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Bringing intelligent vehicles to the road

Deliverable D5.3

Final delivery of data and answers to questionnaires

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Revision and history chart

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Executive summary

The euroFOT project is a large-scale Field Operational Test (FOT) undertaken in Europe in order to evaluate different Advanced Driver Assistance Systems (ADAS) with regard to traffic safety, efficiency and environment. Also usability and acceptance are evaluated. For this reason, test vehicles instrumented with data acquisition systems and equipped with different ADAS have been provided by different manufacturers to ordinary drivers for everyday driving. The FOT is organised by four operational test centres (vehicle management centres) across Europe: Sweden, France, Italy, and Germany.

The responsibility of subproject SP5 (Vehicle and Test Management Centre; VMC) is to prepare and guarantee both a smoothly procedure of the field operational testing (FOT) and the cooperation among the vehicle management centres, as well as to execute the FOT in accordance with the other work packages of the project. It provides the operational platform to SP6 (Evaluation Impact Assessment, Socio-economic CBA) so that the specific ADAS under investigation can be evaluated with regard to the hypotheses.

This deliverable is the result of WP5600 that is responsible for the execution of the FOT. The aim of D5.3 is to deliver the final objective and subjective data that has been gathered over the course of about one year of field operational testing. The data are handed over to SP6 for scientific analysis.

A general overview on how what kind of subjective and objective data has been gathered is given in the general chapters 2 and 3. In the VMC specific chapters an overview on the experimental design and VMC exceptions is given. The focus of this document is on a final delivery of the amount of data that has been gathered and will be available for evaluation. The document does not include any raw data, results or evaluation processes, since this is the task of SP6. Also, it does not go into detail on the type of data collected. For the subjective data an overview is given on

- the number of questionnaires that have been handed out over the course of the FOT
- for each of the questionnaires:
    - the number of questionnaires that have been filled in
    - the number of questionnaires that have not been returned
    - the response rate

For the objective data an overview is given on

- the overall amount of data that has been gathered per VMC
- for each experimental condition:
    - number of overall driven kilometres
    - the number of available driver data sets
    - the number of driving months during which data has been collected
    - the number of trips for which data has been collected

In addition, the amount of data sets with missing / incomplete data, drop-outs etc. are presented.

Data reported in the document reflect the status of September 2011. The amount of data that will finally be handed over for data analysis to SP6 is still subject to change to reflect the project and FOT execution timeline.

1 Introduction

1.1 Objectives

This document provides an overview on the delivery of the final data and answers to questionnaires that have been collected over the course of the euroFOT project. The euroFOT project is a large-scale Field Operational Test (FOT) of different Advanced Driver Systems (ADAS) undertaken in Europe. By driving instrumented vehicles over the course of more than one year in real world traffic conditions, the impacts of ADAS on safety, efficiency and environment as well as the usability and acceptance of the systems are evaluated. The ADAS to be evaluated are either already commercial functions in the market, or they are mature enough developed to be tested as commercial functions. For this purpose, test vehicles, being supplied by European manufacturers, were equipped with several different data acquisition systems (DAS) to monitor as many aspects of individual real-world driving behaviour as possible (e.g. by using CAN-data, video, GPS). In addition, questionnaires were handed out to gain deeper insight into the ordinary driver's perception of ADAS. Functions of interest are:

- Longitudinal: Adaptive Cruise Control (ACC), Forward Collision Warning (FCW), Speed Limiter (SL), Cruise Control (CC)
- Lateral: Lane Departure Warning (LDW), Impairment Warning (IW), Blind Spot Information System (BLIS)
- Others: Safe Human-Machine-Interaction (SafeHMI; navigation system), Curve Speed Warning (CSW), Fuel Efficiency Advisor (FEA)

The FOT is organised and managed by four Vehicle Management Centres (VMCs) across Europe: Sweden, France, Italy, and Germany (with two operation centres). It is the responsibility of SP5 (i.e. Sub project 5) to coordinate the VMCs, to prepare and guarantee a smooth performance of the FOT and to execute the FOT in accordance with the other SPs. All in all, data of almost 1000 vehicles (cars and trucks) with different ADAS have been gathered, which means that a wide range of data will be available for analysis and a detailed understanding of the impacts of ADAS can be gained.

This deliverable presents an overview on the amount of data that has been collected over the course of more than one year of field operational testing and will be handed over to SP6 for the evaluation process. The document includes both an overview on

- subjective data and
- objective data

The document focuses on the amount of data which has been gathered and will be available for evaluation, including missing and incomplete data where possible. The document does not include any raw data, results or evaluation processes, since this will be the task of SP6, and does not go into detail with regard to the type of collected data (e.g. situational variables, events, incidents etc.). The deliverable provides an overview on the work done in WP5600 (i.e. Execution of the FOT). An overview on the data can only be given as far as they are available yet at each of the VMCs.

1.2 Overview of functions per VMC

At each of the four VMCs and one to five OEMs contribute to the FOT by providing test vehicles. Due to several organisational reasons (e.g. functions tested, DAS used, geographical location), the German VMC with its five contributing OEMs is divided into two operation centres. At each of the VMCs and operation centres, different ADAS are of special interest and thus evaluated. Table 1 gives an overview on the VMCs, the operation sites (OEMs), the functions to be tested, and the number and equipment of the test vehicles.

Table 1: Overview of VMCs, operation sites, test vehicles, and functions of interest in the euroFOT project

VMC		Operation Site	Equipment	FCW	ACC	SL & CC	LDW	BLIS	Safe HMI	CSW	FEA
French VMC		CEESAR	35 cars CAN + Radar 5 cars CAN+Radar+Video+ additional sensors			✓					
German VMC	Operation Centre 1	FORD	95 cars CAN Only	✓	✓					✓ (2 to 5 cars)	
		MAN	56 trucks CAN Only	✓	✓		✓				
		VW/Audi	40 cars CAN Only		✓		✓				
	Operation Centre 2	BMW	15 cars (45 drivers) CAN+Video						✓		
		DAG	15 cars (60 drivers) CAN+Video						✓		
Italian VMC		CRF	280 cars with LDW, 290 cars control group Questionnaires only				✓				
Swedish VMC		VOLVO	30 trucks with CAN+Video+extra sensors (including eyeTracking)	✓	✓		✓				
			50 trucks								✓
		VCC	100 cars with CAN+Video+ extra sensors (including eyetracking)	✓	✓		✓ (+IW)	✓			

1.3 Interaction with other work packages

The work carried out in WP5600 depends on the work of other work packages, in the same way as the work of other work packages depends on WP5600. The work in euroFOT is based on the work that has been done during the FESTA project [1], whereby the general methodology of FESTA has been adopted to the requirements of the specific functions being investigated in the euroFOT project. The FESTA project provides a comprehensive handbook on experimental methodologies to carry out FOTs.

Figure 1 shows the role that SP5 plays in the FOT chain as introduced in FESTA. In the FESTA V-chain it is assumed that in a first step, the functions to be tested have to be identified and described. In the next steps, research questions together with the hypotheses are generated. Following these steps, the study design is developed and performance indicators are defined. Subsequently, measures and sensors can be selected and implemented in the test vehicles. Now, data acquisition can begin. This step corresponds to the work of SP5 in euroFOT. The gathered data is stored into a database, and data analysis can begin. Thus, research questions, hypotheses and system functions can be analysed. In a last step, the socio economic impact assessment can be realised.

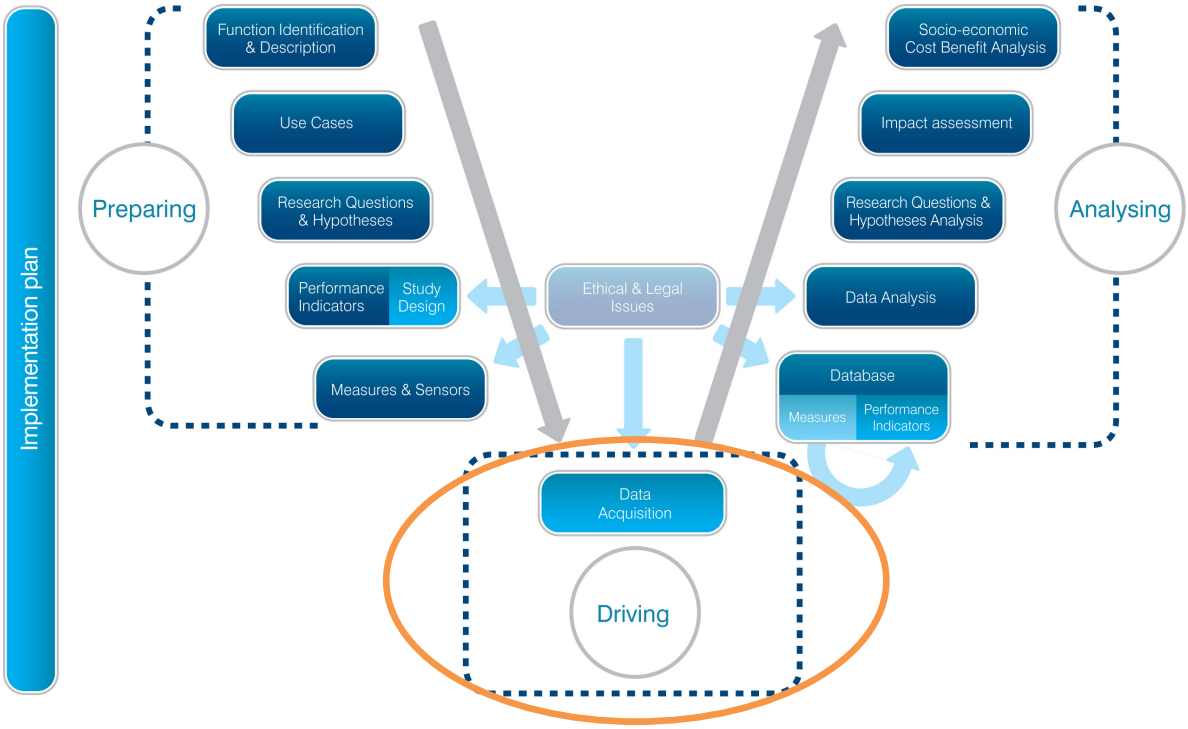

Figure 1: The FOT chain according to FESTA. The large arrows indicate the timeline. The part of SP5 is marked in orange.

Some modifications had to be made to the FESTA chain for euroFOT. For example, the SPs did not start one after another, but were running in parallel, which led to strong interactions between the work packages. The most important interactions with other subprojects and work packages are described below:

- SP2 (In-vehicle systems for driving support): In this Subproject, the requirements and specifications for testing the selected functions have been provided and hypotheses have been developed. Based on these specifications and hypotheses, the test subjects and practical requirements for running an FOT have been defined (see Deliverable 2.1 - Specifications and Requirements for Testing In-vehicle Systems for Driving Support [2])

- SP3 (Data Management): In this Subproject the best suited data acquisition systems for data collection during the FOT have been specified and the installation process has been defined. The requirements and strategies for data storage, upload/download and the development of a data analysis tool have been provided. Relevant deliverables are Deliverable D3.1 – Selection Procedure for Data Acquisition, Sensors and Storage for euroFOT [3]; Deliverable D3.2 – Base Functionality Data Analysis Software – Updated Version [4]; Deliverable D3.3 – Data Management in euroFOT [5].
- SP4 (Methodology and experimental procedures): The work of SP4 determined what kind of data has been collected in which experimental setting and thus strongly influences the results of WP5600.
    - In WP4300, the relevant performance indicators describing driving behaviour, system usage and acceptability, as well as traffic safety, traffic efficiency and impacts on traffic environment have been identified, selected, and defined. This applies both for subjective and objective performance indicators (Deliverable D4.1 – Report on specification of performance indicators [6]). In order to measure the subjective performance indicators, a common, standardized questionnaire pack has been developed, which contains general and VMC specific items and which has been adapted to the specific requirements of each of the VMCs in SP5. For the objective data, a list with defined performance indicators has been created.
    - In WP4400 the experimental procedures have been defined: e.g. selection of participants, experimental design, and the duration of the FOT (Deliverable D4.2 – Report on specification of experimental procedures [7]).
- SP6 (Evaluation, Impact Assessment, Socio-economic CBA): The objective of SP6 is to analyse the data that have been gathered and which will be handed over by SP5. Evaluation includes
    - the analysis of all user related aspects and user acceptance (WP6300), as well as
    - the identification of system impacts on traffic and driving safety, traffic efficiency and on environment (WP 6400).

  The data requested, including data-quality assurance needs, have been defined by SP6 in advance.

In addition to this document, relevant documents of SP5 are Deliverable D5.1 – Description of the VMCs and common guidelines [8], and Deliverable D5.2 – List of drivers, vehicles, equipment, Legal aspects and report on installation of the logging devices [9].

1.4 Organisation of the document

Chapter 2 briefly describes the development of the general euroFOT questionnaire package, as well as the general methodology that has been used to carry out the process of subjective data gathering.

Chapter 3 gives a general overview of the objective data that have been gathered during the FOT, the general methodology and how the data are treated before being handed over to SP6 for data evaluation. This should make it easier for the reader to classify the data presented in this document with regard to how and what kind of data have been gathered.

Chapter 4 defines what kind of data are presented in this document in the VMC specific chapters and describes the problems that occurred with final delivery of data at this point of time.

Chapters 5 to 10 are the core of the document. Each of the operation sites is described briefly with regard to the specific requirements of the VMC and its experimental procedures. An overview is given on what amount of data will be available and handed over to SP6 for evaluation, both for subjective and objective data. The focus is on how much data has been collected during the FOT, and on how much data is missing, due to drop-outs or problems with data loggers for example.

2 Subjective Data

2.1 Questionnaire definition and development

Based on the description of work and the hypotheses defined in SP2, it was one of the goals of SP4 to identify relevant performance indicators. With regard to the subjective data, it was important to be able to measure

- Acceptability
- Trust
- Subjective mental workload
- Self-report behaviour

concerning the systems under evaluation.

Based on these global concepts, a standardised questionnaire pack has been developed in WP4300. It was the aim of the common questionnaire pack to harmonise the questionnaires between the VMCs and operational test sites as far as possible and to agree on as many common questions as possible. The defined set of constructs contains:

- Demographic data
- Travel patterns
- Experience with in-vehicle technologies
- Experience with other technologies
- Personality
- Driving behaviour
- Subjective mental workload
- Perceived usefulness
- Perceived ease of use
- Perceived satisfaction
- Perceived social acceptability
- Perceived effectiveness
- Behavioural intention
- Attitude toward target behaviours
- Trust
- Social influence
- Affordability
- Self report misuse/abuse
- User practice

Several questionnaires resulted for the standardised common questionnaire pack to meet the different aims of system evaluation (please refer to D4.2; [7] for a more detailed description of questionnaire development):

- Non-participation questionnaire: Handed out to drivers that chose not to participate in the FOT.
- Screening questionnaire: Focus is on background information, such as demographic and personal data, travel patterns, experience with in-vehicle and other technologies
- Questionnaire 1: Focus is on driver attitudes, accident record, travel patterns and sensation seeking, after getting used to the new vehicle, but before driving with the interesting function
- Questionnaire 2: Measures pre-trial acceptability, self-reported driver workload and driving behaviour
- Questionnaire 3: Measures acceptability and self-reported driver workload during the treatment phase
- Questionnaire 4: Determines more detailed acceptability and workload after the treatment phase
- Exit interview: For drop-out drivers
- Debriefing questionnaire: Focus is on organisation of the FOT and on what occurred in any particular safety critical scenarios

The standardised questionnaire package mainly contains constructs and items that apply to all VMCs and functions. In addition, the operational test centres were free to include function (or operational test site) specific items. The common and harmonised questions allow an overall evaluation. Comparisons between the VMCs are possible.

A significant effort was devoted to the development of questionnaires that could be translated into different languages, as questionnaires were provided to participants in different countries (e.g. Sweden, UK, Germany, France, and Italy).

2.2 Administration of the questionnaires

The common questionnaire package has been developed on the basis of a general time plan. The time plan mirrors the common experimental design defined in WP4400. Each driver participating in euroFOT experiences at least two experimental conditions: A baseline period condition in which the system under evaluation cannot be used, and a treatment period condition in which the driver can use the system at his or her discretion. In WP4400 the baseline period was defined to last at least 1/3 of the treatment phase. At most of the operational test sites the duration of the complete FOT varies between nine and twelve months per driver, leading to a baseline period of usually 3 months.

Figure 2 gives an example of a hypothetical 9 month FOT on the times when each questionnaire was supposed to be filled in by the drivers (T1 – T4). The actual questionnaire time plans were adjusted by each VMC with regard to operational issues and the experimental procedures. A more detailed description of the VMC specific questionnaire administration can be found in Chapters 5 to 9.

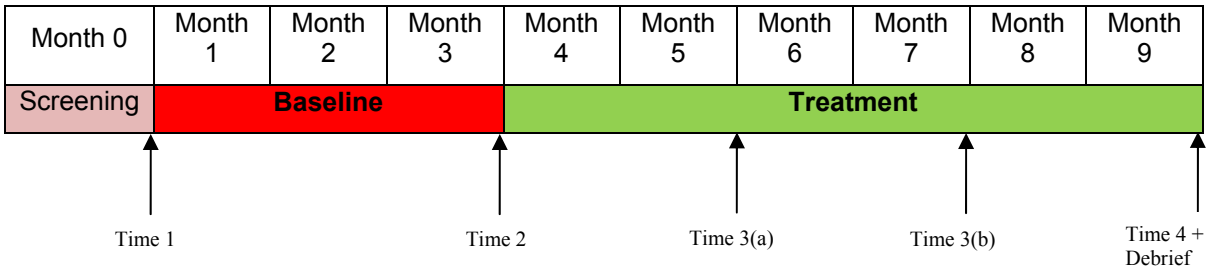

Figure 2: Exemplary timeline for questionnaire administration

With regard to the operational organisation at each operational test site (concerning experimental design, driver recruitment, vehicles, data handling), three different general methodologies for gathering subjective data were chosen by the VMCs:

- Paper-based questionnaires
- Online questionnaires
- Telephone interviews

Table 2: Overview of questionnaire administration at each VMC

VMC		Operation site	T1	T2	T3	T4
French VMC		CEESAR	Online or paper-based version	Online or paper-based version	Online or paper-based version	Online or paper-based version
German VMC	Operation Centre 1	FORD	Paper-based	Paper-based	Paper-based	Paper-based
		MAN	Not separately, but together with T2	Telephone Interview	Telephone Interview T3a + T3b	Telephone Interview
		VW/AUDI	Per email	Per email	Per email	Per email
	Operation Centre 2	BMW	Paper-based, when meeting the drivers in person	Paper-based, when meeting the drivers in person	Online	Paper-based, when meeting the drivers in person
		DAG	Paper-based, when meeting the drivers in person	Paper-based, when meeting the drivers in person	Online	Paper-based, when meeting the drivers in person
Italian VMC		CRF	Paper-based version sent out Email	Paper-based version sent out Email	Paper-based version sent out Email T3a + T3b	Paper-based version sent out Email
Swedish VMC		VOLVO	When meeting the drivers in person	For NL: Telephone interview For UK: paper-based, largely when meeting the drivers in person	For NL-first version: Telephone Interview All others: paper-based, largely when meeting the drivers in person	Paper-based, largely when meeting the drivers in person
		VCC	Online	Online	Online	Online

The VMCs either chose one of the methodologies, or, where necessary, a combination of them (see Table 2 for an overview).

The paper-based questionnaires were

- handed out to and filled in by the drivers when they were at the operation site anyway, or
- sent out to and returned filled in by drivers by mail

For the online questionnaires each driver got his or her access data by email or given before the FOT started. For a more detailed description of how the subjective data were collected at each VMC, please refer to the VMC specific chapters 5 to 9.

3 Objective data

The following chapters give an overview on how objective data were gathered and stored. For more detailed information please refer to the other reference documents [3], [4], and [5].

3.1 Definition of performance indicators

Within the work of WP4300, performance indicators (PIs), events, and situational variables (SVs) have been identified, selected, and specified. PIs, events, and SVs are based on measures (e.g. CAN, extra sensors) and are strongly related to the hypotheses formulated in SP2. The specification of PIs, events, and SVs determines which data have to be collected during the execution of the FOT and how. According to D4.1 [6], PIs are “qualitative or quantitative indicators which are used to compare the performance of a driver or a function in terms of driving behaviour, system performance, environmental aspects, traffic efficiency, acceptance, and workload. This comparison can be performed with respect to another driver or function, or to a baseline period, or to some predetermined value.” Events “are occurrences in traffic that at any given time either occur or not” (e.g. crash), whereas SVs describe “the state of a specific condition while travelling” (e.g. road type, weather) ([6], p. 1).

A measure matrix was generated within the work of WP4300 in order to provide a common list of measures necessary for SP3 to specify the DAS. Common descriptions of indicators, events and variables, necessary due to the hypotheses, were defined. For a detailed description of how PIs were identified and defined, please refer to Deliverable D4.1 [6].

The measure matrix from WP4300 and the hypotheses list developed in SP2 define the minimum number of signals which need to be logged for each VMC and each ADAS. Since the signals available in the vehicles differ between the vehicles, the exact logging protocol has been developed for each vehicle type separately. Besides the signals needed to answer the SP2 hypotheses, most OEMs also collect other signals, for instance for internal use. Therefore, due to technical as well as practical reasons, no common list of logged signals exists. Instead, it was the responsibility of each VMC (in collaboration with SP3) to ensure that the logged signals enable SP6 to provide answers to all hypotheses. Generally, the following list of measures was considered necessary to be collected:

- Longitudinal driving behaviour: e.g. speed, mileage, acceleration, breaking
- Lateral driving behaviour: e.g. steering wheel angle, lateral position of the vehicle, yaw rate, direction indicator
- Data from radar and other vehicle sensors: e.g. distance to vehicle ahead, wiper, headlight activation
- Driver based systems: e.g. activation and setting of safety systems
- GPS data: e.g. time, date
- Map-based data
- Engine information: e.g. fuel consumption
- Vehicle systems: e.g. ABS
- Weather data: e.g. rain, outside temperature, lighting conditions
- Video data
- Eye movement
- Derived measures: e.g. time headway, time to collision, time to line crossing

3.2 Data logging

Most of the VMCs do not only collect questionnaire data, they also log objective data in the vehicles. To do so, data acquisition systems (DAS) have been developed in SP3. For running the FOT in WP5600, DAS are installed in the vehicles participating at the FOT.

Because requirements on data logging differ with relation to the planned analysis (e.g. video data yes or no, extra-sensors yes or no), no common DAS could be used. As a consequence, there are several solutions for logging objective data in euroFOT.

Table 3 shows separately for the different OEMs the number of vehicles logging the different types of objective data.

Table 3: Overview of the number of vehicle collecting the different types of objective data at each VMC

VMC		Operation site	CAN	Video	Extra sensors	Eye tracker	GPS	GPRS/ UMTS
French VMC		CEESAR	40	5	40	5	40	35
German VMC	Operation Centre 1	FORD	99+2	-	2	-	99+2	99+2
		MAN	56	-	-	-	56	56
		VW/AUDI	32	-	-	-	32	32
	Operation Centre 2	BMW	15	15	15	-	15	15
		DAG	15	15	15	-	15	15
Italian VMC		CRF	-	-	-	-	-	-
Swedish VMC		VOLVO	30	30	30	30	30	30
		VCC	100	100	100	100	100	100

The following extra-sensors have been used in euroFOT:

- French VMC:
  - Long range radar (in all 40 vehicles);
  - Mobileye system (position on lane, in 5 cars)
  - Eyetracker (in 5 cars)
- German VMC Operation Centre 1(Ford)
  - Digital Map data (processed in a framework called Advanced Driver Assistance System Research Platform – ADAS-RP – to generate Curve Speed Warnings)
  - Additional GPS sensors for ADAS-RP
- German 2 VMC (BMW):
  - Mobile navigation system logging the state of the system.
- German 2 VMC (Daimler):
  - Mobile navigation system logging the state of the system;
  - Incident button starting voice recording of 30 seconds;
  - Button to code familiarity of the route at the beginning of each drive

- Swedish VMC (Volvo and VCC):
  - Eye trackers;
  - External accelerometers.

3.2.1 Vehicle data

In the vehicles, signals like speed, acceleration, steering angle etc. are recorded continuously during each drive. To do so, the DAS log data provided by CAN-bus or some other vehicle-bus (see Table 4).

Table 4: Vehicle data logged at the different VMCs.

VMC		Operation site	Vehicle data	Number of vehicles	Number of logged CAN-buses	Other vehicle buses
French VMC		CEESAR	✓	40	4	-
German VMC	Operation Centre 1	FORD	✓	99+2	3 (+1 CSW)	-
		MAN	✓	56	3	-
		VW/AUDI	✓	32	3	-
	Operation Centre 2	BMW	✓	15	4	MOST FlexRay
		DAG	✓	15	4	-
Italian VMC		CRF	-	-	-	-
Swedish VMC		VOLVO	✓	30	4	-
		VCC	✓	100	4	-

3.2.2 Video data

At some of the VMCs, video cameras have been installed in the test vehicles in order to get additional information about the driver's behaviour and the vehicle's surrounding environment. With the help of video data, the analysis of the CAN data can be supported and controlled. No audio data is recorded. Table 5 shows at which VMCs video cameras have been installed and how many cameras were used. Cameras usually record at least the driver himself, the driver's front and rear view and the centre console (driver's hands or feet).

Table 5: Overview of video data recording at the VMCs

VMC		Operation site	Video	Number of vehicles with cameras	Number of cameras/vehicle
French VMC		CEESAR	✓	5	4
German VMC	Operation Centre 1	FORD	-	-	-
		MAN	-	-	-
		VW/AUDI	-	-	-
	Operation Centre 2	BMW	✓	15	4
		DAG	✓	15	4
Italian VMC		CRF	-	-	-
Swedish VMC		VOLVO	✓	30	5 (including eyetracker)
		VCC	✓	100	5 (including eyetracker)

3.3 Data handling

Each operation centre implemented a data base into which the recorded data is uploaded. The data bases will be used by SP6 to conduct the data analysis. Before the data is uploaded to the data base, the following steps have to take place:

1. Online control of the data during the FOT, e.g. to check that the DAS is still working and the cameras are still in place.
2. Collection of the data to transfer the data from the vehicles to the site where the data bases are hosted.
3. Data pre-processing and up-load of the data to the database.

3.3.1 Data control

To ensure that the DAS work stable during the FOT, some of the used DAS allow the experimenter to control the status of the DAS during the FOT via UMTS or GPRS. Depending of the system, the wireless connection either is used to transfer all logged vehicle data or to send status reports containing information regarding the status of the DAS (see Table 6). Such information could for instance be an up-to-date picture of the cameras or information regarding the spare capacity of the hard drive.

Table 6: Online control during the FOT

VMC		Operation site	Control of DAS status	Control of vehicle data	Control of cameras
French VMC		CEESAR	✓	✓	-
German VMC	Operation Centre 1	FORD	✓	✓	-
		MAN	✓	✓	-
		VW/AUDI	✓	✓	-
	Operation Centre 2	BMW	✓	-	-
		DAG	✓	-	✓
Italian VMC		CRF	-	-	-
Swedish VMC		VOLVO	✓	✓	✓
		VCC	✓	✓	✓

3.3.2 Data collection

To transfer the logged data from the vehicle to the site of the data base, two different methodologies can be differentiated:

- Manual data pick-up: Data are stored on hard discs, hard discs are exchanged manually in regular time intervals
- On-the-fly transmission: data are transferred to the database via UMTS & GPRS

VMCs use either one or two of the methodologies. See Table 7 for an overview.

Table 7: Overview of chosen data pick-up methodologies at each VMC

VMC		Operation site	Hard discs	On-the-fly transmission (GPRS)
French VMC		CEESAR	✓	✓
German VMC	Operation Centre 1	FORD	-	✓
		MAN	-	✓
		VW/AUDI	-	✓
	Operation Centre 2	BMW	✓	-
		DAG	✓	-
Italian VMC		CRF	No DAS	No DAS
Swedish VMC		VOLVO	✓	-
		VCC	✓	-

3.3.3 Data pre-processing and up-load

After the data has been transferred to the site of the data base, each VMC implemented routines for data control, enrichment and up-load to the data base.

Routines for data enrichment include, for instance, adding variables that are either derived from a digital map or from other logged raw signals. At the end of that step, a data base is available that contains for each driver and each experimental condition a quantity of trips. The trips in the data base are the basis for the data analysis to be conducted in SP6.

4 Final delivery of subjective and objective data: Definitions

The objective of this document is to provide information about the final delivery of the subjective and objective data that have been collected over the course of one year of field operational testing by each of the VMCs. For this document it is of main interest how much data has been gathered and will be handed over to SP6 for further analysis. Thus, in Chapters 5 to 10, each VMC will give a general overview of how much data has been collected, and how much data is missing, but no raw data, or statistical analyses will be presented. Delivered data are presented in different ways which are described and defined in this chapter both for subjective and objective data.

4.1 Definition of presented subjective data

Over the course of the FOT, several questionnaires have been administered to gain insight into different subjective aspects of driving with and without the tested ADAS. This document gives on overview on how many questionnaires have been handed out and filled in at different points of time during the FOT:

- Pre-FOT: before the FOT started; before the test driver has familiarised with the test vehicle and the relevant system
- Pre-treatment / End of baseline: after the driver has familiarised with the test vehicle, at the end of the baseline, before driving with the relevant system
- During treatment: During the period of driving with the relevant system
- End of trial: after the FOT has been finished, after driving with the relevant system

For each questionnaire the following information in this document:

- “N handed out”: Number of questionnaires that have been handed out
- “N filled in & returned”: Number of questionnaires that have been completed and returned (independent of quality of answers and of some missing items) by the test drivers
- “N missing”: Number of questionnaires that have been handed out but that have not been completed by the test drivers
- “Response rate”: Percentage of completed questionnaires

“Questionnaires handed out” includes all types of questionnaires that have been used for the FOT: paper-based, online, and telephone interviews.

Table 8 to Table 10 show the basic structure of the tables in which the VMCs deliver their subjective data. VMCs adapted the tables according to the specific requirements of the experimental design.

Table 8: Basic structure to present data from questionnaires handed out before treatment

Pre-FOT						pre-treatment/ end of baseline	
Non-participation		***Screening***		***Time 1***		***Time 2***	
N handed out	X	N handed out	X	N handed out	X	N handed out	X
N filled in & returned	X	N filled in & returned	X	N filled in & returned	X	N filled in & returned	X
N missing	X	N missing	X	N missing	X	N missing	X
Response rate (%)	X	Response rate (%)	X	Response rate (%)	X	Response rate (%)	X

Table 9: Basic structure to present data from questionnaires handed out during and after treatment

During treatment				***End of trial***			
Time 3 (a)		***Time 3 (b)***		***Time 4***		***Debrief***	
N handed out	X	N handed out	X	N handed out	X	N handed out	X
N filled in & returned	X	N filled in & returned	X	N filled in & returned	X	N filled in & returned	X
N missing	X	N missing	X	N missing	X	N missing	X
Response rate (%)	X	Response rate (%)	X	Response rate (%)	X	Response rate (%)	X

Table 10: Basic structure to present questionnaire data from drop-outs

Exit interview/ drop-outs	
N handed out	X
N filled in & returned	X
N missing	X
Response rate (%)	X

4.2 Definition of presented objective data

The objective data is reported both for baseline and treatment. The following general information is presented:

- “Overall amount of data”: Overview on overall amount of data that has been collected during the baseline and treatment phase respectively, in megabyte, gigabyte or terabyte
- “Overall km driven”: Overview on overall kilometres that have been driven by all of the drivers during the baseline and treatment phase respectively

To go into more detail, data are reported with respect to drivers, driving months, and trips:

- Drivers: test drivers participating in the FOT

  - "N drivers overall": Number of all drivers that have taken part in the baseline or treatment phase, independent of potential data recording problems, and including drop-outs
  - "N drivers complete": Number of all drivers with data recording complete, i.e. drivers who have finished the FOT according to the original time plan (no drop-out), and no data is missing due to problems with data recording
  - "N drivers incomplete": Number of drivers who have finished the baseline and/or treatment period as planned (no drop-out), but parts of data are missing due to data logging problems for some days/trips etc.
  - "Drop-outs": Number of drivers who have not finished the FOT according to the time plan, because they quit the study for some reason
- Driving months: Each month over the course of the FOT in which a test driver undertook trips with the equipped test vehicle (independent of the actual number of days with trips over the month)
  - "N overall driving months": Number of all driving months over the course of the FOT (baseline and treatment respectively), across all drivers, independent of potential data logging problems
  - "N driving months complete": Number of all driving months with complete data recording and no data missing (e.g. no data logging problems, no drop-outs etc.), across all drivers
  - "N driving months incomplete": Number of months with parts of data missing (e.g. data logging problems for a couple of days); at least some data are available for the month
  - "N driving months missing": Number of full driving months with missing data, because data recording did not work (no data at all available for the month)
- Trips: when the driver turns the engine of the equipped test vehicle on, until engine is turned off
  - "N overall trips": Number of all trips undertaken by all of the drivers in the baseline and treatment period, respectively, independent of potential data logging problems
  - "N trips complete": Number of trips that have been recorded completely (e.g. no data logging problems)
  - "N trips incomplete": Number of trips with parts of the data missing, due to data logging problems; at least some data are available for the trip
  - "N trips missing": Number of trips missing completely due to data logging problems

Table 11 shows the basic structure of the table in which the VMCs deliver their objective data. VMCs adapted the table according to the specific requirements of the experimental design.

Table 11: Basic structure to present objective data collected during baseline and treatment period

Baseline							
Overall amount of data (MB, TB)	X						
Overall km driven	X						
Drivers							
N drivers overall	X	N drivers complete	X	N drivers incomplete	X	Drop-outs	X
Driving months							
N Overall driving months	X	N driving months complete	X	N driving months incomplete	X	N driving months missing	X
Trips							
N overall trips	X	N trips complete	X	N trips incomplete	X	N trips missing	X
Treatment							
Overall amount of data (MB, TB)	X						
Overall km driven	X						
Drivers							
N drivers overall	X	N drivers complete	X	N drivers incomplete	X	Drop-outs	X
Driving months							
N Overall driving months	X	N driving months complete	X	N driving months incomplete	X	N driving months missing	X
Trips							
N overall trips	X	N trips complete	X	N trips incomplete	X	N trips missing	X

4.3 Problems occurring for final delivery of data

Final delivery of data is complicated due to difficulties encountered during the FOT, such as problems occurring with data logger installation, data logging, and the general organisation of the FOT. Thus, some of the VMCs have not finished field operational testing at the deadline of this document, or have only recently finished data collection. The FOT is in the process of uploading collected data to the databases, of pre-processing data and of preparing data for data analysis. Due to the huge amount of data that has been gathered this takes a lot of time and information cannot easily be retrieved from the data. This means that not all of the VMCs have full access to all of the information that is relevant for this document. VMCs fill in the tables as far as possible and as much updated as possible. However, it is possible that not all final data will go into the data analysis.

Numbers that are not final yet are marked in the tables by italics, or – if no information is available yet – cells are either filled in with “0” or left blank. If a questionnaire has not been used by the VMC, this is indicated by “N/A”. VMCs insert the date of their last data update and indicate how much data in relation to the final data set is available yet (as far as possible).

5 French VMC

5.1 Operational procedures

5.1.1 Functions, vehicles, and experimental procedures

At the French VMC, the use of the systems Speed Limiter (SL, allows the driver to choose the maximum speed at which the vehicle travels) and Cruise Control (CC, allows the driver to choose a constant speed at which to travel) is tested. In this study, SL and CC are regarded as two different functions without any possible interaction, because when one system is in use, the other is deactivated.

Test vehicles are either RENAULT Laguna III or Clio III.

The fleet consisted of a total of 40 vehicles:

- 35 customer cars (14 Clio III and 21 Laguna III)
- 5 cars owned by CEESAR (2 Clio III and 3 Laguna III).

For each of the N=35 drivers, the FOT took 12 months in total. For most of the time during the FOT, the participants were driving their own cars, interrupted by three short periods during which participants were being given one of the five CEESAR vehicles. The CEESAR vehicles were rotated among the drivers. Two experimental conditions are compared in the particular French experimental design (see Figure 3 for an overview):

- Baseline condition: Driving without using the systems of interest (SL and CC are off). For each driver, this included ten weeks with his/her own car with “light instrumentation”, and two weeks with one of CEESAR’s fully instrumented cars (see D5.2 and D3.1 for a more detailed description of the “light” and “fully” instrumented vehicles).
- Test condition: Driving with the systems SL and CC. This period included two 2-weeks periods using a fully instrumented car by CEESAR in-between the test period and at the end of the test period.

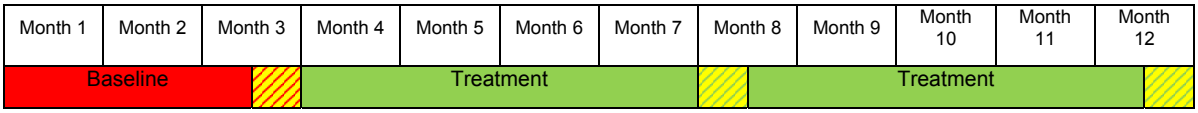

Figure 3: Experimental design at the French VMC (yellow means driving with CEESAR owned vehicle)

Concerning the recruitment procedure of the participants, CEESAR approached car dealerships (with support from Renault) to find Clio III and Laguna III owners. Those car owners were asked to participate in the study. All the potential participants were contacted first by post and then by phone. In France, only few LAGUNA III have been sold to private users, which ended up in serious difficulties to recruit Laguna drivers. The last remaining Laguna cars necessary to complete the fleet were instrumented in early June 2011.

5.1.2 Questionnaires definition and development

The French VMC used the common questionnaire defined in WP4300. Due to organisational reasons at driver recruitment, the non-participation questionnaires could not be administered to drivers who were not willing to participate.

5.1.3 Questionnaire operational procedures

At the French VMC, questionnaires are accessible online, thanks to a LimeSurvey operated web server. Each driver received an Email with a personal link to fill in the questionnaire.

In case a driver felt uneasy with the web or did not have access to internet, it was possible to complete the questionnaire online at CEESAR's facilities or on a paper-based version which was later digitised by CEESAR's team.

Consistent with the general time plan for the questionnaire pack, participants were asked to fill in the questionnaires according to the following time plan (see Figure 4 for an overview):

- Briefing and time 1 questionnaire: prior to baseline period, when customer car got instrumented
- Time 2 questionnaire (training session): at the end of the baseline period
- Time 3(a) questionnaire: halfway through treatment period, when customer car got exchanged for fully instrumented CEESAR car
- Time 3(b) questionnaire: in second last week of treatment period, when customer car got exchanged for fully instrumented CEESAR car
- Time 4 and debriefing questionnaire: at the end of the study, when CEESAR car got exchanged for the customer's car

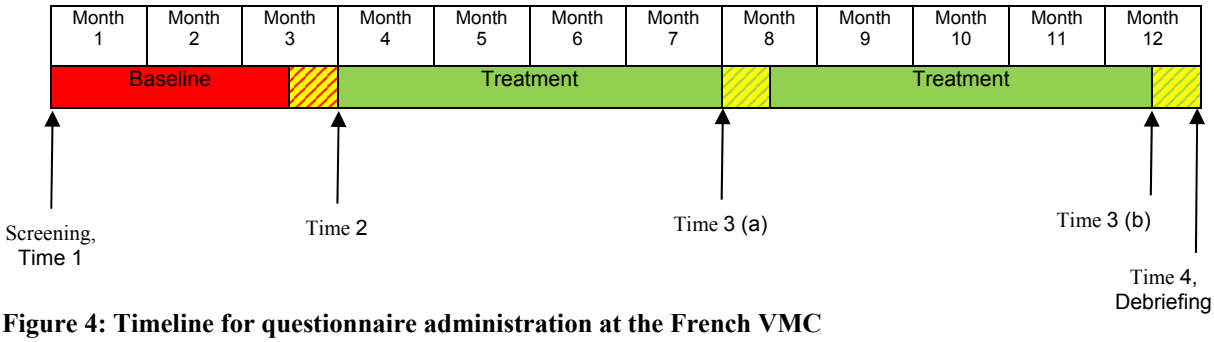

Figure 4: Timeline for questionnaire administration at the French VMC

5.1.4 CAN data gathering, transmission and storage

The DAS used at the French VMC is a modular system and consists both of a data logger built by CTAG and of several optional equipments. This modular system can be as simple as a "CAN only" (and GPS) data logger or it can also support radar, video logging, eye tracking, and lateral position management. CAN data (including GPS and radar) is transferred directly from cars to CEESAR's Central Management System using GPRS. The system provides constant monitoring of DAS operation, data transfer and implements an alert system with mail reports in case of error. The data is stored in a data base with a MySQL server solution.

For a detailed description see D3.1 [3] and D3.3 [5].

5.1.5 Video data gathering, transmission and storage

Video data was recorded in the 5 CEESAR owned vehicles by a digital video recorder that had been designed at CEESAR and synchronized to the data recorder. Four video cameras were installed:

- View of the driver's face
- View of the road to the front
- View of the centre console
- View of the right vehicle side

No audio signal is recorded. Video data is transferred using a network connection when the CEESAR owned cars were brought back to CEESAR's facility.

For detailed description of the handling of video data see [3] and [5].

Video data is stored on a file server and later used in the original acquisition format (h.264 codec), without further re-encoding.

5.2 Driver sample

Status 01.09.2011

N=35 drivers participate in the French FOT. The sample represents 27 (77%) men and 8 (13%) women. No drop-out happened after the start of the experiment.

Average age of the participants is m=48.97 years (sd=12.90 years), with the youngest driver being 21 years, the oldest driver 70 years. As shown in Figure 5, most of the participants are between 46 and 65 years of age (60%).

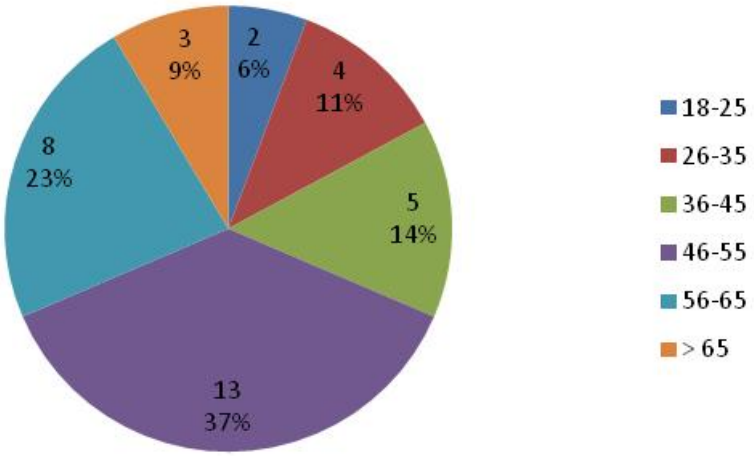

Figure 5: Age distribution of the French VMC test drivers (n=35)

The participants indicate to drive averagely m=18117 kilometres per year (sd=5715 kilometres). Figure 6 gives an overview on the distribution of annual mileage. About three

quarters of the n=35 participants usually drive between 11000 kilometres and 20000 kilometres per year (74%). A further 20% usually drive between 21000 kilometres and 30000 km. Only 6% (n=2) of the drivers have a low annual driving mileage of between 5000 and 10000 km.

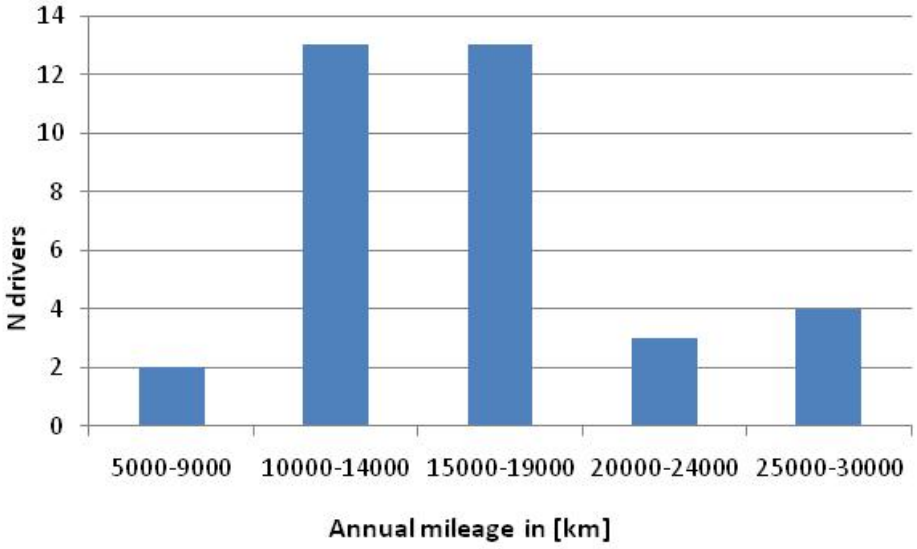

Figure 6: Distribution of annual mileage of the French VMC test drivers [in km] (n=35)

5.3 Subjective data (answers to questionnaires)

Status 03.10.2011 *(numbers in bold are not final)*

The tables in chapter 5.3 contain the subjective data of the French VMC as available until August, 24th, 2011. About 500 potential participants had been contacted by post and by phone. Of the contacted drivers, n=49 potential participants had filled in the screening questionnaire. Due to the answers from these questionnaires, n=35 drivers have been selected to participate in the experiment. At the time of the deadline of this document, all of the n=35 drivers have started the FOT, but none of the participants has finished the FOT so far, thus reported data are not complete yet.

Concerning the Time 1 questionnaire, n=35 questionnaires are filled in. N=33 participants have completed the Time 2 questionnaire, and the n=2 remaining participants will complete it by the end of October 2011.

Regarding questionnaire Time 3(a), n=15 questionnaires out of n=35 are filled in. The first participants will complete questionnaire Time 3(b) at the beginning of October 2011.

The first “End of trial” questionnaires (Time 4, Debrief) will be completed in November 2011.

Table 12: Available data from questionnaires handed out before treatment (French VMC)

Pre-FOT						pre-treatment/ end of baseline	
Non-participation		***Screening***		***Time 1***		***Time 2***	
N handed out	N/A	N handed out	49	N handed out	35	N handed out	***33***
N filled in & returned	N/A	N filled in & returned	49	N filled in & returned	35	N filled in & returned	***33***
N missing	N/A	N missing	0	N missing	0	N missing	***0***
Response rate (%)	N/A	Response rate (%)	100	Response rate (%)	100	Response rate (%)	***100***

Table 13: Available data from questionnaires handed out during and after treatment (French VMC)

During treatment				***End of trial***			
Time 3 (a)		***Time 3 (b)***		***Time 4***		***Debrief***	
N handed out	***15***	N handed out	***2***	N handed out	***0***	N handed out	***0***
N filled in & returned	***15***	N filled in & returned	***2***	N filled in & returned	***0***	N filled in & returned	***0***
N missing	***0***	N missing	***0***	N missing	***0***	N missing	***0***
Response rate (%)	***100***	Response rate (%)	***0***	Response rate (%)	***0***	Response rate (%)	***0***

Table 14: Available questionnaire data from drop-outs (French VMC)

Exit interview/ drop-outs	
N handed out	***0***
N filled in & returned	***0***
N missing	***0***
Response rate (%)	***0***

5.4 Objective data

Status 03.10.2011 *(numbers in bold are not final)*

Table 15 gives an overview on the objective data that are available at the French VMC at the deadline of this document. As none of the drivers has completed the FOT yet, only a limited amount of data is available at the deadline of D5.3 for the French VMC. Due to the dependent experimental design, each of the drivers first participates in the baseline condition, then in the treatment condition. N=33 drivers have completed the baseline and started the treatment period, whereas n=2 drivers are still in the baseline period, thus not all data have been gathered yet. For this reason, more detailed information on driving months and trips (complete, incomplete, and missing) is not accessible yet.

Table 15: Available objective data (French VMC)

Baseline							
Overall amount of data (MB, TB)	***215 GB***	*(at end of FOT, should be 220 GB)*					
Overall km driven	***154000***	*(at end of FOT, should be 160000 kilometres)*					
Drivers							
N drivers overall	35	N drivers complete	***33***	N drivers incomplete	***2***	Drop-outs	***0***
Driving months							
N Overall driving months	90	N driving months complete	***88***	N driving months incomplete	***2***	N driving months missing	
Trips							
N overall trips	***13500***	N trips complete		N trips incomplete		N trips missing	
Treatment							
Overall amount of data (MB, TB)	***280 GB***	*(at end of FOT, should be 500 GB)*					
Overall km driven	***205000***	*(at end of FOT, should be 390000 kilometres)*					
Drivers							
N drivers overall	35	N drivers complete	***1***	N drivers incomplete	***34***	Drop-outs	***0***
Driving months							
N Overall driving months	***320***	N driving months complete	***187***	N driving months incomplete	***133***	N driving months/days missing	
Trips							
N overall trips	***14800***	N trips complete		N trips incomplete		N trips missing	

So far, for the baseline 215 GB data have been collected and 154000 kilometres have been driven by the test drivers during the baseline. After extrapolating already available data, it is expected that the French VMC will have access to 220 GB of data and 160000 kilometres driven by the participants for the baseline. For the treatment period, 280 GB and 205000 driving kilometres have been collected – by the end of the treatment period it is expected to have collected 500 GB of data and 390000 km.

5.5 Lessons Learned

A summary of lessons learned collected by the French VMC during data acquisition activities in the euroFOT project are reported below. Lessons learned have been reported by the OEMs involved in the French VMC.

Lessons learned about subjective data acquisition

- The initial experimental plan was to instrument the vehicles by waves of 5 drivers (3 Laguna III and 2 Clio III). 7 waves of 5 participants were planned for the 35 participants. But because of the difficulties met with the recruitment of Laguna III drivers, instrumentation was done according to the driver selected. The first vehicles were instrumented in November 2010 and the last ones (especially Laguna cars) in June 2011.

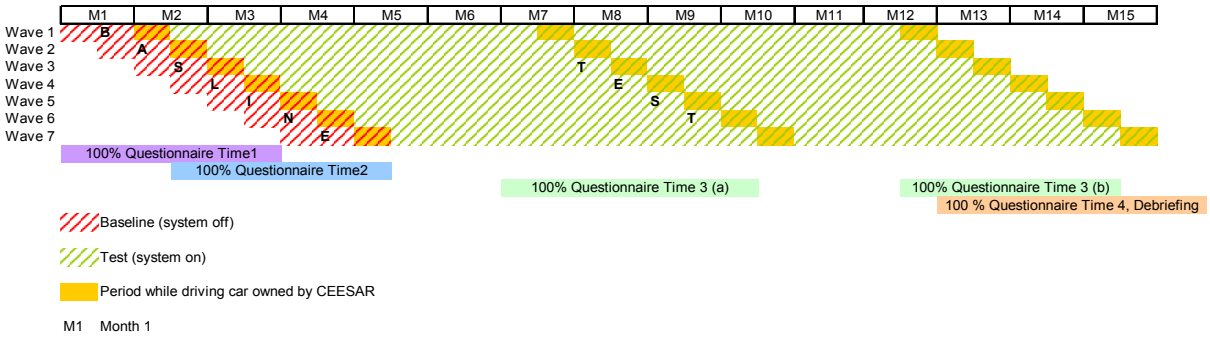

Figure 7: Initial experimental plan

- Staggering of the recruitment did not allow keeping the initial experimental plan. Consequently the turnover of the vehicles, period participants driving cars owned by CEESAR and the distribution of the questionnaires were made according to vehicle instrumentation. The current experimental plan shows the percentage of the questionnaires that have been obtained during the experiment.

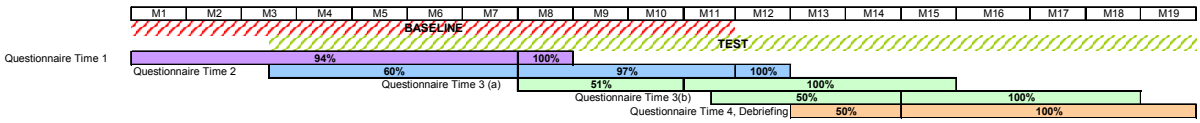

Figure 8: Actual experimental plan

- Regarding questionnaires, certain participants had problems to fill in online, but otherwise no other issues were raised by them.

Lessons learned about objective data acquisition

- The data transfer with embedded GPRS modem proved problematic. Network coverage and transfer rates were generally insufficient to ensure that all data could be transferred while vehicles were driven. Configuring data transfer to continue after the vehicle stopped did not solve the issue for drivers who only parked their car in underground parking. Hence, for some drivers, data transfer was significantly delayed, and data finally had to be retrieved manually. This ended up not only being expensive in terms of additional human resources, but it also prevented a quick

diagnosis to be performed from the data received. Hence, for future projects, we would recommend:

  - 1. Using more modern transfer protocols (e.g. UMTS), to allow better transfer rates,
  - 2. On board calculation of quality indicators (relating to technical aspects and driver behaviour/compliance to protocol), which could easily be transferred even with poor bandwidth.

- Most issues observed during the experiment, and especially the most critical ones (loss of radar channel for several weeks), were caused by cables/plugs issues. Even though automotive certified connectors were used, and no problem appeared during piloting, intermittent shortcuts and disconnections appeared after several months of experiment on a few cars. This was observed on the main data logger cable, which slightly moves when the passenger seat is adjusted (the data logger is under that seat), as well as on the radar connector, which is exposed to dust and water, under the front bumper. This underlines the extreme care which must be taken when building custom cables. Unfortunately, in one case where data transfer was delayed, several weeks were necessary to remotely identify the issue. Furthermore, the problem could not quickly be solved, as the car was far away from Paris for months.
- Other issues were software related and ended up with a few data loggers being "locked", not acquiring data, and not reachable by the GPRS connection. This was solved early in the experiment by a data logger firmware update which was remotely applied to all data loggers, preventing further occurrences of the problem. This shows the necessity of such an ability to remotely monitor a data logger status and apply eventual patches.

6 German VMC Operation Centre 1

6.1 Operational procedures

6.1.1 Functions, vehicles, and experimental procedures

FORD

Ford has 99 customer driven (CD) cars as test vehicles, namely Mondeo, S-Max, and Galaxy, which are equipped with DAS in order to record driving data. The test vehicles are not equipped with video cameras. Functions to be evaluated are

- ACC: This function supports the driver in selecting and then automatically maintaining a chosen speed and distance to the vehicle in front. The function adjusts the speed according to a potential front vehicle and accelerates and decelerates automatically.
- FCW: This function detects and tracks other vehicles (travelling in the same direction) in front of the vehicle and provides a warning to the driver in case the evaluation of trajectories and relative speed of the subject vehicle and the obstacle show a high probability of a collision.
- CSW (Curve Speed Warning): This function warns the driver of potentially dangerous situations if the vehicle is approaching a curve at a speed that is higher than the recommended value.

As CSW is not yet an option for series cars, CSW is tested in two additional test vehicles by a different set of drivers. The test site for all three functions was mostly Germany, where most of the everyday driving happened, and Europe for occasional trips.

Two experimental conditions and a dependent experimental design were chosen to evaluate the impact of ACC and FCW (see Figure 9):

- Baseline: Driving without using ACC (three months)
- Treatment: Driving with unrestricted use of ACC and FCW (nine months)

Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Baseline			Treatment: ACC+FCW								

Figure 9: Experimental design at the German VMC Operation Centre 1 (FORD)

Each participant was supposed to be in the FOT for 12 months, but a shortened participation in the FOT was possible under certain circumstances. Ford organised a two stage approach in order to recruit test drivers: 14 Ford dealerships in Germany were selected due to a high sales volume of CD cars and were provided with a total of 1500 euroFOT brochures for customers. Although 700 EUR were provided as incentive for customers (as well as 100 EUR "new order" incentive for the sales person and 150 EUR for the management of participants), this approach was not sufficient to gather enough participants. At the time of driver recruitment, German legal permission for mailing actions were changed and due to the new data privacy rules it was not considered feasible to directly address selected customers who had ordered ACC and FCW.

Together with the dealership approach, large fleet customers (i.e. companies with large orders of ACC equipped vehicles) were identified and contacted. However, Ford could not provide incentives for finding customers through the companies' fleet manager (tax reasons, company rules) and thus only one fleet customer (also a euroFOT partner) was able to provide three participants.

In the next stage the operational centre of Ford organised a mailing action for the Ford site in Cologne (engineering and also production of the Ford Fiesta series) and recruited the missing participants.

MAN

MAN examines the impacts of the systems

- ACC: This function supports the driver in selecting and then automatically maintaining a chosen speed and distance to the vehicle in front. The function adjusts the speed according to a potential front vehicle and accelerates and decelerates automatically.
- LDW: This function warns the driver when the vehicle is unintentionally departing from its intended lane.

Both of these systems are available as a product in MAN trucks since 2002.

The test vehicles are heavy trucks of the type TGX, which is mainly used for long haul transportation (see Figure 10). All of the trucks are equipped with ACC and LDW.

Figure 10: German VMC Operation Centre 1 MAN truck

The impacts of ACC only, LDW only, and the combination of the two systems on driving behaviour is of main interest. For this reason, the mixed experimental design is divided into 4 phases (see Figure 11):

Phase 1: Baseline 1 – Driving without ACC or LDW for 3 months, in order to collect normal driving behaviour data

Phase 2: Treatment Phase 1 – Driving with either ACC or LDW system for 3 months

Phase 3: Treatment Phase 2 – Driving with ACC and LDW system for 3 months

Phase 4: Baseline 2 – Driving without ACC and LDW for 2 months

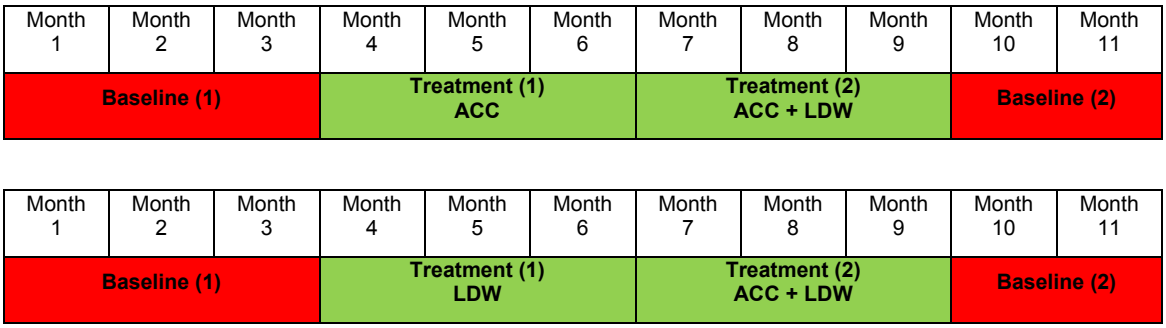

Figure 11: Experimental design at the German 1 VMC (MAN)

Each test driver was in the FOT for 11 months. Whereas all of the drivers participated in each of the four phases of the experimental plan and phases 1 and 3 were the same for all, drivers were split into two groups concerning phase 2 (treatment phase 1): One half of the drivers used the ACC, the other half of the drivers used the LDW. During phase 4 (baseline 2) ACC and LDW were deactivated again.

In order to recruit test drivers, new customers (usually fleet owners) who ordered a truck with the assistance systems under investigation were asked to participate by the sales department. In total, N=56 vehicles took part in the FOT. In case a customer agreed to participate, he or she got a price reduction on the driver assistance systems ACC and LDW. The fleet owners decided which truck drivers drove the new trucks and thus became test drivers. The test drivers are usually linked to a specific vehicle. Therefore no age or gender specific selection was planned.

Due to problems with installing the data loggers into the trucks, with parameterising them and – at the end of a phase – getting the trucks to the dealer's garage for parameterising them newly, the time plan at MAN is quite delayed. At the end of August 2011, only Phase 1 (baseline (1)) is about to be finished. An end of the FOT is not expected until February 2012.

VW/AUDI

Volkswagen examines two functions that are built into VW vehicles in series: Lane Assist (LA) and ACC. The Lane Assist actively steers back if the vehicle is about to unintentionally leaves the lane. The function is automatically deactivated when the direction indicators are used, indicating a planned leaving of the actual lane (for instance due to an overtaking manoeuvre). The ACC supports the driver by automatically keeping a certain safety distance to the cars driving ahead. The driver can set a desired travelling speed, and the function accelerates and decelerates the vehicle depending on the speed of the vehicles ahead.

AUDI also tests two functions in series: Lane Departure Warning (LDW) and ACC. LDW is a complementary system to the LA. It is only active when the turn-signals are used. If a driver indicates a lane change by activating the direction indicator, and the system detects another vehicle in the intended lane, the driver is warned not to change lanes by means of a flashing light-signal in the corresponding side-view mirror.

Test vehicles of VW are Passat Variant and Passat CC, the test vehicle of AUDI is an A4 all-road-model. All of the test vehicles were leasing cars of company employees. For VW, N=32 test drivers could be successfully recruited for the FOT, for AUDI N=1 test driver.

Two experimental conditions are compared:

- Driving without assistance systems
- Driving with assistance system

A dependent design was chosen so that each driver participated in each experimental condition (see Figure 12). Each participant drove the car for 6 months. Since it had been defined in WP4400 that the baseline phase should endure at least 1/3 of the treatment phase, VW realized a baseline phase of 3 months and a treatment phase of 3 months. In sum five questionnaires have been handed out by mail (paper-and-pencil).

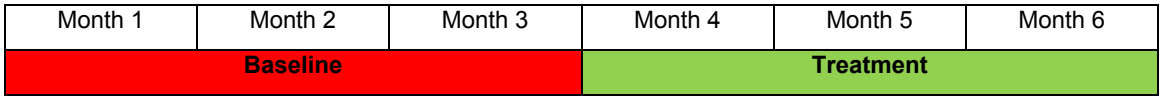

Figure 12: Experimental design at the German VMC Operation Centre 1 (VW/AUDI)

In order to recruit test drivers, the in-house Volkswagen-Distribution-Service in Wolfsburg, which is responsible for company car leasing, identified orders of the selected vehicle models equipped with LA and ACC that had been placed by company employees. These employees were asked to participate in euroFOT with their new leasing vehicle. The “Volkswagen Probandenpool” (internal agency responsible for organizing car-clinics) did the relevant contracting. Before handing out the leasing vehicles to the employees, data loggers and GPS-technology were implemented. The normal duration of leasing is 6 months. In the case of a delayed implementation of data acquisition systems, leasing-contracts were prolonged. Although the AUDI recruitment process was similar to VW, only one driver was willing to participate in the euroFOT project.

6.1.2 Questionnaires definition and development

FORD

The standardised common questionnaire pack has been used by Ford. A translated German set was kindly provided by the VW translation service. No questions were added or deleted. However, no "Non-participation" questionnaire was handed out. Together with the first questionnaire (paper based) the participants also received a driver manual and a printed list to record the times at which another driver (apart from the main driver) was driving the vehicle.

MAN

The common standardised questionnaire package was adapted by MAN in order to interview professional drivers. In general, all questions relating to private journeys were deleted, because the drivers were using the trucks only for commercial purposes.

Subjective data regarding affordability were gathered, but it has to be taken into account that the test drivers were not the customers and thus not responsible for buying trucks and driver assistance systems. Because of this, some items concerning affordability were added:

- Drivers were asked whether they knew the approximate price of the truck and its components.
- Drivers were asked whether they have any say in the buying decisions.

If the drivers answered the questions with “no”, the items concerning affordability were dropped.

The section “Social Acceptability” was adjusted in order to get truck driver relevant information about the driving groups.

There was no screening questionnaire, but personal and demographic data were inquired in the Time 1 questionnaire at the end of baseline (1). The MAN Time 2 questionnaire at the end of treatment phase (1) contains either items concerning ACC or LDW, dependent on whether the driver was in the ACC or LDW condition.

The non-participation questionnaire was dropped: Participation in the euroFOT project was offered to the customers during a truck sales conversation which should not be influenced in a negative way by the questionnaire.

VW

Volkswagen used the common questionnaire package. No parts have been added to the common questionnaire pack.

6.1.3 Questionnaire operational procedures

FORD

ACC+FCW

During pre-piloting a test was made with a web-based questionnaire and an estimate of the effort needed to setup a German web-based questionnaire (POLI kindly provided the web access to their server and an English version of the LimeSurvey software). However, the web-based survey was considered to be inefficient. Many of the test drivers were not used to using the internet and preferred a paper-based version.

At Ford all questionnaires were sent out in hard copy to the participating drivers. After the installation of the data loggers, each driver received a box with the following content:

- Screening and First questionnaire with a stamped and addressed return-envelope
- euroFOT writing pad
- euroFOT pen
- euroFOT keychain
- Logbook (in case different people were driving the car)
- Background information about euroFOT and manual with instructions (do's and don’ts during the FOT)

Each participant got a specific driver-ID which is written on the questionnaires (no names are on the questionnaires in order to assure anonymity). Screening was done beforehand through telephone interviews. Six participants were rejected as there was confusion between the cruise-control function (CC) and the adaptive CC.

Ford was able to follow the general timeline for questionnaire administration (see Figure 13):

- The screening questionnaire was sent together with the first questionnaire to complete information already gathered through telephone.
- The second questionnaire was sent out when the baseline was finished (after three months in the FOT).
- The third questionnaire had to be filled in after three months in the treatment period.
- The fourth and last questionnaire was sent out after the participant had finished the FOT (after one year).

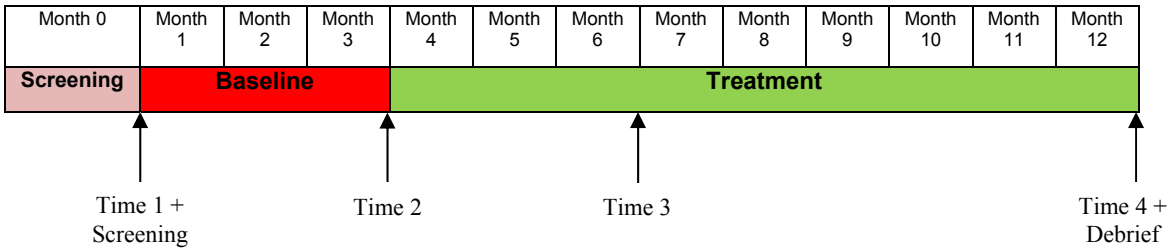

Figure 13: Timeline for questionnaire administration at the German VMC Operation Centre 1 (FORD)

After receiving the filled in questionnaires, they are scanned and saved (file name=driver-ID). Additionally, Ford tracked the questionnaires by maintaining a list with the following information:

1. Questionnaire 1 (or 2, 3, 4) sent out to driver (driver-ID)
2. Questionnaire 1 (or 2, 3, 4) received from driver (driver-ID)

This list provides a check whether the participants sent back their questionnaires or not. If the latter is the case, the participants are called and asked to send it back as soon as possible.

CSW

Test drivers of the CSW-group, recruited internally at Ford, were screened during a personal interview first (longer drives preferred, best on non-highway, no nearby commuters). Each test driver received a screening + Time 1 questionnaire before driving and, when one or several trips had been driven, the participant received a second questionnaire. The second questionnaire was identical to the Time 4 questionnaire of the standardised common questionnaire pack. The questionnaires will be evaluated when all data are collected (November 2011).

MAN

The questionnaire was surveyed by telephone interviews. Therefore the paperwork had been translated into an application for computer aided telephone interviews (CATI). The interview status and the results are controlled and stored computer based. Additionally, the interviews were recorded in order to evaluate feedback, which is not directly covered by the questionnaire. Telephone interviews were conducted at the end of each FOT phase (see Figure 14):

- Time 1 questionnaire (incl. screening): at the end of baseline (1) (Phase 1); corresponds with screening questionnaire, Time 1 and Time 2 questionnaire of the standardised common questionnaire pack
- Time 2 questionnaire: at the end of treatment phase (1) (Phase 2); either ACC or LDW, dependent of experimental condition; contains items of the Time 4 questionnaire of the standardised common questionnaire pack (end of treatment period)
- Time 3 questionnaire: at the end of treatment phase (2) (Phase 3); contains items of the Time 4 questionnaire of the standardised common questionnaire pack (end of treatment period)

- Time 4 questionnaire and debrief: at the end of baseline (2) (Phase 4); contains items of the Time 2 questionnaire of the common questionnaire pack (end of baseline period) and debriefing

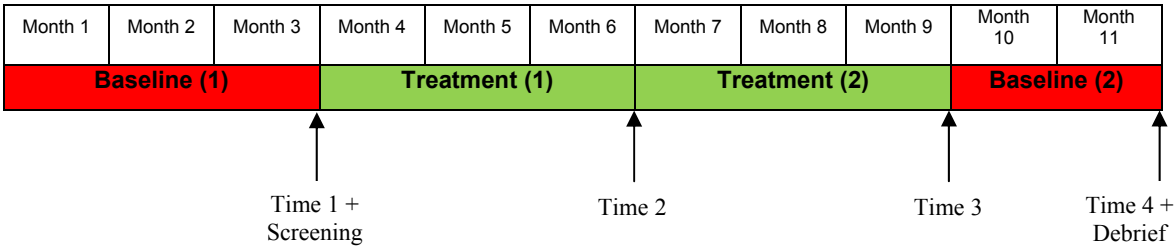

Figure 14: Timeline for questionnaire administration at the German VMC Operation Centre 1 (MAN)

VW/AUDI

As defined in WP4400, each driver participating in euroFOT experienced two experimental conditions: A baseline condition in which the systems under investigation could not be used, and a treatment phase, in which the drivers were free to use the systems at their discretion. The recommendations of WP4400 regarding the time plan of the questionnaire administration could be widely followed by VW and AUDI (see Figure 15 for an overview on when each questionnaire was supposed to be filled in by the drivers):

- Screening questionnaire: at the beginning of the FOT
- Time 1, Time 2 questionnaire: at the end of the baseline period (after three months), before the beginning of the treatment phase
- Time 3 questionnaire: halfway-through the treatment phase (after 6 weeks in the treatment phase)
- Time 4, Debriefing questionnaire: after the end of the treatment phase (after 3 months in the treatment phase)

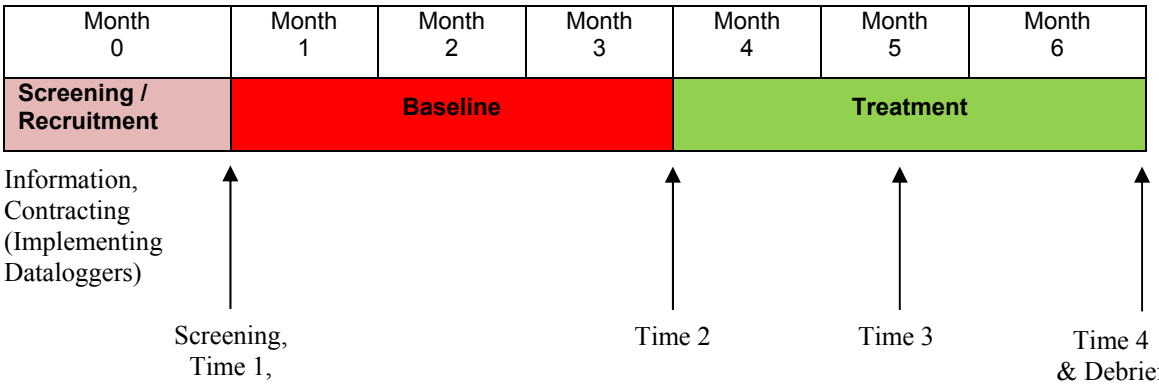

Figure 15: Timeline for questionnaire administration at the German VMC Operation Centre 1 (VW/AUDI)

Paper-and-pencil questionnaires were sent out to the test drivers by the "Volkswagen Probandenpool" and returned filled in to the Probandenpool by the drivers. Drivers were rewarded twice for participating: After 3 months (end of baseline), and after finishing the study. Incentives were delivered by Volkswagen-Shop Wolfsburg.

6.1.4 CAN data gathering, transmission and storage

FORD

The CTAG data logger for CAN+GPS collection is installed in the glove compartment, the reception unit is placed below the windshield. This accessible installation, although in danger of possible mishandling and theft, has proved to be very helpful for maintenance (e.g. SD card change through participants and resetting the logger). Signals collected are described in the SP6 documents. Their total number is much higher, as the data logger transmits full messages and each CAN-message contains several signals. Three CAN-channels are recorded (Highspeed, Midspeed, Radar).

The same DAS was used also for CSW-data collection enhanced by a fourth CAN-channel for the CSW-messages.

Due to Ford rules, the installation of the data loggers had to be free of invasive changes of the vehicles. Thus a reversible installation procedure was designed for each type of car. Logger, cable harness and antenna were assembled, fully tested in a Mondeo for operation and server connection and then packed (one logger set per box, key-chain, questionnaire, driver manual) and shipped to one of the 16 Ford dealerships.

MAN

As DAS for the MAN trucks the data logger solution of CTAG was chosen to collect the relevant CAN-bus signals. The CAN-bus has three connections: sensors – connecting rod – Info – CAN.

A GPS/GPRS antenna is installed into the CTAG data logger.

The data logger stores the data on an SD-memory card and sends it via GPRS to the data central server placed at IKA in Aachen. IKA prepares the data with the additional situational relevant information.

VW/AUDI

For the data acquisition system of Volkswagen/AUDI, the data logger solution of CTAG was chosen to collect the relevant CAN-bus signals and to perform the data upload to the server via GPRS. The data logger is connected with the CAN-Bus via specially prepared wiring harnesses. A GPS/GPRS-antenna serves to determine the exact position of the vehicle and to upload the measured data to the central server placed by IKA in Aachen.

Some of the euroFOT hypotheses required the recording of additional signals of the ACC sensors that are normally not available on the CAN-bus. These are distance and relative velocity of the ACC-target. Therefore, a special adaptation of the ACC-sensor has been developed and tested in the pilot-phase of the project.

The test vehicles are equipped with radar and camera sensors that provide information about the traffic and road situation. This is necessary for the realisation of the assistance functions (ACC and LA/LDW). The radar sensor is located at the front of the vehicle, behind the Volkswagen logo. The camera is mounted inside the car, behind the windshield. The signals relevant for the EuroFOT project are provided via a CAN-gateway. An adapter wiring harness has been designed in order to connect the CTAG data logger to the vehicle's CAN-bus without modifying the original wiring harness. The position of the data logger has been chosen carefully so that the designed bracket for the data logger matches all possible equipment versions of the three car models. The data logger is placed in the vehicle's trunk behind the carpeting. The data logger's cabling from the front to the trunk is placed in line with the original wiring harnesses. The driver only notices the presence of additional equipment due to the additional GPS/GPRS antenna.

The collected data in Volkswagen/AUDI vehicles is: Vehicle state and its dynamic specific data, position specific data, and function specific data.

The data logger stores the data on an SD-memory card and sends it to the data central server placed at IKA in Aachen. IKA prepares the data with the additional situational relevant information. This enrichment process consists of signal filtering, derivation of new signals (e.g. TTC), event classification and annotation (e.g. lane changes) and situational variables annotation.

From this moment the data are prepared for analysis according the defined euroFOT assessment procedures.

6.2 Driver sample

FORD

Status 01.08.2011

In total, n=99 vehicles are participating in the Field Operational Test (FOT) with one and more drivers per vehicle testing ACC and FCW. Questionnaire data has only been gathered from the main drivers. For the description of the driver sample information about n=99 drivers is available. One drop-out has been registered after one and a half months of participation. So far N=21 participants have finished the FOT, with n=11 not having completed a whole year, but they have participated long enough in the FOT to not count as drop-out.

Additionally, Ford has recruited n=30 drivers evaluating CSW – but not all drivers have started the experiment yet. Thus, information about the drivers of the CSW-group is not included in the driver sample description.

In the ACC+FCW-group, n=7 drivers are female, n=92 are male. The drivers averagely are m=47.9 years old in average (sd=11.3), with most of the drivers being between 36 and 55 years old (n=65; 66%). None of the participants is younger than 26 years, n=8 drivers are older than 65 years (see Figure 16).

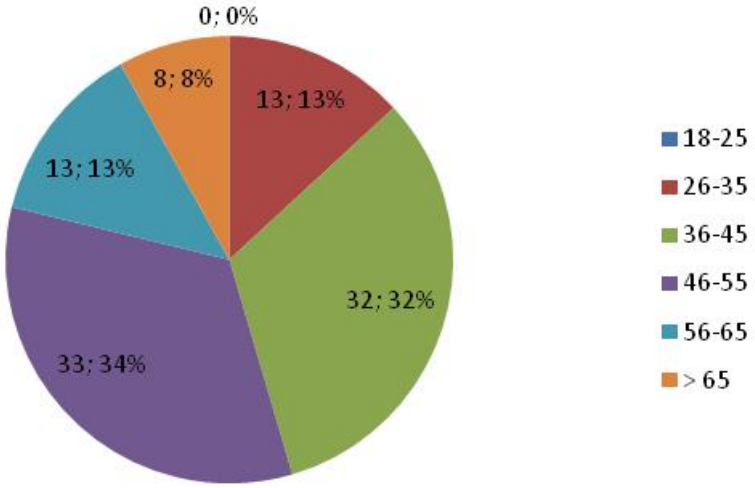

Figure 16: Age distribution of the FORD test drivers (n=99)

Drivers reported to averagely drive m=25695 kilometres per year in average (sd=14567). N=5 participants drive less than 10000 kilometres per year, n=4 participants drive between

60000 and 70000 kilometres per year. Most of the drivers indicate to drive between 10000 and 29000 kilometres per year (n=58; see Figure 17). Most of the drivers indicate to have a driving experience of between 10 and 39 years (n=90 drivers). N=2 drivers report to have been driving for less than 10 years, n=4 drivers have a driving experience of more than 50 years. Average reported driving experience is m=28.8 years (sd=10.2).

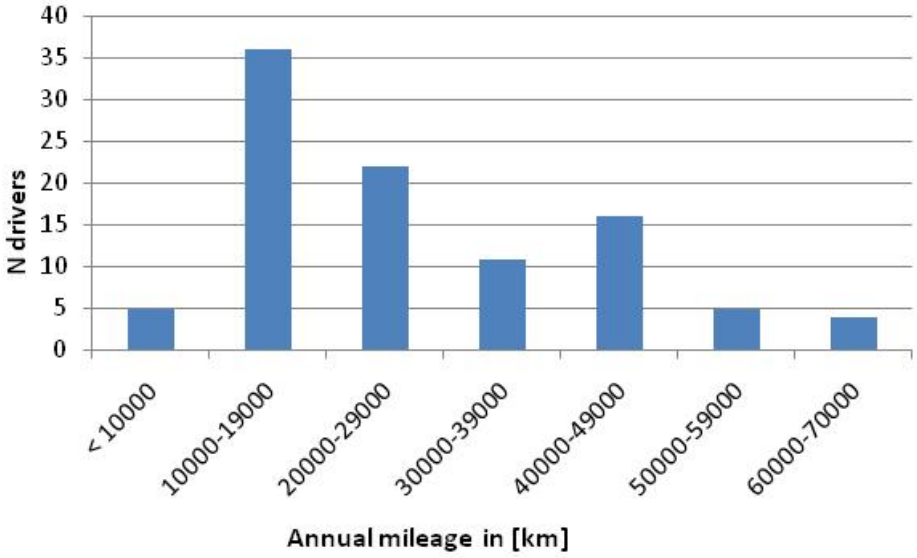

Figure 17: Distribution of annual mileage of the FORD test drivers [in km] (n=99)

MAN

Status 23.08.2011

At MAN the FOT is delayed due to problems with the data loggers and with installing the data loggers into the trucks. At the moment of the deadline of this document, only Phase 1 (baseline (1)) is about to be finished. This means that personal and demographical information about the drivers is not available yet, because not all of the drivers have finished Phase 1 and thus not been interviewed with the Time 1 questionnaire which contains the relevant information. For those drivers who have already been interviewed with the Time 1 questionnaire, the relevant information cannot yet be retrieved from the data base and analysed. Thus, no information can be given on the driver sample so far.

VW/AUDI

Status 19.08.2011

At the time of the deliverable deadline, the driver sample includes data of N=32 drivers. N=31 drivers are male, n=1 driver is female. Not included in the data are n=31 drop-outs who ended their participation in euroFOT before the baseline started, during the recruitment and contracting period.

Average age of the drivers is m=50.0 years (sd=9.7 years), with the youngest driver being 34 years, the oldest driver 74 years. Most of the drivers are between 36 and 55 years old (71.9 %). Figure 18 gives an overview on the distribution of the driver age.

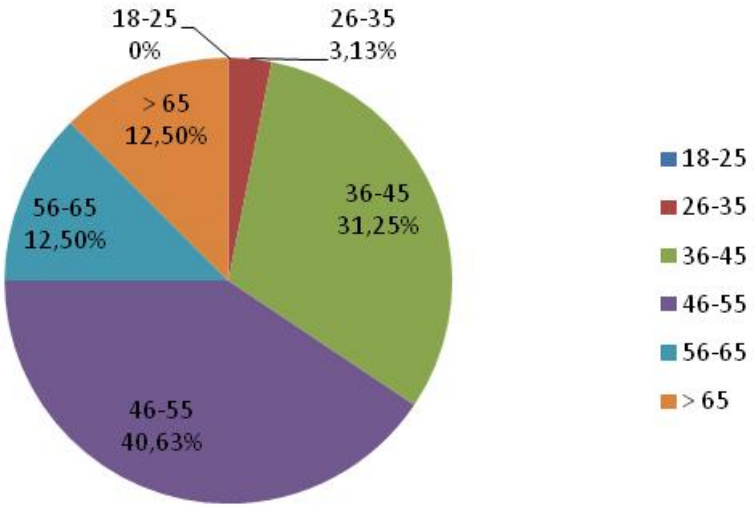

Figure 18: Age distribution of the VW test drivers (n=32)

On average, test drivers have a driving experience of m=32.9 years (sd=9.7 years), with the minimum being 17 years and the maximum being 54 years. Test drivers indicate to drive averagely m=25667 kilometres per year (sd=12890 kilometres). About 20 % usually drive less than 20000 km. About 30 % of the participants drive 20000-29000 km/year and 30000-39000 km/year respectively. Approximately 20% of the drivers indicate to drive 40.000 kilometres or more per year (see Figure 19 for an overview). Table 16 gives a more detailed overview on the driving experience of the test drivers with regard to frequency of driving per week, month, and per year.

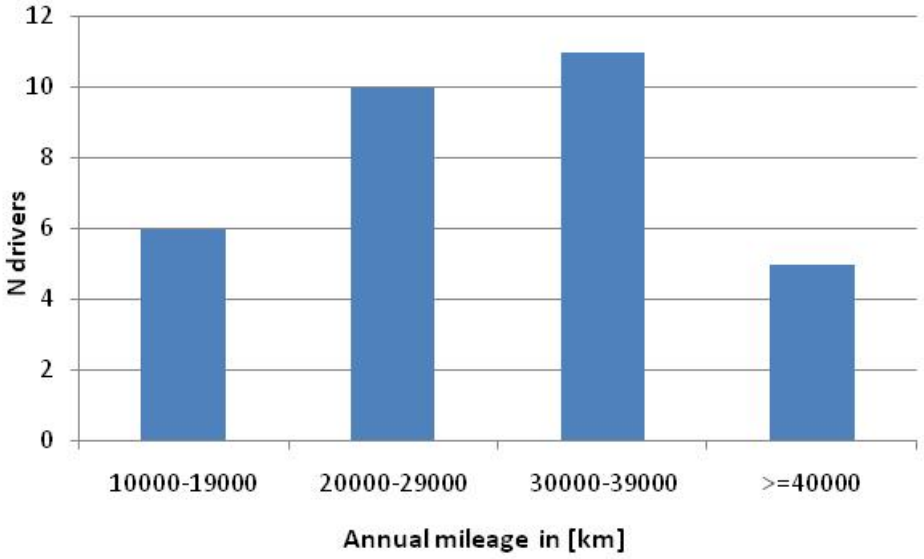

Figure 19: Distribution of annual mileage [in km] of the VW test drivers (n=32)

Table 16: Average mileage [in km] of the VW test drivers per week, month and year

On average, how many kilometres do you drive…?		km a week	km a month	km a year
N	Valid	3	2	27
Mean		733,33	4250,00	25666,67
Standard-Deviation		251,661	1060,660	12890,068
Minimum		500	3500	12000
Maximum		1000	5000	80000

6.3 Subjective data (answers to questionnaires)

6.3.1 Subjective data: FORD

Status 01.08.2011 *(numbers in bold are not final)*

ACC and FCW

The FOT is still on-going and not all participants have returned their questionnaires yet. The last participant is expected to return the final questionnaire in November 2011. The phase-out of participants (having reached an FOT-duration of one year) already began in May 2011.

Table 17: Available data from questionnaires handed out before treatment (FORD; ACC and FCW)

Pre-FOT						**pre-treatment/ end of baseline**	
Non-participation		***Screening***		***Time 1***		***Time 2***	
N handed out	N/A	N handed out	99	N handed out	99	N handed out	99
N filled in & returned	N/A	N filled in & returned	96	N filled in & returned	96	N filled in & returned	95
N missing	N/A	N missing	3	N missing	3	N missing	4
Response rate (%)	N/A	Response rate (%)	97	Response rate (%)	97	Response rate (%)	96

Table 18: Available data from questionnaires handed out during and after treatment (FORD; ACC and FCW)

During treatment				***End of trial***			
Time 3 (a)		***Time 3 (b)***		***Time 4***		***Earlier finish of FOT***	
N handed out	98	N handed out	N/A	N handed out	***62***	N handed out	***8***
N filled in & returned	***93***	N filled in & returned	N/A	N filled in & returned	***38***	N filled in & returned	***7***
N missing	***5***	N missing	N/A	N missing	***24***	N missing	***1***
Response rate (%)	***95***	Response rate (%)	N/A	Response rate (%)	***61***	Response rate (%)	***88***

Table 19: Available questionnaire data from drop-outs (FORD; ACC and FCW)

Exit interview/ drop-outs	
N handed out	***1***
N filled in & returned	***1***
N missing	***0***
Response rate (%)	***100***

CSW

The CSW-FOT is on-going and will end in November 2011. The number of administered questionnaires is low as we are still tracking the participants as long as they do not leave the company. We expect to reach the planned number of 30 drivers with more oral communications and dissemination through test drivers. Data collection will end in November 2011.

Table 20: Available data from questionnaires handed out before treatment (FORD; CSW)

Pre-FOT			
Non-participation		***Screening***	
N handed out	N/A	N handed out	***13*** **(30)**
N filled in & returned	N/A	N filled in & returned	***5***
N missing	N/A	N missing	***0***
Response rate (%)	N/A	Response rate (%)	***46***

Table 21: Available data from questionnaires handed out during and after treatment (FORD; CSW)

End of trial			
Time 4		***Debrief***	
N handed out	***12***	N handed out	***0***
N filled in & returned	***4***	N filled in & returned	***0***
N missing	***8***	N missing	***0***
Response rate (%)	***33***	Response rate (%)	***0***

Table 22: Available questionnaire data from drop-outs (FORD; CSW)

Exit interview/ drop-outs	
N handed out	***0***
N filled in & returned	***0***
N missing	***0***
Response rate (%)	***0***

6.3.2 Subjective data: MAN

Status 23.08.2011 *(numbers in bold are not final)*

At the MAN test site the FOT is delayed due to problems with data loggers and data logger installation, thus Phase 1 (baseline (1)) has not been finished yet. Since the end of Phase 1 is the first time drivers are interviewed in the FOT, no information on subjective data is available yet. However, as the surveys are conducted as telephone interviews, it is expected that by the end of Phase 1 all of the N=56 test drivers will have completed Time 1 questionnaire (see Table 23). If there are no drop-outs, all the remaining questionnaires should be completed by all of the drivers as well until the end of the FOT, with the response rate being 100%. It is not sure, however, which of the data can still be included in the statistical analysis by SP6. The end of the FOT is not expected until February 2012

Table 23: Available data from questionnaires after the first baseline (MAN)

Pre-treatment (Phase 1/baseline 1)					
Non-participation		***Screening***		***Time 1***	
N handed out	N/A	N handed out	56	N handed out	56
N filled in & returned	N/A	N filled in & returned	56	N filled in & returned	56
N missing	N/A	N missing	0	N missing	0
Response rate (%)	N/A	Response rate (%)	100	Response rate (%)	100

Table 24: Available data from questionnaires handed out after treatment periods (MAN)

At the end of treatment phases				**End of trial (Baseline 2/Phase 4)**			
Time 2 (Phase 2)		***Time 3 (Phase 3)***		***Time 4***		***Debrief***	
N handed out	***0***	N handed out	***0***	N handed out	***0***	N handed out	***0***
N filled in & returned	***0***	N filled in & returned	***0***	N filled in & returned	***0***	N filled in & returned	***0***
N missing	***0***	N missing	***0***	N missing	***0***	N missing	***0***
Response rate (%)	***0***	Response rate (%)	***0***	Response rate (%)	***0***	Response rate (%)	***0***

Table 25: Available questionnaire data from drop-outs (MAN)

Exit interview/ drop-outs	
N handed out	***0***
N filled in & returned	***0***
N missing	***0***
Response rate (%)	***0***

6.3.3 Subjective data: VW/Audi

Status 18.08.2011 *(numbers in bold are not final)*

The data collection at the VW test site has been finished. A response rate of 100% has been reached for all questionnaires (see Table 26 and Table 27).

The FOT at the VW/AUDI operation centre was delayed because of problems with the test driver recruitment. At least 31 drop-outs in the recruitment and contracting-phase have been documented and had to be compensated. Reasons for drop-outs were:

- Lack of time
- Inconvenience caused by the installation-process for technical equipment
- Delayed delivery of cars forced people to switch to other types of cars not useable for euroFOT (missing Lane Assist or LDW).

Table 26: Available data from questionnaires handed out before treatment (VW/AUDI)

Pre-FOT						**pre-treatment/ end of baseline**	
Non-participation		***Screening***		***Time 1***		***Time 2***	
N handed out	N/A	N handed out	32	N handed out	32	N handed out	32
N filled in & returned	N/A	N filled in & returned	32	N filled in & returned	32	N filled in & returned	32
N missing	N/A	N missing	0	N missing	0	N missing	0
Response rate (%)	N/A	Response rate (%)	100	Response rate (%)	100	Response rate (%)	100

Table 27: Available data from questionnaires handed out during and after treatment (VW/AUDI)

During treatment				***End of trial***			
Time 3 (a)		***Time 3 (b)***		***Time 4***		***Debrief***	
N handed out	32	N handed out	N/A	N handed out	32	N handed out	32
N filled in & returned	32	N filled in & returned	N/A	N filled in & returned	32	N filled in & returned	32
N missing	0	N missing	N/A	N missing	0	N missing	0
Response rate (%)	100	Response rate (%)	N/A	Response rate (%)	100	Response rate (%)	100

6.4 Objective data

6.4.1 Objective data: FORD

Status 01.08.2011 *(numbers in bold are not final)*

At Ford the overall collected raw data (DAS with CAN and GPS-tracks) amounts to 500 Gigabyte (GB) for the FOT. The Pilot data is 7 GB (amount is not proportional).

For a CAN-only DAS with no additional watchdog-device (i.e. a second or even third logger to record ignition activity) it is difficult to decide if days/weeks without any trips recorded are due to vacation, job travel, vehicles in repair. DAS with problems (e.g. SD cards not recording or SIM-cards not sending) were identified and repair actions have been taken. This involved sending replacement cards, issuing maintenance instructions or personal visits. Due to participants being away, being less attentive or going to their dealer for the maintenance a defect DAS means unreported data for days to weeks. The numbers of months/trips missing is an estimate.

The "overall amount of data" reported in the following table is the amount of data received from the DAS. Subsequent format change to MatLab-format increases the amount by a factor of three to eight (depending on the information content kept in the MatLab-conversion).

The phase-out of participants (having reached an FOT-duration of one year) already began in May 2011, data will be collected until November 2011 when the last participants have finished.

ACC and FCW

Table 28: Available objective data (FORD; ACC+FCW)

Baseline							
Overall amount of data (MB, TB)	***145 GB***						
Overall km driven	***352000***						
Drivers							
N drivers overall	99	N drivers complete	98	N drivers incomplete	0	Drop-outs	1
Driving months							
N Overall driving months	***296***	N driving months complete	***280***	N driving months incomplete	***12***	N driving months missing	***4***
Trips							
N overall trips	***32200***	N trips complete	***32000***	N trips incomplete	***200***	N trips missing	NA
Treatment							
Overall amount of data (MB, TB)	***348 GB***						
Overall km driven	***842000***						
Drivers							
N drivers overall	99	N drivers complete	***23***	N drivers incomplete	***75***	Drop-outs	***1***
Driving months							
N Overall driving months	***294***	N driving months complete	***280***	N driving months incomplete	***10***	N driving months missing	***4***
Trips							
N overall trips	***77000***	N trips complete	***76600***	N trips incomplete	***400***	N trips missing	NA

CSW

At Ford the CSW-FOT data was collected with two Mondeo, equipped with extra hardware (computer, Centrestack display and high precision GPS-sensor). Both Mondeo provide full ACC and FCW functionality and the collected data can be compared to the large ACC+FCW experiment. The datalogger was programmed to include the additional CSW-signals; the base signal set is that of the large FOT.

The setup of the CSW-system required many changes to a series car (additional hardware, replacement of the Centrestack display in front of the driver, sensors). Therefore the CSW-FOT had to be performed with a test car (which has a special legal status). Ford policy

regarding the use of test cars restricts the usage to weekdays only. To increase the number and length of trips, after additional internal safety checks, a separate signature procedure could be installed to allow a euroFOT-only exception for weekend drives. With an internal acquisition procedure we were thus able to offer "free"-weekend usage of the vehicles. However, due to the additional hardware installation the luggage space was very small. Some longer weekend drives were made and provided for a more comfortable test-environment. The number of trips missing reflects the malfunctions of the hardware for the CSW-system. The number of months is small as the test drivers use the cars for few trips only. There are no baseline trips (i.e. CSW messages switched off) as the number of samples (number of trips) is too small.

Table 29: Available objective data (FORD; CSW)

Treatment							
Overall amount of data (MB, TB)	***3.8 GB***						
Overall km driven	***5800***						
Drivers							
N drivers overall	30	N drivers complete	***13***	N drivers incomplete	***17***	Drop-outs	***0***
Driving months							
N Overall driving months	***8***	N driving months complete	***7***	N driving months incomplete	***0***	N driving months missing	***1***
Trips							
N overall trips	***122***	N trips complete	***105***	N trips incomplete	***0***	N trips missing	***17***

6.4.2 Objective data: MAN

Status 23.08.2011 *(numbers in bold are not final)*

As reported earlier, at the MAN test site the first baseline has not been finished by all drivers and the first treatment period has not yet started. Thus, no objective data are available so far. It is not possible to make any approximate guesses on how many objective data will be available for statistical analysis at the end of the FOT.

Table 30: Available objective data (MAN)

Baseline (1)							
Overall amount of data (MB, TB)	***0***						
Overall km driven	***0***						
Drivers							
N drivers overall	56	N drivers complete	***0***	N drivers incomplete	***56***	Drop-outs	***0***
Driving months							
N Overall driving months	***0***	N driving months complete	***0***	N driving months incomplete	***0***	N driving months missing	***0***
Trips							
N overall trips	***0***	N trips complete	*0*	N trips incomplete	***0***	N trips missing	***0***
Treatment phase (1)							
Overall amount of data (MB, TB)	***0***						
Overall km driven	***0***						
Drivers							
N drivers overall	***0***	N drivers complete	***0***	N drivers incomplete	***0***	Drop-outs	***0***
Driving months							
N Overall driving months	***0***	N driving months complete	***0***	N driving months incomplete	***0***	N driving months/days missing	***0***
Trips							
N overall trips	***0***	N trips complete	***0***	N trips incomplete	***0***	N trips missing	***0***
Treatment phase (2)							
Overall amount of data (MB, TB)	***0***						
Overall km driven	***0***						
Drivers							
N drivers overall	***0***	N drivers complete	***0***	N drivers incomplete	***0***	Drop-outs	***0***
Driving months							
N Overall driving months	***0***	N driving months complete	***0***	N driving months incomplete	***0***	N driving months/days missing	***0***

Trips							
N overall trips	***0***	N trips complete	***0***	N trips incomplete	***0***	N trips missing	***0***
Baseline (2)							
Overall amount of data (MB, TB)	***0***						
Overall km driven	***0***						
Drivers							
N drivers overall	***0***	N drivers complete	***0***	N drivers incomplete	***0***	Drop-outs	***0***
Driving months							
N Overall driving months	***0***	N driving months complete	***0***	N driving months incomplete	***0***	N driving months/days missing	***0***
Trips							
N overall trips	***0***	N trips complete	***0***	N trips incomplete	***0***	N trips missing	***0***

6.4.3 Objective data: VW/Audi

Status 18.08.2011 *(numbers in bold are not final)*

Because the database for VW data has not been finished up to now, it is not yet possible to retrieve the objective data for baseline period and treatment period separately. Table 31 gives an overview on all data that have been collected over the course of the FOT.

Table 31: Available objective data (VW/AUDI)

VW FOT-Data							
Overall amount of data (GB)	36 GB						
Overall km driven	345508						
Drivers							
N drivers overall	32	N drivers complete	28	N drivers incomplete	1	Drop-outs	3
Driving months							
N Overall driving months	192	N driving months complete	181	N driving months incomplete	6	N driving months missing	5
Trips							
N overall trips	25873	N trips complete	25873	N trips incomplete	N/A	N trips missing	N/A

Due to connectivity problems some dataloggers (at least N=8) did not send data to Aachen for a couple of weeks. Therefore there are n=6 incomplete and n=5 missing driving months in the data set.

6.5 Lessons Learned

A summary of the lessons learned collected by German1 VMC during data acquisition activities in the euroFOT project is reported below. Lessons learned have been reported by the OEMs involved in German VMC Operation Centre 1.

Ford

- Plan enough time to discuss the subjective questionnaire in-house to include topics relevant for internal departments. Additional questions must comply with the structure and overall intentions of the original questionnaire – so add more time to discuss with the proper work-package in the FOT project.
- Consider online-services for the questionnaire with respect to the age and internet-usage of the customer.
- Questionnaire software can be very language dependent – simple translation is not possible (i.e. buttons have to be changed; forking decisions have to be changed, etc.).
- Consider outsourcing questionnaire work (printing, sending, and reminding, checking, questions) as this work does not fit very well into the workflow of an automotive company.
- Prepare for exchange of faulty devices (in our case we had to send SD-cards to more than fifty customers and ask them to return the old SD-cards with valuable data). In some cases we even asked to return the DAS itself. Of course, this does not apply to bulky equipment or devices which need recalibration.
- Design the DAS installation for easy exchange of devices. Keep in mind, that easily accessible devices are prone to theft or damage.
- Setup procedures for exchange of equipment (letter, gimmicks, parcels with padding material, prepaid stamps, lists for send/return).

VW/AUDI

- Consider that the planned incentives for the acquired customers really overdrive the necessary additional costs for the required extra car equipment.
- Consider that the chosen car models are available during the whole acquisition process; otherwise it will be necessary to adapt the data acquisition system to each model individually.
- Make sure that all individual components of the whole data acquisition system (hardware and software) are sufficiently tested before their installation in the cars is tested – even before the pilot phase.
- Control the data acquisition and communication process all the time, and especially at the project's significant points (start and end of baseline and treatment period). React immediately if insufficiencies occur.
- Consider additional time and financial efforts for the maintenance of broken DAS or communication components.

7 German VMC Operation Centre 2

7.1 Operational procedures

7.1.1 Functions, vehicles, and experimental procedures

At the German VMC Operation Centre 2, the system under investigation is called “SafeHMI”, meaning that different HMI-solutions (or system integration levels) for navigation systems are compared. The selected navigation systems are

- a mobile device by Harman/Becker,
- The BMW and Daimler proprietary solutions for built-in navigation systems.

Test vehicles are the new E-class model by Daimler and the new series-5 model by BMW. The Daimler vehicles were leased to customers by a special Daimler department. Customers were offered reduced leasing rates for agreeing to participate in the FOT (for the time being in the FOT). The BMW vehicles were owned by BMW. BMW customers were asked to participate in the FOT by the BMW sales department and were offered to drive the new series-5 model for the time being in the FOT. Vehicles were equipped with all drivers’ assistance systems available for the models, in particular with ACC and LDW in order to gain information on distances to lead vehicles and lane position from the associated sensors. Both BMW and Daimler each had N=15 vehicles available (for a further description refer to D5.1, D5.2).

Three experimental conditions were compared (see Figure 20 for an example):

- Driving without navigation system
- Driving with mobile navigation system
- Driving with built-in navigation system

Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Period 1			Period 2			Period 3			Period 4		
base	Built-in	mobile	Built-in	Mobile	Base	Mobile	Base	Built-in	Base	Mobile	Built-in

Figure 20: Experimental design at the German VMC Operation Centre 2 (BMW and Daimler). Randomisation of experimental conditions is exemplary.

The order of the three experimental conditions has been balanced between the drivers. Table 32 shows all possible orders of the three experimental conditions.

Table 32: All possible orders of experimental conditions of the German VMC Operation Centre 2

1 Period		
Month 1	**Month 2**	**Month 3**
Baseline	Mobile device	Built-in navigation
Baseline	Built-in navigation	Mobile device
Built-in navigation	Baseline	Mobile device
Built-in navigation	Mobile device	Baseline
Mobile device	Baseline	Built-in navigation
Mobile device	Built-in navigation	Baseline

A dependent design has been chosen so that each driver participated in each experimental condition. The time period for the Daimler FOT was 12 months, for BMW 9 months. It has been decided to let each condition last one month. Thus, each driver was in the FOT for three months. Since Daimler had the vehicles in total for 12 months in the FOT, this leads to four phases of data collection with 15 drivers each, making a planned overall sample size of N=60. For BMW, the total planned sample size was N=45, but due to additional data gathering, the BMW sample size was increased to N=51 drivers.

7.1.2 Questionnaires definition and development

At the German VMC Operation Centre 2 test site the function of interest is the navigation system at different integration levels. This means several navigation system specific requirements additional to the common standardised questionnaire pack has to be met by the questionnaire. Of special interest are experiences with navigation systems, usage of the navigation systems, and travel patterns that might be related to using navigation systems (e.g. unfamiliar routes). Because of this, and due to the special experimental procedures at the German VMC Operation Centre 2 test site, some modifications to the general questionnaires pack had to be made. Modifications apply for both BMW and Daimler.

Since the test drivers are customers of either BMW or Daimler and approached by the BMW sales department or Daimler vehicles leasing department, it has not been possible to hand out the non-participation questionnaire to drivers that refused to take part in the FOT.

In addition to the screening questionnaire, a questionnaire concerning an overview of the driver's general experiences with navigation systems has been introduced at the beginning of the FOT (T1; "Experiences with navigation systems"). Main content of the questionnaire is to gain information about to what extend navigation systems had been used by the driver in the past and how the driver assessed those systems with regard to usefulness and enjoyment. Additionally, drivers were asked to specify their usage behaviour concerning those systems.

A set of additional items has been added to the Time 2 questionnaire (at the beginning of an experimental condition), which is supposed to gain information about what expectations drivers had of driving with the navigation system of the following experimental condition. Added items are the same both for mobile and built-in navigation systems. No items about the expectation have been asked at the beginning of the baseline condition.

The Time 3 questionnaire which was administered during an experimental condition contains several additional items regarding system usage. The additional items apply both for BMW and Daimler, as well as both for mobile and built-in navigation systems. The T3 questionnaire administered during the baseline period does not include the additional items.

After an experimental condition with either the mobile or the built-in navigation system, questionnaire Time 4 was administered to the drivers in order to evaluate the particular navigation system. The SafeHMI questionnaire contains some additional items to the common standardised questionnaire pack. Additional items are the same both for BMW and Daimler as well as mobile and built-in navigation system.

7.1.3 Questionnaire operational procedures

Due to the experimental design of the German VMC Operation Centre 2, some distinctions to the common euroFOT design with regard to the questionnaire operational procedures are necessary. In the German VMC Operation Centre 2, the three experimental conditions are not tested in a fixed order but randomized across drivers. As can be seen in Figure 21, every driver experienced three conditions, each lasting one month. For instance, one third of the drivers started with baseline condition, one third with the mobile navigation system available and one third could use the built-in navigation system in the first month. Therefore, the labelling of the questionnaires used by SP4, that relates to a certain time during the trial but also to start / end of either baseline or treatment condition is difficult to apply directly to the German VMC Operation Centre 2.

Instead, it is necessary to use a labelling that codes the condition together with the point in time:

- Before start of FOT: T1 + Screening
- At the beginning of a condition: T2 – Base, T2 – Mobile, T2 – Built-in
- During a condition: T3 – Base, T3 – Mobile, T3 – Built-in
- At the end of one condition: T4 – Base, T4 – Mobile, T4– Built-in
- At the end of the FOT: Debriefing

Timeline:

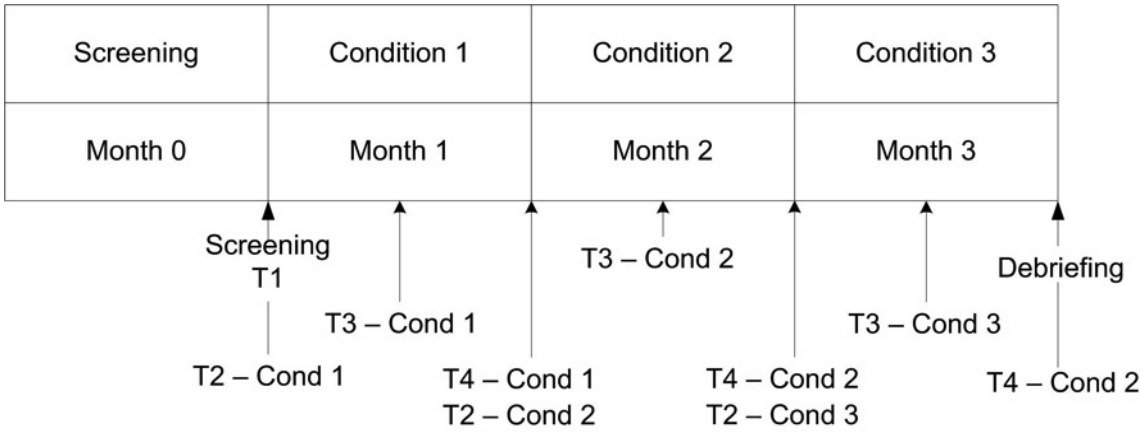

Figure 21: Timeline for questionnaire administration at the German VMC Operation Centre 2

Paper-and-pencil questionnaires were handed out to the drivers directly when they were at BMW or Daimler for changing conditions and exchanging hard discs. Drivers were briefed for the following month, the navigation systems were exchanged (or completely de-activated if a baseline drive was about to follow) and hard discs replaced by new ones. Drivers were asked to fill in the questionnaires on site.

The Time 3 questionnaire (in-between treatment conditions) was, due to organisational issues, an online questionnaire. The questionnaire was designed with help of “lime survey” and uploaded at the IZVW server. At the beginning of each condition period, drivers were asked to fill in the questionnaire after two weeks. They were handed out the web-address and a keyword that allowed them to get access to the online questionnaire. If the questionnaire was not filled in within the appointed time-frame, drivers were reminded of it either by telephone or E-Mail.

7.1.4 CAN data gathering, transmission and storage

Both BMW and Daimler used their own in-house solution for DAS. For Daimler, the subcontractor MBTech designed a DAS that logged CAN and video data. The data logger used by BMW was developed by BMW. It logs data from CAN, MOST and FlexRay as well as video data.

To be able to evaluate safety effects, information regarding following distance and lane keeping is needed. Therefore, all FOT vehicles are equipped with ACC and LDW. The systems provide the information needed as CAN-signals.

During the FOT, it is possible to connect to the vehicles via UMTS in order to control the status of the DAS (e.g. left capacity on the hard disc, positioning of the cameras).

For both BMW and Daimler CAN and video data is stored on hard discs in the vehicle. The hard discs are exchanged every month. The exchange of the hard discs takes place at the site of the OEM during the monthly meetings with the drivers. In the vehicles, the data is stored in a specific format that can only be read by the OEM.

After collecting the hard discs, the raw data is stored as backup at the OEM on a server. Then, the signals needed for euroFOT are converted from the specific format of the data logger into MatLab-files. At the OEM, the MatLab-files are copied onto new hard discs. Whenever one of those hard discs is full, it is sent via mail to the University of Würzburg. Here, the vehicle data is pre-processed and uploaded to the euroFOT database. The database consists of a defined folder structure that contains a MatLab-file for each drive.

7.1.5 Video data gathering, transmission and storage

In the Daimler vehicles four cameras are installed. Videos are recorded without audio information. Camera views are (see Figure 22 left):

- View of the driver's face
- View of the road to the front
- Rear view of the vehicle
- View of the COMAND-system and the centre console

At BMW the following cameras are used (see Figure 22 right):

- View of the driver's face
- Rear view of the vehicle
- Driver activity (hands, feet)
- View of the road to the front

Again, no audio signal is recorded.

Figure 22: Camera views in the Daimler (left) and BMW (right) FOT vehicles.

For both BMW and Daimler, video data is stored on hard discs in the vehicle. The hard discs are exchanged every month. The exchange of the hard discs takes place at the site of the OEM during the monthly meetings with the drivers.

After collecting the hard discs, the raw data is stored as backup at the OEM on a server. At the OEM, the video data is copied onto new hard discs. Whenever a hard disc is full, it is sent via mail to the University of Würzburg. Here, a backup copy is made. The videos are not copied onto the server but are stored on external hard drives.

7.2 Driver sample

At the German VMC Operation Centre 2 test site, the chosen experimental design is dependent, which means that each of the drivers participated in both the baseline condition and the two treatment conditions (mobile vs. built-in navigation system). Thus, all of the driver characteristics are the same for baseline and treatment conditions and will not be presented separately for the different conditions.

BMW

Status 01.09.2011

The driver sample presented in this document includes N=41 BMW test drivers (no drop-outs). N=3 drivers are female, n=38 drivers are male. BMW has decided to gather data of an additional n=10 drivers. Data collection is still running at the deadline of this deliverable and information about these 10 drivers is not available yet. Anyway, it is not sure yet whether data of the 10 additional drivers will make it into the statistical analysis of SP6. Data gathering will be finished by the end of September which might be too late to upload and pre-process the data in time.

Average age of the BMW test drivers is m=45.2 years (sd=10.5 years). None of the drivers is younger than 26 years, the eldest driver is 68 years old (see Figure 23). Most of the drivers are between 36 and 45 years old (n=15; 4%). The rest of the drivers is equally proportioned between the age categories 26-35 years (n=8; 19%), 46-55 years (n=9; 22%) and 56-65 years (n=8; 20%). BMW test drivers indicate to have an average driving experience of m=25.9 years (sd=10.0).

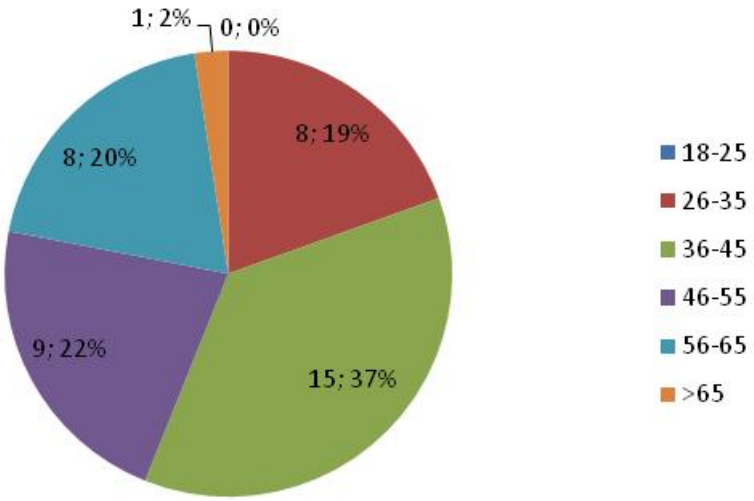

Figure 23: Age distribution of the BMW test drivers (n=41)

Test drivers indicate to have been driving averagely m=37195 kilometres (sd=20319 kilometres) over the course of the 12 months prior the FOT. None of the drivers has been driving less than 10000 kilometres per year or more than 90000 kilometres (see Figure 24). Most of the drivers have been driving between 20000 and 49000 kilometres per year (n=26; 6%).

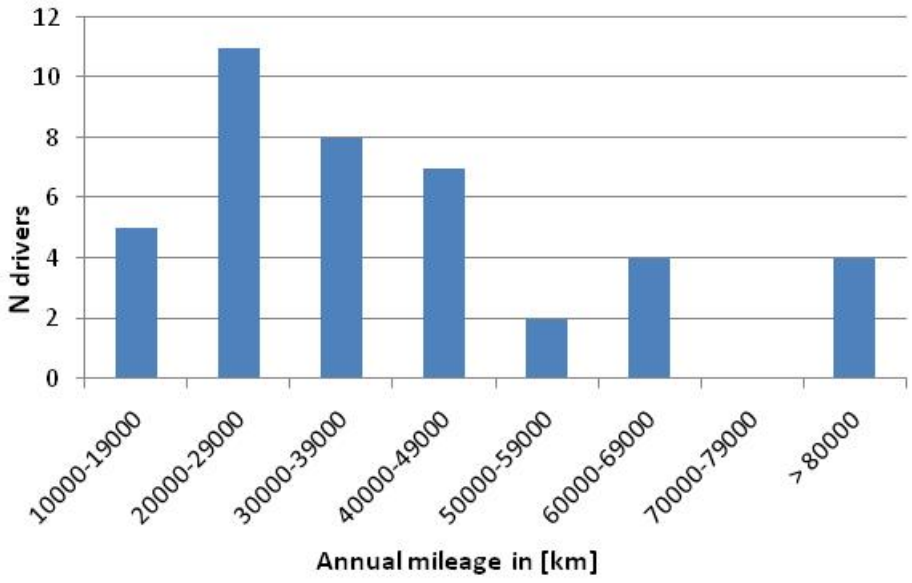

Figure 24: Distribution of annual mileage [in km] of the BMW test drivers (n=41)

DAIMLER

Status 01.09.2011

The driver sample includes data of N=64 drivers (incl. n=4 drop-outs). N=2 drivers are female, n=62 drivers are male.

For Daimler, information about N=63 drivers is available for this document.

Average age of the drivers is m=44.8 years (sd=8.3 years).The youngest driver is 27 years old, the eldest driver 67 years, whereby only two drivers are elder than 65 years. Most of the

drivers (n=31) are, with a percentage of 49%, between 36 and 45 years old. 20 drivers are between 46 and 55 years (see Figure 25).

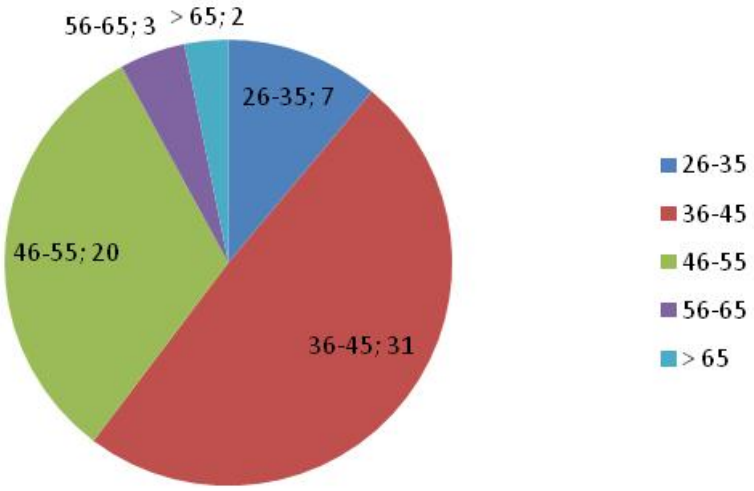

Figure 25: Age distribution of the Daimler test drivers (n=63)

Daimler test drivers averagely have a driving experience of m=25.7 years (sd=8.4). They indicate to have been driving averagely m=50726 kilometres (sd=24219) during the 12 months prior to the FOT. None of the drivers has been driving less than 10000 kilometres per year and two drivers approximately 10000 km, whereas three drivers indicate to have been driving more than 100000 kilometres (see Figure 26). Most of the drivers indicate to have been driving between 40000 and 49000 kilometres (n=18 drivers).

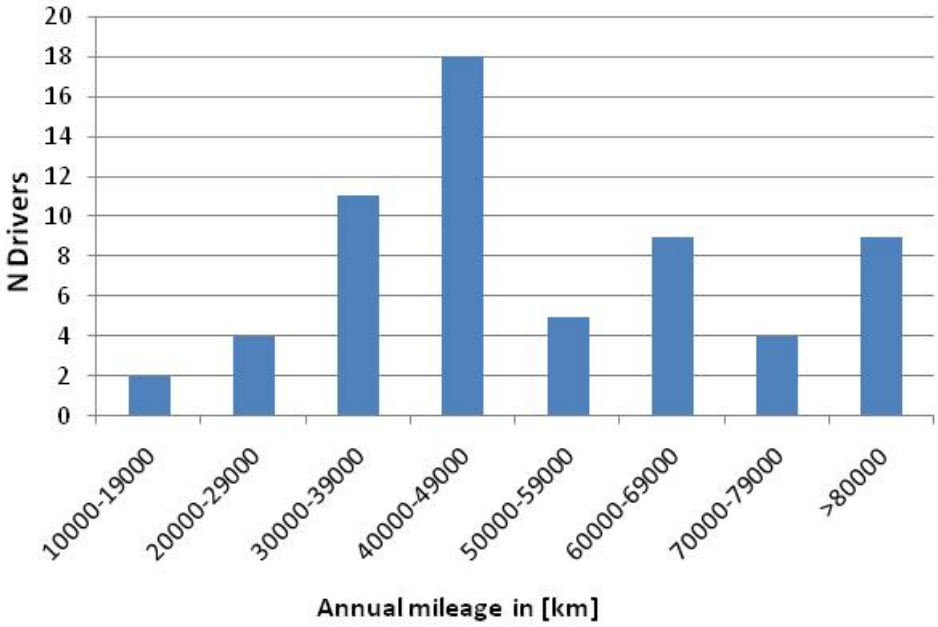

Figure 26: Distribution of annual mileage [in km] of the Daimler test drivers (n=63)

7.3 Subjective data (answers to questionnaires)

The tables in chapter 7.3.1 and 7.3.2 contain the subjective data of BMW and Daimler as available until September, 1st, 2011. Due to the independent design, each of the drivers had

to fill-in all of the questionnaires in each of the experimental conditions (baseline, mobile, built-in).

7.3.1 Subjective data: BMW

Status 01.09.2011 *(numbers in bold are not final)*

N=41 drivers have finished the FOT by the beginning of September 2011. Since BMW has decided to gather data of an additional n=10 drivers, data collection is still running at the deadline of this deliverable. Data gathering will be finished by the end of September. It is not sure, however, whether data of the additional 10 drivers will go into statistical analysis, since it might take too long to upload and pre-process the data. For the subjective data, information about all BMW drivers is included as far as possible. It is expected that all N=51 drivers will have completed the questionnaires by the end of the FOT, because drivers have to fill in the questionnaires when they are at BMW for change of hard discs.

Table 33: Available data from questionnaires handed out before treatment (BMW)

Non-participation		***Screening***		***Time 1***	
N handed out	N/A	N handed out	51	N handed out	51
N filled in & returned	N/A	N filled in & returned	51	N filled in & returned	51
N missing	N/A	N missing	0	N missing	0
Response rate (%)	N/A	Response rate (%)	100	Response rate (%)	100

Table 34: Available data from questionnaires handed before, during and after the conditions baseline, mobile and built-in navigation system (BMW)

Baseline						***Mobile navigation system***					
T2		***T3***		***T4***		***T2***		***T3***		***T4***	
N handed out	51	N handed out	***47***	N handed out	***47***	N handed out	***50***	N handed out	***49***	N handed out	***49***
N filled in & returned	51	N filled in & returned	***45***	N filled in & returned	***47***	N filled in & returned	***50***	N filled in & returned	***46***	N filled in & returned	***49***
N missing	0	N missing	***2***	N missing	***0***	N missing	***0***	N missing	***3***	N missing	***0***
Response rate (%)	100	Response rate (%)	***96***	Response rate (%)	***100***	Response rate (%)	***100***	Response rate (%)	***94***	Response rate (%)	***100***

Built in navigation system					
T2		***T3***		***T4***	
N handed out	***50***	N handed out	***48***	N handed out	***48***
N filled in & returned	***50***	N filled in & returned	***43***	N filled in & returned	***48***
N missing	***0***	N missing	***5***	N missing	***0***
Response rate (%)	***100***	Response rate (%)	***90***	Response rate (%)	***100***

Table 35: Questionnaire data from debriefing questionnaires and from drop outs (BMW)

Debrief		***Exit interview/ drop-outs***	
N handed out	***41***	N handed out	0
N filled in & returned	***41***	N filled in & returned	0
N missing	***0***	N missing	0
Response rate (%)	***100 %***	Response rate (%)	0

7.3.2 Subjective data: Daimler

Status 01.09.2011 *(numbers in bold are not final)*

Subjective data is available for N=60 Daimler test drivers who have finished the FOT, plus n=4 drops-outs who quit the FOT for personal reasons. Thus, the presented information about subjective data is complete for Daimler.

Table 36: Available data from questionnaires handed out before treatment (Daimler)

Non-participation		***Screening***		***Time 1***	
N handed out	N/A	N handed out	64	N handed out	64
N filled in & returned	N/A	N filled in & returned	64	N filled in & returned	64
N missing	N/A	N missing	0	N missing	0
Response rate (%)	N/A	Response rate (%)	100%	Response rate (%)	100 %

Table 37: Available data from questionnaires handed out before, during and after the conditions baseline, mobile and built-in navigation system (Daimler)

Baseline						***Mobile navigation system***					
T2		***T3***		***T4***		***T2***		***T3***		***T4***	
N handed out	62	N handed out	61	N handed out	63	N handed out	64	N handed out	63	N handed out	61
N filled in & returned	62	N filled in & returned	59	N filled in & returned	62	N filled in & returned	61	N filled in & returned	57	N filled in & returned	61
N missing	0	N missing	2	N missing	1	N missing	3	N missing	6	N missing	0
Response rate (%)	100	Response rate (%)	97	Response rate (%)	98	Response rate (%)	95	Response rate (%)	90	Response rate (%)	100

Built in navigation system					
T2		***T3***		***T4***	
N handed out	60	N handed out	60	N handed out	60
N filled in & returned	60	N filled in & returned	56	N filled in & returned	60
N missing	0	N missing	4	N missing	0
Response rate (%)	100	Response rate (%)	93	Response rate (%)	100

Table 38: Questionnaire data from debriefing questionnaires and from drop outs (Daimler)

Debrief		*Exit interview/ drop-outs*	
N handed out	60	N handed out	4
N filled in & returned	60	N filled in & returned	4
N missing	0	N missing	0
Response rate (%)	100	Response rate (%)	100

7.4 Objective data

The tables in chapter 7.4.1 and 7.4.2 contain the objective data of BMW and Daimler as available until September, 1st, 2011. Due to the independent design, data has been collected for each of the drivers over one month in each of the experimental conditions (baseline, mobile, built-in).

7.4.1 Objective data: BMW

Status 09.09.2011 *(numbers in bold are not final)*

N=41 drivers have finished the FOT so far. BMW has decided to gather data of an additional n=10 drivers. Data collection is still running at the deadline of this deliverable and information about these 10 drivers is not available yet. The data of the 10 additional drivers might not make it into the statistical analysis of SP6. Data gathering will be finished by the end of October which might be too late to upload and pre-process the data in time.

Currently, 33 complete datasets are available. Data for 8 drivers who have completed the FOT is still missing. The table contains CAN-data that has already been uploaded to the database. Furthermore, about 8 TB of video data will be available at the end of the FOT.

Table 39 only includes CAN-data that has already been pre-processed and uploaded. Because of the chosen process, data exists that has already been logged but not uploaded to the data-base. Figure 27 presents the overall collected and uploaded data of BMW with regard to how many kilometres and how many hours have been driven over the course of the FOT.

Table 39: Available objective data pre-processed and uploaded (BMW)

Baseline							
Overall amount of data (MB, TB)	***11.2 GB***						
Overall km driven	***82379***						
Drivers							
N drivers overall	***34***	N drivers complete	***34***	N drivers incomplete	***0***	Drop-outs	***0***
Driving months							
N Overall driving months	***34***	N driving months complete	***34***	N driving months incomplete	***0***	N driving months missing	***0***
Trips							
N overall trips	***3445***	N trips complete	***3445***	N trips incomplete	***0***	N trips missing	N/A
Mobile navigation system							
Overall amount of data (MB, TB)	***11.8 GB***						
Overall km driven	***82706***						
Drivers							
N drivers overall	***33***	N drivers complete	***33***	N drivers incomplete	***0***	Drop-outs	***0***
Driving months							
N Overall driving months	***33***	N driving months complete	***33***	N driving months incomplete	***0***	N driving months missing	***0***
Trips							
N overall trips	***3677***	N trips complete	***3677***	N trips incomplete	***0***	N trips missing	N/A
Built-in navigation system							
Overall amount of data (MB, TB)	***12.0 GB***						
Overall km driven	***91979***						
Drivers							
N drivers overall	***33***	N drivers complete	***33***	N drivers incomplete	***0***	Drop-outs	***0***
Driving months							
N Overall driving months	***33***	N driving months complete	***33***	N driving months incomplete	***0***	N driving months/days missing	***0***
Trips							
N overall trips	***3627***	N trips complete	***3627***	N trips incomplete	***0***	N trips missing	N/A

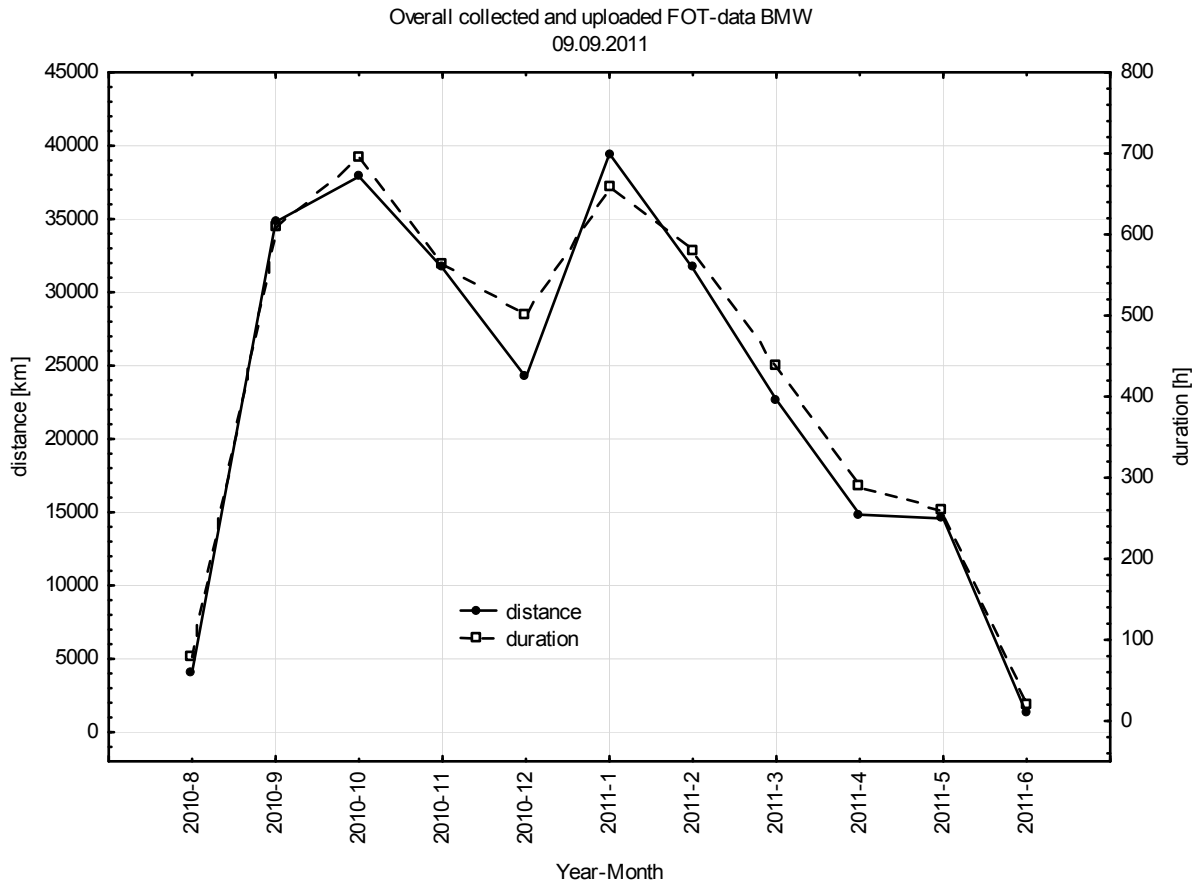

Figure 27: Overview on overall data collected and uploaded by BMW (km and hours driven)

7.4.2 Objective data: Daimler

Status 01.09.2011 *(numbers in bold are not final)*

For Daimler, N=64 drivers have finished the FOT. Of those 64 drivers, n=4 are drop outs.

Table 40 includes only CAN-data that has already been pre-processed and uploaded. The cell 'overall amount of data' relates to CAN data only. Furthermore, about 5 TB of video data is available for the trips already uploaded into the database.

The number of incomplete drivers (incomplete months) relates to driving data that has been collected but has not been pre-processed and uploaded yet. In total, 57 complete data sets are available for this document. Complete data sets include only drivers for whom the complete data for all three conditions is available, pre-processed and uploaded. Figure 28 presents the overall collected and uploaded data of Daimler with regard to how many kilometres and how many hours have been driven over the course of the FOT.

Table 40: Available objective data pre-processed and uploaded (Daimler)

Baseline							
Overall amount of data (MB, TB)	***11.5 GB***						
Overall km driven	***206650***						
Drivers							
N drivers overall	62	N drivers complete	***59***	N drivers incomplete	***3***	Drop-outs	0
Driving months							
N Overall driving months	62	N driving months complete	***59***	N driving months incomplete	***3***	N driving months missing	***0***
Trips							
N overall trips	***7557***	N trips complete	***7557***	N trips incomplete	***0***	N trips missing	N/A
Mobile navigation system							
Overall amount of data (MB, TB)	***11.4 GB***						
Overall km driven	***198352***						
Drivers							
N drivers overall	64	N drivers complete	***60***	N drivers incomplete	***4*****	Drop-outs	4*
Driving months							
N Overall driving months	64	N driving months complete	***60***	N driving months incomplete	***4*****	N driving months missing	***0***
Trips							
N overall trips	***7981***	N trips complete	***7699***	N trips incomplete	***282*****	N trips missing	N/A
Built-in navigation system							
Overall amount of data (MB, TB)	***11.6 GB***						
Overall km driven	***210150***						
Drivers							
N drivers overall	60	N drivers complete	***57***	N drivers incomplete	***3***	Drop-outs	0
Driving months							
N Overall driving months	60	N driving months complete	***57***	N driving months incomplete	***3***	N driving months missing	***0***
Trips							
N overall trips	***7411***	N trips complete	***7411***	N trips incomplete	0	N trips missing	N/A

*Drop-outs occurred at the end of the condition and thus count as complete drivers.

**For two drivers, the incomplete data in the condition mobile navigation system is due to problems with data logging on the mobile device. For the two drivers (i.e. two months) logging of CAN-data is complete but the data from the mobile device is missing. For two further drivers data has not been pre-processed and uploaded yet.

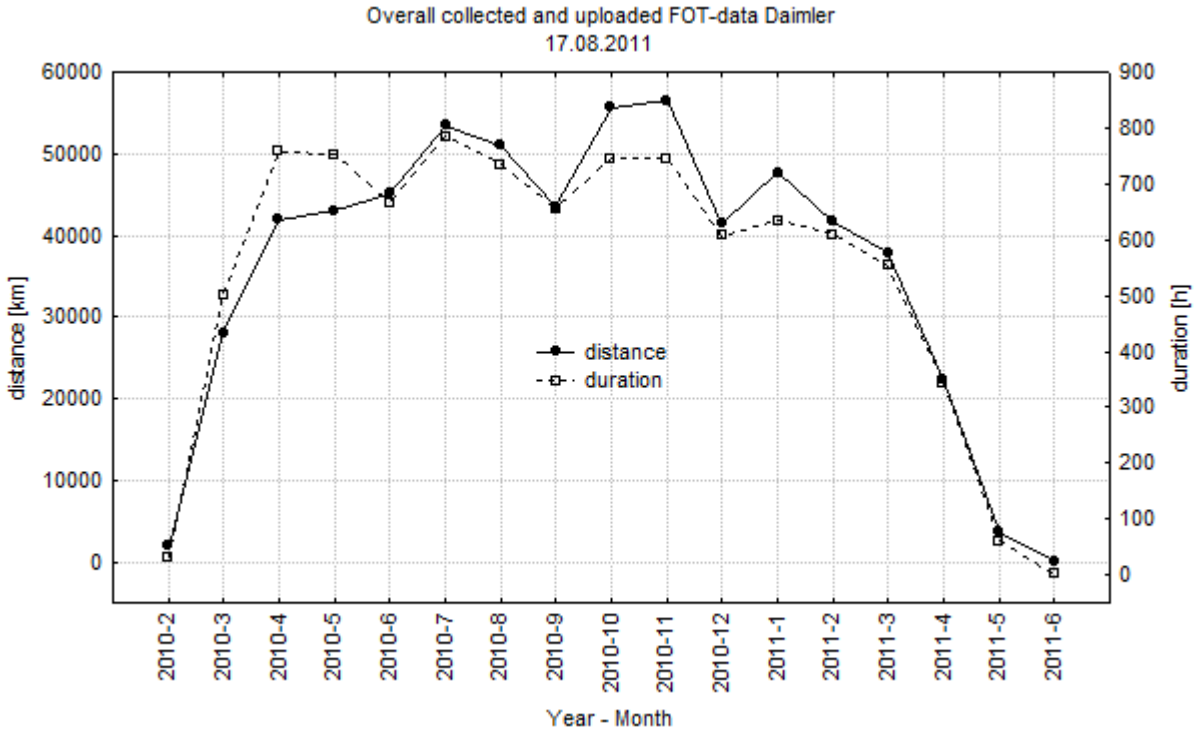

Figure 28: Overview on overall data collected and uploaded by Daimler (km and hours driven)

7.5 Lessons Learned

A summary of lessons learned collected by German VMC Operation Centre 2 during data acquisition activities in euroFOT project are reported below. Lessons learned have been reported by both BMW and Daimler.

Lessons learned generally

- In order to organise and guarantee a smoothly execution of such a huge study as an FOT, the piloting is very important to test whether the data recording works well and everything can be done as planned. Thus, enough time should be arranged for an extensive piloting phase. The piloting phase should be subdivided accurately into different experimental conditions and iterations should be included.
- A selection of test participants with regard to certain criteria (e.g. age, gender etc.) was not possible as the choice of test vehicles already determined some driver characteristics. There were not enough drivers fulfilling the above criteria to be contacted for participation.
- The installation of complex DAS into customer cars does not work. It is recommended that the participating OEMs provide test vehicles. This means that more expenses need to be budgeted for the FOT on OEM side as this was done for euroFOT.
- During the execution of the FOT the contact to the test drivers should run directly via the OEM. The DAS is too complicated to include any third party for driver support. Moreover, driver support should be locally, with a short distance to the drivers, so that

direct and quick help in the case of technical problems (DAS, change of hard discs) is available.

Lessons learned about subjective data acquisition

- The questionnaires should not be too lengthy and detailed, as this might negatively influence the quality of the answers and willingness to respond to the questions decreases. Especially the open questions suffer from a too extensive questionnaire and are skipped by the test participants.
- Drivers should be asked at the end of FOT whether they agree to be contacted later on for further interviews with regard to the project.
- It proved to be successful to have the drivers fill in the questionnaires when they were at the test site of the operation centre, as this led to a response rate of 100%. The use of a web based questionnaire (when it was not possible to have the questionnaire filled in at personal meetings) also led to a very high response rate, especially in combination with the possibility of reminding the drivers via email or telephone. The fact that the test drivers were allowed to use a new BMW 5 at no charge or a new Daimler E class with a reduced leasing rate in combination with a good instruction helped to increase participants' commitment to the study.

Lessons learned about objective data acquisition

- Data processing is very time consuming. Thus, it has to be started as soon as possible. Data processing steps should be implemented and tested early on and very carefully, so that no re-processing will be necessary due to errors in the implementation phase.
- The overall amount of objective data that will have to be pre-processed should be known very early. Data processing worked well at the beginning of the piloting phase (with only few data). As soon as the final amount of data was known the chosen processing solution proved to be too slow so that a new data conversion programme had to be implemented.

8 Italian VMC

8.1 Operational procedures

8.1.1 Functions, vehicles and experimental procedures

The Italian VMC evaluates the LDW system. The system provides feedback through a torque applied through the steering wheel when the vehicle leaves the lane without the turn indicator being activated. Test vehicles are Lancia Deltas equipped with the LDW optional feature called *Driving Advisor.*

The FOT involved n=580 customers of Lancia Delta and followed them for nine months. Two experimental groups are compared (see Figure 29 for an overview on the experimental design):

- LDW group: n=280 vehicles equipped with LDW
- Control group: n=290 vehicles not equipped with LDW

In the LDW group drivers were asked to not use the LDW for the first three months in order to ensure a baseline period. In the subsequent treatment period they were free to use the system at their discretion (six months). This will allow a within subject analysis in the LDW Group in order to detect changes in the self-reported measures over time. The comparison of the LDW and the control group ensures a between subjects analysis. Drivers participated either in the LDW or in the control group.

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
LDW Group	Baseline LDW OFF			Treatment LDW ON					
Control Group	NO LDW								

Figure 29: Experimental design at the Italian VMC

Potential test drivers were buyers of a new Lancia Delta, equipped either with or without LDW. The equipment with or without the LDW determined the driver's experimental condition. Drivers were contacted directly by the Italian VMC and asked to participate. Recruitment was focused on Italy, but also European customers were contacted and recruited. Non-Italian project participants are from France, Belgium, Germany, Switzerland, Austria, Luxembourg, Portugal, and Spain. The vehicles are owned by the project participants.

The vehicles have not been equipped with a Data Acquisition System. Data has been collected through self-reported measures only, gathering information about acceptance, trust, mental workload and the usability of the system as well as describing the frequency of system activation.

8.1.2 Questionnaires definition and development

Because of the huge number of project participants involved at the Italian VMC only the subjective aspects of the test are considered. Due to the specific requirements of the Italian FOT, where only subjective data have been gathered, the common questionnaire package developed by SP4 had to be modified and items had to be added in order to get more insight into the participants' experienced behaviour and system perception.

Questionnaires were designed to be filled in by two different groups of users: the LDW group and the control group. The LDW group involves participants driving their own car equipped

with the LDW system, the control group involves participants driving their own car not equipped with the LDW system. Items that are related to LDW system use have not been administered to the control group. The control group questionnaires are focused on driving attitudes and behaviours as well as on LDW system expectations.

At the Italian VMC some peculiarities can be found with regard to the questionnaire pack and the schedule:

- The "first contact" letter for the customers also includes the "screening" questionnaire;
- The "non-participation" questionnaire is not administered;
- The survey involves 5 times of questionnaire administration (namely A, B, C, D, E questionnaire). The Time 3 questionnaire is handed out repeatedly as Time 3 (a) (quest. C), and Time 3 (b) (quest. D);
- The time 4 questionnaire (quest. E) also includes the "Debrief" section that is not administered as a separate one;
- "Exit interviews - Drop-outs" are not investigated through a specific questionnaire, but information about exit motivations of withdrawn users is gathered;
- Users are asked to fill in a weekly paper-and-pencil diary about vehicle usage during the FOT;
- Users can report relevant events involving the LDW in specific "Event register" sheets.

The Italian questionnaires existed in Italian and English language. Drivers not living in Italy could choose between the two versions.

8.1.3 Questionnaire operational procedures

Due to the experimental design of the Italian VMC, some distinctions to the common euroFOT design with regard to the questionnaire operational procedures were necessary.

At the beginning potential project participants were contacted and asked to fill in the screening questionnaire. If a driver agreed to participate, the completed questionnaire was collected. For the screening procedure joining forms have been used that were designed according to the sample definition of SP4.

During project participation, the questionnaires were administered to the test drivers five times (see Figure 30 for an overview of the timeline):

- At the beginning of the baseline period: Time 1 questionnaire
- At the end of the baseline / after 3 months: Time 2 questionnaire
- During treatment period / after 5 months: Time 3 (a) questionnaire
- During treatment period / after 7 months: Time 3 (b) questionnaire
- At the end of the FOT / after 9 months: Time 4 questionnaire

In addition, drivers were asked to fill-in their weekly diary and event register sheet on a regular basis.

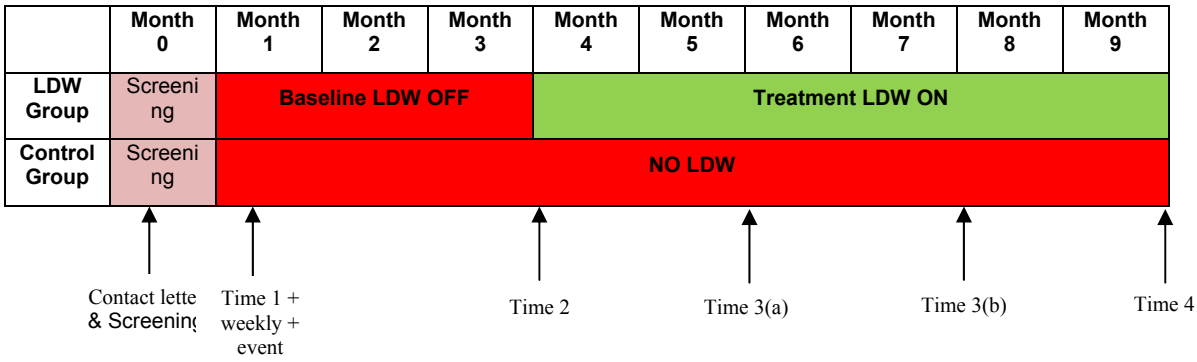

Figure 30: Timeline for questionnaire administration at the Italian VMC

All questionnaires were available in both paper-based (see Figure 31 for an example) and web-based versions. The online questionnaire had been designed with help of the "lime survey" software (www.limesurvey.org; see Figure 32 for an example). At defined deadlines (i.e. every 2 months) the paper-based questionnaires were posted to the participants. If participants had provided their email-address at the beginning of the FOT, they got invitations to fill in the questionnaire via email. Thus participants were able to choose between the paper-based and the online version of the questionnaires. If a participant did not fill in a questionnaire, he or she was sent an email to remind him or her of the questionnaire. Email was also used for staying in touch with the participants as much as possible. Non-Italian project participants could only use the online questionnaire.


Bringing intelligent vehicles to the road

European Large-Scale Field Operational Tests on In-Vehicle Systems
7th Framework programme
INFORMATION AND COMMUNICATION TECHNOLOGIES

Questionario A

Premessa

Questo questionario non intende valutare o giudicare le azioni o le capacità del guidatore e non intende porre in risalto eventuali comportamenti virtuosi o ritenuti non corretti. L'iniziativa mira a valutare l'efficacia e l'efficienza del dispositivo Lancia Driving Advisor nell'ambito del progetto europeo euroFOT. I dati forniti da ogni singolo guidatore non verranno diffusi e non verranno considerati nella loro singola specificità, ma verranno considerati e analizzati solo in forma aggregata. Non sarà quindi in alcun modo possibile risalire all'identità dei partecipanti.

Istruzioni di compilazione

Grazie per aver aderito al progetto euroFOT.

Il questionario è un po' articolato, ma tutte le informazioni richieste sono indispensabili per la buona riuscita di questo progetto.

Le chiediamo cortesemente di aiutarci e possibilmente di compilarlo in tutte le sue parti. Le chiediamo inoltre di rispedire il questionario compilato utilizzando la busta preaffrancata che le è stata inviata.

Nel caso lei abbia fornito un indirizzo di posta elettronica al momento della sua adesione al progetto euroFOT, riceverà una email in cui troverà tutte le istruzioni per compilare il questionario online in formato elettronico. In questo caso non sarà necessario compilare e rispedire questo questionario cartaceo.

Grazie.

- Tempistiche di compilazione: **possibilmente al ricevimento del questionario o nei giorni immediatamente successivi.**
- Modalità di compilazione: **cartacea oppure via internet** (utilizzando l'invito ricevuto all'indirizzo email da lei eventualmente fornito).
- Rispedizione: **inviare il questionario dopo averlo compilato utilizzando la busta preaffrancata fornita** (solo per compilazione cartacea).

Per ulteriori informazioni:
http://www.eurofot.it
email: info@eurofot.it
telefono: 0522-522663

Participant ID: euroFOT

Altro (specificare)

Aspettative in merito al sistema Lancia Driving Advisor

Pensi a come ritiene che sarà la guida utilizzando il sistema Lancia Driving Advisor. Pensi al sistema e a come potrebbe influire sulla guida.

Indichi la sua impressione su come si aspetta che sarà il sistema Lancia Driving Advisor, contrassegnando la casella di ogni riga che maggiormente esprime la sua sensazione.

Utile	☐	☐	☐	☐	☐	Inutile
Piacevole	☐	☐	☐	☐	☐	Spiacevole
Buono	☐	☐	☐	☐	☐	Cattivo
Gradevole	☐	☐	☐	☐	☐	Fastidioso
Necessario	☐	☐	☐	☐	☐	Superfluo
Tranquillizzante	☐	☐	☐	☐	☐	Irritante
D'aiuto	☐	☐	☐	☐	☐	Ininfluente
Desiderabile	☐	☐	☐	☐	☐	Indesiderabile
Favorisce l'attenzione	☐	☐	☐	☐	☐	Induce sonnolenza
Efficace	☐	☐	☐	☐	☐	Inefficace
Aumenta la confidenza	☐	☐	☐	☐	☐	Crea incertezza
Semplice	☐	☐	☐	☐	☐	Complicato
Soddisfacente	☐	☐	☐	☐	☐	Non soddisfacente
Attendibile	☐	☐	☐	☐	☐	Inattendibile
Intuitivo	☐	☐	☐	☐	☐	Non intuitivo
Di buona qualità	☐	☐	☐	☐	☐	Di scarsa qualità
Affidabile	☐	☐	☐	☐	☐	Inaffidabile
Attraente per l'acquisto	☐	☐	☐	☐	☐	Non attraente per l'acquisto

Questionario A
15

Figure 31: Example of the paper-based questionnaire of the Italian VMC

Figure 32: Screenshot of the online questionnaire at the Italian VMC

Users who filled in the paper-based questionnaires posted them back to the Operational Centre using the previously provided envelopes. At the VMC, the questionnaires are scanned and the files are uploaded to the database and server. Thus, for each driver raw data are stored and the files can be used as documentation material. The data of the paper-based questionnaires are digitalized by data entry procedures performed in LimeSurvey.

Answers from the online questionnaires were directly recorded by the online system and stored in the database and on the servers of the Operational Centre.

The SQL database of the Italian VMC is structured in two tables:

- Data about participants: E.g. personal and contact data
- Data about questionnaire status: questionnaire posted to the participant, questionnaire filled in, questionnaire sent back and data entry (see Figure 33).

The database allows the Operational Centre to search information about users and to extract data about response rate and timing. Still, all answers to each questionnaire, both for online and paper-based versions, are collected and stored anonymously via LimeSurvey. Data may be exported in different formats to be suitable for any data analysis procedures.

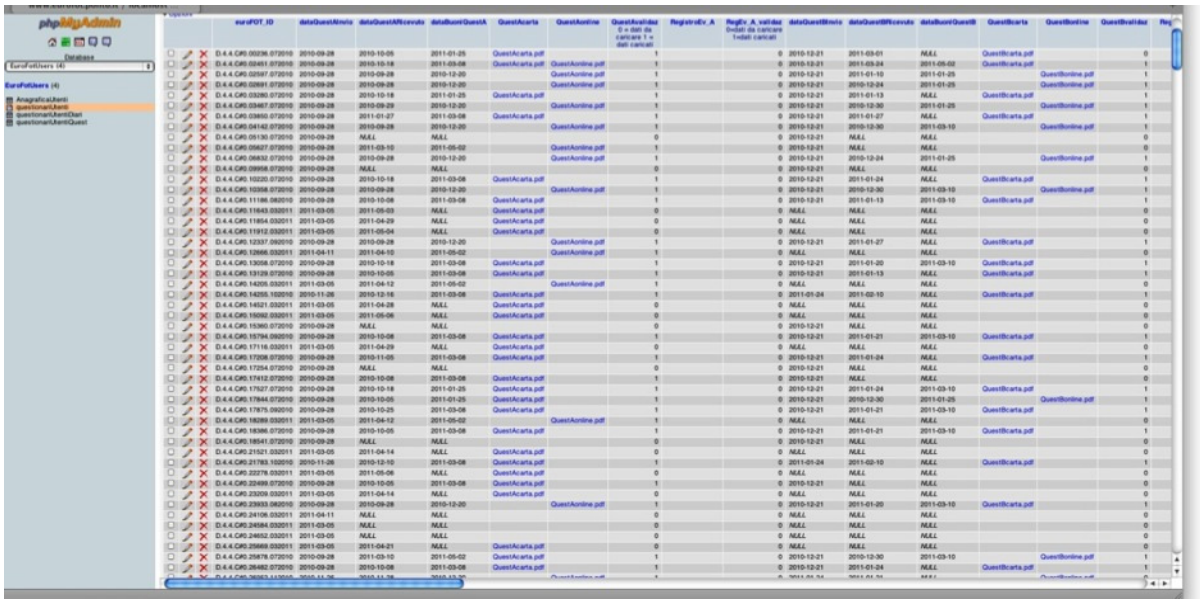

Figure 33: Overall SQL database of the Italian VMC

The labelling of the questionnaires has been adapted to the needs of the Italian VMC. The coding and labelling of the questionnaires have been defined in detail in order to improve data quality, identification, consistency and coherence in data collection and storage.

8.2 Driver sample

Status 29.08.2011 *(numbers in bold are not final)*

The project participants of the LDW group are representative of the population of the drivers who have bought a Lancia Delta vehicle with the specific LDW function (i.e. Driving Advisor optional feature). The FOT is focused on Italy mainly, but some additional vehicle owners were contacted and recruited abroad.

The project participants of the control group are representative of the population of the drivers who have bought a Lancia Delta vehicle without the specific LDW function. Owners of Lancia Delta have been selected in order to keep the samples balanced. Vehicle equipment and type are two of the criteria considered for the selection.

Recruitment for the FOT started in February 2010 as ramping-up phase. The recruitment ended in April 2011, when the designated number of participants had been reached.

In the first contact letter, drivers were asked to indicate how many kilometres per year they normally drive and how often they drive on LDW relevant roads (i.e. highway and interurban roads). Overall mileage and mileage on LDW relevant roads was important for driver selection. Table 41, Figure 34 and Figure 35 give an overview on the current status of driver recruitment and drop-outs. In total, N=1761 drivers have been contacted and asked to participate in EuroFOT. Of these, n=570 drivers agreed to participate. Of these, n=280 drivers are in the LDW group (49%), and n=290 (51%) drivers in the control group. Whereas n=532 drivers remained in the project, n=38 drivers withdrew for different reasons (see Table 44), all of them except for one participant in the LDW group. Since data collection has not been finished at the moment of the deliverable deadline, reported numbers cannot be final yet and more drop-outs are possible until the end of the project.

Table 41: Italian VMC Recruitment and Participant status

	Total	LDW Group	Control Group
Contacted	1761	866	895
Joined	570	280	290
Active	532	243	289
Withdrawn	38	37	1

Figure 34: Italian VMC recruitment history

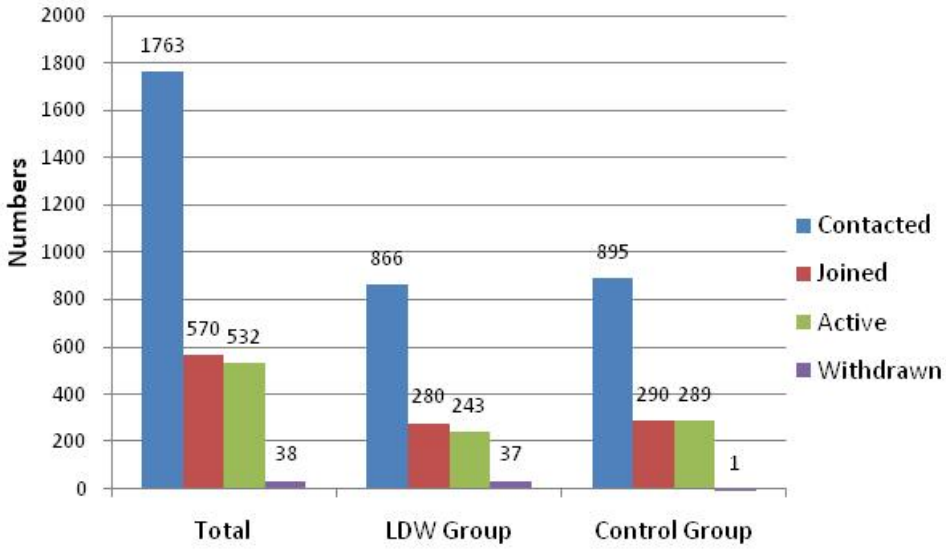

Figure 35: Italian FOT recruitment overall chart

Driver sample LDW group

For the LDW group, information of n=157 drivers is available at the deadline of this document. Most of the test drivers in the LDW group are male (n=137; 88 %). Only n=14 (9 %) of the drivers are female, of n=4 drivers no gender information is available (see Figure 36). N=32 project participants do not live in Italy.

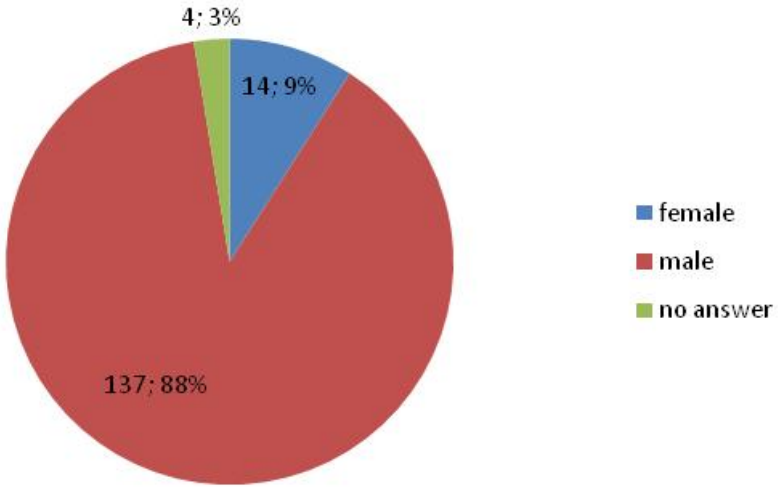

Figure 36: Gender distribution of the Italian VMC test drivers (LDW group; n=157)

Average age of the drivers in the LDW group is m=52.7 years (sd=13.3), with the youngest driver being 27 years old, and the eldest driver being 86 years old. Although most of the drivers are between 56 and 65 years old (n=45; 28.7 %), drivers are rather equally distributed over the different age categories (see Figure 37).

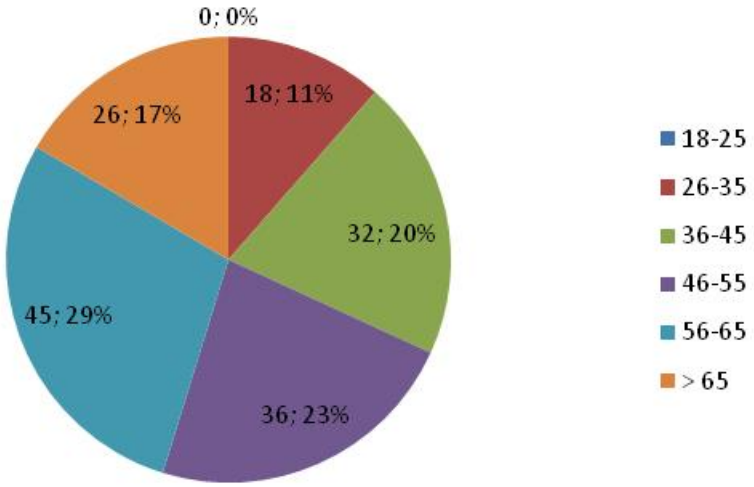

Figure 37: Age distribution of the Italian VMC test drivers (LDW group; n=157)

Test drivers of the LDW group indicate to averagely drive m=26328 kilometres (sd=13644) each year. Most of the participants drive more than 30000 kilometres per year (n=42; 26.8 %), but again, annual mileage is rather equally distributed among the different categories (see Figure 38).

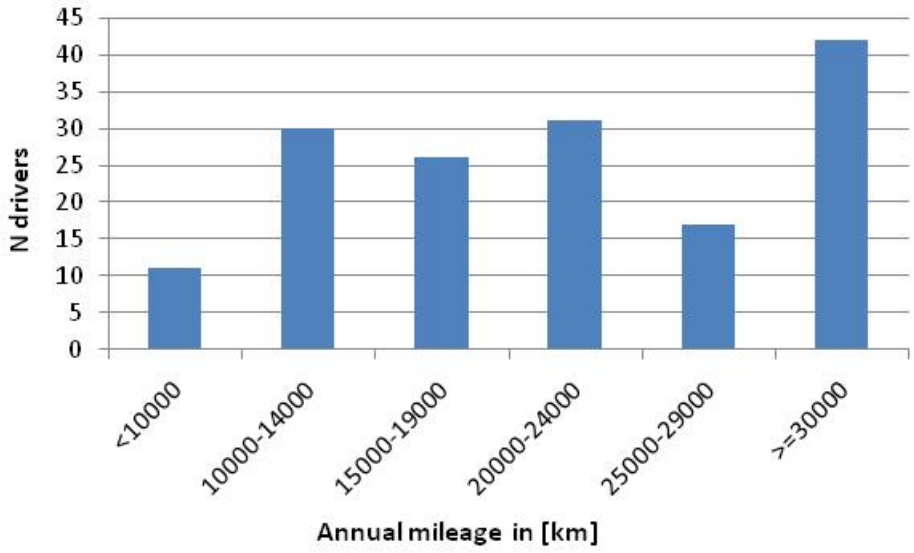

Figure 38: Distribution of annual mileage [in km] of the Italian VMC test drivers (LDW group; n=157)

Driver sample control group

For the control group, information about n=249 drivers is available at the deadline of this document.

In the control group – as in the LDW group – most of the drivers are male (n=221; 9%). N=28 (11%) of the drivers are female (see Figure 39).

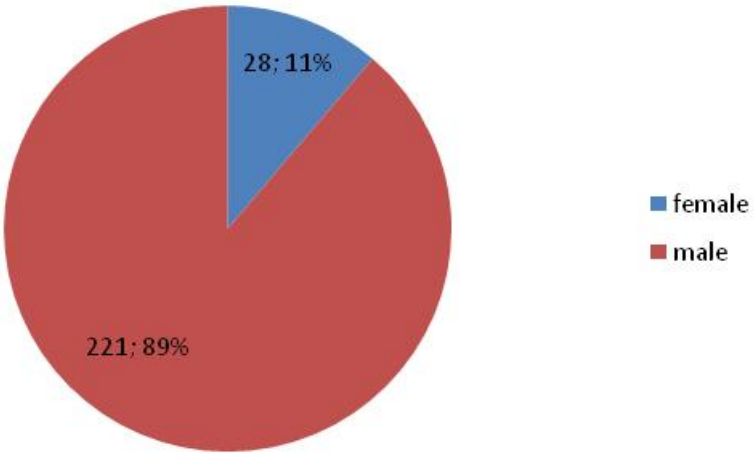

Figure 39: Gender distribution of the Italian VMC test drivers (control group; n=249)

Average age of the drivers in the control group is m=47.1 years (sd=14.4), with the youngest driver being 22 years old, and the eldest driver being 76 years old. Drivers are rather equally distributed among the different age categories (see Figure 40).

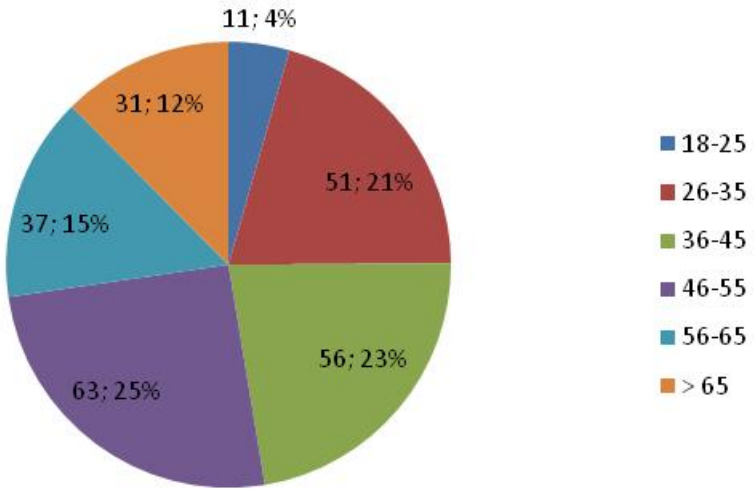

Figure 40: Age distribution of the Italian VMC test drivers (control group; n=249)

Test drivers in the control group indicate to drive averagely m=28317 kilometres (sd=16363 kilometres) each year (see Figure 41).

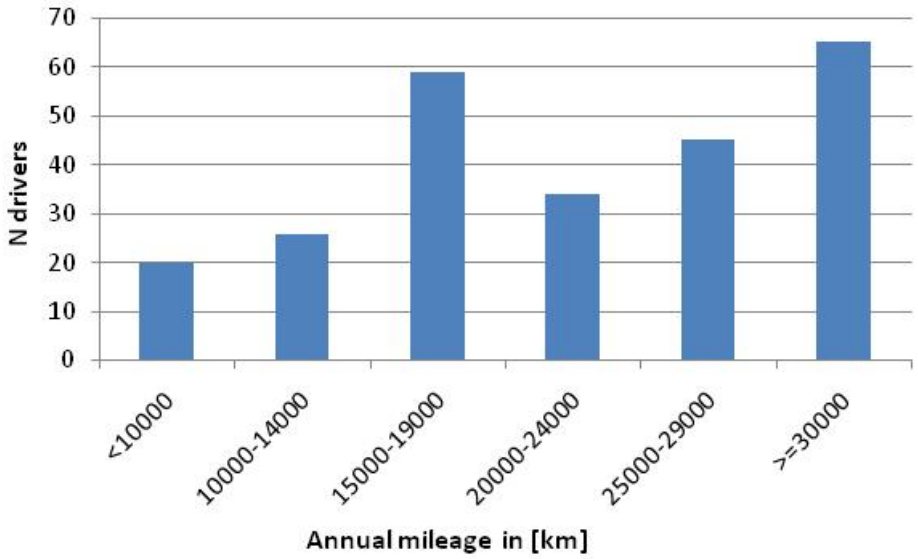

Figure 41: Distribution of annual mileage [in km] of the Italian VMC test drivers (control group; n=249)

8.3 Subjective data (answers to questionnaires)

Status 29.08.2011 *(numbers in bold are not final)*

Table 42: Available data from questionnaires handed out before treatment (Italian VMC, LDW group)

PRE-FOT		**Start FOT**		**End of baseline**	
Screening		***Time 1***		***Time 2***	
N handed out	866	N handed out	282	N handed out	269
N filled in & returned	280	N filled in & returned	***157***	N filled in & returned	***146***
N missing	586	N missing	***125***	N missing	***123***
Screening rate (%)	32,33	Response rate (%)	***55,67***	Response rate (%)	***54,28***
		N Weekly Diary	***95***	N Weekly Diary	***70***
		N Event Register	***43***	N Event Register	***15***

Table 43: Available data from questionnaires handed out during treatment (Italian VMC, LDW group)

During treatment				***End of trial***	
Time 3 (a)		***Time 3 (b)***		***Time 4 and debrief***	
N handed out	249	N handed out	*245*	N handed out	*243*
N filled in & returned	***145***	N filled in & returned	***142***	N filled in & returned	***121***
N missing	***104***	N missing	***103***	N missing	***122***
Response rate (%)	***58,23***	Response rate (%)	***57,96***	Response rate (%)	***49,79***
N Weekly Diary	***56***	N Weekly Diary	***53***	N Weekly Diary	***37***
N Event Register	***8***	N Event Register	***1***	N Event Register	***1***

Drivers of the LDW group were asked to fill in a weekly diary about car usage during project participation. One form sheet has been provided for each week of project participation. The overall weekly sheet pack is clustered into little groups of sheets according to Time 1 (beginning of baseline), Time 2 (after baseline), Time 3a and b (during treatment), Time 4 (end of FOT) for each participant. Each time drivers sent back their completed questionnaires to the Operational Centre (after Time 1, Time 2, Time 3a and b, Time 4), participants had the chance of also sending back the filled in weekly sheets. The numbers reported in Table 42 and

Table 43 refer to the group of filled in sheets for each time of administration across participants (e.g. 95 weekly diaries at Time 1 means that 95 drivers have sent back the filled in sheets of weekly register referred to period 1 of project participation).

In addition, drivers of the LDW group were asked to report events which they perceived as relevant with regard to the LDW system with help of an event register. The filling in of the event register was not mandatory and no deadlines had been fixed for reporting the events. The numbers reported in Table 42 and

Table 43 refer to the collected group of filled in sheets of event registers for each time of administration (e.g. 43 event registers at Time 1 mean that 43 users have sent back the filled in sheets of event register referred to period 1 of project participation).

Table 44: Available data from drop-outs (Italian VMC, LDW group)

Exit interview/ drop-outs	
N LDW group drop-outs	***37***
Reason: N disposal of the vehicle	***9***
Reason: N time	***14***
Reason: N health issues	***5***
Reason: N other	***9***

Data about numbers of questionnaires administered and number of filled in questionnaires in the LDW group are not complete, since data collection has not been finished yet. Latecomers concerning the sending back of completed questionnaires (particularly of the paper-based versions) are still possible. Although all of the Time 1, Time 2 and Time 3 (a) questionnaires have been administered completely to the drivers, not all of them have been returned yet, not least because some of the drivers have only started the FOT. Thus, the number of drop-outs is not final yet, too. The comparably low numbers of the event register can be explained by the driver instruction: They only had to be filled in if events occurred during driving or if drivers perceived an event important with regard to usage or effects of the LDW system (both positive and negative effects) and drivers would like to report them to the Operational Centre. Figure 42 and Figure 43 give an overview on the current status of questionnaire administration and questionnaire filling in.

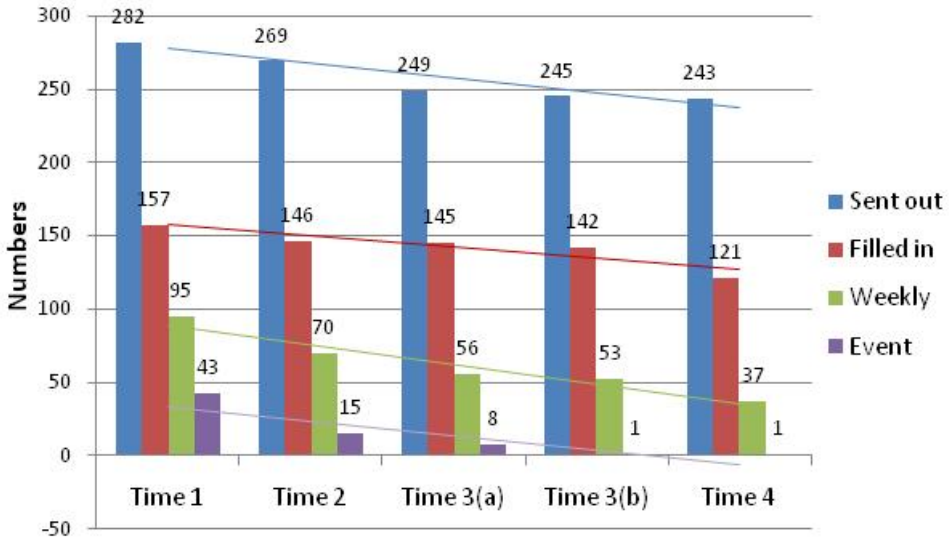

Figure 42: Overall chart of available data from the Italian VMC, LDW group

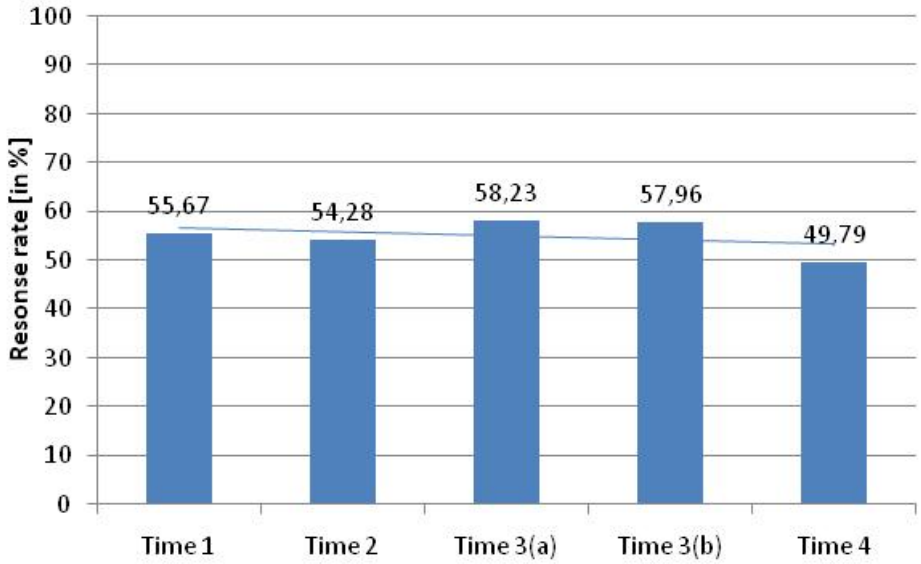

Figure 43: Overall chart of the response rates of the Italian VMC, LDW group

Table 45: Available data from questionnaires handed out during baseline (Italian VMC, control group)

PRE-FOT		Start FOT			
Screening		***Time 1***		***Time 2***	
N handed out	895	N handed out	290	N handed out	290
N filled in & returned	*290*	N filled in & returned	*252*	N filled in & returned	*243*
N missing	*595*	N missing	*38*	N missing	*47*
Screening rate (%)	*32,40*	Response rate (%)	*86,90*	Response rate (%)	*83,79*

Table 46: Available data from questionnaires handed out during baseline (Italian VMC, control group)

				End of trial	
Time 3 (a)		***Time 3 (b)***		***Time 4 and debrief***	
N handed out	290	N handed out	290	N handed out	290
N filled in & returned	*247*	N filled in & returned	*254*	N filled in & returned	*236*
N missing	*43*	N missing	*36*	N missing	*54*
Response rate (%)	*85,17*	Response rate (%)	*87,59*	Response rate (%)	*81,38*

Table 47: Available data from drop-outs (Italian VMC, control group)

Exit interview/ drop-outs	
N Control group drop-outs	**1**
Reason: N disposal of the vehicle	**1**
Reason: N time	**0**
Reason: N health issues	**0**
Reason: N other	**0**

Numbers of questionnaires filled in are not complete yet for the control group, since the FOT has not been finished yet. Latecomers are possible, too. This means that the response rates for the questionnaires might still increase. At the same time, numbers of drop-outs can only be preliminary as well. The control group did not have to fill in the weekly diaries and the event register. Figure 44 and Figure 45 give an overview on the current status of questionnaire administration, questionnaire filling in and the response rates.

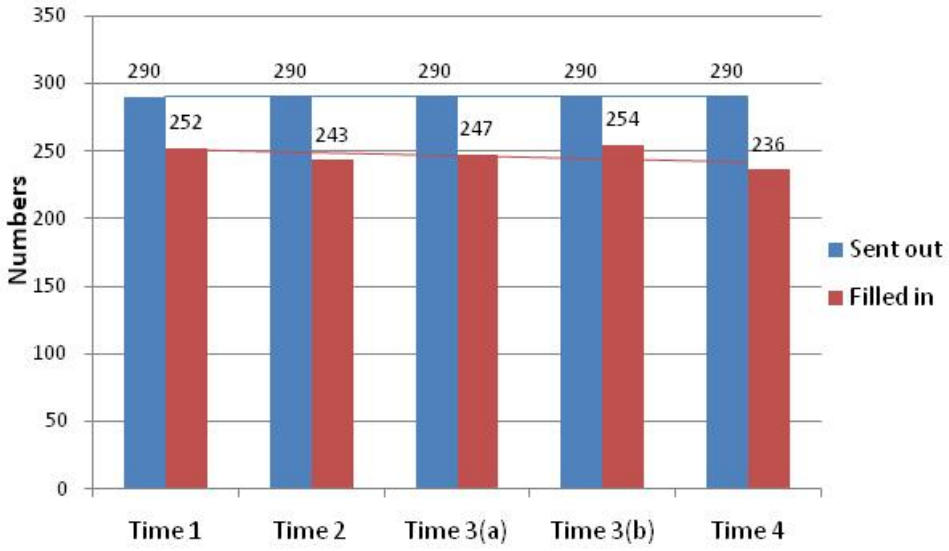

Figure 44: Overall chart of available data from the Italian VMC, control group

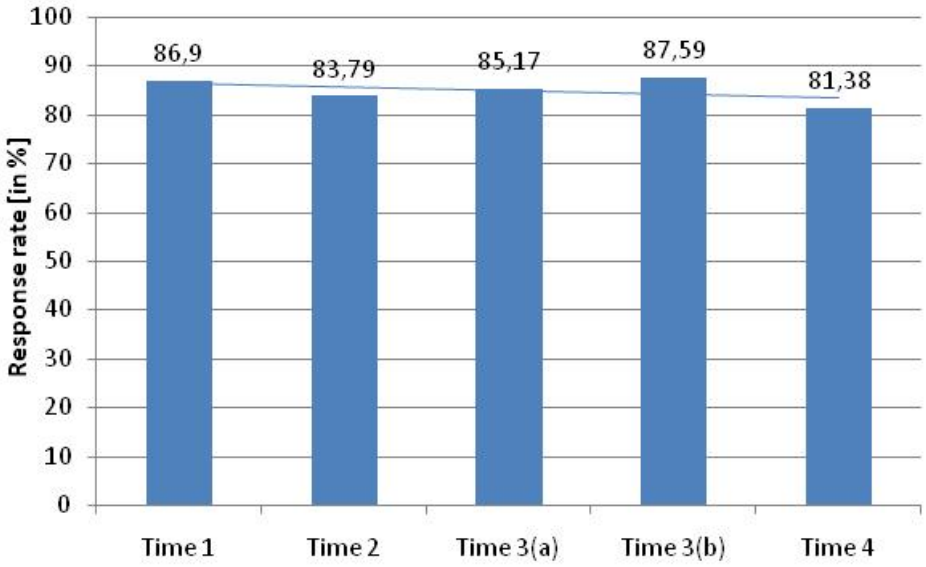

Figure 45: Overall chart of the response rates of the Italian VMC, control group

8.4 Lessons Learned

A summary of lessons learned collected by the Italian VMC during the data acquisition activities in the euroFOT project is reported below. Lessons learned have in parts been reported by the project participants themselves.

Lessons learned about subjective data acquisition

- Incentives could help to increase the recruitment ratio, but it seems to be almost impossible to reach very high percentages (e.g. more than 90%) with relatively high incentives.
- Withdrawals mainly appear before filling in the first questionnaire. This questionnaire is also the heaviest one in terms of number of questions. A more balanced

distribution of questions, with a lighter first questionnaire, could help to reduce this number of withdrawals.

- Contact material for driver recruitment is very important to maximize the response rate.
- It is very important to highlight the research aims of the whole project while recruiting drivers. The piloting phase is crucial to improve these procedures and highlight the most effective contact protocol, therein including wording.
- Pre-screening of customers impacts the final recruitment and participation rate. Recent customers of new vehicles seem to be more sensitive to be involved in transport safety initiatives than experienced owners.
- Continuous tasks, for example to register events during driving, are very difficult to be well performed, compared with the discrete task to fill questionnaires in.
- In order to reach more drivers and improve their response rate it is very good to duplicate or offer multiple options for filling questionnaires in (i.e. hard copy and on-line).
- Piloting should provide feedback concerning the whole experimental design and the practical issues. The FOT could be deeply revised after the pilot results.
- When preparing questionnaires to be used in different countries, translations and related validation should be considered from the very first draft.
- It is very important to develop and improve a web-based survey tool for data collection in order to save time and prevent data transcription mistakes.
- It is very important to improve and share driver liaison centre procedures in order to provide the best support possible to project participants.
- It is very important to get in touch with project participants, in order to ensure data collection, but this has to be done case by case, since some drivers could be bothered because of that. Any request has to be timely answered.
- A link to the OEMs customer services has to be established from the beginning, since customers could use the survey also to send questions that are not related to the project itself, but to the vehicle.
- It is not clear why the response rates of the LDW and the control group differ. Possible reasons could be
    - Users' sensitivity about safety issues and surveys
    - Length of questionnaires (LDW questionnaires are longer than control group questionnaires)
    - Different types of questionnaires, and additional event and weekly registers for the LDW group
    - Incentives (LDW group receives more incentives for questionnaire completion, but at the same time a higher effort was required)
    - Still, the response rate is a very complex factor deriving from several aspects.

9 Swedish VMC

9.1 Operational procedures

9.1.1 Functions, vehicles, and experimental procedures

The partners involved in the Swedish VMC are AB Volvo, Volvo Cars Corporation (VCC), and Chalmers. In total, 130 vehicles have been equipped with logging equipment. The vehicles are based in different locations:

- 100 VCC personal vehicles in Sweden;
- 15 Volvo heavy trucks from a fleet in the UK;
- 15 Volvo heavy trucks from a fleet in the Netherlands.

In addition to the 130 vehicles equipped with data loggers, the Swedish VMC has access to information (in an aggregated form) from 50 additional trucks equipped with Fuel Efficiency Advisor (FEA). Nevertheless, due to limited data acquisition and logging capability in these vehicles, only an analysis of narrow scope can be performed.

VCC

Two vehicle types are used by VCC: V70 and XC70. The functions under investigation are:

- FCW and FCW with Brake support: This function detects and tracks other vehicles (travelling in the same direction) in front of the vehicle and provides a warning to the driver in case the evaluation of trajectories and relative speed of the subject vehicle and the obstacle show a high probability of a collision.
- ACC: This function supports the driver in selecting and then automatically maintaining a chosen speed and distance to the vehicle in front. The function adjusts the speed according to a potential front vehicle and accelerates and decelerates automatically
- LDW: The function warns the driver when the vehicle is unintentionally departing from its intended lane.
- Blind Spot Information System (BLIS): This function continuously monitors the rear blind spots on both sides of the vehicle. In case an obstacle is detected in the blind spot the information or a warning is issued to the driver.
- Impairment Warning (IW): The function is intended to attract the driver's attention when the driver starts to drive less consistently, e.g. becomes distracted or starts to fall asleep.

A dependent design has been chosen, and each of the vehicles was supposed to participate for 12 to 14 months in the FOT (see Figure 46 for an overview):

- Baseline: without systems of interest, duration 4 months
- Treatment: with systems of interest, duration 8 to 10 months

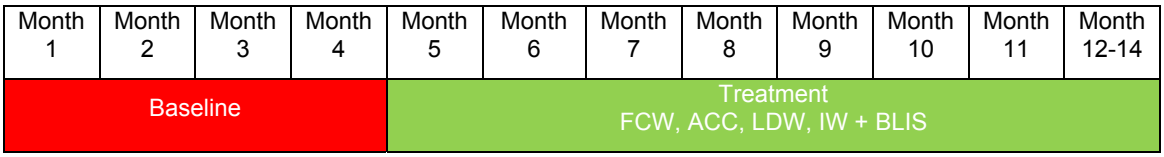

Figure 46: Experimental design at the Swedish VMC (VCC car)

Only VCC Company cars have been used. Test drivers of the 100 personal vehicles are Volvo employees as main drivers and their family members as secondary drivers. Participants have been selected to reflect the customer segments at Volvo Car Corporation, with respect to age, gender and annual mileage. The main part of the drivers was supposed to be between 30 and 59 years old. Driving distribution between male and female in Sweden is currently 60% and 40% respectively: this information was used as the target for the VCC test fleet. Young drivers are most likely included as secondary drivers. The minimum mileage for the main driver should be 15,000 kilometres per year as suggested in SP4.

AB Volvo

Two vehicle types are used by Volvo: FH6x2 and FH4x2. The functions under investigation are:

- FCW and FCW with Brake support
- ACC
- LDW

A dependent design has been chosen and each of the vehicles was supposed to participate for 12 months in the FOT (see Figure 47 for an overview):

- Baseline: driving without systems of interest, but with regular cruise control activated; duration 4 months
- Treatment: driving with FCW, ACC and LDW; duration 8 months

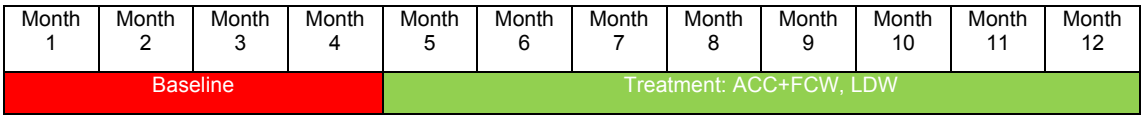

Figure 47: Experimental design at the Swedish VMC (Volvo trucks)

The Volvo trucks fleet is subdivided into two independent groups: The Dutch fleet (n=15 trucks) and the UK fleet (n=15 trucks).

Contacts with Volvo truck customers were done in collaboration with the Volvo Field Test organisation, whose main task is to evaluate either complete vehicles, systems or components performance and durability, by running tests on Volvo owned vehicles driven by fleet owners or by using vehicles from them. In euroFOT, the fleets' own vehicles have been used. Regular truck drivers employed by the fleet owners in the Netherlands and UK have been taking part in the study. They drove the trucks according to their regular working schedule. Each driver was instructed about the study and asked for consent by a project member from AB Volvo prior to participation. In each vehicle, there was information for drivers temporarily driving the vehicles but who were not currently enrolled in the euroFOT project (e.g. mechanics, managers).

9.1.2 Questionnaires definition and development

The questionnaires included within the euroFOT project and adopted by the Swedish VMC have been designed to measure a wide area of topics. E.g.:

- subjective mental workload;
- perceived usefulness (e.g. how the system supports the driving task) and satisfaction (evaluation of systems desirability, likeability etc);
- drivers' confidence in the system;
- perceived ease of use (ability to use the system successfully with minimal effort) etc.

Due to the specific requirements of the Swedish test site, and especially due to the sample of the test drivers (professional truck drivers), some modifications to the common questionnaire pack had to be made. Four main questionnaires were administered (Time 1 to 4). The screening questionnaire could not be used by VCC due to the fact that drivers were selected on a voluntary basis among VCC company car drivers that were interested to drive V70 or XC70 as company car and also interested to participate in the FOT project. Background information, such as demographics, travel patterns etc. was collected in the first questionnaire (Time 1). It was not possible to hand out the non-participation questionnaire to drivers that refused their consent to participate in the euroFOT project.

The common questionnaires were considered to be very lengthy as well as to some extent intrusive. In order to still guarantee a high response rate, a smaller portion of the questions had to be removed from the questionnaires for the professional truck drivers of the Volvo sample. Thus, some of the background questions had to be dropped, such as the ones regarding disabilities (e.g. hearing impairment) as well as the workload questions in the following questionnaires (partly this was due to the difficulty of the drivers to understand the scale used). In order to not miss out the opinions from the drivers due to reduced number of questions, a final event has been organised in Sweden where the NL drivers were invited. The same is planned for the UK drivers in the fall of 2011. Furthermore, some questions were added to the Time 3 and Time 4 questionnaires with regard to Workload, system use, perceived ease of use and system effects.

To reduce the number of questions for the individual drivers of the VCC vehicles, they were split in two groups. The first group was, in addition to the general questions, asked to answer all questions concerning three of the ADAS (LDW, DAC, BLIS) while the second group was asked to cover the remaining ADAS (FCW, ACC).

9.1.3 Questionnaire operational procedures

Both VCC and Volvo test drivers were asked to fill in questionnaires at five times during their participation in the euroFOT project (see Figure 48 for an exemplary time line of questionnaire administration):

- Questionnaire 1 was administered before the active safety systems were activated in the vehicles in order to obtain measures of driver attitudes, accident record, travel patterns, and sensation seeking.
- Questionnaire 2 aims to determine pre-trial acceptability. Additionally, ratings on self-reported workload and driving behaviour are taken.
- In Questionnaire 3, acceptability and workload measures are taken. It was administered twice during the treatment phase, i.e. when the active safety systems were activated in the vehicles.
- Questionnaire 4 aims to determine acceptability and workload in more depth and is to be administered at the end of the data collection.

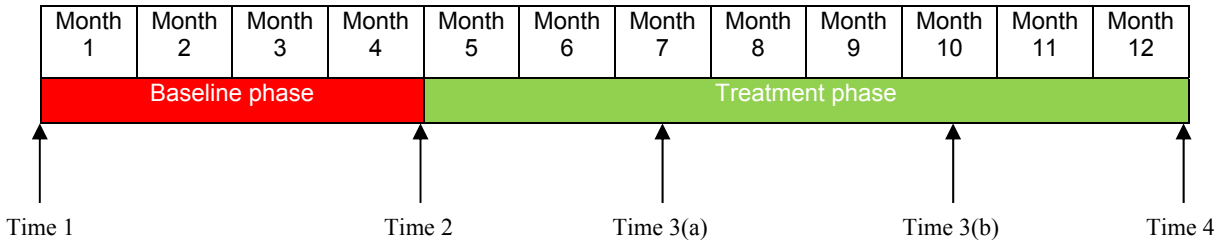

Figure 48: Exemplary timeline for questionnaire administration at the Swedish VMC

VCC

VCC used web-based questionnaires only. The web-addresses of the questionnaires were distributed as emails sent-out to each participant. In addition to the first email sent-out, additional two reminders were sent-out via emails if necessary.

Volvo

AB Volvo mainly used paper-based questionnaires for the truck drivers instead of an electronic web format. This was due to the lack of Internet access for many of the truck drivers and caused a lot of extra work and considerations to ensure data could still be collected with high quality. The initial idea was to administer the questionnaires either face to face with each driver or via phone interviews. The demographic questions as well as Questionnaire 1 were done when meeting the drivers in person. Questionnaire 2 for the Dutch drivers where done via phone as well as the first version of Questionnaire 3, however, this was considered very inefficient and with low response rate as a result. Thus, all the following questionnaires were administered as paper-based versions and to a large extent when meeting the drivers in person. Answers are later fed into the database.

Due to a limited access to data from FEA trucks, as stated earlier, only very restricted driver information is available, what made it impractical to administer questionnaires to FEA drivers.

All handling of the questionnaires were outsourced; this includes building up the web questionnaires, distributing the questionnaires, sending out reminders and recording of the answers.

9.1.4 CAN data gathering, transmission and storage

The data loggers used by both OEMs in the 130 vehicles of the Swedish VMC are of the same type, i.e. the SAFER loggers that were custom-made to fulfil the euroFOT Swedish VMC requirements. The loggers are based on PC technology and commercial off-the-shelf components.

The logger wirelessly sends a status summary to the central monitoring system at the VMC after each trip. This status summary gives information, among others, about the health check of the hard disk, status of the cameras, remaining storage space on compact flash card and hard disk, as well as remaining money on the SIM card. The monitoring is done by VMC personnel daily. When a problem is found, the person responsible for monitoring performs the necessary checks and, if necessary, asks the driver liaison to contact the driver.

All collected data (CAN, video, and eyetracker information) are stored on a hard disk in the vehicle. The hard disks are exchanged when they are almost full, as indicated in the central monitoring server. The hard disks are collected by OEM's personnel (VCC) or fleet personnel (Volvo), and pre-processed at the OEM site. Next, processed data are uploaded to the OEM-database. Part of the pre-processed data is copied to the transfer disks to be uploaded to the Swedish VMC database at Chalmers.

The pre-processing steps include decrypting data, filtering, re-sampling, quality checking per sample, per measure, and per trip, calculating derived measures and events, adding map data, and converting video to X264 format. Although the pre-processing steps are run at the OEMs, the software is built together by the Swedish VMC partners.

9.1.5 Video data gathering, transmission and storage

Four cameras and an eyetracker were installed in 100 Volvo cars and 30 Volvo trucks involved in the study. Camera views are:

- driver seat;
- view of the road to the front;
- rear view of the vehicle;
- driver foot (pedal area).

No audio information is recorded.

As described in chapter 8.1.4, video data is first stored on a hard disk in the vehicle. During the pre-processing stage at the OEMs, video data is converted to X264 format, and then copied to both on-site fileservers and to a transfer disk, which is later sent to Chalmers. At Chalmers, video files are copied to another fileserver.

No video footage is available for FEA trucks.

9.2 Driver sample (Volvo and VCC)

Status 22.08.2011 *(numbers in bold are not final)*

One important and complex issue to consider when collecting data in field operational tests, perhaps in particular when enrolling professional drivers who often shift between vehicles, is

that drivers originally signed up to participate in the study end up either leaving the company or may not drive the relevant vehicles with the systems to be assessed to mention some issues. Following this, new drivers might drive the relevant vehicles. If these “new” drivers drive the equipped vehicles extensively they could be considered to be enrolled.

VCC

At VCC, questionnaires have been sent out to all participants, main drivers as well as secondary drivers. In total, there are 205 registered drivers of the initial 100 cars. There was two drop-outs leaving 98 cars as potential contributors to the questionnaires.

Driver sample 1 consists of Main Drivers only, i.e. 98 persons. Gender distribution is 88% male and 12% female. Mean age of this sample is m=48.5 years (sd=7.3), with most of the drivers being 46 to 55 years old and none of the drivers being younger than 26 years or elder than 65 years (see Figure 49).

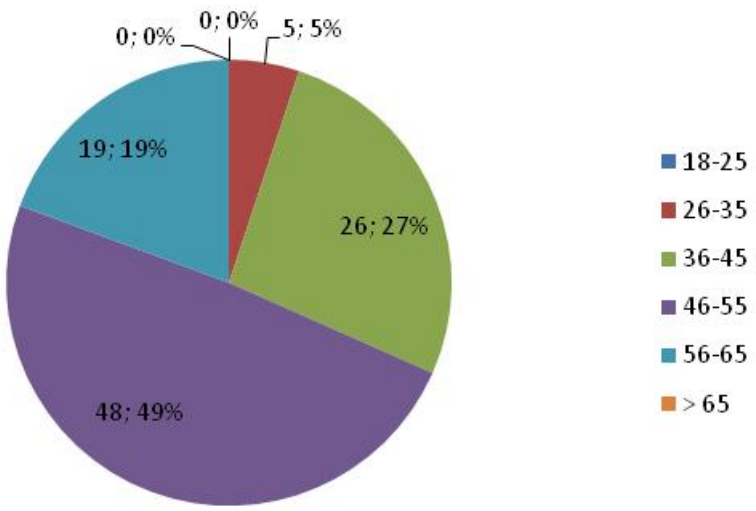

Figure 49: Age distribution of the VCC test drivers (main drivers; n=98)

Annual average driving distance is m=25900 kilometres and average driver license possession is m=30.5 years. Most of the test drivers either indicate to drive less than 5000 kilometres per year or to drive between 15000 and 30000 kilometres per year (see Figure 50).

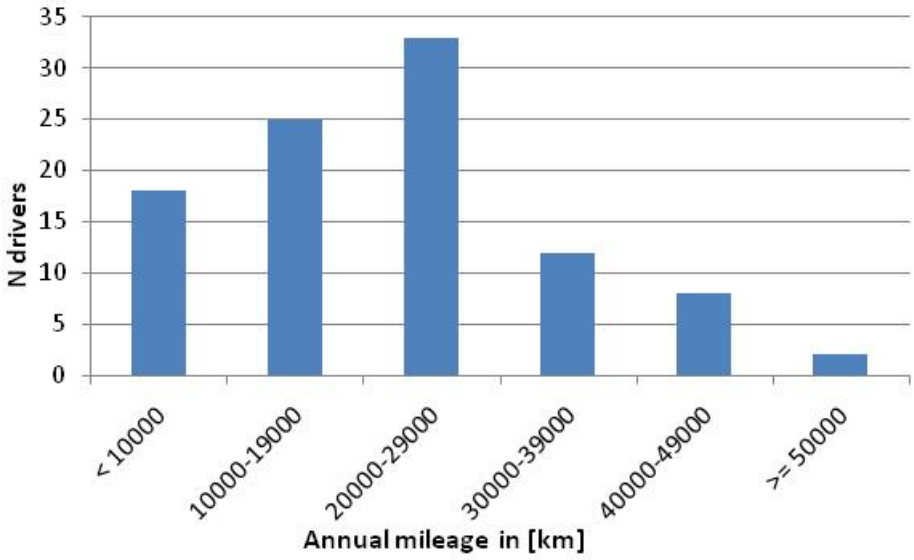

Figure 50: Distribution of annual mileage [in km] of the VCC test drivers (main drivers; n=98)

Driver sample 2 consists of all drivers, main as well as secondary, totally 205 persons. In this group gender distribution is 58% male and 42% female. The mean age is m=45.3 years with most of the drivers being 46 to 55 years old (see Figure 51). None of the drivers is elder than 65 years. Some of the secondary drivers are between 18 and 25 years old.

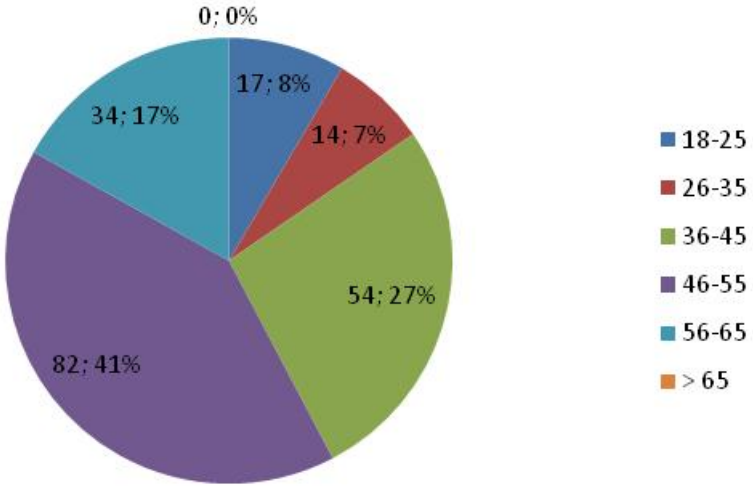

Figure 51: Age distribution of the VCC test drivers (all drivers; n=205)

Annual driving distance is 18790 kilometres and average driver license possession is 26.3 years. Most of the drivers indicate to drive less than 5000 kilometres per year (see Figure 52).

In total, there are two drop-outs within driver sample 1 and 22 within driver sample 2.

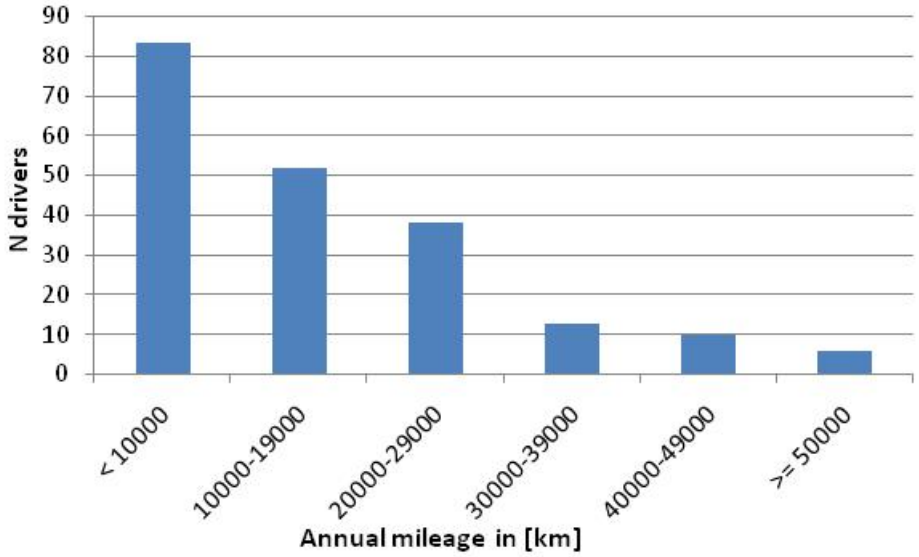

Figure 52: Distribution of annual mileage [in km] of the VCC test drivers (all drivers; n=205)

Volvo

A quite large amount of drivers at the UK fleet was planned to be driving the 15 equipped vehicles and therefore signed the consent forms. For the Dutch fleet, fewer drivers were planned to drive the equipped vehicles and thus only those originally considered were informed and were asked to give their consent to participate in the study. For both fleets a sub-set of the drivers has been identified as euroFOT drivers and has responded to the questionnaires; however, it is clear that there is a considerable amount of vehicle data from a larger group of drivers. No data can be used from drivers who have not been given their consent. Therefore, consent to enrol in the study will be asked from the drivers who have driven extensively. No questionnaires will however be sent out apart from the sub-set group.

At the time of the Questionnaire 1, 37 professional truck drivers from the UK fleet were informed, signed the consent form and responded to the questionnaire. The mean age was 48 years old (sd=8.7) and they have held their driving licences for personal vehicle (B) and heavy truck with trailer (CE) in average for 32 and 22 years, respectively. Information about the annual mileage is not available for the drivers of the UK fleet. For the Dutch fleet 16 professional truck drivers were informed, signed the consent form, and answered the questionnaire. The mean age was 47 years old (sd=10.5) and they have held their driving licenses for personal vehicle (B) and heavy truck with trailer (CE) in average for 31 and 30 years, respectively. All drivers are male. The Dutch drivers indicate to averagely drive m=141000 kilometres per year, with the minimum being 110000 kilometres and the maximum 160000 kilometres (sd=15000).

9.3 Subjective data (answers to questionnaires)

9.3.1 Subjective data: VCC

Status 09.06.2011 *(numbers in bold are not final)*

Table 48: Available data from questionnaires handed out before treatment (VCC, Driver sample 1)

Pre-FOT						**pre-treatment/ end of baseline**	
Non-participation		***Screening***		***Time 1***		***Time 2***	
N handed out	N/A	N handed out	N/A	N handed out	98	N handed out	98
N filled in & returned	N/A	N filled in & returned	N/A	N filled in & returned	98	N filled in & returned	98
N missing	N/A	N missing	N/A	N missing	0	N missing	0
Response rate (%)	N/A	Response rate (%)	N/A	Response rate (%)	100	Response rate (%)	100

Table 49: Available data from questionnaires handed out during and after treatment (VCC, Driver sample 1)

During treatment				***End of trial***			
Time 3 (a)		***Time 3 (b)***		***Time 4***		***Debrief***	
N handed out	98	N handed out	98	N handed out	98	N handed out	N/A
N filled in & returned	***91***	N filled in & returned	***92***	N filled in & returned	***94***	N filled in & returned	N/A
N missing	***7***	N missing	***6***	N missing	***4***	N missing	N/A
Response rate (%)	***92,9***	Response rate (%)	***93,9***	Response rate (%)	***95,9***	Response rate (%)	N/A

Table 50: Available questionnaire data from drop-outs (VCC, Driver sample 1)

Exit interview/ drop-outs	
N handed out	N/A
N filled in & returned	N/A
N missing	N/A
Response rate (%)	N/A

9.3.2 Subjective data: Volvo

Currently, there is available data from Questionnaire 1, 2 and 3a for the two AB Volvo fleets. The second version of Questionnaire 3 is about to be processed.

Status 30.09.2011 *(numbers in bold are not final)*

Table 51: Available data from questionnaires handed out before treatment (Volvo)

Pre-FOT				**pre-treatment/ end of baseline**	
Screening		***Time 1***		***Time 2***	
N handed out	N/A	N handed out	52	N handed out	52
N filled in & returned	N/A	N filled in & returned	52	N filled in & returned	28
N missing	N/A	N missing	0	N missing	24
Response rate (%)	N/A	Response rate (%)	100	Response rate (%)	54

Table 52: Available data from questionnaires handed out during and after treatment (Volvo)

During treatment				***End of trial***			
Time 3 (a)		***Time 3 (b)***		***Time 4***		***Debrief***	
N handed out	52	N handed out	52	N handed out	52	N handed out	N/A
N filled in & returned	28	N filled in & returned	***29***	N filled in & returned	***12***	N filled in & returned	N/A
N missing	24	N missing	***23***	N missing	***40***	N missing	N/A
Response rate (%)	54	Response rate (%)	***56***	Response rate (%)	***23***	Response rate (%)	N/A

9.4 Objective data

9.4.1 Objective data: VCC

Status 10.06.2011 *(numbers in bold are not final)*

The numbers in Table 53 are taken from the uploaded data in the Oracle Database at VCC. The rest of the collected data is copied from the USB-disks to the file management system (FMS), and will be uploaded to the database during the summer.

Currently, the data in the database at VCC represents 13% of the all data that is going to be collected. The data that is going to be used in the final statistical analysis will represent 50% of the collected data.

The number of drivers that is presented in the table corresponds to the number of drivers automatically identified in the upload process. Manual drivers' identification will be performed during the summer to identify all drivers.

Table 53: Available objective data (VCC)

Baseline							
Overall amount of data in Oracle DB	195 GB						
Overall km driven	153560						
Drivers							
N drivers overall	19	N drivers complete	19	N drivers incomplete	NA	Drop-outs	NA
Driving months							
N Overall driving months	11	N driving months complete	11	N driving months incomplete	NA	N driving months missing	NA
Trips							
N overall trips	10064	N trips complete	10064	N trips incomplete	NA	N trips missing	NA
Treatment							
Overall amount of data in Oracle DB	334 GB						
Overall km driven	251900						
Drivers							
N drivers overall	***29***	N drivers complete	***29***	N drivers incomplete	NA	Drop-outs	NA
Driving months							
N Overall driving months	***11***	N driving months complete	***11***	N driving months incomplete	NA	N driving months/days missing	NA
Trips							
N overall trips	***17163***	N trips complete	***17163***	N trips incomplete	NA	N trips missing	NA

9.4.2 Objective data: Volvo

Status 30.09.2011 *(numbers in bold are not final)*

The numbers in Table 54 are taken out from the uploaded data in the Infobright database at VTEC (September 2011). The rest of the collected data is copied from the USB-disks to the file management system (FMS), and will be uploaded to the database during the summer.

Currently, the data in the database at VTEC represents about 66% of 24 months of data collection (12 in the UK and 12 in the Netherlands).

For the 50 FEA trucks, we have access to around 3 800 000 kilometres of aggregated data collected over 6 months.

Table 54: Available objective data (Volvo)

Baseline							
Overall amount of data in Infobright DB	***1.47TB***						
Overall km driven	***733813***						
Drivers							
N drivers overall	***51***	N drivers complete	***51***	N drivers incomplete	***0***	Drop-outs	***0***
Driving months							
N Overall driving months	***165***	N driving months complete	***165***	N driving months incomplete	***0***	N driving months missing	***0***
Trips							
N overall trips	***15983***	N trips complete	***15983***	N trips incomplete	***0***	N trips missing	***0***
Treatment							
Overall amount of data in Infobright DB	***1.62TB***						
Overall km driven	***806390***						
Drivers							
N drivers overall	***49***	N drivers complete	***49***	N drivers incomplete	***0***	Drop-outs	***0***
Driving months							
N Overall driving months	***198***	N driving months complete	***198***	N driving months incomplete	***0***	N driving months/days missing	***0***
Trips							
N overall trips	***17233***	N trips complete	***17233***	N trips incomplete	***0***	N trips missing	***0***

For many drivers we only have a few trips during a specific month due to the fact that the drivers move around on a lot of trucks, of which not all are included in the euroFOT project.

9.5 Lessons Learned

A summary of lessons learned collected by the Swedish VMC during data acquisition is reported below. Lessons learned have been reported by the OEMs involved in the Swedish VMC.

VCC

Lessons learned about subjective data acquisition

1. Questionnaire Development

- The process to develop the questionnaires was extensive and it took a lot of effort to harmonize the questionnaires. In some parts the questionnaires become too extensive.
- Following was identified when VCC did the pilot for the questionnaires:
  - The VCC drivers found it hard to answer the questions concerning affordability; some of the drivers even skipped the items.
  - Workload, the drivers perceive this scale as quite strange.
  - Spontaneous reaction from one of the VCC drivers was: “Too much! I would never ever answer all this.”
  - The drivers give up and do not fill in all the open questions. The drivers’ common reaction was that we are asking the same questions several times.
- To reduce the number of questions for the individual drivers of the VCC vehicles, they were split in two groups. The first group was, in addition to the general questions, asked to answer all questions concerning three of the ADAS (LDW, DAC, BLIS) while the second group was asked to cover the remaining ADAS (FCW, ACC).

2. Questionnaire Administration, execution and analyses.

- It is recommended to use a web-based questionnaire since this will prevent data transcription mistakes and it will improve the responses from the drivers.
- Drivers found it very hard to distinguish between reliable, trustworthy and confidence which made that part of the questionnaire confusing. In general the drivers would have desired less but more distinct questions.
- Drivers would have preferred to have access to their previous answers because sometimes they could feel that they changed opinion while filling in or could not quantify it correctly since they did not remember their earlier opinions.
- Big spread in the answers on the “reference question” on workload made this question not useful for the analysis.
- Information about amount of driving since previous questionnaire (hours or mileage) for each driver should have been provided each time a questionnaire was filled in. Would have been useful information during the analysis.
- The knowledge about ADAS systems was very different from driver to driver. It would have been fair to give all drivers the same brief description, in written format, about the systems provided at the Treatment phase.
- The result of the split was that most of the drivers answered the questions in respective group. But in the evaluation of the FOT there were still comments that the questionnaires were too extensive. It is a risk that questions / answers not have got the right attention from the respondents.

Lessons learned about objective data acquisition

- Collaboration with SP3 (data management) from early time was very useful.
- Saving the data on the DAS is very useful, since sending it via GPRS all the time is not always reliable.
- Possibility to follow the status of DAS on the web is very useful since errors on the DAS can be noticed in early stage.
- Collecting the data from vehicles, processing, and uploading until hypothesis analysis should be tested in the beginning, since some signal errors were noticed in the last analysis part.
- Having a test database including a subset of the data should be created to test the analysis scripts since it is more time efficient than working on the whole database.
- Encoding the video data from xvid format to h264 format helps reducing the data storage by 40% at Swedish VMC.
- Having a data analysis tool in the early stage is very useful since it helps in finding the errors in the data and the synchronization together with the video.

VOLVO

- There are a number of steps from data acquisition to delivery to SP6 that must not be underestimated. These steps, which include data pre-processing and upload to the database, are extremely time-consuming and error-prone. Prior to the start of a new FOT, lessons learned from previous projects involving data acquisition ought to be taken into account.
- Since the data processing is so time consuming, it is important to validate the processed data as early as possible to avoid having to re-process data at a later stage.
- Handling large amounts of CAN data and videos turned out to be extremely costly and alternatives such as computer clusters together with MatLab parallel toolbox and MatLab distributed computing server proved to be useful at Volvo. Drawbacks of the cluster approach include difficulties in handling unique row id's and increased complexity.
- In general, the large amount of data that has to be handled has also put a lot of requirements on the IT infrastructure. An efficient and well planned process for all parts of the data handling, from copying the data from the USB disks to re-encoding the video files and uploading the processed data to the database, have a great impact of overall ability to manage the collected data.
- Continuous on-line monitoring of data loggers helped assuring high-quality data, despite the high cost of data transfer through mobile phone network.
- Interaction with SP6 at early stages of data acquisition and processing turned out to be crucial for identification of issues and potential improvements. Since re-processing large amounts of data might take weeks, delayed feedback from SP6 can hinder analysis efficiency.
- Data upload to a SQL database has both advantages and disadvantages that must be considered in advance. At Volvo, the possibility of working with both SQL database and a file system (data stored in MAT files) allowed SP6 analysis to be

more flexible. Efficient scripts could be written by mixing both SQL database and file system taking advantage of what both approaches have to offer.

- By converting video data from xvid to h264 the data storage need was reduced by 40% at Swedish VMC. The process is very CPU intensive and a cluster of computer nodes were needed to perform this task.
- Telephone-based subjective data acquisition turned out to be impractical due to a number of reasons.
    a) It was difficult to set up time intervals where both the drivers and interviewers were available.
    b) The interviewers' did not come from a system developing team at Volvo and was viewed by the drivers as being very naïve to the systems they requested opinions about.
    c) Telephone interviews with drivers asking questions including scales is not a good idea.
- For future studies with truck drivers it is probably good to allow for a personal meeting visiting the fleet and have drivers fill in electronic forms while being present. The cost for doing this would be well spent and would increase the drivers' trust in how we handle data and emphasise the value we put in their responses. To compensate for the low response rate in early stages of the Volvo trial very successful focus groups were held where the last questionnaires for the Dutch drivers were administrated as well.

10 Conclusions

The aim of this document was to report on the final delivery of the amount of data that has been gathered over the course of more than one year of field operational testing in the work of SP5 (WP 5600) and which will be available for evaluation. The document does not include any raw data, results or evaluation processes, since this will be the task of SP6, and does not go into detail with regard to the type of collected data. An overview is given on how many questionnaires have been handed out, have been filled in, and are missing, as well as on the objective data sets that have been collected or are incomplete (with regard to drivers, driving months, and trips).

10.1 Driver sample

All in all, data of about n=973 vehicles and about n=1207 test drivers has been gathered over the course of one year of field operational testing. For only a subset of participants information is available yet. At some of the operational test sites the FOT is still running or not all of the data could be uploaded to the data bases in time for this document.

The average age of the test drivers whose data are available yet is m=47.78 years (sd=2.55). The variation among the operational test sites is not very large, i.e. test driver age is very similar across the VMCs. 58% of the participants are between 36 and 55 years old (see Figure 53). Only 3% of the participants are younger than 26 years. This corresponds with the recommendations of [4] to have an age band of 30 to 50 years and to not include novice drivers as far as possible.

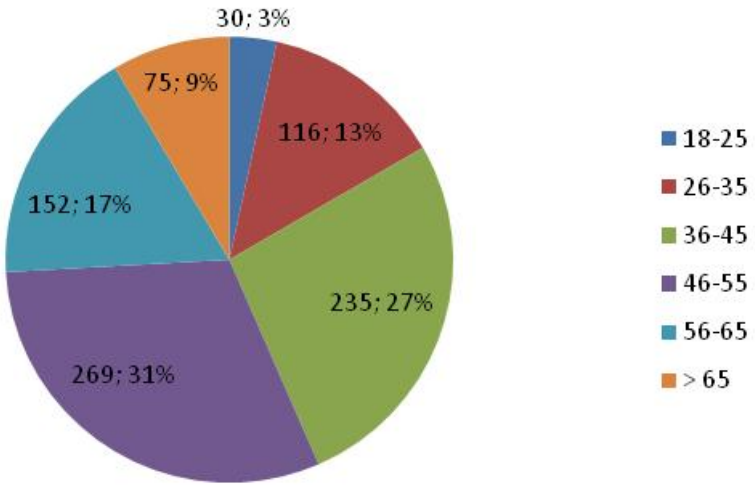

Figure 53: Overall age distribution of test drivers across all operational test centres (n=877)

The majority of the test drivers whose data are available yet is male (n=667; see Figure 54). Only n=105 test drivers are female. The recommendation of SP4 [4] was to select a sample that is as homogenous as possible, also regarding gender. Nevertheless, SP4 acknowledged that the sample would be skewed towards male drivers. This is accounted for by the chosen vehicle models, which are more likely to be driven by males.

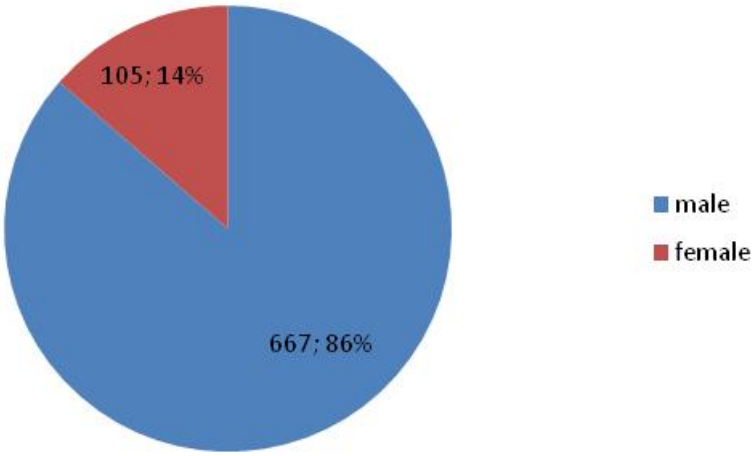

Figure 54: Overall gender distribution of test drivers across all operational test centres (n=772)

The average annual mileage of the test drivers without the truck drivers is m=28854 (sd=10632). Here, the Daimler drivers increase the average annual mileage, which can be referred to the fact that most of the Daimler drivers had a lot of job-related trips to do. Most of the drivers report to drive between 10000 and 40000 kilometres per year (n=648; 74%; see Figure 55). The truck drivers averagely drive m=141000 kilometres per year (Volvo). This meets the requirements of SP4 [4] that the main driver of a test vehicle should be expected to drive at least 15000 kilometres per year, the second driver at least 5000 kilometres per year. A minimum mileage of 15000 kilometres per test vehicle and per year was set.

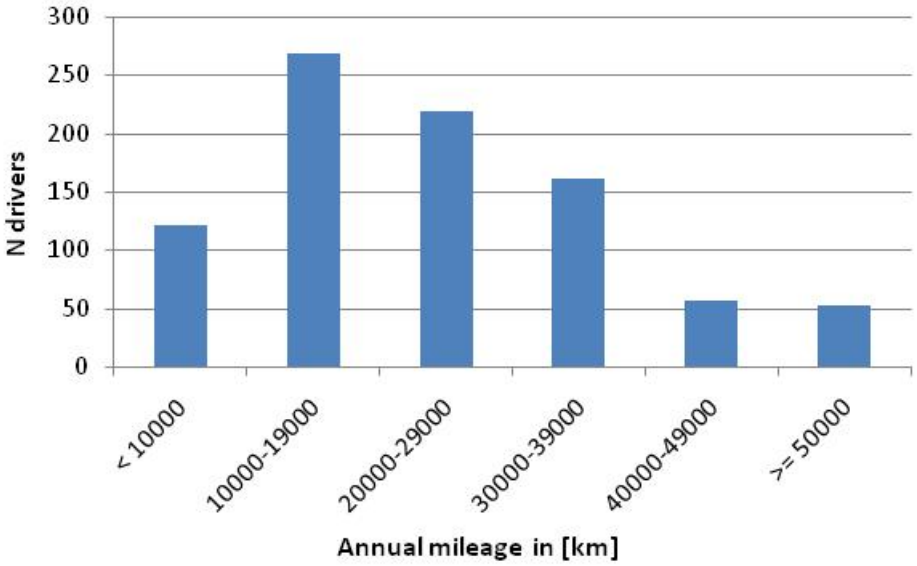

Figure 55: Overall distribution of annual mileage across all operational test centres (n=877)

10.2 Overall subjective data

Table 55 to Table 57 give an overview on how many questionnaires have been handed out and filled in by test drivers across all operational test sites, as far as data are already available. Numbers are preliminary only, as not all of the FOTs have been finished yet and

more filled in questionnaires can be expected. Additionally, the overall number of missing questionnaires and the response rate is presented. Both are preliminary as well.

- The non-participation questionnaire could not be handed out by any of the operational centres. This is accounted for by the recruitment procedures at the operational test sites and how potential participants were approached. Most of the contacted drivers were customers of the dealerships involved in the FOT and should not be bothered more than necessary or were not available to fill in the questionnaire.
- All in all, n=2125 screening questionnaires have been handed out across the operational test centres to participants or potential participants. Of these, n=923 questionnaires have been filled in and returned by the drivers, whereas n=1251 questionnaires have not been filled in. This leads to an overall response rate of 43.4%. The high number of missing questionnaires results from the large number of questionnaires that had to be handed out by the Italian VMC (as a first contact letter) in order to contact as many drivers as possible to gain a satisfactory number of participants. If the numbers of the Italian VMC are excluded, n=364 screening questionnaires have been handed out totally, with n=361 being filled in. This leads to a response rate of 99.2%.
- The Time 1 questionnaire before the start of the FOT has been handed out n=1059 times. Of these, n=893 questionnaires have been filled in and returned to the operational test centres, whereas n=166 questionnaires are missing. This leads to an overall response rate of 84.3%.
- At the end of the baseline, the Time 2 questionnaire has been handed out n=1274 times. N=1021 have been returned filled in, n=253 are still missing, leading to a response rate of 80.1%. More Time 2 than Time 1 questionnaires have been handed out, because the Time 2 questionnaires could be handed out several times (more than one baseline).
- During the treatment, n=764 Time 3(a) questionnaires have been handed out so far. Of these, n=606 questionnaires have been filled in by the participants, n=158 questionnaires are still missing. It has to be pointed out that some FOTs are still running and a higher number of handed out and returned questionnaires are expected. So far, the overall response rate is 79.3%. The Time 3(b) questionnaire has only been handed out by the Italian VMC and by VCC so far. The drivers of the French VMC are about to fill in the questionnaire in September, the Volvo questionnaire data have not been processed for Time 3(b) yet. At the other operational test centres the Time 3(b) questionnaire has not been used due to operational procedures. Thus, only n=397 questionnaires have been handed out. Of these, n=265 have been filled in so far, resulting in a response rate of 66.8%.
- The Time 4 questionnaire and debriefing have mostly been combined in one Time 4 questionnaire, thus the debriefing numbers seem lower than they actually are. All in all, n=725 Time 4 (and n=376 debriefing) questionnaires have been handed out. N=526 (n=254 debriefing) have been filled in yet, leading to a response rate of 72.6% (67.6% debriefing).
- All in all, so far n=43 drop-out questionnaires have been registered, with all of them having been filled in.

Table 55: Overall number of questionnaires handed out before treatment

Pre-FOT						pre-treatment/ end of baseline	
Non-participation		***Screening***		***Time 1***		***Time 2***	
N handed out	X	N handed out	2125 (364)*	N handed out	1059	N handed out	1274
N filled in & returned	X	N filled in & returned	923 (361)*	N filled in & returned	893	N filled in & returned	1021
N missing	X	N missing	1202 (3)*	N missing	166	N missing	253
Response rate (%)	X	Response rate (%)	43,44 (91.2)*	Response rate (%)	84.3	Response rate (%)	80.1

* Numbers of questionnaires and response rate excluding the Italian VMC recruitment questionnaires

Table 56: Overall number of questionnaires handed out during and after treatment

During treatment				***End of trial***			
Time 3 (a)		***Time 3 (b)***		***Time 4***		***Debrief***	
N handed out	764	N handed out	397	N handed out	725	N handed out	376
N filled in & returned	606	N filled in & returned	265	N filled in & returned	526	N filled in & returned	254
N missing	158	N missing	132	N missing	199	N missing	122
Response rate (%)	79.3	Response rate (%)	66.8	Response rate (%)	72.6	Response rate (%)	67.6

Table 57: Overall number of questionnaires from drop-outs

Exit interview/ drop-outs	
N handed out	43
N filled in & returned	43
N missing	0
Response rate (%)	100

Response rates of approximately 80% are comparatively high for such a field operational test. The high response rates could be reached by the operational test sites due to the implementation of the FOT and the organisation of questionnaire administration:

- Questionnaires were for example filled in when drivers were at the test site anyway (e.g. BMW, Daimler, Volvo), or telephone interviews were implemented (e.g. MAN).
- At some test sites (e.g. French VMC, BMW, Daimler) it was possible for the participants to choose between the web-based and the paper-based version of the questionnaires, thus considering personal preferences of the drivers.
- If drivers forgot to fill in the questionnaires, they were reminded of it via email (e.g. BMW, Daimler, and VCC). VW introduced a special rewards system: drivers were rewarded twice during the FOT for participating.

All these methods obviously helped to reach a higher response rate for the questionnaires than would be expected for a field operational test. Again, it has to be pointed out that especially the numbers for the questionnaires of the treatment periods are only preliminary:

FOTs are still running, or have just been finished, and questionnaires, although maybe already handed out, have not been returned by the drivers yet (but will be returned), or data have not been processed completely yet, thus correct numbers not being accessible yet.

10.3 Overall objective data

Table 58 gives an overview on the amount of data that has been gathered, pre-processed and uploaded to data bases at the deadline of this document. It has to be emphasized that the larger part of the data is not accessible yet and information cannot be retrieved yet. It has to be assumed that a considerably larger amount of data will be handed over to SP6 for data analysis. So far, 2.07 TB of data has been gathered for baseline driving (including VW data as baseline), and 2.60 TB for treatment periods. So far, data of n=388 drivers in the baseline and n=432 drivers in the treatment period are included, with drivers partially counting doubly, due to dependent experimental designs. Data of drivers can be incomplete either because the FOT has not been finished yet, because the data have not been pre-processed yet, or because data is missing due to data logging problems. This can only be sorted out when all of the data has been pre-processed and uploaded. The same applies for the number of driving months and trips. So far, 2027910 kilometres are available for the baseline, and 2694277 kilometres for the treatment period. These kilometres have been driven in 108622 trips under baseline conditions and 149014 trips under treatment conditions.

Not included in Table 58 is the mileage of the Italian VMC project participants. Although at the Italian VMC only subjective data were collected, an estimation of the overall mileage can be made as an additional measure. The (self-reported) data can be derived from the questionnaires and the weekly registers about vehicle usage. In total, the n=243 test drivers of the LDW group have driven approximately 3571614 kilometres during their project participation. Similarly, the Italian VMC assumes about 3500000 kilometres for the n=290 test drivers of the Control Group.

This increases the available overall euroFOT mileage to 5527910 kilometres for the baseline, and 6265891 kilometres for the treatment period.

Table 58: Overall objective data across all operational test centres (as far as information is available)

Baseline							
Overall amount of data (GB)	2,07 TB (2119 GB)						
Overall km driven	2027910 (5527910)*						
Drivers							
N drivers overall	388	N drivers complete	322	N drivers incomplete	63	Drop-outs	1
Driving months							
N Overall driving months	850	N driving months complete	818	N driving months incomplete	23	N driving months missing	9
Trips							
N overall trips	108622	N trips complete	56058	N trips incomplete	10264	N trips missing	N/A
Treatment							
Overall amount of data (MB, TB)	2,60 TB (2667,5 GB)						
Overall km driven	2694277 (6265891)*						
Drivers							
N drivers overall	432	N drivers complete	298	N drivers incomplete	129	Drop-outs	5
Driving months							
N Overall driving months	1021	N driving months complete	846	N driving months incomplete	166	N driving months missing	9
Trips							
N overall trips	149014	N trips complete	133515	N trips incomplete	15482	N trips missing	17

* Including self-reported mileage of Italian project participants

10.4 Improvement of methodology

As pointed out in chapter 1.3, the organisation of the euroFOT project is based on the V-chain provided in the FESTA handbook [1]. Although FESTA presents a valuable guideline to conduct an FOT, some modifications had to be made for the euroFOT project and are recommended for future FOTs.

First, the steps of the FESTA chain are sequential. This did not prove to be feasible in euroFOT. Here, several work packages, such as SP2 (functions, hypotheses), SP3 (data management) and SP4 (experimental procedures) did run in parallel. Also, SP6 (evaluation) started before SP5 (data acquisition) ended. This modification was necessary as the work of

each work package influences the work of the other work packages. E.g. the available vehicle sensors determine which data can be gathered and thus which research questions can be answered. Additionally, SP6 had to begin earlier, as data bases and data processing procedures had to be developed and data pre-processing had to be started. As this is a very complex and time consuming process, it would have taken too long to wait until all the data would have been gathered.

Second, the FESTA chain did not contain any piloting. It was essential for euroFOT to include a piloting phase in order to test the data acquisition systems, data pre-processing and data analysis. During the piloting phase problems with data logging could be detected and solved, as well as data pre-processing could be implemented and tested. This has to be done prior to the actual FOT and with a smaller set of data. As this step is very time consuming, problems and mistakes in programming need to be detected early. Otherwise, with the huge FOT data set, it would take too much time if, due to errors, data would have to be pre-processes again and again. It is recommended to allow for an even longer and more extended piloting phase in the next FOT.

Concluding, this means that an FOT is more an iterative process than a sequence of several steps. Strong interactions of the partners are necessary to ensure an FOT in which everything works, is well-matched and feasible. This should be considered in the FOT chain.

Additional recommendations to improve the general FOT methodology in the future are:

- Make the hypotheses formulation process simpler and more efficient, i.e. try to streamline the process as far as possible. (euroFOT partners have been repeatedly obliged to fill in very similar and quite long MS Excel-tables – this should be reduced significantly).
- Hypotheses have to be very detailed and specific in use cases in order to understand exactly drivers' behaviours and the potential impact of functions on safety, traffic and environment. Too general hypotheses could derive misleading results about effective impacts.
- The FESTA methodology appears to start the FOT chain with participants as a given item, i.e. they simply exist and criteria are discussed how to select participants. The FOT Implementation Plan (FOTIP) has an activity 7 with the title "Find vehicles". EuroFOT showed that finding and contracting ordinary drivers with private cars (this is called "borrowing" in the FOTIP) is difficult. In euroFOT, VMCs learned that the information path to the potential participant is one of most relevant problems (e.g. at Ford). One example could be: leave brochures with nice numbers of incentives (cash for the participant) at the dealer – and find them unobtrusive beside twenty other interesting brochures. Mailing actions to owners of a car with the necessary functions installed (i.e. contact to a selected focus group) is not possible anymore (data protection issues) and a more general mailing is very costly and might e.g. produce many phone calls from owners with cruise control, when we are interested in adaptive cruise control.
- It is very difficult for the research departments to organise the common, technical-oriented acquisition process of customers because these departments are mainly predestined for the investigation of very specialized driver assistance systems and do not have the infrastructure for the acquisition process. Contrary to the agreement established in euroFOT, the customer liaison and support service should not be a part of the research tasks of each project partner. The experienced effort for this activity has led OEMs (e.g. VW) to stop acquiring ordinary customers (buying cars in a really broad operation field), and to acquire test persons form the group of OEM company car users instead. OEMs' attempts to acquire ordinary customers have resulted in very insufficient actions which have required a lot of time and produced a lot of frustration (e.g. VW). On the other hand, the isolation of customers and researchers (due to the necessity for customer privacy protection) causes an ethical

issue, especially with the gathering of subjective data. It also results in an alienation of the participants and only a weak knowledge about their subjective opinions about the project in general.

- The installation of complex DAS into customer cars did not seem to be practical. It is recommended that the participating OEMs consider the providing test vehicles. This means that more expenses need to be budgeted for the FOT on OEM side as this was done for euroFOT.

10.5 Final remarks

A very large amount of data can be gathered in a European field operation project such as euroFOT. Thus, everyday use of ADAS and their acceptance and impacts on traffic efficiency, safety, and environment can be analysed in real world driving. However, it has to be considered from the beginning that such large amounts of data need to be handled, and that it takes a lot of time to pre-process and upload them in order to be finally able to retrieve information. This has to be taken into account during the planning of an FOT.

Moreover, the final delivery of data was complicated due the difficulties encountered such as problems with data logger installation and data logging at the beginning. At some operational centres it was difficult to acquire enough drivers for project participation. This, again, led to delays in the time plan and should be considered right from the beginning in future FOT projects.

For future projects, it might be helpful to organise extra dedicated project -or to plan more time at the beginning of an FOT- for dealing with piloting only, so that enough time will be available for testing data logging and building up a data base. Thus, operational test centres would not have to deal with installation and data logging problems while at the same time having to recruit drivers and already having to start the FOT. As can be seen in the relatively high response rates for the subjective data, a well-conceived planning and organisation can lead to good results.

Several lessons learned about subjective and objective data gathering have been identified by VMCs and partners involved in FOT executions. They have been listed in details in VMCs' specific chapters.

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[10] Common questionnaire pack (Confidential document), euroFOT project SP4, S. Jamson, K. Chorlton, January 2010

Annex 1 Keywords

Field Operational Test

euroFOT project

Advance Driver Assistance System

FOT execution

Final data delivery

Data availability

Data Analysis Plan

Statistical analysis

Driver sample

Objective data

Processing

Questionnaire

Response rate

Subjective data

Upload

Annex 2 Glossary

ACC - Adaptive Cruise Control

ADAS - Advanced Driver Assistance System

BLIS - Blind Spot Information System

CAN - Controller Area Network

CBA - Cost-benefit Analysis

CSW - Curve Speed Warning

DAS - Data Acquisition System

FCW - Forward Collision Warning

FEA - Fuel Efficiency Advisor

FOT - Field Operational Test

GPRS - General Packet Radio Service

GPS - Global Positioning System

HMI - Human-Machine Interface

IW - Impairment Warning

LDW - Lane Departure Warning

OC - Operational Centre

OEM - Original Equipment Manufacturer

SRS - Speed regulation System

UMTS - Universal Mobile Telecommunications System

VMC - Vehicle Management Centre

Annex 3 Common questionnaire pack

Common questionnaire pack to be used in FOT execution by each VMC per each tested function has been developed by SP4. VMCs adopted it but they have been able to add specific items according to their experimental design.

Please, for details refers to the following documents:

- Deliverable D4.2 v0.7, Experimental Procedures, S. Jamson, K. Chorlton, C. Gelau, R. Schindhelm, E. Johansson, A.-S. Karlsson, B. Metz, R. Tadei, M. Benmimoun, C. Val, M. Regan, E. Wilschut, & R. Brouwer, October 13, 2009
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