drivers should receive at least part of the incentive directly (as it is still up to the fleet manager to decide, another form of incentive than purely monetary could be imagined).

Regarding the scooters, if a smaller DAS would have been used, which could be mounted on any PTW, the recruitment process would have been easier and the Austrian OS could have run its operation.

Most of the operation sites recruited participants who lent their private car to be instrumented. Because of the specific make and model of each type of vehicle, the recruitment process was challenging. However, the PTWs and the Dutch cars were rented, which made recruitment much easier and allowed to have more than one wave of participants. Even if it might be more expensive, this option saves time and permits to adjust the participants to a representative sample. If lease cannot be an option, what is then important to anticipate and secure in advance is efficient recruitment channels (per pilot site location) that can deliver enough interested contacts at the time the actual recruitment takes place: e.g. motorists association database, fleet owners or volunteers from own organisation, etc. Other recruitment channels used in UDRIVE included flyers distributed at car dealerships, universities and big stores and supermarkets car parks, as well as advertisements in traditional, online and social media or some car owners' database.

One of the barriers to recruitment is the duration of the study itself, i.e. the perceived inconvenience for the participant of having one's vehicle immobilised for instrumentation first and consecutive interventions (e.g. for debugging or replacement of equipment as necessary). Hence the importance of the incentive: if not high enough; the ratio monetary benefit / duration of the study won't be positive enough to convince potential participants.

Another important issue were the drop outs. Give the participants clear and accurate information about the project to clarify their expectations and to let them know their role in the project is very important. It is essential to comply with the dates given to the participants. So a very detailed realistic plan of action has to be developed in order to avoid delays which can cause participants drop outs. A set of replacement participants has to be maintained until the end of the project to cover any eventual drop out.

The pilot plan was created from scratch developing all procedures, centralizing information from all the partners within the project. Every OS had to develop/adapt critical documents as questionnaires, briefing material, but also all instruction manuals and guidelines to instrument vehicles, pick-up and ship

hard-drive, use the online monitoring tool, etc. The result was a very detail "handbook" for OS's. The document also comprised recommendations for piloting each step of the OS operation and a thorough checklist aiming at making sure that each OS didn't overlook any detail and giving them a clear list of their responsibilities before their starting collecting data. This process was very time consuming.

During the pilot and the installation phases there were some mistakes with imcomplete and/or wrong system delivery by the DAS provider. The lesson learnt was to check all the materials before installing them in the vehicles. However, the fact that there was no status reports on the OMT during the piloting phase, made more difficult to check the functioning of the equipment.

Regarding the equipment, the most important problem was the broken DAS's. Some DAS's had to be sent back to the provider or manufacturer and the repair time was very long. This problem could be mitigated by having spare DAS's that could be shared around OS's as needed.

The DAS should be adapted to each type of vehicle. For the scooters, the fact that the DAS was the same than for cars created a problem. The DAS weight (15kg) exceed the maximum weight permitted for a normal PTW support bracket (5kg-8kg) which made change the vehicle model, the top case and the whole equipments installation. For the trucks, the technical system was too sensitive for heavy use trucks which cause that part of the time for some of the trucks data are not complete. In naturalistic driving studies with trucks, the systems have to be extra robust to prevent broken systems.

Around 90% of the participants were aware that they had been recorded when driving. The lesson that can be learnt, is that somehow the equipment should be installed even more hidden if possible not to make participants change their behaviour.

Finally the ethical and legal issues should not be underestimated either and approval from the competent national authorities for data protection should be sought from the very start, as soon as the pilot site locations are determined, in order to avoid delays in the workplan when operations have already started.

Carrying out a Naturalistic Driving Study is very complex and even more when three different types of vehicles are included across six European countries; however the amount of data collected will give insight into many road safety problems.

6   References

- Fifth International Symposium on Naturalistic Driving Research. (2016). Design and expected results of the European Naturalistic Driving Study UDRIVE (abstract revised, Version 20160613): Nicole van Nes
- UDRIVE project deliverable. (2016). Overview of OS preparation, sample characteristics and piloting (Version 20160719: Karla Quintero.

List of abbreviations

DAS	Data Acquisition System
ND	Naturalistic Driving
OS	Operation Site
PTW	Powered-Two Wheelers
UDRIVE	eUropean naturalistic Driving and riding for Infrastructure and Vehicle safety and Environment
GPS	Global Positioning System
HDD	Hard Disc Drive
SDD	Solid State Drive
IR	Infra-red
HP	Hazard perception
LDC	Local Data Centre
OMT	Online Monitoring Tool

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7   ANNEX I EXIT QUESTIONNAIRE

Exit Questionnaire

Please answer the following questions as accurately as possible. You may choose to take some time to think about each item. Remember, all anwers are kept completely confidential.

1. On average, how much life stress did you feel during your participation in the study? Please choose only one of the following:

☐ 1. Almost no stress

☐ 2. Slight stress

☐ 3. Moderate stress

☐ 4. High stress

☐ 5. Extremely high stress

2. How much is your driving affected by stress? Please choose only one of the following:

☐ 1. Not affected

☐ 2. Slightly affected

☐ 3. Moderately affected

☐ 4. Very affected

☐ 5. Extremely affected

3. To what degree do you feel your participation in the study altered your driving behaviour? Please choose only one of the following:

☐ 1. Not altered

☐ 2. Slightly altered

☐ 3. Moderately altered

☐ 4. Very altered

☐ 5. Extremely altered

4. You indicated that your driving was affected by your participation in the study.In what way was it affected? (Only answer this question if the answer to the previous question was 'Extremely altered' or 'Very altered' or 'Moderately altered' or 'Slightly altered') Please write your answer here:

5. How would you rate how safely you drove during your participation in the project compared to all of your previous years of driving? Please choose only one of the following:

☐ 1. Much more safely

☐ 2. Somewhat more safely

☐ 3. About the same

☐ 4. Somewhat less safely

☐ 5. Much less safely

6. How would you rate your driving ability compared to the average driver? Please choose only one of the following:

☐ 1. Much better

☐ 2. Somewhat better

☐ 3. About the same

☐ 4. Somewhat worse

☐ 5. Much worse

7. How do you restrict your driving? Please choose all that apply:

☐ 1. Avoid driving at night

☐ 2. Avoid highways or interstate travels

☐ 3. Avoid left turns across traffic, where possible

☐ 4. Avoid high traffic volumes

☐ 5. Avoid driving in unfamiliar areas

☐ 6. Other

8. Please describe: (Only answer this question if the answer at the previous question was 'Other') Please write your answer here:

9. Were you aware that your driving was being recorded during the study? Please choose only one of the following:

☐ 1. Not aware

☐ 2. Sometimes I was aware

☐ 3. Most of the times I was aware

☐ 4. I was conscious that I was in a study all the time

10. Did the equipment interfere with your normal driving? Please choose only one of the following:

☐ 1. Not affected

☐ 2. Slightly affected

☐ 4. Moderately affected

☐ 5. Very affected

☐ 6. Extremely affected

11. How likely are you to give up driving altogether within the next 12 months? Please choose only one of the following:

☐ 1. Very unlikely

☐ 2. Somewhat unlikely

☐ 3. Neither likely nor unlikely

☐ 4. Somewhat likely

☐ 5. Very likely

12. Is there any events or incidents that happen during the study that you would like to tell us about? Please choose only one of the following:

☐ 1. Yes

☐ 2. No

13. Approximate Date (Only answer this question if the answer to the previous question '12' was 'Yes'). Please write your answer here:

Date	Time	Incident Description

14. Approximate Time (Only answer this question if the answer to the previous question '12' was 'Yes'). Please write your answer here:

15. Description (Only answer this question if the answer to the previous question '12' was 'Yes'). Please write your answer here:

16. How would you rate your experiences participating in this study? Please choose only one of the following:

☐ 1. Very favourable

☐ 2. Somewhat favourable

☐ 3. Neither favourable nor unfavourable

☐ 4. Somewhat unfavourable

☐ 5. Very unfavourable

17. If there is a similar project **would you be interested** on participate on it? Please choose only one of the following:

☐ 1. Yes

☐ 2. No

18. If there is a similar project **would you suggest a friend or family member** to participate on it? Please choose only one of the following:

☐ 1. Yes

☐ 2. No

18. Is there anything in particular that you would like to bring to our attention or any suggestion that can help improving the Udrive project or future projects of the same nature? Please write your answer here:

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Thank you very much for your participation in the Udrive project!