ASSET Road

Integrated
System Solution
for Safety

Advanced
Safety and Driver
Support for
Essential Road
Transport

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Executive summary

The ASSET-Road project is focussing on improving road safety and road traffic by pushing different transportation stakeholders to interact between each other and integrating modern communication and sensing technologies. The vision of the project as Description of Work states is:

> *…substantially contribute to safe and sustainable transportation by linking road traffic and safety information from all essential system elements. Improving driver awareness and behaviour is a key issue.*
>
> *This will be achieved through an advanced sensor and processing network providing assistance and information for drivers, traffic control agencies and infrastructure operators***.**

Since the area of what the project is dealing with is large covering theories, practices, technologies, hard- and software and different application areas, this deliverable focuses on a specific road safety issue, that has not been deeply investigating during years: behaviours of heavy vehicles drivers, and how their behaviours are influenced by their level of knowledge. Starting from that, the topic of the research described here is the design of an In-Vehicle Information support Systems, including information provision strategies and HMI.

In fact, in the global project vision a crucial aspect are drivers, and a key success factor is analyzing their behaviours while driving, as a starting point to implement innovative strategies to mitigate risks of crashes and reduce negative impacts on all systems' components (users first).

This is the main objective of Work Package 3, and it could be specified as follows:

1. to investigate driver compliance with road regulations and safe driving practices, in order to assess their knowledge and confidence of traffic regulations and the consequences of hazardous behavior and rule violations;
2. to fill the gap between current and desired driver knowledge with regards to regulation, using an informative approach;
3. to design Interactive Intelligent HMI (LISA) as smart In-Vehicle Information System, which will keep drivers aware about road scenarios, regulations and potentially safety-

critical situations, minimizing distraction through an ergonomic-based interface design;

4. to design and process a simulator study using smart ITS prototype devices to observe drivers behaviour and performances during the interaction.

This deliverable is the result of the project tasks 3.1 (Regulation knowledge & awareness study), 3.2 (Situation identification & information presentation) and part of task 3.3 (Smart information provision Mechanism & HMI). In brief, objectives of the deliverable are:

1. to report the study conducted in task 3.1 where information about how deep drivers' knowledge is (for truck and coaches drivers) have been collected in several countries in relation to road and safety regulations (e.g. speed limits on different roads, traffic rules, safety equipments, etc.). This is the first part of the document and includes two studies, the first one conducted in Europe and the second one conducted in Tanzania; a comparison between them is proposed;
2. to describe the smart In-Vehicle Information System specifications based on the requirements collected in WP1 (task 1.2 Users needs and requirements). In this section systems features are briefly introduced and the simulator study setup where the system will be tested is described, including scenario setup, situation identification and simulator iterations.

The work conducted in task 3.1 and 3.2 generated two internal reports merged and harmonized in this document, specifically; a report on drivers knowledge study and a white paper describing the design of the support system and simulator scenarios for future tests.

As the whole deliverable DEL 3.1 is public, it will be integrated to and presented via the ASSET web page: (www.project-asset.com) for public access.

1 Europe study

The first section of this document describes an interview study on traffic safety conducted on 256 drivers divided into 119 truck drivers and 134 bus drivers, and three drivers who drove both bus and truck.

Data have been collected in several European countries, namely:

- Finland;
- Hungary;
- Italy;
- Romania;
- Sweden.

1.1 Introduction

This study is aimed at assessing basic **knowledge of heavy vehicles drivers related to road rules and regulation**: the ones they know, the ones they feel unsure about and the ones they should know in order to grant a high level of safety during their routes.

A key issue of this survey is to investigate cross-countries knowledge, that is, how drivers are aware of different rules and regulations in different countries, what do those differences means and how to manage them: for this reason, drivers who are used to cross country routes have been involved.

The minimum target number of subjects has been set to 40 for each country (200 totals). The following table shows the distribution of participants among involved countries. Note that a participant from Italy (for instance) could be a Swede, i.e. the place of survey collection and participant nationality could differ. All in all 256 participants answered the survey.

Number of participants for each involved country.

Country	**Truck drivers**	**Bus drivers**	**Both**	**TOTAL**
Finland	25	15	3	**43**
Hungary	20	70		**90**
Italy	27	12		**39**

Romania	20	20		**40**
Sweden	27	17		**44**
TOTAL	**119**	**134**	**3**	**256**

In the following paragraphs an overview of statistical data (coming from CARE database [1]) is presented. The purpose of this overview is to set this study into Heavy Goods Vehicles (HGVs), Buses and Coaches accidents context. Data shown are related to different EU-levels. The different EU-levels include different countries, as defined in the following table.

Definition of EU-level and used Country abbreviations.

EU 14 includes:		**EU 16 = EU 14 +**	
BE	Belgium	EE	Estonia
DK	Denmark	HU	Hungary
EL	Greece		
ES	Spain	**EU 17 = EU 16 +**	
FR	France	MT	Malta
IE	Ireland		
IT	Italy	**EU 27 = EU 17 +**	
LU	Luxembourg	BG	Bulgaria
NL	Netherlands	CZ	Czech Republic
AT	Austria	CY	Cyprus
PT	Portugal	DE	Germany
FI	Finland	LV	Latvia
SE	Sweden	LT	Lithuania
UK	United Kingdom	PL	Poland
		RO	Romania
		SI	Slovenia
		SK	Slovakia

1.1.1 Fatality rates and risk

Road traffic accidents involving HGVs tend to be more severe than other accidents because of the great size and mass of these vehicles. Crashes involving buses and coaches could lead to similar consequences, because they are normally relatively large too and, in addition, they transport people.

Table 1 presents the number of people killed in accidents involving HGVs in each of the EU-17 countries for each year for which the data are available over the last ten years. The total number killed in these accidents are shown in Figure 1. The total fell from 4.586 in 1996 to 3.350 in 2005, a reduction of 27%.

Table 1. Fatalities in accidents involving Heavy Goods Vehicles, 1996-2005.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
BE	192	195	228	193	204	193	178	136	143	161
DK	102	93	88	86	97	78	80	69	65	79
EE										50
EL	245	242	277	268	205	220	219	217	181	158
ES	839	888	959	905	920	803	860	834	766	714
FR	1.155	1.113	1.164	1.090	1.051	1.057	988	758	727	726
IE	54	85	63	61	67	70	42	54	-	-
IT	484	476	421	562	582	411	359	358	336	-
LU	8	6	7	3	5	6	12	-	-	-
HU										248
MT										0
NL	209	177	140	175	168	169	129	158	-	-
AT	136	150	145	177	143	122	143	140	144	126
PT	365	356	219	296	284	197	214	213	187	163
FI	91	112	88	121	77	118	105	97	107	92
SE	100	97	117	93	119	118	135	92	59	61
UK	605	554	605	641	581	607	561	548	478	510
EU-14	4.586	4.544	4.521	4.671	4.503	4.169	4.026	3.686	3.417	3.350
Yearly change		-1%	-1%	3%	-4%	-7%	-3%	-8%	-7%	-2%

Source: CARE Database / EC.

Table 2 reports the number of people killed in each of the EU-17 countries over the last ten years in accidents involving buses and coaches.

The total number of people killed in these accidents fell from 888 in 1996 to 633 in 2005, a reduction of 29%. The totals from this and the previous table are presented in Figure 1. They have fallen in parallel, with approximately five times as many people killed per year in accidents involving HGVs as in accidents involving buses or coaches. National data for bus and coach accidents will not be presented, because of the relatively small numbers.

Table 2. Fatalities in accidents involving Buses or Coaches, 1996-2005.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
BE	37	37	47	23	28	29	31	29	31	19
DK	24	15	11	25	14	14	22	26	15	11
EE										7
EL	66	79	93	79	71	59	60	94	48	53
ES	154	180	184	163	144	135	109	126	80	108
FR	109	188	127	127	144	117	109	97	99	91
IE	15	11	16	14	12	9	8	2	-	-
IT	121	137	105	131	119	113	105	122	125	-
LU	5	3	0	0	4	6	4	-	-	-
HU										62
MT										1
NL	23	29	29	21	23	27	21	21	-	-
AT	18	25	14	41	36	33	17	20	24	10
PT	86	104	145	58	57	66	51	26	41	23
FI	12	20	22	18	18	28	17	13	29	13
SE	35	15	16	23	16	32	29	33	16	13
UK	184	174	198	182	176	215	165	160	154	140
EU-14	888	1.018	1.006	905	862	883	749	774	689	633
Yearly change		15%	-1%	-10%	-5%	2%	-15%	3%	-11%	-8%

Source: CARE Database / EC.

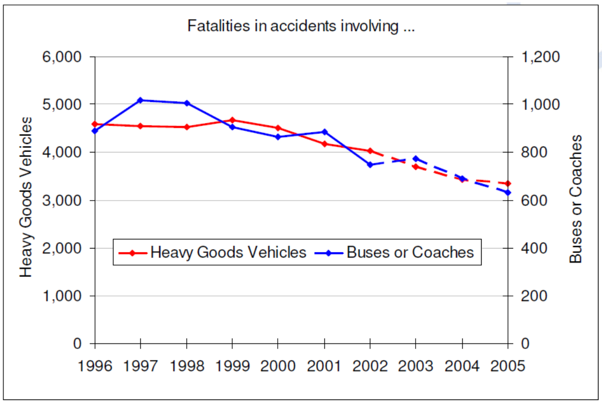


Figure 1. The number of fatalities in accidents involving Heavy Goods Vehicles and Buses or Coaches, EU-14, 1996-2005.

Source: CARE Database / EC.

The risk of being killed in one of these accidents can be compared for each member state using the rate of deaths per million population. The EU-17 average fatality rate in accidents involving HGVs is 11.5 per million population, and ranges from 5.7 in Italy to 37.2 in Estonia. For accidents involving buses or coaches, the EU-17 average fatality rate is 2.1 per million, and ranges from 0.5 in Ireland to 5.2 in Estonia (the high rate in Luxembourg is based on only 4 fatalities).These rates for 2005 are shown in Table 3 and Figure 2.

Table 3. The fatality rates per million population in accidents involving HGVs and Buses or Coaches, 2005.

	HGV accidents	Bus or Coach accidents
BE	15,4	1,8
DK	14,6	2,0
EE	37,2	5,2
EL	14,2	4,8
ES	16,5	2,5
FR	11,6	1,5
IE**	13,0	0,5
IT*	5,7	2,1
LU***	26,2	8,7
HU	24,6	6,1
MT	0,0	2,5
NL**	9,7	1,3
AT	15,3	1,2
PT	15,5	2,2
FI	17,5	2,5
SE	6,8	1,4
UK	8,5	2,3
EU-17	11,5	2,2

Source: CARE Database / EC.

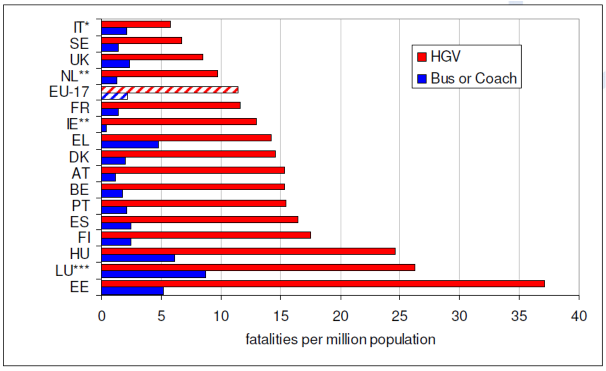


Figure 2. The fatality rates in accidents involving HGVs and Buses or Coaches, 2005.

Source: CARE Database / EC.

Averaged over the EU-17 countries, 13.3% of deaths occurred in 2005 in accidents involving Heavy Goods Vehicles, and 2.6% in accidents involving buses or coaches. Figure 3 shows considerable variation about these averages in individual countries.

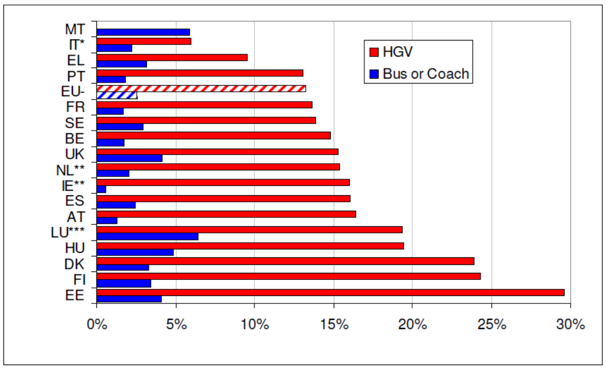


Figure 3. The proportion of fatalities in accidents involving HGVs and in accidents involving buses or coaches, 2005.

Source: CARE Database / EC.

Figure 1 showed that the number of deaths in accidents involving Heavy Goods Vehicles and in accidents involving Buses or Coaches fell between 1996 and 2005, but the EU-14 total number of deaths also fell over this period. Figure 4 depicts that these numbers tended to fall as a proportion of the total.

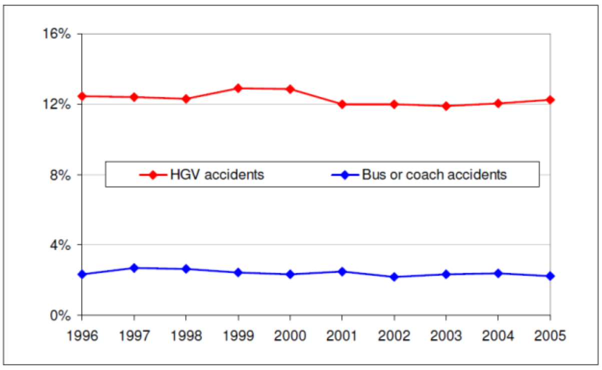


Figure 4. The proportion of fatalities in accidents involving Heavy Goods Vehicles and Buses or Coaches, EU-14, 1996-2005.

Source: CARE Database / EC.

1.1.2 Road user types, road types and accidents causes

These accidents injured those outside the vehicles as well as their occupants. Across the EU-17, 12.9% of those killed in HGV accidents in 2005 were occupants of HGVs, and 15.3% of those killed in Bus or Coach accidents were occupants of Buses or Coaches. Table 4 lists those killed in these accidents in the latest year by road user type. The distributions are illustrated in Figure 5. **The road user type with the highest fatality rates in accidents**

involving both HGVs and buses or coaches are the car occupants; 54% for HGVs and 37% of the buses or coaches accidents.

Table 4. Fatalities in accidents involving HGVs and in accidents involving Buses or Coaches, by road user type, EU-17, 2005.

accidents involving	HGVs fatalities		Buses or Coaches fatalities	
HGV occupant	**469**	**13%**	3	0%
Bus or Coach occupant	10	0%	**108**	**15%**
Car occupant	1.986	54%	262	37%
Light GV occupant	204	6%	14	2%
Moped rider	120	3%	28	4%
Motorcycle rider	238	7%	61	9%
Pedal cyclist	174	5%	42	6%
Pedestrian	377	10%	175	25%
Other/unknown	69	2%	10	1%
All	3.648	100%	703	100%

Source: CARE Database / EC.

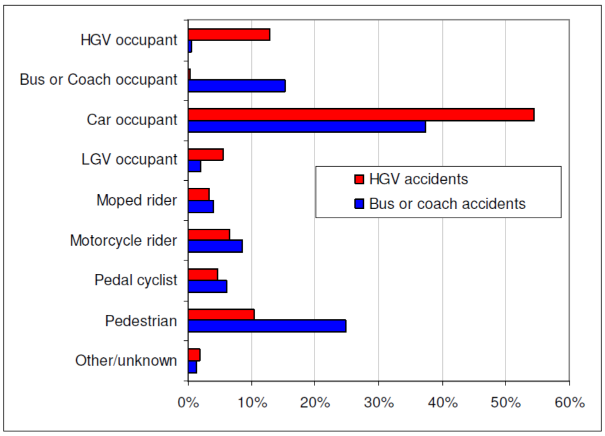


Figure 5. Distribution of fatalities in accidents involving HGVs and in accidents involving Buses or Coaches, by road user type, EU-17, 2005.

Source: CARE Database / EC.

CARE data distinguish accidents that occurred on motorways and, for non-motorway accidents, whether on urban or rural roads. Motorway accidents are not fully recorded in Greece and Finland, and there were no fatal HGV accidents in Malta. Table 5 shows the distribution of fatalities in accidents involving HGVs and in accidents involving Buses or Coaches for the remaining countries. The results for the 14 EU countries in the latest year are illustrated in Figure 6.

Table 5. Distribution of fatalities in accidents involving HGVs by road type, 2005.

	motorway	non-motorway		not known
		rural	urban	
BE	35%	47%	18%	0%
DK	13%	52%	35%	0%
EE	0%	72%	28%	0%
ES	4%	89%	7%	0%
FR	14%	64%	22%	0%
IE**	4%	65%	31%	0%
IT*	39%	39%	22%	0%
LU***	58%	42%	0%	0%
HU	8%	67%	25%	0%
NL**	25%	48%	27%	0%
AT	25%	53%	22%	0%
PT	15%	61%	24%	0%
SE	8%	69%	21%	2%
UK	18%	54%	20%	8%
EU-14	16%	63%	19%	1%

Source: CARE Database / EC.

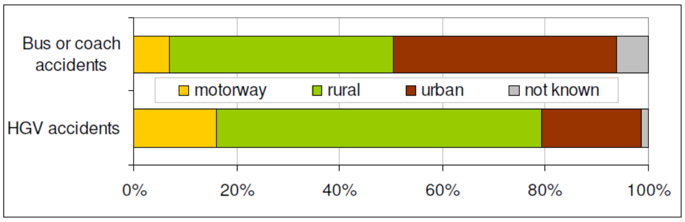


Figure 6. Distribution of fatalities in accidents involving HGVs and in accidents involving Buses or Coaches by road type, EU-14, 2005.

Source: CARE Database / EC.

The major accidents causes for HGVs and buses or coaches are now introduced, i.e. speed, driver fatigue and alcohol.

Speed

Speed is at the core of the road safety problem. In fact, speed is involved in all accidents. **In around 30% of the fatal accidents speed is an essential contributory factor**. First of all, speed affects the risk of being involved in an accident. At a higher speed it is more difficult to react in time and prevent an accident. Moreover, speed affects the injury consequences of an accident. At a higher (impact) speed, more energy is released when colliding with another vehicle, road user or obstacle.

Speed limits provide information to the drivers about the safe travel speed in average conditions. **Exceeding the speed limits is very common**. Typically, 40 to 50% of the drivers travel faster than the speed limit. Typically, 10 to 20% exceed the speed limit by more than 10 km/h. In addition, drivers adapt their speed insufficiently to local and temporary conditions related to traffic and weather. They often set a speed that is inappropriate for the prevailing conditions. Speed choice is related to the drivers' habits, attitudes, risk perception and risk acceptance. Furthermore, speed choice is affected by road characteristics, driving context and vehicle configuration.

Fatigue

Fatigue is a major factor in a large proportion of road crashes (varies between 10-30% in different studies). Several studies suggest that there is a correlation between fatigue and crash risk (Anund, 2008, for an overview). A person who drives after being awake for 17 hours has a risk of crashing equivalent to being at the 0.05 blood alcohol level (i.e. twice the normal risk). The increased risk often results from a combination of biological, lifestyle- and work-related factors.

Alcohol

About 25% of all road fatalities in Europe are alcohol related whereas about only 1% of all kilometres driven in Europe are driven by drivers with 0.5 g/l alcohol in their blood or more. The crash rate increases with Blood Alcohol Concentration (BAC) in the driver: this increment is progressive. Compared to a sober driver the crash rate of a driver with a BAC of 0.8 g/l (still the legal limit in 3 of 25 EU-member states) is 2.7 times that of sober drivers. When a driver has a BAC of 1.5 g/l his crash rate is 22 times that of a sober driver. Not only the crash rate grows rapidly with increasing BAC, the crash also becomes more severe. With a BAC of 1.5 g/l the crash rate for fatal crashes is about 200 times that of sober drivers.

1.1.3 ASSET-Road

The ASSET-Road project is mainly concerned with improving traffic safety in Europe with new methods like vehicle-to-infrastructure technologies. The main focus is directed at heavy vehicles, as they constitute a substantial traffic hazard due to different reasons, especially they drive much longer distances, which puts great demands on the drivers, both in terms of driver state and knowledge about traffic regulations in different countries, and they lead potential destructive impact if involved into crashes. Overloading and insufficient vehicle maintenance is other common factors that are detrimental to road safety.

Further information about the ASSET-Road project in general can be found on www.project-asset.com.

1.1.4 The present study

In order to increase traffic safety, and reduce problems with understanding traffic regulations, the ASSET-Road project evaluates driver support functionalities provided by driver support systems. However in order to develop good functions, i.e. functions that truck and bus drivers need to be able to reduce problems with regulations, the ASSET-Road project carried out a survey to collect experiences of traffic regulations. To be able to develop the needed functionalities, truck and bus drivers' opinions were considered. This report is the documentation of the questionnaire study.

1.2 Method

A questionnaire containing 32 questions, some of them with sub-questions, on traffic safety for experienced by truck and bus drivers from different European countries was developed. The complete questionnaire is divided into **3 sections**:

- **SECTION A – BACKGROUND INFORMATION**. The aim of this section is to analyze and categorize subjects involved in the survey. For this reason demographic information like age, nationality and gender were collected, together with driving experience information (when drivers got their professional licence and how long they have been working as professional drivers), and additional data about the type of driven vehicle.

  As mentioned above, the distinctive aspect of this research is to assess drivers' knowledge in different countries: therefore, in this section specific questions about countries most frequently drivers pass through and routing habits (i.e. whether they have a routine destination or not) were asked.

  Moreover, 2 questions concern duration and frequency of drivers' routes were proposed, in order to assess the impact of **physical** and **mental efforts** on driver's efficiency and safety.

- **SECTION B - PERSONAL OPINIONS**. The aim of this section is to collect data on drivers thoughts about safety priorities, which factors are more important for safe driving, which are their planning modalities and information sources.

  Useful information about on-board systems for safety (i.e. Drivers Assistance Systems – DAS - and Advanced Drivers Assistance Systems - ADAS) were collected in order to assess drivers' familiarity with these technologies and, more important, to assess if they feel their absence as a need to be satisfied.

  The final question of this section concerned road signs in different countries: in fact, while symbols are almost the same all over Europe, textual information associated to symbols change consistently creating language barriers which could have negative effects on global safety.

- **SECTION C - QUESTIONS ABOUT REGULATIONS**. This section is focused on the most important road rules and regulations and it is aimed at assessing driver's specific knowledge.

  In particular, questions concerning the maximum number of hours per week and month drivers are allowed to work were proposed, investigating drivers approach of one of the most critical issues of heavy vehicles driving: drivers tiredness and decreasing of attention and reflexes.

  Moreover, questions about vehicles maintenance and safety characteristics (e.g. brakes overheating, minimum thread depth and Blood Alcohol Concentration limits) were proposed.

The complete questionnaire in English is attached as ANNEX A.

The questionnaire was developed by Italian and Swedish researchers and before distribution to other nations the questionnaire was piloted in Italy and Sweden. The purpose of the piloting was to investigate the time it took to complete and if the chosen questions were understandable and clear. The piloting ended up in a number of adjustments.

The questionnaire was then distributed to researchers in Finland, Hungary, and Romania. The researchers in different countries were asked to reflect and comment on one final version. When the adjustments were handled accordingly, involved partners distributed the questionnaire to at least **20 bus** drivers and **20 truck** drivers with experience in their own country.

However, since the English version was translated by a number of researchers from a number of nations, small differences between questionnaire versions exist. Thus, **small differences exist, these differences were considered during data analysis**. The most serious problem was the differences among scale levels. This issue was solved by scaling down to a more fine scale, making data from different questionnaires compatible.

Data collection was conducted differently in different countries:

FINLAND (VTT): The questionnaire papers were left to a foreman in one company office and the plan was to come and collect the filled-in papers after two weeks. However, some respondents acted independently and sent the forms back to VTT by mail, and after two weeks, VTT had about 15 filled-in forms. This wasn't a very productive way to gather information, because most of the drivers spent so little time in the company office that they probably didn't have a chance to get the questionnaire in their hands at all. Another methods for data collection was therefore tested, and researchers decided to go to Germany (Travemunde) by ferry to meet drivers in the ferry and deliver the questionnaire papers face-to-face. This was found to be effective: answers from 25 drivers were collected during the journeys between Helsinki and Travemunde. All persons contacted face-to-face were willing to fill in the questionnaire. Respondents were given the opportunity to answer completely anonymous. Empty, non-coded envelopes were enclosed with all the questionnaire forms, and the filled-in questionnaire forms could be put in the envelope afterwards.

ITALY (UNIMORE): Participants were selected basing on their availability and schedules. In order to make questionnaire compilation as quick as possible, UNIMORE agreed with responsible that it could be done in no more than 2 sessions. UNIMORE personally contacted drivers' responsible and they gave them an overview of the ASSET-Road project. Then, they described in details specific activities treating heavy vehicles safety topics and why we decided this survey could be very useful. Afterwards, responsible forwarded the same information to drivers through private talks: this approach was adopted because drivers schedule made quite difficult to organize a plenary session to present the project to them all. Two sessions for questionnaires filling were planned. The presentation of the survey was quite effective and participants joined pleased. Responsible left participants the opportunity to compile questionnaires in a room, and gave them 30 minutes to do it. Even if questionnaires are anonymous, their participation was not anonymous, allowing responsible to trace drivers from their age and nationality.

HUNGARY (CLC): Random companies and random respondents were contacted by telephone, e-mail using some contacts and some conf calls. Approximately 40% of the companies approached were willing to participate; no data about the refusal rate among the approached employees were collected. Questionnaires collection was made by mail and e-mail. Questionnaires were anonymous, only company name and the participants' number were filled in.

ROMANIA (TUI): Initially data were collected by truck and bus drivers from companies in Iasi, Oradea and a large international transport company from Sibiu. First results obtained seemed unrealistic so a new data collection session was performed during summer 2009 in Constanta and Bucharest. During this run, data were collected talking personally with truck, bus and coach drivers gathering the desired number of respondents, i.e., 20 trucks and 20 bus drivers.

SWEDEN (VTI): The Asset-Road partner in Sweden (VTI) used a number of their previous contacts at different companies and received contact information to approximately 30 bus drivers and 30 truck drivers. The questionnaires were distributing by the companies or sent directly home to drivers. The questionnaires were filled out at their homes or workplace, on their free time or during work hours. All participants were thanked with a cinema ticket when the questionnaire was received at VTI. One note for remembering was sent to the drivers before the specified number of 20 of each kind was reached.

Once all the nations had reached the specified number of participants all respective nations entered their questionnaire data into an electronic sheet (excel file) and sent it to UNIMORE in Italy and VTI in Sweden. Data files were iterated a number of times due to the problems discussed above and quite a few hours were used to create a database that could make all the data comparable.

The complete excel file was imported into SPSS (Version 17.0) for statistical analysis. When statistical testing was computed the level of significance was chosen to 0.05 for all tests. Trends will be presented as well, i.e. effect between 0.10 and 0.05 will be interpreted as trends.

1.3 Analysis

The categorised answers given by truck and bus drivers were entered into a data sheet prepared in SPSS (version 17.0).

However, before the results are presented, a discussion of the analysis is needed to:

- understanding data received
- understanding why the analyses computed were chosen in the first place

The answers to the questionnaire were organised in the data sheet with all the background data at the beginning. The number of drivers that completed the questionnaire was 256. The background data can therefore be used to divide the participants into a huge number of different categories.

The objective of the questionnaire was to investigate truck and bus drivers' degree of regulation knowledge among drivers that work abroad. With this purpose in mind, and with the objective of design and develop in Task 3.3; a Smart Information System (called LISA) to provide drivers a useful support on road rules and regulations, help them to overcome possible difficulties and improve and promote safe driving behaviours – the answers in the questionnaire have been formulated.

Thus, the purpose of the questionnaire is:

- to investigate regulation knowledge among truck and bus drivers
- to provide inputs to the development of a regulation of knowledge support system

It is therefore not of primary interest to compare nationality of the driver or in which country the questionnaire was completed. More interesting is the separation of profession. The information needed by truck drivers might differ from the information needed by the bus drivers. Secondly, the experience with technical support systems and devices might be valuable in order to understand the functionalities needed in a user-friendly system.

The analysis performed compares bus drivers with truck drivers: it also compares more experienced truck drivers with less experienced truck drivers. The same is done for bus drivers. Hence, the idea is to create a 2 by 2 design (factorial between participant designs) and study the answers given by the drivers in the questionnaire from that perspective.

1.4 Elaborated results

1.4.1 Background aspects

Firstly, in order to understand the data participant characteristics are evaluated. Table 1 presents descriptive information from the 256 participants who answered the questionnaire. However, the sum of responses to each question is always below 256 since not all participants answered all questions.

Table 6 uses profession as a separation value for the 256 participants. The table reveals that bus driver characteristics and truck driver characteristics are similar. The participant groups chosen are a) comparably old, b) have had their driving licence for approximately equal duration c) been working the same amount of years as drivers. Hence, in that sense the comparison of bus drivers and truck drivers works well.

Table 6 Provide descriptive information about truck and bus drivers background.

	vehicle type driven (numeric)	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
driver's age	bus	108	43,41	9,826	0,945
	truck	101	43,41	11,312	1,126
driver's licence - year	bus	127	1986,58	9,638	0,855
	truck	115	1987,41	11,845	1,105
age of driver's licence	bus	110	22,16	9,885	0,943
	truck	115	21,59	11,845	1,105
years at work	bus	132	19,08	10,298	0,896
	truck	115	19,78	11,001	1,026

Furthermore, only 3 females answered the questionnaire and results will therefore not be discussed from a gender perspective since the female participants are too few.

These data in Table 6 further suggest that experience at work is approximately the same for both groups (truck and bus drivers). This indicates that we might be able to use the same cut off thresholds for both groups (truck and bus drivers) concerning experience at work.

The question is if drivers should be categorised into two of three groups (for practical reasons) concerning experience at work. It is therefore interesting to study the distribution, see Figure 7. . It will provide the information needed in terms of number of groups.

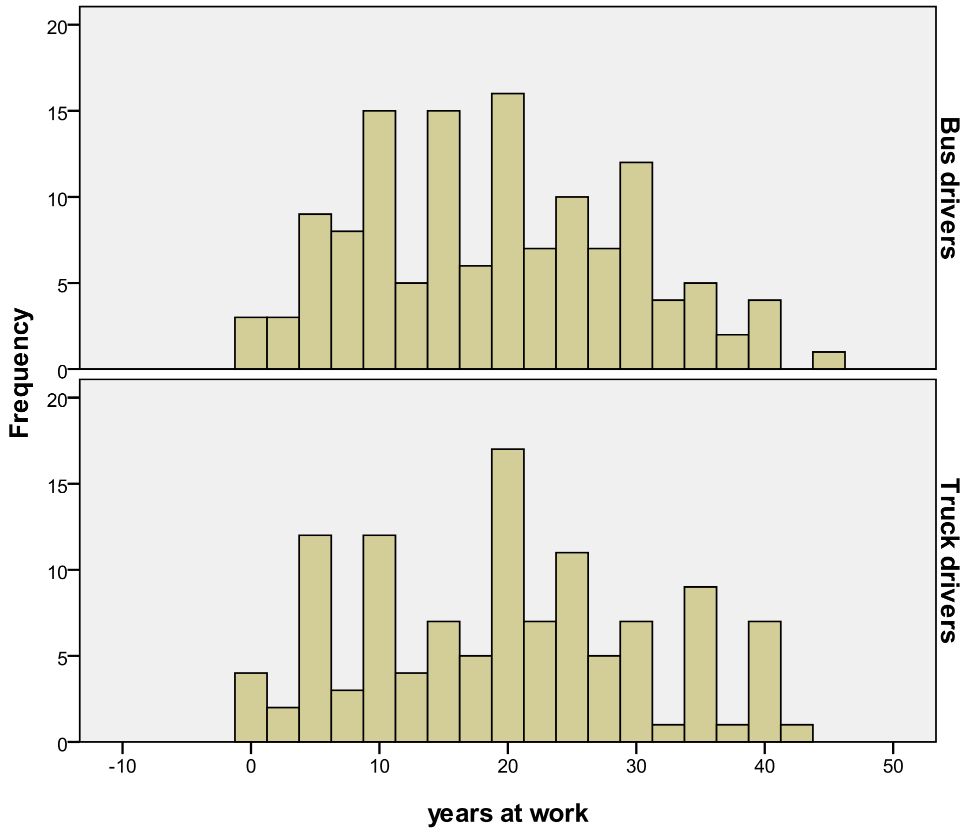


Figure 7. The histogram show how the number of years at work are distributed for truck and bus drivers.

The categorisation into two groups seems to work well. The distribution does not reveal a skewed or problematic pattern. However, since the categorisation into two groups is arbitrary it is recommended to not to overemphasise results as an effect of years at work.

The cut off point chosen at twenty years reveal a categorisation with two groups approximately the same number of participants. Table 7 shows how many bus and truck drivers respectively that would be categorised as More experienced versus Less experienced.

Table 7. Reveal how the frequency distribution turns out with a cut off with 20 years.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less Exp.	118	46,8	48,2	48,2
	More Exp.	127	50,4	51,8	100,0
	Total	245	97,2	100,0	
Missing	System	7	2,8		0,0
Total		252	100,0		

The presented results reveal that the categorisation of the participants into four separate groups is possible. It is not perfect in any respect but it is rather fair and useful in order to succeed with the two-fold purpose described earlier, i.e. **the purpose with the questionnaire is two-fold, a) investigate regulation knowledge among truck and bus drivers and b) give input to the development of a regulation of knowledge support system.**

Based on the fact that bus drivers and truck drivers' tasks are different, they might need different support in terms of regulation knowledge. Based on an understanding that experience is related to regulation knowledge – Less experienced might need different support than More experienced. Thus, the following result section will use the categorisation of a 2 by 2 design. This means that the answers in the questionnaire will be analysed from a factorial 2 by 2 between-participant design. Each analysis will reveal if there is a difference between:

- bus drivers versus truck drivers;
- More experienced versus Less experienced;
- and if there is an interaction of driver (bus/truck) versus experience (More/Less).

Before analyses results, additional background data will be presented.

Table 8 shows the number of drivers from countries with more than 1 participant. A few come from other countries but are excluded in this presentation because they represent exceptions.

Table 8. Show how many drivers (bus and truck) came from different nations.

Vehicle driven	**Finland**	**Hungary**	**Italy**	**Romania**	**Sweden**
Bus	15	71	12	20	16
Truck	24	19	14	28	23
Bus and Truck	3	0	1	0	1
Total	42	90	27	48	40

Another background information is the type of vehicle driven. The bus drivers drove different kinds of busses and the truck drivers also drove different kinds of trucks. Table 9 and Figure 8 provides information on which kinds of vehicles the participants drove.

Table 9. Provide information on the vehicles types driven by the truck and bus drivers.

Vehicle driven	**D**	**DE**	**D1**	**C1E**	**CE**
Bus	84	52	12		
Truck				19	92

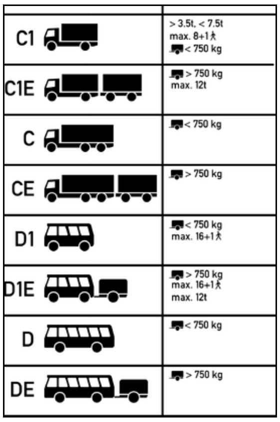


Figure 8. Information on the vehicle types that the drivers had to choose from.

These data, i.e., type of vehicle driven, could be interesting if we find differences between bus drivers and truck drivers (or More or Less experienced) in further analyses. The analysis will however not include vehicle type driven in the 2 by 2 design discussed earlier (experienced versus Less experienced and bus versus truck driver).

The questionnaire also asked in which countries drivers mainly transport goods or passengers. Table 10 shows that:

- truck drivers and bus drivers travel to the same number of countries;
- More experienced, to some extent, travel to a larger number of countries.

Table 10. Reveals the distribution for truck and bus drivers and More and Less experienced drivers in terms of countries they transport goods or passengers to.

			bus	truck	
			1,00	2,00	Total
Less Exp.	Nations	DEU	7	7	14
		ESP	0	1	1
		EST	2	0	2
		FIN	2	3	5
		HUN	33	8	41
		ITA	5	14	19
		NLD	0	1	1
		NOR	0	1	1
		ROU	16	17	33
		SWE	0	1	1
	Total		65	53	118
More Exp.	Nations	CZE	1	0	1
		DEU	9	17	26
		DNK	2	0	2
		ESP	0	4	4
		EST	1	0	1
		FIN	5	8	13
		HUN	37	11	48
		IRL	1	0	1
		ITA	2	6	8
		NLD	0	8	8

	NOR	0	3	3
	ROU	4	5	9
	RUS	1	0	1
	SWE	1	0	1
	SWE, NOR	1	0	1
Total		65	62	127

The next question asked if the participants had a routine destination. Table 11 reveals that experienced bus drivers more often have a routine destination than the Less experienced and that the vice versa is true for truck drivers.

Table 11. Shows how many of the participants that have a routine destination.

			Bus	Truck	
			1,00	**2,00**	**Total**
Less Exp.	Regular route				
		N	32	27	59
		Y	32	24	56
	Total		64	51	115
More Exp.	Regular route				
		N	25	35	60
		Y	38	27	65
	Total		63	62	125

Thereafter, it was analysed if the time to complete transportation to a routine destination varied. The 2 by 2 ANOVA revealed that no significant effects were obtained. Neither for:

- time it took to complete the trip;
- times per month (how often) it was completed ($p>0.05$).

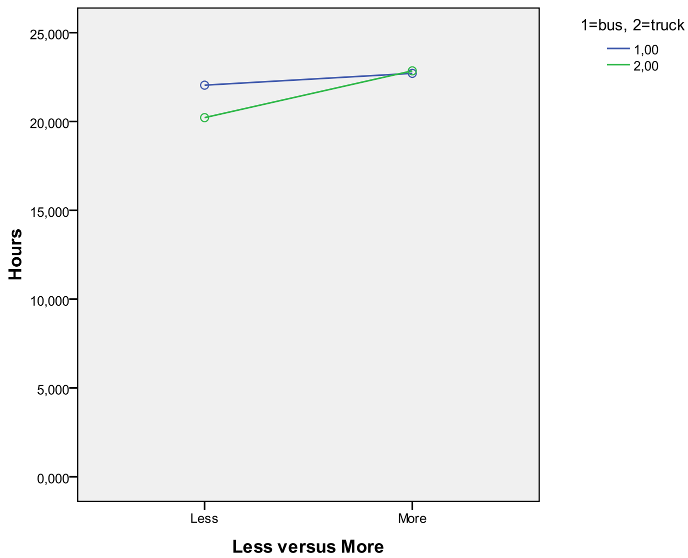


Figure 9. Shows how many hours transportation to a routine destination takes for the 4 groups of interest.

Table 12. Reveals how many times per month the participants go to their routine destination.

Experience	Bus / truck	Mean	Std. Deviation	N
Less	Bus	7,21	8,828	39
	Truck	9,82	8,387	22
	Total	8,15	8,693	61
More	Bus	5,51	5,548	45
	Truck	7,24	6,969	17
	Total	5,99	5,962	62
Total	Bus	6,30	7,261	84
	Truck	8,69	7,811	39
	Total	7,06	7,491	123

These questions were followed up by another question concerning other destinations different from the routine. The analysis revealed that half of our participants also had other destinations apart from their routine destination.

Table 13. Shows how many of the participants had other destinations than their routine destination.

Experience			Bus 1,00	Truck 2,00	Total
Less Exp.	Other routes		2	5	7
		N	13	17	30
		Y	50	31	81
	Total		65	53	118
More Exp.	Other routes		3	2	5
		N	5	11	16
		Y	57	49	106
	Total		65	62	127

These data show that all four groups go to a number of destinations even though half of them have a routine destination. That suggests that the participants go to a number of countries.

The next question in the questionnaire focused on that aspect. Table 14 shows how frequent different alternatives were concerning passing through other countries (A = 1, B = 2-4, C = more than 5, and finally D = None).

Table 14. Shows how many countries our participants usually pass through during their trips (including starting destination).

Experience			Bus 1,00	Truck 2,00	Total
Less Exp.	Number of countries per trip				
		A	4	12	16
		B	22	8	30
		C	29	16	45
		D	8	14	22

More Exp.	Number of countries per trip				
		A	7	11	18
		B	19	7	26
		C	25	26	51
		D	10	18	28

Table 14 reveals that most of our participants pass trough more than 5 countries (alternative C in the questionnaire). The second most frequent alternative is B which means that they pass 2-4 countries during a trip. The conclusion is that participants go through a number of countries regularly even if they have a routine destination.

The question is then if they feel that they understand traffic regulations in each respective country. Table 15 shows how the four groups answer that question with a Yes or No.

Table 15. Show how More or Less experienced drivers believe they know traffic regulations in different countries.

Experience			Bus	Truck	Total
Less Exp.	Laws/regulations known?	Missing	1	1	2
		N	22	19	41
		Y	42	33	75
	Total		65	53	118
More Exp.	Laws/regulations known?	Missing	1	0	1
		N	27	31	58
		Y	37	31	68
	Total		65	62	127

The answers suggest that approximately **40% of our participants believe that they do not know the traffic regulations in countries they regularly pass through during transportation of goods and passengers**.

In which countries do they find it harder than in others? The only country that the participants had written down more than 3 times was France. However, a great number of countries were mentioned and France was not that frequent either.

Approximately **20% of the participants state that they encounter problems with understanding foreign road signs** (Table 16).

Table 16. Reveals how many participants find it hard to understand foreign road signs.

Experience			Bus	Truck	Total
Less Exp.	Problems with signs?	Missning	1	1	2
		N	54	37	91
		Y	10	15	25
	Total		65	53	118
More Exp.	Problems with signs?	N	54	49	103
		Y	11	13	24
	Total		65	62	127

No country is pointed out in this respect since the participants spread their comments on a great number of countries (over 15 countries were mentioned).

Conclusions on BACKGROUND information

The results on the background section reveal that the chosen aspects of interest, i.e. **a) type of driver and b) degree of experience** are possible to define in the chosen way. It is not the only way to characterise the participants in this study, but given the purpose presented above it is suggested that it will fill its purpose.

The results also suggest that traffic regulation knowledge is an aspect that seems to be necessary to support the drivers with. For instance, as many as **40 % believed that they had problems with traffic regulations** and in the same time **passed through a number of countries during their trips** to different destinations. And approximately **20% of the participants state that they encounter problems with understanding foreign road signs.** Most of the participants also **quite often transported goods or passengers to other destination than their routine destination. Only 50 % had a routine destination.**

Taken together, these results point into the direction of a need of support with traffic regulation.

The question about understanding foreign road signs was ending the background part of the questionnaire. The next section will continue with an area called personal opinion.

1.4.2 Personal opinions

The first question was concerned with how drivers would prioritise (1 = very important and 5 = not important) between 4 important objectives for heavy vehicle transports, namely:

A) delivery time;

B) driver comfort (for truck drivers) or passengers comfort (for bus drivers);

C) driver safety (for truck drivers) or passenger safety (for bus drivers);

D) to follow laws and regulations.

Alternatives were treated as a within-participant variable. This analysis was a 2 x 2 x 4 split plot ANOVA. Driver by Experience by Alternative was the design analysed.

The analyses reveal a tendency for a main effect and two significant interactions.

The main effect ($F(3, 114)=2.40$, $p=0.07$, $MSe=1.06$) show that, **overall, alternative A (delivery time) is less important compared to the other 3 alternatives given.**

The first significant interaction ($F(3, 114)=16.59$, $p<0.05$, $MSe= 1.06$), is presented in Figure 10 and shows that:

- truck drivers prioritise delivery time to a higher degree than bus drivers;
- bus drivers prioritise passenger comfort and safety to a higher degree (the pair wise comparisons was Bonferonni [2] adjusted and significant).

The other two comparisons were not significant ($p>0.05$). The results are obviously affected by the difference between truck and bus drivers' alternative B.

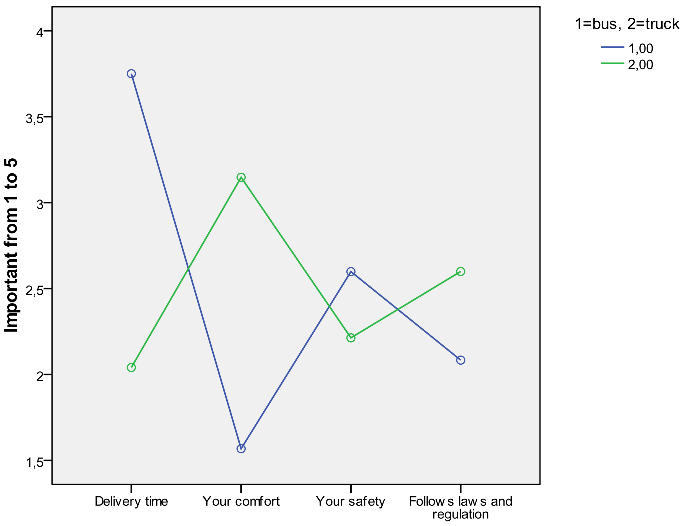


Figure 10 . Shows the interaction between Driver and Alternatives (1: very important; 5: not important).

The second interaction effect ($F(3, 114)=4.83$, $p<0.05$, MSe= 1.06), Alternative by Experience presented an interaction and where two simple effects again were significant with Bonferonni correction for multiple t-tests. See Figure 11. The first simple main effect reveals that:

- More experienced drivers (overall, bus and truck drivers) think that delivery time is less important compared to Less experienced drivers;
- Less experienced drivers (bus and truck) think that to follow laws and regulation is less important than More experienced drivers.

The other two comparisons are not significant.

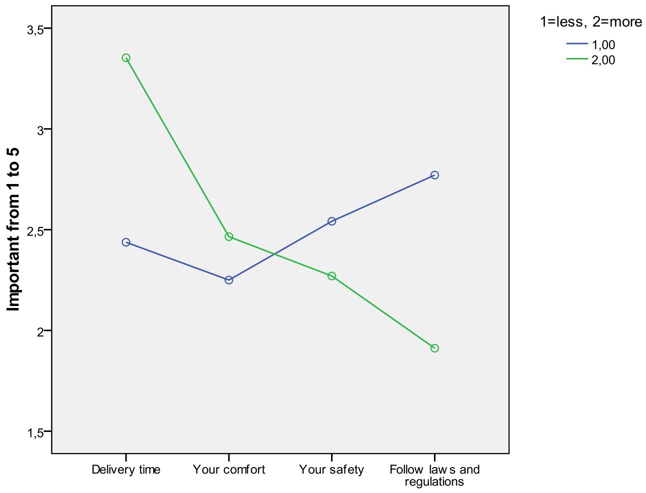


Figure 11. Shows the interaction between Alternatives and Experience.

This interaction effect makes it clear that More experienced drivers compared to Less experienced drivers, prioritise the different alternatives given, in a different way. We do not have the same problem with this interaction effect concerning different perspectives on alternative B, indicating that degree of experience is important.

The questionnaire continued with a question on collecting information about their routes, and specifically **when and where the drivers collect information**.

The question had to be answered via a matrix which provided 65 answer alternatives. Participants answered the question 65 times (in a matrix, see ANNEX B). However they only marked in the questionnaire the cells with a 1 if it was applicable. The **when** information was collected and divided into 3 alternatives:

a) before the trip;

b) during the trip;

c) after the trip.

Each one of the 3 alternatives was divided into five circumstances. The five circumstances were varied as follows:

1. vehicle restrictions;
2. time periods restrictions;
3. weather forecast;
4. traffic conditions and congestions;
5. obligations of snow chains or winter tires.

The 3 alternative times 5 circumstances leave the participant with 15 cells to answer. Each one of the cells produces one table.

Table 17 is an example of the 15 tables analysed which are included in ANNEX B.

Table 17. Shows how many of the participants collect information Before the trip concerning Vehicle restrictions.

Experienced		Bus	Truck	Total
Less Exp.	No	14	18	32
	Yes	51	35	86
Total		65	53	118
More Exp.	No	14	20	34
	Yes	51	42	93
Total		65	62	127

Table 17 reveals that **73 % of the drivers collect information about vehicle restrictions (1.) before the trip**. Both bus and truck drivers do that to the same extent. Both Less, as well as, More experienced driver collect data beforehand concerning vehicle restrictions.

The four other tables (see ANNEX B) on **when** information **before the trip** is here summarised in words.

2. Concerning **time periods** restrictions the data pattern shows that Less experienced (80%) collect data beforehand. The More experienced on the other hand do not to the same extent collect data beforehand (50%). No differences were found between types of drivers.
3. Concerning **weather forecast** restrictions the data pattern shows that Less experienced (50%) collect data beforehand. The More experienced on the other hand do not to the same extent collect data beforehand (61% do not collect) and especially truck driver do not collect data beforehand (76%).
4. Concerning **traffic conditions** and congestions the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way. Approximately 26 % collect data beforehand.
5. Concerning **obligations of snow chains or winter tires** the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way. Approximately 71 % collect data beforehand.

The same five tables were analysed for **during the trip** compared to **before the trip** as above.

1. Concerning **vehicle restrictions** the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way. Approximately 24 collect data during their trip.
2. Concerning **time periods** restrictions the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way. Approximately 32 % collect data during their trip.
3. Concerning **weather forecast** the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way. Approximately 48 % collect data during their trip.
4. Concerning **traffic condition and congestions** the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way. However, as many as 68 % of the participants collect data during their trip.
5. Concerning **obligations of snow chain and winter tyre** the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way. Approximately 21 % collect data during their trip.

The same five tables were analysed for after the trip compared to before and during the trip as above.

The five tables (see ANNEX B) that provide information about *when* information and ask if the driver collect information after the trip.

The results point clearly in the same direction for all 5 tables. **Extremely few collect any kind of data after a trip**.

Summary of <u>when</u> information: *The 15 tables reveal that information is mostly collected before the trip, if necessary. However, a surprisingly large extent of information is collected during the trip as well. Bus drivers and truck drivers seem to collect the same kind of information even if exceptions exist. Less experienced and More experienced seem also to collect the same kind of data most often. However, some differences exist between the two groups of experience.*

The **where** information was collected and divided into eight alternatives:

- traffic signs;
- colleagues;
- radio;
- television;
- websites;
- navigator;
- newspaper;
- others.

Each one of the alternatives was cross tabulated with the same five circumstances as for **when** questions, i.e., vehicle restrictions, time periods restrictions, weather forecast, traffic conditions and congestions, and obligations of snow chains or winter tires. The 8 alternative times 5 circumstances leave the participant with 40 cells to answer, i.e. 40 tables to interpret. The interpretation of the 5 tables concerning **traffic signs** is presented first.

1. Concerning **vehicle restrictions** the data pattern shows that Less experienced drivers (68%) collect information more often than More experienced drivers do (47%) from traffic signs.

2. Concerning **time period restrictions** the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way. Approximately 32 % collect from traffic signs.
3. Concerning **weather forecast** the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way. But only 4 % collect from traffic signs.
4. Concerning **traffic conditions and congestions** the data pattern shows that both experienced categorises and drivers of both kinds behave in the same way except for the Less experienced bus drivers. Thus, 50 % of the Less experienced bus drivers collect information on traffic signs whereas 20 % of the other three categorise collect information concerning weather forecast.
5. Concerning **obligations of snow chains and winter tires** the data pattern shows that Less experienced drivers (63%) collect data through traffic signs more often than More experienced drivers (33%).

The interpretation of the 5 tables concerning **colleagues** is presented next. Table 1-5 is presented in detail in the ANNEX B. Approximately the same pattern is obtained for these 5 tables. The data pattern shows that both experienced categorises and drivers of both kinds behave in the same way.

- Vehicle restrictions - approximately 33 % collect from colleagues.
- Time period restrictions - approximately 31 % collect from colleagues.
- Weather forecast - approximately 18 % collect from colleagues.
- Traffic conditions and congestions - approximately 34 % collect from colleagues.
- Obligation of snow chains and winter tires - approximately 26 % collect from colleagues.

The interpretation of the 5 tables concerning **radio** is presented next. The five tables reveal that 4 of them are similar and that weather forecast is not similar. Meaning that the data pattern shows that both experienced categorise and drivers of both kinds behave in the same way.

- Vehicle restrictions - approximately 18 % collect from radio.
- Time period restrictions - approximately 16 % collect from radio.
- Traffic conditions and congestions- approximately 57 % collect from radio.
- Obligation of snow chains and winter tires - approximately 13 % collect from radio.

- Weather forecast - approximately 47 % collect from the radio of the Less experienced. The More experienced bus drivers collect from the radio in 45% of the cases. However the More experienced truck drivers collect from the radio in 65% of the cases.

The interpretation of the 5 tables concerning **TV** is presented next.

The only information collected by TV is the weather forecast information (25%). Otherwise TV is not used as an information source at all.

The interpretation of the 5 tables concerning **websites** is presented next.

The websites are not used very much. But they are used more than the TV, i.e., approximately between 12-22 % for 4 out of 5 circumstances. The only time websites are used more is when drivers need weather information (30%).

The interpretation of the 5 tables concerning **navigators** is presented next.

The navigators are not used much. The percentage that us navigators is between 4 – 17 % and More experienced driver use navigator as often or more than Less experienced.

The interpretation of the 5 tables concerning **newspaper** is presented next.

The newspaper is not used much (between 2-7%).

Finally, the interpretation of the 5 tables concerning **other sources** is presented next.

“Other sources” (see questionnaire) are not used much (15-23%). As above, there are no differences between types of drivers or different experience groups.

Summary of <u>where</u> information: *The most used sources for information collection were radio, colleagues, and traffic signs. No big differences between type of driver or different experience groups were found. The TV and websites can be used to collect weather information. The navigator and the newspaper are rarely used.*

The When and Where composite question was followed by the question regarding **GPS navigation systems**, and specifically if drivers use navigation systems or not. Table 18 shows that most of the drivers have a GPS navigation system (73%).

Table 18. Reveals how many of the participant claim that they have a GPS navigation system in their vehicle.

Experienced			Bus	Truck	Total
Less	Navigation system in vehicle	N	11	17	28
		Y	54	36	90
	Total		65	53	118
	Navigation system in vehicle	N	19	17	36
		Y	45	44	89
	Total		65	62	127

The data pattern in Table 18 also shows that both experienced categories and both driver types behave in the same way.

The GPS question was followed by the **warning system** question. Drivers were asked what kind of warning system they have installed in their truck or bus. This question was divided into 3 different questions in a matrix. The 3 questions were:

a) What do you have?

b) What do you prefer? (among installed)

c) Which you would like to have?

The same analysis as above was performed for 6 different warning systems. Systems chosen were:

- speed alert;
- information about driving time;
- obstacle and collision warning;
- blind spot monitoring;
- lane departure warning;
- real-time traffic information (RTTI).

1. Concerning **speed alert**: participants do have speed alert warning systems installed (70%). Only 20 % like the system and only 9 % would like to have them installed. No significant differences between type of driver or different experience groups were found.
2. Concerning **information about driving time**: participants do have information about driving time systems installed (60%). Only 19 % like the system and 19 % would like to have them installed. No real differences between type of driver or different experience groups were found.
3. Concerning **obstacle and collision warning**: participants do not have obstacle and collision warning systems installed (8% have it). Only 12 % like the system but as many as 41 % would like to have this system installed. No real differences between type of driver or different experience groups were found.
4. Concerning **blind spot monitoring**: participants do not have blind spot monitoring systems installed (15% have it). Only 14 % like the system but as many as 44 % would like to have this system installed. No real differences between type of driver or different experience groups were found.
5. Concerning **lane departure warning**: participants do not have lane departure warning systems installed (7% have it). Only 13 % like the system but as many as 37 % would like to have this system installed. No real differences between type of driver or different experience groups were found.
6. Concerning **real-time traffic information (RTTI)**: participants do not have real-time traffic information systems installed (20% have it). Only 19 % like the system but as many as 45 % would like to have this system installed. No real differences between type of driver or different experience groups were found.

Summary of <u>warning systems</u> information: *There was no difference in opinions concerning warning systems between type of driver or different experience groups. The different systems were, however, rated differently. Two of the systems were installed in a major part of the vehicles (Speed alert and Information about driving time) and four were not. However, a rather large number of drivers would like to have the presented systems installed in their vehicles.*

The next question in the questionnaire concerned the most important factors regarding **safety**. 8 alternatives were given and the participants had to rank from 1 to 8 how important each factor was for traffic safety. The ANOVA computed was a 2 by 2 by 8 factorial analysis of variance (a split plot analysis). As before, degree of experience and type of driver were the two between-participants variables used, and the 8 alternatives given were a within-participant variable.

The factor safety variables were:

- using safety margins;
- driver status (psychological status, comfort, stress, etc);
- speed limits;
- reduce risky manoeuvres;
- avoid accidents;
- keep alertness;
- drive sober;
- slow reactions.

First, a significant main effect of type of driver ($F(1, 222) = 17.02$, $p<0.05$, $MSe = 2.59$) was found. This effect is only due to the fact that more truck drivers completed the rating.

It was an interesting main effect of **safety factor** ($F(7, 1554) = 24.21$, $p<0.05$, $MSe = 4.89$). This effect show that two of the safety factors were rated differently compared to the other 6. **Drive sober** was significantly rated as more important than all of the others and **slow reaction** was significantly rated as less important from a traffic safety perspective. As presented in Figure 12 and Figure 13 two two-way interactions were significant. The experience by safety factor ($F(7, 1554) = 3.01$, $p<0.05$, $MSe = 4.89$) and driver by safety factor ($F(7, 1554) = 3.08$, $p<0.05$, $MSe = 4.89$).

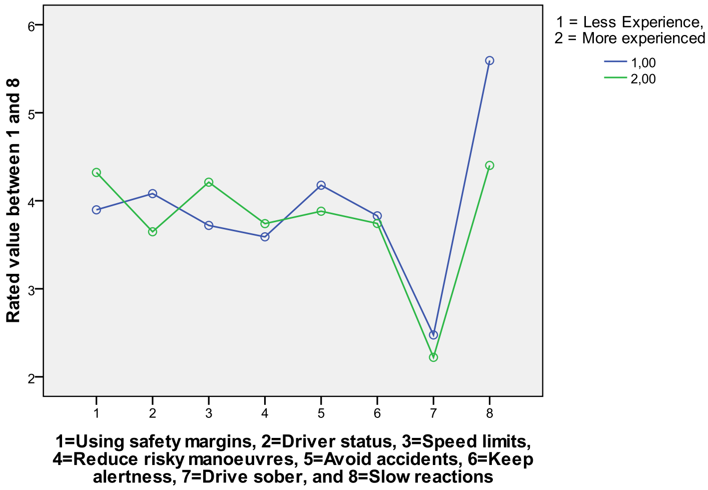


Figure 12. Reveals the interaction effect between Experience and Safety Factor.

The interaction shows that More experienced drivers think that slow reactions are more important than Less experienced drivers do. No one of the other safety factors was affected by experience, i.e., Less and More experienced drivers agree on all Safety Factors except for Factor 8 (Slow reactions).

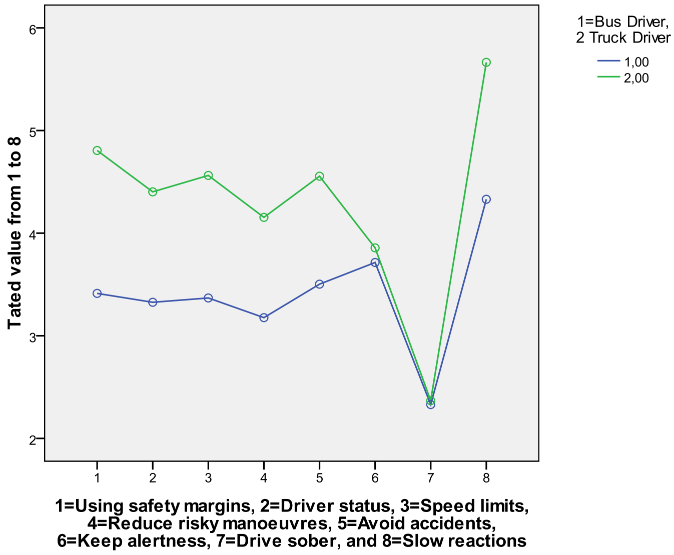


Figure 13. Reveals the interaction effect between Type of Driver and Safety Factor.

Figure 13 reveals that truck drivers and bus drivers agree on two safety factors and disagree on six. Drive sober and keep alertness was rated equally by the two driver types. The other six were significantly different, i.e., statistical simple main effects exist. Truck drivers found these six factors less important for safety compared to bus drivers.

Next question in the questionnaire focused also on safety, but more on **adverse conditions**:

1. bad weather condition like rain, snow, ice, wind, etc.;
2. tired or drunk driver;
3. vehicle condition like old, used tires, broken lights, etc.;
4. poor road maintenance condition;
5. heavy traffic;
6. poor light and visibility.

Participants had to, in the same way, as above, rate how dangerous each one of the six alternatives was. The higher the value, the more dangerous it was. The ANOVA computed was a 2 by 2 by 6 analysis of variance (a split plot). As before, degree of experience and type of driver was the two between-participants variables used, and the six alternatives (dangerous) given was the within-participant variable.

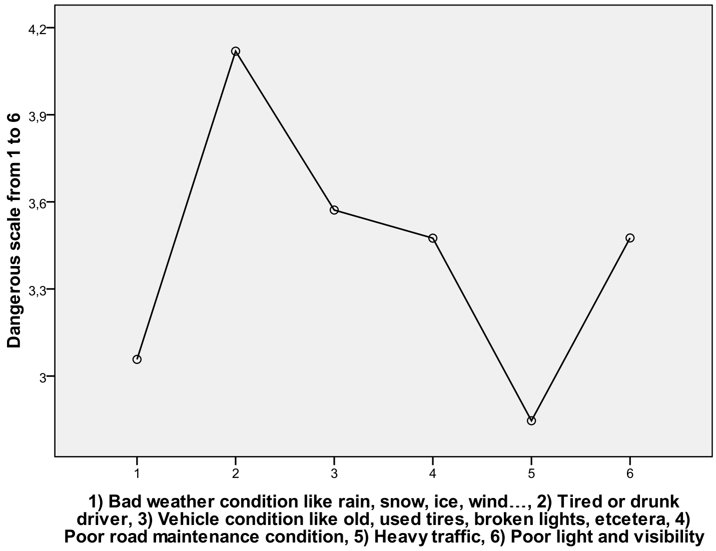


Figure 14. Reveals how different Dangerous factors were rated by all participants.

The significant main effect ($F(5, 1180)=17.01$, $p<0.05$, $MSe=2.74$) reveals that different dangerous factors are experienced to vary to a high degree. The dangerous factor 1 and 5 are less dangerous compared to factor 3, 4 and 6, and finally, the most dangerous is 2 (**tired or drunk driver**). The 2 by 2 by 6 ANOVA did not reveal any effect on type of driver. However the interaction experienced by dangerous factor was significant and presented below ($F(5, 1180)=4.24$, $p<0.05$, $MSe=2.74$).

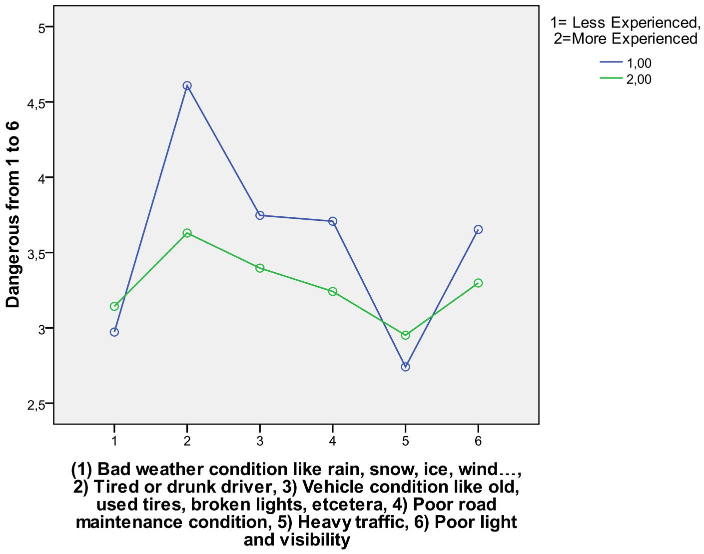


Figure 15. Shows how Less compared to More experienced drivers rated significantly different on two dangerous factors.

To be tired or drunk, and poor road maintenance were rated as less dangerous by the More experienced drivers compared to the Less experienced.

The last question concerned drivers' personal opinions about **road signing in general**.

The analysis revealed that bus drivers and More experienced truck drivers thought it was room for improvement in approximately 47 % of the cases. Of the Less experienced truck drivers, on the other hand, approximately only 24 % believed that there was room for improvement.

Table 19. Reveals how the participants thought about road signs in general.

			Experience		
Driver			**Less**	**More**	**Total**
Bus	Opinion about road signs	Clear and complete	32	29	61
		Room for improvement	26	29	55
	Total		58	58	116
Truck	Opinion about road signs	Clear and complete	37	34	71
		Room for improvement	12	27	39
	Total		49	61	110

The section on personal opinions ended with that question and the last section will be analysed below.

1.4.3 Regulation knowledge

The first question concerns drivers' knowledge about **speed limits in main country** (the country that they had indicated as their main country initially in the questionnaire). The question asked about urban roads, main roads and motorways.

Almost all participants (93%), independent of the indicated main country, believed that the speed limit was 50 km/h on urban roads, with no differences between truck drivers and bus drivers.

However, opinions varied to a lager degree when main roads were concerned. Table 20 present the distribution of answers for main roads.

Table 20. Presents how the participants vary on the speed limit question, on main roads in their main countries.

			Experience		
Driver			**Less**	**More**	**Total**
Bus	Speed limit on main roads	70	23	28	51
		80	36	26	62
		90	2	6	8
		100	2	1	3
	Total		63	61	124
Truck	Speed limit on main roads	60	2	7	9
		70	35	20	55
		80	11	32	43
		90	3	1	4
	Total		51	60	111

The second question was the same but focused on their **second country**, i.e., the country that they drove mostly in besides their main country. The data pattern obtained for the main country was exactly the same as for their second most frequent country, i.e., no data is presented fort this specific follow up question.

The third question concerned **daylight running lights**. The questioned focused on the drivers' main country. Table 21 reveals how the participants responded.

Table 21. Shows how participants respond to the question on light usage.

Driver			Experience Less	Experience More	Total
Bus	Daylight running lights	N	3	6	9
		Y	62	57	119
	Total		65	63	128
Truck	Daylight running lights	N	3	7	10
		Y	48	54	102
	Total		51	61	112

Almost all of our participant use their beam light during daylight.

The fourth question focused on driving hours per day permitted in their targeted main countries. Table 22 presents how the participants answered the question on permitted working hours per day. The alternatives were A=7 hours, B=8 hours, C=9 hours, and D=10 hours.

Table 22. Presents the distribution of participants concerning working hours per day.

Driver			**Experience Less**	**Experience More**	**Total**
Bus	Max number of working hours per day	A	2	2	4
		B	1	0	1
		C	54	46	100
		D	7	10	17
		Other	0	3	3
	Total		64	61	125
Truck	Max number of working hours per day	A	1	0	1
		B	2	2	4

		C	43	41	84
		D	7	15	22
		Other	0	1	1
	Total		53	59	112

The correct alternative is C (9 hours per day). These data suggest that **22 % of the participants do not know that the permitted limitation is 9 hours a day**.

The next question focused on driving hours per week, instead of day, permitted in their targeted main countries. **The correct alternative (56 hours) had accidentally not been included in the alternatives and only 4 participants gave the correct answer in the "other (specify)" alternative**. It is therefore problematic to analyse that question. However, it was a little bit surprising that only four participants gave the correct answer and that most of the participants had marked alternatives B=42 hours, C=48 hours, and D=52 hours, approximately to the same extent. However, since the correct alternative was not included it is not surprising that the participants must have felt unsure about this question.

The next question asked whether the same rules for driving hours are valid in all EU countries (correct answer is YES). Table 23 present the distribution of the answers given to this question.

Table 23. Presents the distribution of the answers given to this question.

			Experience		
Driver			**Less**	**More**	Total
Bus	Working hours the same within EU	yes	60	60	120
		no	2	1	3
		don't know	2	2	4
	Total		64	63	127
	Working hours the same within EU	yes	46	77	113
		no	0	1	1
		don't know	0	1	1
	Total		46	79	115

Very few subjects answered “NO” or “I don’t know”. It is therefore fewer than 4 % of the drivers who do not know that the rules apply for the complete EU.

The next question was concerned with when **hard shoulders usage** is permitted. The question contained 5 alternatives/conditions. Table 24 presents the results. Alternatives were:

a) in case of an emergency or break down;

b) in case of heavy traffic;

c) to overtake a slow vehicle;

d) let the other vehicle overtake you;

e) I don’t know.

The only alternative participants responded YES on was alternative a. Table 24 present the results for alternative A. The four other alternatives had a rate of less than 3 % except for alternative b in which approximately 11 % marked that the hard shoulder could be used in case of heavy traffic.

Table 24. Present the distribution of answers on hard shoulders alternative A.

Driver			Experience: Less	Experience: More	Total
Bus	Shoulder use allowed - breakdown/emergency	No	7	11	18
		Yes	58	54	112
	Total		65	65	130
Truck	Shoulder use allowed - breakdown/emergency	No	15	8	23
		Yes	37	53	90
	Total		52	61	113

The percentage of participants who answered YES, hard shoulder use allowed in case of an emergency or break down, was 83%. No differences exist between type of driver or experience level.

The next question focused on **safety belt usage**. Almost all (a few exceptions exist) participants responded YES, it is mandatory for me as a bus/truck driver to use the seat belt.

The next question was answered only by bus drivers since it concerned their passengers' safety: if safety belt usage is mandatory for passengers in their main countries. Approximately 90 % of the bus drivers responded correctly (YES). No differences between Less or More experienced drivers.

After the seat belt question the questionnaire focused on **brakes maintenance**, namely who performs the ordinary maintenance of vehicle brakes. 67 % of participants answered they did the maintenance by themselves.

This question is followed by **how often** brake maintenance is performed. Table 25 present the answers given. The alternatives given in the questionnaire were:

a) daily;

b) monthly;

c) every week.

Table 25. Presents how many of the participants that responded daily, weekly or monthly on the frequency on the brakes question.

Driver			Experience		Total
			Less	More	
Bus	Brake maintenance frequency	A	19	17	36
		B	15	11	26
		C	4	12	16
	Total		38	40	78
Truck	Brake maintenance frequency	A	10	11	21
		B	22	20	42
		C	5	4	9
	Total		37	35	72

The answers on the periodicity on brake maintenance varied to a great extent.

The third question on brakes is related to causes which could most probably lead to break overheating. Proposed alternatives were:

a) malfunction;

b) vehicle overload;

c) braking frequently.

There were no significant difference between Bus and Truck drivers or More versus Less experienced. Approximately 16 % believed that overheating of the brakes was due to malfunction, approximately 21 % believed that overheating was due to vehicle overload, and finally, **approximately 59 % believed that overheating was due to braking frequently**.

The second last question was a question concerning tires, namely what is the **minimum thread depth** for heavy vehicles in Europe. Four alternatives were given:

a) 1,6 mm;

b) 20mm;

c) 10mm;

d) I don’t know.

Table 26 present the results given by the participants. It is shown that no differences exist between More or Less experienced drivers. However, bus drivers believed that the thread depth was 10 mm in 31 % of the cases and Truck drivers believed it was 10 mm in 9 % of the cases. On the other 3 alternatives truck drivers were approximately 7 % of the cases above the bus drivers. **The most common alternative was 1.6 mm which received 56% of the cases**.

Table 26. Presents the distribution on the thread depth answers for both driver categories and both Experience categories.

Driver			Experience: Less	Experience: More	Total
Bus	Minimum thread depth for heavy vehicle tires (Europe)	A	32	33	65
		B	4	4	8
		C	18	21	39
		D	7	5	12
	Total		61	63	124
Truck	Minimum thread depth for heavy vehicle tires (Europe)	A	30	37	67
		B	5	8	13
		C	5	5	10
		D	11	9	20
	Total		51	59	110

The final question concerned **Blood Alcohol Concentration (BAC)**; if drivers know whether there is a limit for BAC in their country. Three alternatives were given to the participant:

a) yes, and the limit is;

b) no;

c) I don't know.

Table 27 reveals that almost all participants (86%) believed that they had a BAC limit in their home country.

Table 27. Presents the distribution on answers to the BAC limit question.

Driver			Experience Less	Experience More	Total
Bus	BAC limit in home country existing	No	8	16	24
		Yes	52	49	101
	Total		60	65	125
Truck	BAC limit in home country existing	No	3	6	9
		Yes	46	52	98
	Total		49	58	107

If the participants believed that their home country had a BAC limit they were asked what the limit was. Table 28 present that 141 answers on that question.

Table 28. Presents the answers on the BAC limit in home country question.

Driver			Experience Less	Experience More	Total
Bus	BAC limit in home country	0,00	36	22	58
		0,01	1	3	4
		0,05	3	1	4
		0,20	1	4	5
		0,50	2	3	5
		0,80	0	1	1
	Total		43	34	77

Truck	BAC limit in home country	0,00	20	14	34
		0,02	1	0	1
		0,04	1	0	1
		0,05	6	3	9
		0,10	0	1	1
		0,20	2	5	7
		0,30	1	0	1
		0,50	2	8	10
	Total		33	31	64

As can been seen in Table 28 is that 65 % believed that the BAC limit was 0.00.

Conclusions on REGULATION KNOWLEDGE information

The questions on regulation knowledge in the questionnaire were not too difficult. It concerned working hours, light usage, belt usage and so forth. The fact that a rather large number of the participants disagreed on a number of questions is therefore surprising to some extent. However, it motivates a development of a support system that could help the driver with regulations.

It is interesting as well that the drivers answer even if they actually do not know the answer. However, a rather high proportion of the participants indicated in the “road signing in general” question that even road signs have room for improvement. Thus, even the things that seems to be easily accomplished (understandable road signs) was believed to have an potential for improvement.

1.5 Conclusions

The purpose of the survey conducted on 256 truck and bus drivers in Finland, Hungary, Italy, Romania and Sweden is

- to investigate their level knowledge of road rules and regulations;
- to figure out relevant outcomes to be translated into inputs for the design activities of the in-vehicle information support system, hereafter called LISA;

- to translate these outcomes into inputs for the design of scenarios going to be implemented on the VTI driving simulator for LISA system tests with real drivers (Task 3.2 and Task 3.4).

Analysis has been conducted considering two characteristics of the drivers' sample**: drivers type** (truck or bus) and **drivers experience** (years of driving licence). For specific dimensions of the analysis, statistical differences within driver type groups (e.g. truck more experienced versus truck less experienced) have been highlighted and evaluated by means of analysis of variance.

The survey has been divided into 3 sections: background aspects, personal opinions, regulation knowledge. The first two sections have been dedicated to the description of drivers' characteristics in terms of driving experience and preferences/opinions on driving-related questions, while the latter focused on their specific knowledge on road rules.

In the following, the link between relevant results of the analysis and the functional specification of LISA is investigated. To do this, data collected from the three different sections of the questionnaire have been aggregated in order to provide an overall description of **knowledge weakness**, so when, where and how LISA could intervene and provide a useful support to drivers.

With reference to the whole sample of participants (both truck and bus drivers), several results on their **knowledge of traffic rules** have been figured out:

- **40% of drivers state that they don't have a sufficient knowledge of rules and regulations of countries they regularly pass through**: it is often a communication issue, most of the times due to language barriers;
- **approximately 20% of drivers state they have problems in the understanding of foreign road signs**;
- **47 % of Less experienced drivers state that there is room for the improvement of traffic signals understanding**.

This highlights the difficulties of drivers in the understanding of traffic rules in the countries they pass through during their routes.

It suggests that a relevant role of LISA must be:

1. to improve drivers knowledge in countries they are not confident with (due to language differences for instance) by providing automatic and/or on-demand information;

2. to translate (on-demand) traffic signs content when drivers have problems in their understanding.

In the questionnaire section dedicated to **personal opinions**, drivers showed that:

- the categories of information that are mostly collected **<u>before the trip</u>** are **road restrictions (73% of the participants), time periods (80% of less experienced drivers, 50% of more experienced), obligations of snow chains and winter tires (71% c.a. for both less and more experienced drivers)**;
- on the other hand, information that is mostly collected **<u>during the trip</u>** are **weather conditions (about 48% for both less and more experienced drivers) and traffic conditions (68% of the participants)**.
- the most used sources for information collection are **radio**, **colleagues**, and **traffic signs**.

Information on rules and regulations are usually collected before and during the trip if necessary, revealing small differences between bus and truck drivers (less or more experienced) in the kind of information they prefer to collect (weather, traffic, etc.).

Moreover, some sources (traffic signs, radio, colleagues) are currently used as one of the primary source for several information; in particular, it seems that **truck and bus drivers rely on colleagues for trip and safety information** like vehicle restrictions (33% of the participants) and time period restrictions (31%).

These outcomes suggest that LISA should be:

3. designed in order to avoid potential information overlapping with traditional sources of information like signs and radio; at the same time, information that today are usually collected by colleague can be provided by LISA in a more efficient and reliable way.

The question related to the **installed/preferred warning system** reveals that **many drivers have installed speed alert and information on driving time systems (more than 60% of the participants), however most of them (around 80%) would not have it**. It means that LISA must be:

4. designed to provide speed alert and driving time information in an innovative, efficient and effective way.

In the questionnaire section dedicated to **regulation knowledge**, drivers showed that:

The question related to **drivers' knowledge on speed limits and allowed driving time per day revealed that while the 93 % of the participants know the correct speed limits in the main country they usually drive, in 22% of the cases they do not know the time limit (9h per day)**. This mean over speeding is most of the time **intentional**, so LISA should:

5. provide new kind of information together with the speed alert (sanctions or other potential consequences like higher fuel costs).
6. provide the same for the driving time, suggesting period stops in polite and smart ways (like game consoles do for instance).

1.6 Further steps

This report presents the results of the first run of the study.

Our aim is to perform a second run during 2010 involving two European key countries, namely France and Germany: this will make lots of new data available and will be an important inputs source for further re-design phases of the smart information system LISA.

Discussing with police ASSET-Road partners (operators and managers), it has been decided to shorten the original version of the questionnaire, due to the …. The questionnaire is reduced to 10 questions and demographic information. This version of the questionnaire is attached as ANNEX C.

This second phase of the questionnaire will be used to further penetrate the regulation knowledge aspect of truck and bus drivers in order to understand the functionalities needed to support a bus or truck driver that go from country to country. The aim is to involve potentially hundreds of subjects.

2 Tanzania study

A twin study has been conducted in Tanzania, with the objective of investigating the level of road safety and especially truck drivers' experiences of road safety; this study is documented in a report (Kircher, 2009).

With the intention to compare the experiences of truck drivers on road safety a summary of the Tanzanian report is presented here.

Even though the traffic fatality risk (fatalities per 100 000 inhabitants) in Tanzania is quite low, the fatality rate (fatalities per 10 000 vehicles) is one of the highest in the world. With increasing vehicle density this means that the number of people dying in traffic will increase dramatically in the near future. Therefore it is important to implement measures to increase traffic safety as soon as possible, and in order to be able to do this in an efficient way, it is important to investigate where the main problems lie.

Within the EU project ASSET-Road a questionnaire study on road safety was conducted with 250 truck drivers in Tanzania. The study was done to increase the knowledge about the situation of the Tanzanian truckers, who are the most frequent road users in the country. The drivers were interviewed in three different towns in southern Tanzania, and participation was voluntary. The questionnaire treated demographics, the state of the drivers' vehicles, the frequency of breakdowns and the maintenance of the vehicles. Further questions concerned with drivers behaviour, crash involvement, crash risk and crash mitigation.

The drivers who participated in the study were predominantly male and their average age was 36 years. Around 40 % of the trucks did not have any seat belts installed, with a larger share of older trucks lacking belts. Most of the drivers who had seat belts reported to use them, however. Almost 40 % of the drivers reported to have been involved in at least one crash, and 45 % of those drivers had experienced fatal crashes. This underlines that crashes counted per vehicle are very frequent, and the results are often severe, especially when heavy vehicles are involved. Truck drivers reported to drive 10.6 hours without break on average, with several drivers reporting that they had to drive 24 hours without rest. When asked what the three most common crash causes were, driver related causes were prominent. Drivers were said to be reckless, further causes named often were drunkenness, inattention and sleepiness. One of the most mentioned crash mitigation strategy was driver education, but also improvement of the roads and the vehicles. This indicates that countermeasures should be implemented in an integrated fashion, taking the aspects driver, vehicle, infrastructure, legislature and other road users into account.

2.1 Road safety in Tanzania

Even though there are comparatively few vehicles on the roads in Tanzania, the traffic safety problem should be a major public health concern. While in the 1990s highly motorised countries like Australia, the USA and Western Europe had around 60 % of the world's motor vehicles, they accounted for only about 15 % of the population and fatalities (Jacobs, Aeron-Thomas, & Astrop, 2000).

On the contrary, Africa stood for 11 % of the global road fatality share, but only for 3-4 % of the global vehicle share. In the last decade the motorisation rate in Tanzania lay at around 5 vehicles per 1000 inhabitants, while in highly motorised countries this rate lies at around 500 vehicles per 1000 inhabitants or more, with the USA topping the list at almost 800 vehicles per 1000 inhabitants. Therefore, indicators like fatality rate, which is the number of fatalities per 10 000 vehicles, and fatality risk, which is the number of fatalities per 100 000 inhabitants, differ immensely for countries of very different motorisation levels. **With about 111 the fatality rate in Tanzania belongs to the highest in the world**, **while the most highly motorised countries have rates around 2 or below.** The fatality risk, however, is approximately equal in Tanzania and those highly motorised countries with the lowest risk rates. It can be assumed that an increase in the motorisation level in Tanzania would lead to a large increase in fatality risk. Thum (2004) reports that for 2002 the number of registered vehicles per 1000 inhabitants lay at 14, which would be an almost 3-fold increase within only a few years. She states also that the number of motor vehicle crashes increased with 52 % between 1998 and 2002, and that the fatality risk lay at 6 in 2002. The official statistics report 1583 fatalities for 1998 and 2050 fatalities for the year 2002.

Generally the proportion of crashes with fatalities and serious injuries relative to the total amount of crashes is much higher in developing countries than in developed countries, because both the passive and active protection in the vehicle and in the infrastructure are much poorer in developing countries. Additionally, the medical treatment after a crash is much less developed.

A difference between developing countries like Tanzania and highly motorised countries can be found in the distribution of fatalities over road user types. In highly motorised countries the most frequent victims are car occupants, with the pedestrian fatality involvement being usually a third to a fifth of that frequency. On the other hand, in Tanzania in 1995 it was reported that 6 % of the fatalities were drivers, 41 % were passengers, 40 % were pedestrians, and 11 % were bicyclists (Jacobs, et al., 2000). The numbers for 2002 are reported by Thum (2004) and lie at 41 % for pedestrians, 37 % for passengers and 14 % for bicyclists. It has to be noted that in Tanzania people often ride on pickups and trucks, therefore the number of passengers per vehicle is much higher on average than in highly motorised countries.

Rwebangira, Pearce and Maunder (1999) report the percentage of crashes and fatalities for vehicle type for the years 1997 and 1998. They state that even though the involvement of long distance buses in crashes in general lies at 0.3 %, the involvement of those buses in fatal crashes lies at 16.1 %. For motorcycles the corresponding numbers are 2.4 % and 6.8 %, for pedestrians they are 2.6 % and 4.8 %. For all other road user types the crash involvement in general is approximately equal to the fatal crash involvement.

The same authors report crash causes as stated in official police records. For the years 1993 to 1997 the police reported reckless driving to account for more than 50 % of all registered crashes. “Vehicle defects” received the next highest score and lay at about 15-20 %. As further crash causes “speed”, “external factors”, “alcohol”, “motorcyclists”, “cyclists” and “pedestrians” are reported, making the crash causes a mix of road users themselves and other factors.

2.1.1 Other Studies

Rwebangira et al. (1999) conducted a questionnaire survey with 200 randomly selected passengers and drivers of long distance buses and small city buses. The crash causes that were cited most often in this study were reckless driving, speeding and driving errors. It turned out that at times passengers even encourage the bus drivers to speed up. Drugs and alcohol were also mentioned as crash causing factors. The crash causing factors of external nature that were mentioned often were poor road conditions, poor road engineering and alignment, and a lack of road signs and markings. Vehicle defects were another factor that was cited frequently as crash causing.

Another questionnaire study was conducted by Åström, Moshiro, Hemed, Heuch and Kvåle (2006). One goal was to assess the accuracy of perceived vulnerability for road traffic injury. Perceived crash causes and solutions were also investigated. The number of respondents lay at 449. The interviewees considered it to be likely to be involved in road crashes, there was even a tendency to overestimate one’s risk. Driver recklessness was mentioned as the leading factor for crash causation, followed by drunkenness, bad road state, vehicle characteristics and a failure to enforce laws. In urban areas pedestrian carelessness ranked as high as drunkenness and bad road state. When asked about mitigating factors, almost 40 % of the 818 obtained responses indicated that the drivers should be educated. Almost 30 % of the urban responses demanded pedestrian education. Further responses were to improve the road state (ca. 18 %), to enforce the laws, to improve the safety of the vehicles, or to monitor speed.

2.1.2 Road Network

The road network in Tanzania in 2004 consisted of about 80.000 km of roads, with the size of the country lying at 884.000 square kilometres. This means that there are about 96 km of road per 1000 km^2, which is a low coverage. Per 1000 inhabitants there are 2.4 km of road (Thum, 2004). It is reported that in 2004 only 44 % of the road network was in good or fair condition. In 1999 about 3300 km of the trunk road network was paved (Rwebangira, et al., 1999). It is estimated that at least 60 % of the smaller roads, the so-called district and feeder roads, are impassable during the rainy season, mainly due to the lack of bridges and culverts (Thum, 2004). Tanroads, the Tanzanian National Roads Agency, claims, however, that the state of the roads was improved considerably between 2000 and 2006 (www.tanroads.org).

In comparison, the Swedish road network consists of 138.000 km of public roads, 75.000 km of private roads receiving state subsidies, and many more kilometres of private roads without subsidies (Swedish National Road Administration (SNRA), 2009). The size of the country is 411.000 km^2. Germany, a densely populated country 357.000 square kilometres in size, has a road network of 231.000 km length, with an additional 396.000 km in municipal areas (Wikipedia – "Strassennetz"). The road density factor, excluding the municipal areas, is 650 km/1000 km^2, which is almost seven times as dense as in Tanzania.

2.1.3 Traffic Volume

Traffic volumes in Tanzania are low, with 200 to 500 vehicles daily on paved trunk roads in 1999, while unpaved roads saw 100 to 200 vehicles daily (Thum, 2004). Other roads were normally frequented by less than 50 vehicles per day. Traffic is growing fast, however, with an annual rate of 6-7 %, and higher in Dar es Salaam. On a trunk road by far the most vehicles to be seen are trucks (around 45 %), followed by pickups and 4x4-driven vehicles (36 %), buses (18 %) and only a small number of cars (4 %).

As mentioned above, the traffic safety situation in Tanzania is bad, and due to the increasing motorisation worse can be expected in the near future. Polls have been made with bus drivers and passengers (Rwebangira, et al., 1999), and with people who usually use the road as pedestrians (Åström, et al., 2006). As trucks constitute a major share of the vehicles on Tanzania's roads, it was decided to investigate the opinion of truck drivers on traffic safety in Tanzania. Before effective measures can be deployed it is important to gain an understanding of the situation. Most likely the results obtained in Europe and other industrialised countries cannot be applied directly to a country like Tanzania, which has completely different preconditions. This questionnaire study is meant to fill part of the knowledge gap. It is hoped that the results of this study will lead to measures that will ultimately improve the traffic situation in the country.

2.2 Method

A questionnaire containing **24 questions**, partly with sub-questions, on traffic safety as experienced by Tanzanian truck drivers was developed. Demographic data like gender and age were collected, and basic information about the truck driven was asked. Further questions concerned the truck and its quality, the driver's own behaviour, the driver's crash involvement, the driver's opinion about other drivers' behaviour and the driver's view on how certain factors influenced crash risk.

Most questions required either a number as answer, or offered a set of alternative choices. Additionally, some open-ended questions were asked to cover aspects that might be missed by giving pre-determined alternatives.

The questionnaire was translated to Swahili, one of the two official languages in Tanzania. Swahili is spoken by a large percentage of the inhabitants. The questionnaire was printed 260 times and sent by mail to the leader of the investigation in the Mtwara region in southern Tanzania. The same number of yellow safety vests was included, which were to be given to the truck drivers as reward for answering the questionnaire.

Detailed written instructions, translated to Swahili, were sent along with the questionnaires. Five interviewers went to three different towns, which represent three major traffic centres in the Mtwara region. Two people conducted the interviews in Masasi, two in Mnazimmoja, and one remained in Mtwara. Masasi lies at the end of the paved road about 160 km from the coast, Mnazimmoja lies at the junction where the road to Masasi leaves the coastal road between Mtwara and Dar es Salaam, and Mtwara is the capital of the Mtwara region.

Each interviewer interrogated 50 truck drivers. The interviews were conducted within one week in the end of February 2009. In March the interviewers met with the researcher from VTI and gave a detailed verbal account of their experiences during the study.

2.3 Results

The number of drivers who refused to take part in the questionnaire study is unknown, but the interviewers reported that they were not many. Therefore it is assumed that the interviewees are representative for the driver population passing through the region.

The results from the questionnaire are described broken down in sub-categories. For this paper the main focus lies on person related factors. For those questions where no missing value number is mentioned, the number lay below 10 out of 251 drivers.

2.3.1 Descriptives

Nationality, age and gender. All 251 drivers who answered the questions were Tanzanians. For 42 drivers their gender was not coded, of the remaining 209 drivers four were females and 205 were males. Their mean age was 36.4 years (std = 9.3 years), the youngest driver was 20 years and the oldest driver 70 years old.

Work experience and age of licence. The self reported experience of truck driving was on average 11.7 years (std = 8.7 years). The minimum experience was under a year, while the maximum driving experience lay at 47 years. The drivers had held their driver's licences for 11.8 years on average (std = 8.6), with a minimum duration of less than a year and a maximum duration of 49 years. The correlation between years of driver's license possession and years of experience with a truck lay at r = .91.

Route related. Most drivers had only driven within Tanzania during the last year, but a number of drivers had also driven in other African countries, most of those are either neighbouring Tanzania. In total 43 of the interviewed drivers had driven in altogether seven other countries, namely Burundi (3), Kenya (12), Congo (1), Malawi (2), Mozambique (8), Uganda (11) and Zambia (6). Even though the drivers were asked about the mileage that they had driven within the last years in the two countries that they had frequented the most, the answers indicate that a large number of drivers had difficulties estimating the distance or understanding the question correctly, therefore the results are not reported, as they probably are misleading.

2.3.2 Safety Related

Vehicles. The year of manufacture was reported by 102 drivers, many of the drivers who did not report the age and weight of the truck stated that they did not have the vehicle registration card with them, and they did not know without checking the card. The mean age of the trucks for which the year of manufacture was reported was 22.4 years (std = 8.9 years). The newest truck driven in the study was one year old, while the oldest was 47 years. Most (91) trucks were between 10 and 35 years old, and the distribution over these ages was quite even. Slightly more (57 %) of the trucks whose drivers answered this question in the questionnaire are more than 20 years old.

For comparison, heavy trucks in Sweden are ten years on average, and light trucks are eight years on average in 2008. The very heavy trucks with a weight of more than 26.000 tons are the newest with an average age of five years (SIKA Institute, 2009). Generally, a truck owned by a company is younger on average than a truck owned by a person.

Driving Time. The mean reported driving time without breaks lay at 10.6 hours (std = 4.2 hours). The range is big, with one driver claiming that he takes breaks every other hour, while several drivers reported to drive for 24 hours without rest (Figure 3). The recommended driving time per day is eight hours in Tanzania, but there is no law for either driving time or compulsory breaks.

Other Drivers. It can be conclusive to ask people how they think other people behave in a certain situation, especially if the behaviour in question is not socially desirable. In the present case the drivers answered how often they thought their fellow drivers were engaged in certain activities on a scale from “almost always” over “very often”, “often” and “sometimes” to “almost never”.

The question how often other drivers would drive their truck when they were sick was answered by 230 drivers, that is, 91.6 % of all drivers. More than 50 % of the drivers assumed that this happened “almost never”, 27.8 % thought this happened sometimes, while around 14 % indicated that this happened often or more.

The number of drivers that responded to the question how often truckers drive when they are tired lay at 246, which corresponds to 98 % of the interviewees. One third claimed that other truckers drove almost never when they were tired, another third said “sometimes”. The remaining third was split between “often” (17.1 %) and “almost always” (12.2 %), while 4.5 % of the drivers said this happened “very often”.

The next question was how often other drivers were inattentive while driving. It was answered by 217 interviewees and, thus, by 86.5 % of all drivers. About two thirds thought that inattention was generally not an issue – 41.% % of the drivers answered that this occurred “almost never”, and 25.8 % said it occurred “sometimes”. Almost 20 % of the drivers assumed that inattention occurred “often” amongst their fellow drivers, while the remaining 14 % lay at “very often” or “almost always”.

The question how often other drivers drove drunk was answered by 237 interviewees (94.4 %). Of those, one quarter claimed that their fellow drivers were almost never drunk while behind the wheel, and one third responded that they were “sometimes” drunk. Almost 20 % of the drivers thought that other drivers were drunk “often”, 8.9 % said they were drunk “very often”, and 14.3 % stated that their fellow drivers were almost always drunk while driving.

About one quarter of the 234 answering drivers reported that their fellow drivers would ”almost never” drive without seat belt. Another quarter was assumed to drive sometimes without seat belt. The remaining 50 % were distributed across “often” (20.9 %), “very often” (10.3 %) and “almost always” (17.9 %).

Almost a third (29.5 %) of the drivers said that using a cell phone on the road would occur almost never, while another 25.4 % assumed that drivers would sometimes use their phones. The other drivers (54.1 %) estimated phone use to occur often (20.5 %), very often

(14.8 %) or almost all the time (9.8 %). For this question the drivers are quite evenly distributed across the answer categories. It was not asked, however, whether the driver owned a phone himself, which could have been related to the estimated phone use of other drivers.

More than four out of ten drivers (41.9 %) assumed that other drivers would almost never drive too fast. Another 24.1 % assumed that this would happen sometimes. The remaining third of the drivers answered that other drivers drove too fast often (12.9 %), very often (5.4 %) or almost always (15.8 %).

More than half of the 239 drivers who answered the question reported that other drivers would almost never overload their vehicles (55.6 %). Almost a fifth of the drivers thought that this occurred sometimes, while 13 % assumed this to occur almost all the time. The remaining 11.7 % were distributed across “often” and “very often”.

Crash Involvement. Crash involvement was another issue that was investigated in the questionnaire. The drivers were asked how often they had been involved in crashes so far, and whether the crash had resulted in fatalities, severely injured or slightly injured people. Of the 248 drivers (98.8 %) who had answered the question, 96 (38.7 %) reported that they had been involved in at least one crash. About half of those 96 drivers did not report the actual number of crashes, but only that they had been involved in at least one crash. Of the remaining drivers, 29 said that they had experienced one crash, 19 had experienced two crashes, three had experienced three crashes, two had been involved in four crashes, while five and six crashes were experienced by one driver each.

Those drivers who reported to have experienced a crash were asked about the severity of the injuries of the people involved. Just as before, most people did not indicate how many of the experienced crashes resulted in which level, and how many people in a crash had received the respective injury level. However, out of the 96 drivers with one or more crashes, 43 had experienced fatal crashes. That corresponds to 45 per cent of the reported crashes. Of the 96 drivers, 26 reported to have been in crashes with serious injuries, and 59 reported crashes with slight injuries. The numbers do not add up to 96, because drivers could report multiple injury types.

Crash Risk. The drivers were asked to name three common causes for crashes. In total the 251 drivers came up with 682 answers. Nine drivers did not answer the question, the others gave between one and five causes, the average number of answers lay at 2.7 per driver. The answers were coded into the categories “driver”, “other road users”, “bosses”, “police”, “vehicle”, “road” and “other”.

More than 80 drivers stated that driver recklessness was a major reason for crashes, followed by driving under the influence of alcohol, lacking attentiveness, sleepiness and speeding, which were all named by at least 15 % of the drivers. Using a cell phone was only mentioned by a few drivers. Not observing the traffic code was seen as a causal factor for road crashes by a number of drivers, while some others attributed crashes to bad luck.

Of the 27 times other road users were seen as contributing factors to crashes, most blame was put on bus drivers, who race each other, and on pedestrians. All other driver types were only named once or twice. The bosses were blamed 13 times for causing crashes by being thoughtless and careless towards the drivers, by not respecting them and by paying them a too low salary. Eleven drivers named the police as crash causing, because they would accept bribes and would not do their job in an attentive manner.

Problems with the vehicle were seen as a crash cause by many drivers. More than 60 drivers reported problems with the car as leading up to crashes, and when the respondents went into detail they most often blamed the quality of the tyres. Furthermore it was stated that lacking vehicle service lay behind crashes, as did problems with the brake, low quality spare parts in general, a too heavy load of the truck and problems with the headlights.

Almost half of all respondents blamed the low standard and maintenance of the roads for causing crashes. It was also noted that road signs were lacking. Some drivers specified that the mud or gravel surface, the narrowness of the roads and speed bumps were seen as contributing factors to crashes.

Crash Avoidance/Mitigation. After having been asked about the causes for crashes, the drivers were asked what could be done to avoid crashes. Again, the answers were categorised along the same categories as before, except that the category “law” was added. Just like many driver related aspects were seen as causing crashes, in many cases it was assumed that driver related mitigation strategies could avoid crashes. This was followed by road related factors. Mitigation strategies related to the vehicles were also identified 101 times, while the police, the law, the vehicle owners and other road users were only mentioned by a smaller number of drivers.

Almost 40 % of the respondents indicated that they thought that driver education would help avoiding crashes. Individual actions which were singled out by a substantial number of drivers were that drivers should be more attentive, that they should observe the traffic code, and that they should not drive under the influence of alcohol. The remaining driver related strategies to avoid crashes were only mentioned by a small number of drivers each.

Other road users were not mentioned much when it comes to crash avoidance strategies, but also here education was the prominent measure to avoid crashes.

The drivers' bosses were seen as being able to do something to avoid crashes. The general attitude of the drivers was that the bosses should be more concerned about the drivers and pay them better, six drivers suggested education for the bosses.

A number of strategies were mentioned that should be implemented at a political level. **The main driver demand was that the maximum driving hours per day should be regulated by law,** and that the existing laws should be enforced. **In general the drivers wanted the government to be stronger on the enforcement.**

Some of the drivers' answers how to avoid crashes were directly related to the police force. Most importantly the policemen should not accept bribes, and they should adhere to the rules.

With respect to the vehicle, it was in very high demand that the trucks be serviced and repaired regularly. The spares should be of high quality, and again, special focus was put on the tyres. It was also mentioned that the vehicle should be checked before each journey.

Almost half of the drivers assumed that crashes could be avoided if the roads would be repaired and well maintained. Some drivers mentioned explicitly that the roads should get paved. Another aspect that was important to the drivers was that more road signs should be put up.

2.4 Discussion

Just as in Europe the truck drivers were predominantly male. The age span was large, but most drivers were in their 20s and 30s. Only few drivers were older than 60. Generally a higher age also means more driving experience, and most drivers had driven trucks more or less as long as they had held the driver's licence for trucks.

In contrast to European countries, where truck drivers often cross borders and drive in other countries than their own, all interviewees in the present study were of Tanzanian citizenship, and most of them stemmed from the south, the area in which the interviews were being conducted. This leads to the assumption that **the drivers are quite familiar with the roads they drive on, and with the general conditions in the area**. Most drivers also reported that they mainly drove in Tanzania, even though the travelled distance could not be estimated conclusively, due to misunderstandings when asking the question. Some neighbouring countries were visited by a few drivers, but for the drivers interviewed cross-border traffic is rather unusual.

2.4.1 Safety Related

Around 40 % of all drivers interviewed had already been involved in at least one crash, and half of those drivers had been involved in fatal crashes. Fatalities are likely to occur in crashes with trucks, because very often the other involved partner is an unprotected road user, or it is a single accident where the victims are passengers travelling on the cargo area in the back of the truck. Severe injuries were also likely, and considering the state of the health care system severe injuries are likely to lead to death or lifelong damages for the victim.

The high crash involvement rates of the truckers indicate once more that even though the fatality and crash risk for the population is still low, the fatality rate counted per vehicle is very high. Of 248 truck drivers, which is equalled with 248 trucks, 43 have seen at least one fatal crash. If the numbers obtained in the interviews here are representative for the country, the fatality rate per 10.000 trucks would lie at least at 1733! For this computation it was assumed that the 43 trucks were involved in only one fatal crash with only one person dead, which is an underestimation of reality. The fatality rate per vehicle in Tanzania was reported to be 111 (see above), which would imply that **trucks are more than 15 times as deadly as the average vehicle**. Therefore, truck safety should be of paramount concern when dealing with traffic safety in the country.

About a third of the trucks is not equipped with seat belts. Those drivers who have seat belts are, however, very likely to use them. It is known that seat belts are very effective in reducing the fatality risk (Evans, 1988), and a wider spread of seat belts in trucks and cars, both for drivers and passengers, would surely contribute to a reduction in fatalities.

Tanzanian truck drivers **drive for a very long time on average without rest**. The interviewers reported also that the inhumane driving hours imposed by the drivers' bosses were of major concern to the drivers themselves. Driving for so long leads to fatigued, tired and inattentive drivers, which are more likely to end up in hazardous situations or crashes. Some drivers even reported to drive for 24 hours without rest! The situation is aggravated by the fact that there is no simple means of controlling a driver's time at the wheel. Tachographs are not being used, and there is a general lack of central registration of traffic offences. Tackling the problem of extended driving hours is paramount, however, if the traffic safety is to be increased.

More than one third of the drivers reported that it happened often, very often or almost always that drivers drove when tired. Another third said this happened sometimes. This is quite understandable when looking at the trip duration without rest reported by the drivers in this study. The percentage of fatal crashes related to sleepiness in Europe and the USA has been estimated to lie between 10 and 30 % or even higher (Åkerstedt, 2000; Åkerstedt, Connor, Gray, & Kecklund, 2008). Sleepiness based crashes have a tendency to have more severe outcomes than average, because they often occur at relatively high speeds (Zulley, Crönlein, Hell, & Langwieder, 1994). **The prevalence of sleepiness in Tanzanian truck drivers is extraordinarily high**, and around 20 % of the drivers name sleepiness as one major cause for road crashes. The drivers are also aware of the fact that being sleepy and that driving long distances without rest increases the crash risk. It is likely that a substantial number of the more severe crashes are due to sleepiness. Often truck drivers drive at night when on asphalt roads, because then the asphalt is less warm and therefore harder, making driving easier. However, driving at night will increase sleep deprivation, and is also dangerous for other reasons.

When asked about measures for crash prevention, sleepiness related issues were not addressed as directly and as often. That drivers should take a break when tired was only mentioned five times, and one driver demanded education on how to get rid of sleepiness. Almost 40 % of the drivers asked for education, however, and six drivers mentioned specifically that the bosses should be educated. Law enforcements were also mentioned, but without specifically naming sleepiness problems. It might be possible that the drivers do not believe that something can be done about the sleepiness problem, or they hope that general education will help them get rid of it. Another interpretation might be that other issues are more important to them, like the state of the road and the vehicle, and therefore sleepiness related countermeasures were not named among the three most important countermeasures.

Illness was not much mentioned as a crash causing factor. The drivers in this study reported, however, that **it was relatively common for drivers to be on the road while sick**. More than 40 % assumed that this happened at least sometimes. In general the drivers were aware of the fact that driving while sick increases the crash risk, but the percentage of drivers who are not aware of this fact was not neglectable. Information on the consequences of driving when not fully capable of concentrating on the road due to illness might be able to help preventing some drivers from driving while ill.

It can be assumed that most drivers are ready to drive when sick, because they are afraid of losing their jobs. It is dangerous that drivers do not appear to grasp the full implication of the danger of driving while being sick. Here it is probably necessary to address the employers as well, because they often dictate harsh working conditions for the drivers as there are many unemployed people desperate for a job. For the employer not only the live and health of his drivers is at stake, but in case of a crash caused by a sick driver he will also suffer economic loss.

Speeding appears to be common on all road types. The drivers are aware of the risk of driving too fast, as one fifth of the drivers mentioned speeding as a leading crash cause. Nevertheless a large amount of drivers appears to speed.

The single most named crash cause is driver recklessness. “Not observing the traffic code” can also be subsumed under recklessness. The most mentioned driver related countermeasure was education, which, together with enforcement, should be addressed at recklessness. Recklessness often means driving at high and inappropriate speeds, but also risky overtaking manoeuvres and other careless behaviour. A personal communication with the Chief Engineer of the Ministry of Infrastructure in Tanzania revealed that **the truck driver education only comprises of teaching how to drive the vehicle, but there is no education about traffic rules and traffic safety related issues.** It can therefore be assumed that drivers do not necessarily act out of ill will, but that they sometimes just do not know any better. Furthermore, since the vehicle density in Tanzania is so low, “traffic sense” is not necessarily instilled during childhood and while growing up, because many drivers probably get into a vehicle on a regular basis first after they have got their driver’s licence.

About a quarter of the drivers assume that other **drivers are distracted** often while driving. Almost 20 % also name a lack of attention as a major crash cause. The lack of attention could be subsumed under recklessness, but is of a slightly different quality. While recklessness comprises more active “bad behaviour”, lacking attention is not necessarily seen as risky by the driver. A driver might talk on the phone, talk with a passenger, or be distracted due to other causes. In the US and European countries distraction is assumed to lie behind a large percentage of crashes (Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006; Klauer, Sudweeks, Hickman, & Neale, 2006; Stutts, et al., 2003; Stutts, Reinfurt, Staplin, & Rodgman, 2001). The types of distraction are, however, most likely very different in industrial countries where vehicles typically are equipped with info- and entertainment systems, and where traffic looks completely different than in Sub-Saharan Africa. In order to estimate the percentage of crashes due to distraction in Tanzania the prevalence of distraction both during normal driving and for crashes would need to be established, as data from industrialised countries cannot be taken as reference.

Talking to passengers and on the cell phone is seen as crash risk increasing by a number of drivers, but just as many think that crash risk will be reduced. A possible interpretation might be that the drivers think a conversation will keep them from falling asleep. Especially passengers have actually been found to have a slight crash risk reducing effect (Dingus, et al., 2006), because they can point out things to the driver that the driver missed. Talking on a cell phone, however, is generally seen as detrimental to traffic safety (Kircher, et al., 2004). To the knowledge of the author, there are no studies that investigate the role of a mobile phone as sleep preventing, which could be of interest for future studies.

Of the driver related factors, **drunkenness is the second most mentioned crash cause**. Also, the drivers assume that being drunken increases the crash risk substantially and ceasing to drink while driving is mentioned as a crash reducing measure by 30 of the 250 drivers. Drunkenness is therefore an issue that many drivers are aware of, and that was mentioned as a measure to fight sleepiness. As sleepiness and drunkenness interact and increase crash risk vehemently (Åkerstedt, et al., 2008), a reduction of both would probably have a large impact on traffic safety. Here again, as with speed, we encounter the problem that drivers are aware of the risks with alcohol, but they drink nevertheless. Therefore, pure driver education is not enough, a structural change involving politicians, legal instances, enforcement and possibly a campaign to address the public opinion are necessary.

2.4.2 Vehicle Related Problems

The vehicles in use are rather old on average, more than twice as old as the average truck in Sweden. An old vehicle fleet entails a number of problems, one of which is a lack in safety equipment. Older trucks are less likely to have seat belts, for example, which unnecessarily endanger the drivers' lives. Even though seat belts are an effective and relatively cheap method to save at least the driver's life, they are unlikely to be retro-fitted in old trucks. Also, older trucks are more likely to break down, which is easily understandable. It might seem paradoxical that in spite of this older trucks are serviced or repaired more rarely in official garages. It is possible, however, that vehicle owners who have old trucks are more likely to save money, thus, they own older vehicles, and they do not grant them a more expensive service or repair in an authorised garage. They either turn to the cheaper local workshops that are often less competent and well equipped for repair and maintenance work or they make the necessary repairs themselves and skip those that are not necessary to keep the truck running. Hence, these **older trucks are a traffic hazard** both to their own drivers and passengers and other people on the road, because vital parts are more likely to fail than on newer trucks.

2.4.3 Road Related Problems

Drivers mentioned the bad state of the roads very often. Some drivers wanted more roads to be paved, but the general demand was that the roads be maintained better. Another issue that was important to drivers were the road signs. **A lack of road signs was seen as causing crashes**, and an installation of signs was suggested frequently as a crash avoiding factor. Exactly which type of signs should be installed was not mentioned, but it is likely that drivers are interested in **warning signs** that draw their attention to particular hazards. To illustrate this, in one instance of a crash, for example, the bridge across a river had been washed away by a flood years ago. The sign indicating that had been stolen, and a new bus driver on the road received no warning for the lacking bridge when driving fast along the asphalt covered road in darkness. He drove into the hole and the river below at full speed, killing all his passengers and himself. This type of crash is not unusual, and driving at night oftentimes means to drive in complete darkness, except for the often not very well operating vehicle headlights. Here, warning signs could really improve the perception of unexpected hazards. This would also mean, however, that the signs need to be guarded, as theft is not uncommon, with metal being a valuable material.

Especially during the rainy season the roads in southern Tanzania are notoriously bad. At times even the main roads become impassable or very difficult to navigate due to mud, slippery soil and flooding. Therefore it is important for drivers to collect fresh information about the state of the road before heading out for a longer trip. It is important that those drivers who are in need of information about the state of the road should be able to get it, because this could prevent a number of crashes, but also keep drivers from getting stuck on the road, which can lead to other hazards like robbery, being bitten by mosquitoes transmitting malaria, or other illnesses.

2.4.4 Other Issues

Even though the **bosses** were not often directly named as causing crashes, they appeared somewhat more frequently when talking about crash avoidance strategies. The drivers were of the opinion that the bosses do not listen to them, and that they put them under a lot of pressure without paying them appropriately. Furthermore, it is the bosses' responsibility to ensure that the vehicle is in good working order. Some drivers suggested that the bosses be educated, which should clearly be considered when developing an integrated traffic safety concept. The **police** received some criticism from the drivers. It was mentioned that policemen accepted bribes instead of collecting fines for offences, and therefore the traffic safety would not be increased.

The police was also mentioned in connection with crash avoidance measures. Specifically, policemen should not accept bribes and adhere to the rules. It has to be mentioned, however, that even if the police did their job completely accurately, they would confront a number of obstacles. There is no central register for traffic offences, therefore repeat offenders are not punished more than first time offenders, for example. As indicated above, it is not either possible to control the working hours of the truck drivers, there is not even a legal limit for how long the drivers are allowed to drive. Here, not only the police has to improve its quality of service, but also the legislation has to be improved to protect the truck drivers, and by that the other road users as well.

2.4.5 Conclusions

Now is the time when actions should be taken to reduce the fatality rate, not only because the fatality risk will increase dramatically with an increasing motorisation, but also because now only a small percentage of the population is in possession of a driver's licence. It should still be possible to reach most of those drivers with further educational

measures, and it is of necessity to educate new learner drivers about traffic safety. Furthermore, education of the drivers' bosses, of the enforcement organs and other road users is important, but the state of the vehicles and the roads should not be neglected, either.

The research done contributed with new information about a group of drivers that had not been investigated before in this manner. It is hoped that this will spur further projects, which will actually take action to improve the situation for all road users in Tanzania.

3 Studies comparison

What this study shows is that, in Tanzania as in Europe, problems inducted by heavy vehicles presence on road safety are in essence the same, but they stay at different, and very far, levels: vehicle safety equipments, driving time, speeding, recklessness, distraction, old vehicles, poor roads maintenance, lack of signs, inadequate education are the main safety issues emerged from data collected.

It is clear that a direct comparison between the two studies is impossible because of both countries and persons differences, different technology assets, different transport modalities and objectives, and different resources. In fact, while Europe is today committed to develop new technologies, intelligent vehicles and infrastructures, and co-operative systems, **Tanzania needs strategic improvements at a very basic level, and first of all at educational level**.

What emerged from questionnaire and interviews in Tanzania is a growing perception into the drivers of roads risks, a more clear view of implications between causes and effects in crashes and fatalities and a concrete sensibility towards mitigation strategies: for this reason a policy which aim to inform about road risks and how they could be reduced, and to promote safe driving culture is the key action leading the developing process.

4 Driver support system development

The purpose with the questionnaire was to investigate how truck drivers and bus drivers experience their task in a number of respects. The objective was to understand the functionalities needed in a driver support system in order to help the drivers with, among other things, self experienced problems such as traffic regulations.

4.1 Live In-vehicle Smart Assistant (LISA)

LISA is a **In-Vehicle Information System module** which will support heavy vehicle drivers in adopting and maintaining correct and safe behaviours on the road: it will do this acting as **co-pilot**, reporting to the driver about his **driving behaviours in relation to road rules and regulations**.

This will be extremely useful in those scenarios drivers could feel unsure because of:

- interpretation,
- decoding and
- knowledge

problems related to road rules and regulations.

To reach this objective LISA has been structured in order to manage information related to:

- **vehicle status** (e.g. speed, breaks conditions, time forward, etc.);
- **vehicle behaviour** (e.g. car following, overtaking, accelerating, braking, etc.);
- **surrounding environment** (e.g. GPS position, weather conditions, type of road, road surface status, etc.)
- **surrounding vehicles behaviours** (e.g. vehicle type, relative position and speed, trajectories, manoeuvres, etc.).

LISA uses available data to detect specific scenarios, and will act consequently, giving driver **support at 4 different levels**:

1. **ALARM**, if driver violates one or more road rules in a dangerous scenario;
2. **WARNING**, if a violation could lead a safe scenario towards a critical one;
3. **INFORMATIVE**, if useful information are available in a safe scenario (no violation);
4. **CULTURAL**, providing useful information to promote safe driving behaviours acting as a **TUTORIAL**.

To do this, appropriate information management strategies have been implemented, basing on different information priorities, driver status and behaviour, cognitive capabilities, culture and language.

4.2 System architecture

LISA acquires necessary information interfacing with **Virtual Agents software** through **TCP/IP protocol**, with a **XML parser** component, and interact with driver through a 7’’ touch screen user interface placed in the cabin.

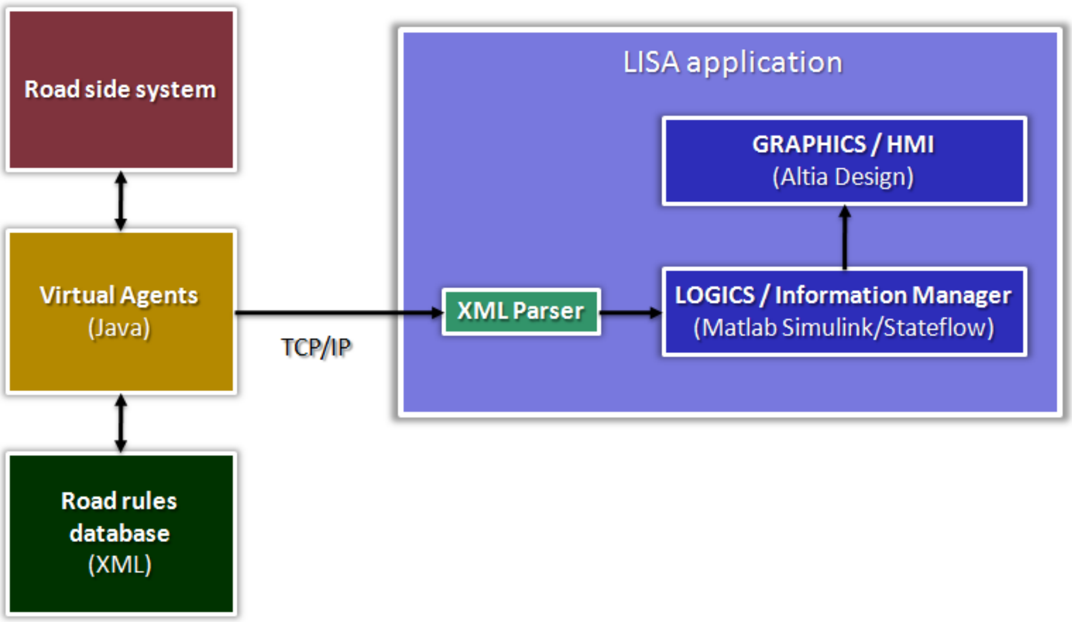


Figure 165 – LISA architecture

4.3 System requirements

To define a **preliminary set of driver needs and requirements** 2 questionnaire studies have been performed.

The first one was aimed at defining users needs and system's requirements related to its nature of In-Vehicle Information System (IVIS). This leaded to the identification of **general**, **functional**, **operational** and **performance requirements**.

The second one has been performed with 119 truck drivers 134 bus drivers 3 truck and bus drivers has been performed with the purpose to **investigate regulation knowledge among truck and bus drivers**.

Results coming from these studies have been taken into account to design LISA graphical interface and to implement information management strategies to support drivers in adopting and maintaining safe driving behaviours.

4.4 Application scenarios

LISA behaviour and support level will change depending on the specific driving scenario, so it will be design consequently. To do this, the first thing to do is to define how many different scenarios categories have to be considered, basing on their potential severity and risk for drivers and passengers. At this step **3 kinds of scenario** have been defined: they consist of a basic scenario, considered **SAFE**, which could evolve to more critical ones depending on weather and traffic conditions (**ATTENTION** and **DANGEROUS**).

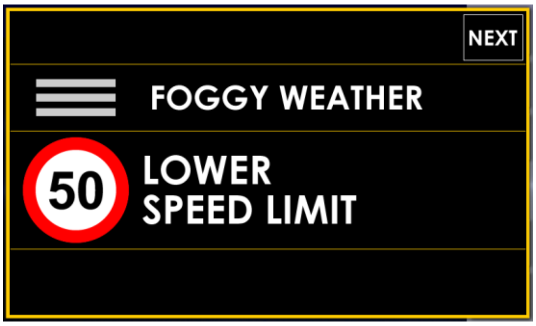
4.5 Information provided

LISA provides different kinds of information that have been grouped into specific **CATEGORIES**, considering their meaning and aims. This allows implementing provision strategies depending on specific support levels.

1. **VIOLATIONS**. These are the highest priority information; those **driver must promptly be informed**. Violation information are derived by Virtual Agents matching vehicle behaviour (e.g. speed, road, lane, driving time, etc.) with road rules database.

2. **RESTRICTIONS**. This category includes that information on what driver cannot do in relation to the specific vehicle, its status (weight) and the specific road.

3. **CHANGING SCENARIO**. Information provided when scenario modifications lead to a change of rules and regulations. For instance if weather become foggy the speed limit changes consequently and driver must be aware of it. **Which regulation changes and in which way must be communicated**.



4. **USEFUL INFORMATION**. Drivers need support not only for safety reasons, but also for informative and comprehension support. So, LISA will give support providing useful general or specific information, both on-event and on-demand.

These categories are directly connected with the kind of LISA support, as shown in the following picture.

		SYSTEM SUPPORT			
		ALARM	WARNING	INFO	TUTORIAL
INFORMATION CATEGORIES	VIOLATIONS	X			X
	RESTIRICTIONS		X	X	X
	CHANGING SCENARIO		X	X	X
	USEFUL INFORMATION			X	X

Figure 16 – Information categories and LISA support.

4.6 Information management

Depending on the specific scenario, information will be filtered and configured to fit drivers' cognitive level and maximize information accessibility and usefulness.

		SYSTEM SUPPORT			
		ALARM	WARNING	INFO	TUTORIAL
SCENARIO	SAFE	X	X	X	X
	ATTENTION	X	X		
	DANGEROUS	X			

Figure 17 – Scenario severity and LISA support.

As shown in the picture:

- In a **SAFE** scenario, all support levels will be available and driver could interact freely with the system.
- In a **ATTENTION** scenario the TUTORIAL mode will be disabled since a free interaction could lead to an excessive driver's distraction on a truck or bus. In this case, inputs tasks will be limited to **ACKNOWLEDGEMENTS** of message provided.
- In a **DANGEROUS** scenario, only information related to safety will be provided and all inputs tasks will be inhibited.

4.7 Levels of automation

LISA is a configurable system in terms of **level of automation**: it means drivers could change which kind of messages will be sent automatically and which one will be received on demand.

Implemented levels of automation are:

- **FULLY AUTOMATED**: alarms and warning information will be provided automatically on event;
- **MEDIUM AUTOMATION**: alarms provided automatically on event, while a reminder will inform the driver about warning and info: so the driver could chose when access the information;
- **MANUAL**: a reminder will inform the driver about alarms, warning and info: the driver will choose when access the information.

		SYSTEM SUPPORT		
		ALARM	WARNING	INFO
AUTOMATION LEVEL	FULLY AUTOMATED	A	A	M
	MEDIUM AUTOMATION	A	M	M
	MANUAL	M	M	M

Figure 18 – Automation level and LISA support.

5 Simulator study

The purpose of the simulator study is to evaluate the driver support system LISA in order to help truck drivers with a number of problems they encounter while performing regular and daily work.

The questionnaire study revealed a number of problems concerning traffic rules and how truck and bus drivers collect necessary information. The purpose of the forthcoming simulator experiments is to gain knowledge about how a driver support system could help the driver to avoid unnecessary complications and probably stressful situations by providing requested information in different ways.

The driver support system LISA will be studied in an iterative way. The purpose with the iteration is to be able to adjust the functionalities of LISA step by step. The objective is to avoid one large simulator study with the possibility to end up with inconclusive results, to avoid fundamental pitfalls and problems that could occur in earlier phases of product developments. The iterative process chosen leaves us with the possibility to go back, change and improve and thereafter conduct new evaluations.

The plan is to conduct 3 runs of evaluations with a smaller amount of participants. The last and final one of the runs will therefore be the driver support system that has resulted in the most promising functionalities.

The rest of the chapter will present the status of the simulator experiments so far. The actual running of experiment will take place after the deadline of this report. Thus, modification of situations, events chosen and even characteristics of participating subjects might be adjusted accordingly depending on the process of implementing scenarios, events and LISA in the VTI simulator.

5.1 Scenario setup

This section describes the scenario setup in a general way, so that it corresponds with the objective with the simulator experiments. The events and the instructions and participant characteristics will be discussed in the next sections. The general scenario set-up will be presented initially.

Firstly, the intention is to use a balanced experimental design as presented in Figure 19 with 3 runs with adjusted versions of the LISA. The experimental design will be within-participant design where all participants at all times will evaluate/experience two conditions of a driver support system (even without LISA is treated as a condition of driver support systems from an experimental perspective).

Distribution of Truck drivers

	LISA 1	LISA 2	LISA 3	Without LISA
Run 1	5			5
Run 2	5	5		
Run 3		5	5	

Figure 19 show how runs and different versions of the LISA will be evaluated.

Moreover, all participants will, at the first run at least, experience a number of situations that include specific events. These events will be balanced accordingly (Figure 20). The event variable will be a within-participant variable as well.

	Country X				Country Y				Country Z..
Condition	Event 1	Event 2	Event 3	Event 4	Event 2	Event 3	Event 4	Event 1	Event 3…
A1									
A2									
B1									
B2									
	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩
LISA Info/Level	Green	Yellow	Red	Red	Yellow	Green	Red	Red	Red

Figure 20 – General design of the simulator study

	SAFE
	ATTENTION
	DANGEROUD

Figure 21 below reveals how the scenario is organised into 4 separate 20 minutes phases. Twenty minutes in each country. The scenario and all events will take place on two-lane highways.

Training ~ 10min

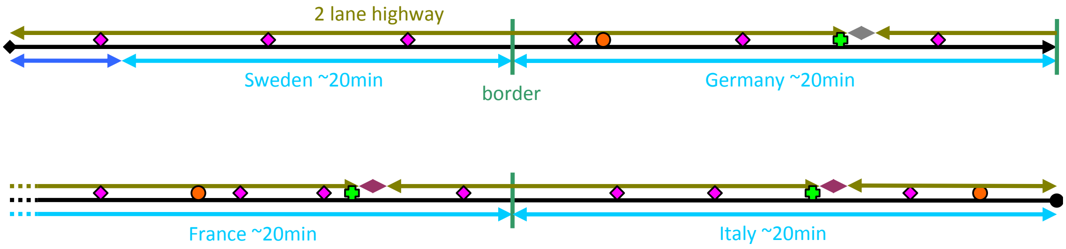


Figure 21 – General design of the simulator study

The events that will be used as specific events will be:

Road repair ahead

Overloaded truck

Rest stop where driver may or may not stop

Highway to highway

Border crossing

Finally, conditions in terms of weather and traffic density will be varied in a systematic way during scenario completion. This independent (weather condition) measure will be a within-participant variable as well.

5.2 Situation identification

The following sections describe the actual scenario setup based on the questionnaire study. First, under section 9.2, the relevant results from the questionnaire study will be summarised, in terms of countries, regulations, driving conditions etc. Sections 9.2.1 - 9.2.3 will describe how the latter are implemented in the scenario setup as well as how the LISA safety levels are associated with the scenario setup. Sections 9.3 and 9.4 describe the selection of test drivers and the simulator iterations.

The questionnaire showed that almost all drivers pass through 3 countries each trip, followed by 2 countries. This implies that relevant events should occur in several countries during the simulator study. The questionnaire also revealed that 40% of drivers state that they don't have a sufficient knowledge of rules and regulations of countries they regularly pass through and approximately 20% of drivers' state they have problems in the understanding of foreign road signs, and finally 47 % of less experienced drivers state that there is room for the improvement of traffic sign understanding.

With reference to regulations, the questionnaire study showed that the categories of information that are mostly collected before the trip are road restrictions (73% of the participants), time period restrictions (80% of less experienced drivers, 50% of more experienced). In particular, the question related to allowed driving time per day revealed that in 22% of the cases the drivers did not know the driving time limit (9h per day).

Moreover it seems as if truck and bus drivers rely on colleagues for trip and safety information like vehicle restrictions (33% of the participants) and time period restrictions (31%). On the other hand, information that is mostly collected during the trip concerns weather conditions (about 48% for both less and more experienced drivers) and traffic conditions (68% of the participants).

These outcomes suggest that LISA should be designed in order to avoid potential information overlapping with traditional sources of information like signs and radio; at the same time, information that today are usually collected by colleague can be provided by LISA in a more efficient and reliable way.

5.2.1 Countries

4 countries have been chosen and presented below since the simulation study is collaboration between Italian and Swedish researchers and that it is then natural to pass through Germany to get to Italy. France was experienced to be more difficult than other countries in the answers given by the questionnaire participants. Therefore, we ended up with 4 countries which also fit into the practical setup of driving range and time.

For these reason countries chosen for the study are:

- Sweden;
- Germany;
- Italy;
- France.

5.2.2 Events

Information concerning relevant traffic regulations and information will be implemented and tested in the simulator study by means of events. The simulator study includes four events which are associated with a specific traffic regulation or type of traffic information: **road works**, **truck overloaded**, **driving time almost exceeded** and **border crossing**.

The reasons for selecting these events are stated below, while Table 29 explains how the events will be realised in the scenario setup.

Road works. This event involves a road repair, which is an important type of traffic information that requires planning and actions from the driver in due time to retain safety and delivery time.

Truck overloaded. Overloaded trucks increase road wear and tear, expose bridges to excess weight, and increase the severity of accidents. A truck driver may however not be aware that the truck is overloaded, if he/she wasn’t involved in the actual loading procedure. In the ASSET-Road project, Weigh-In-Motion (WIM) road sensors are developed and tested, so that overloaded trucks can be detected while they are travelling on the road. It is important that the driver receives this information as well as recommendations on how to handle the situation. For example where it is appropriate to unload and reload goods.

Driving time almost exceeded. Exceeding the allowed driving time is an apparent safety risk, which is why the drivers' working hours are heavily regulated within the European Union. Interpreting the regulations may however be complicated as the allowed driving time depends on a combination of the number and length of rests, and the driving hours reached per day and week. The regulation complexity is reflected in the results from the questionnaire study, which showed that in 22% of the cases the drivers do not know the daily driving time limit (which is 9h).

Border crossing: By entering the issuing country of the driver’s license, LISA can emphasise important differences of the legal regulations, based on the actual geographic position of a vehicle. The idea is to supply information to a driver before border crossings in order to raise the awareness regarding special legal regulations, for example differences in speed limit intervals.

Table 29 The four events in the simulator study

No.	Event	Explanation of event
1	Road repair	A crash barrier on a highway bridge is being repaired 2 km ahead. The repair occupies the rightmost lane, which means that the two highway lanes are reduced to one.
2	Truck overloaded	A road sensor detects that the truck is overloaded (the driver is not aware of this).
3	Driving time almost exceeded	The allowed driving time is almost exceeded and the driver has to take a rest at the next rest stop.

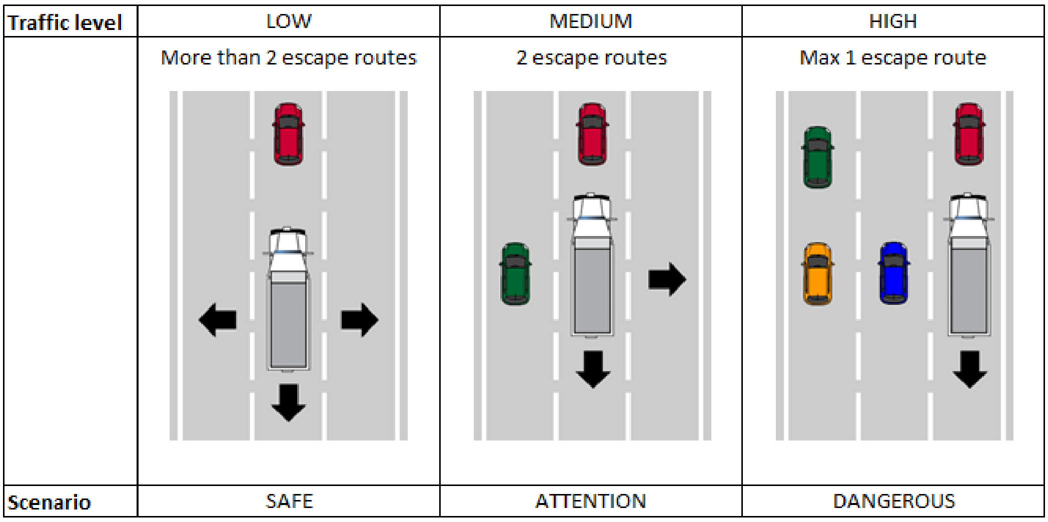
4	Border crossing	Information that the driver is approaching a border where LISA can provide some kind of general safety information that the driver should be aware of. For example speed limits.

5.2.3 Conditions

Two conditions will be varied in a systematic way during scenario completion: weather conditions and traffic density level. Table 30 shows the two conditions and the associated levels that will vary during the events in the scenario setup.

Table 30 Traffic level and weather conditions that will be used in the simulator study.

Condition	**Level**		**Explanation**
Weather (A)	A1	Clear	Sight distance: "unlimited"
	A2	Mist	Sight distance: 200 m
	A3	Fog	Sight distance: 100 m
Traffic density level (B)	B1	Low	See picture below, but imagine the traffic levels with two lanes instead of three
	B2	Medium	
	B3	High	



5.3 Test drivers

More experienced and less experienced truck drivers (two levels) will be recruited for the simulator study. The objective is to investigate if less experienced (and therefore often younger) experience a drivers support system such as LISA in a different way compared to more experienced (and therefore often older).

All participants will be professional truck or bus drivers with experience of the international context.

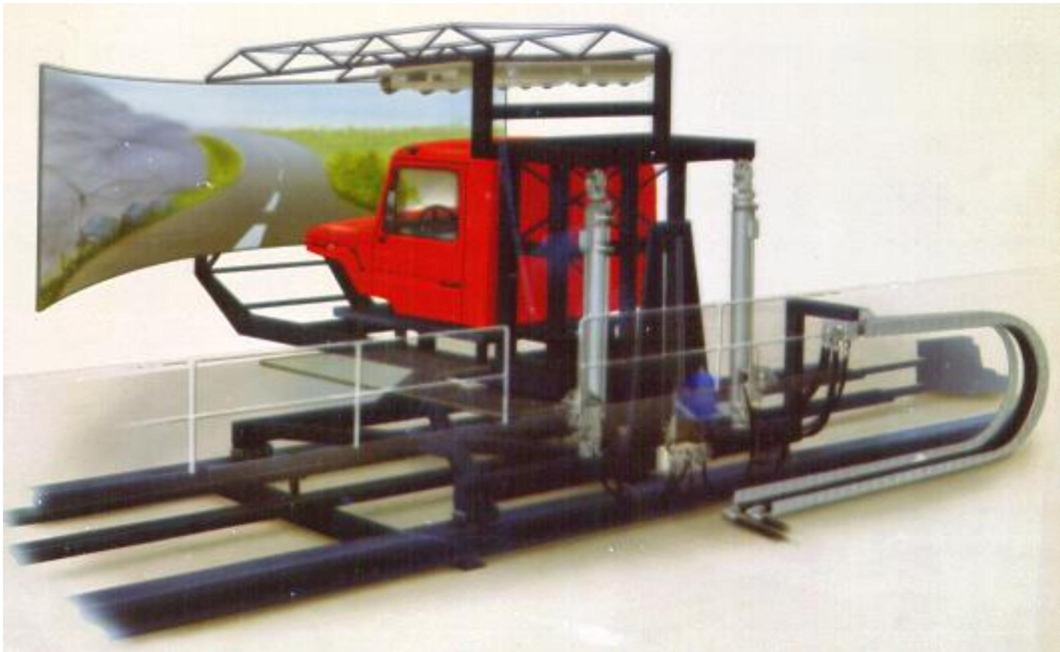
5.4 Simulator iterations

The objective is to complete 3 iterations with LISA in the simulator.

This means that LISA first version will be tested with a low number of participants. The results coming from this first run will be used as input to improve LISA or the simulator study set up. The iterative approach will be used in order to make sure that the simulator study will end up with, to some extent, more straightforward conclusion concerning traffic safety and the use of driver support systems such as LISA.

6 VTI simulator

The last chapter of this deliverable describes the simulator that will be used in the iterative simulator study evaluating LISA functionality.



6.1 General description

VTI simulator II is a moving base driving simulator with interchangeable cabins. Normally a Scania T112H cabin is mounted on the motion platform. The moving base system is a unique solution that has been designed and constructed by VTI. The simulator is situated at VTI's head office in Linköping.

6.2 Visual system

The visual system consists of 3 LCD projectors providing a 120 degrees forward field of view. Each projector has a resolution of 1024x768 pixels. 4-5 rear view mirrors are simulated: left and right side mirrors, left and right wide angle side mirrors and right side mirror. The front mirror is not included.

6.3 Moving base system

The moving base is used to generate forces felt by the driver while driving. It can be divided into 3 separate parts: a large linear motion, tilt motion and a vibration table. The linear drive operates in the vehicles lateral direction to simulate forces when cornering. The tilt motion is used in the roll and pitch direction to simulate long term accelerations such as driving in a curve or longitudinal acceleration and deceleration. The vibration table provides additional capabilities to generate road roughness for higher frequencies. While the tilt motion tilts both the cabin and the graphics projection screen, the vibration table moves the cabin relative to the projection screen. This feature is relatively unique to VTI's simulators II (and simulator III; passenger car) and gives a good possibility to create realistic inputs from the road. This has for example been used in some experiments to create a realistic sensation when driving on rumble strips.

6.4 Technical data

Motion system	
Pitch angle	± 24 degrees
Roll angle	± 22 degrees
External linear motion	
Maximum amplitude	± 3.5 m
Maximum speed	± 2.0 m/s
Maximal acceleration	± 0.4 g
Vibration table	
Vertical movement	± 5.0 cm
Longitudinal movement	± 7.5 cm
Roll angle	± 7 degrees
Pitch angle	± 4 degrees
Visual system	
Forward view	120 degrees
Rear view in three mirrors	
PC–based graphics	

6.5 Applications

VTI simulator II is mainly used for experiments involving heavy goods vehicles. It is the first hand choice when a realistic road sensation or sever cabin movements (e.g. tire rupture) is prioritised.

6.6 Simulator environment

A highway road, consisting of four parts of 40 km road, has been designed for ASSET-Road purposes. Each part represents one of the four country's Sweden, Germany, France and Italy. Between each country there is a border crossing with an EU sign where the new county name appear, an information sign with for the country special speed restrictions and a sign with the current speed. On every country stretch there is a part with road construction, a resting place and one exit ramp, with unique cultural surroundings. Every country has its one surrounding nature/vegetation. In the simulator scenario there is surrounding traffic both passenger cars and trucks.

6.7 Data collection tools

Several aspects could be measured during simulator studies, namely:

- Extended vehicle and environment data.
- Speed, acceleration, yaw, lateral position, road curvature, slope, wind, friction, etc.
- CAN-bus data.
- Psychophysiological data; such as EOG, EMG, ECG, EEG.
- Real time eye glance measurement of the driver.
- Gaze direction, target, transitions, etc.
- Various subjective scales.
- Sleepiness, workload, stress, etc.
- Complete video recording of driving sessions.
- Other data, such as grip pressure on steering wheel on demand.

Measures to be used in the Asset-Road experiment are still under specification.

6.8 Scenarios

Each scenario takes approximately 2 hours to drive across the four countries. In each country the driver have to decide if it is necessary to stop for a rest depending on the driving time and the regulation concerning this country.

The driving time will be shown on a prepared clock in the cabin. When the driver have stopped at a rest place in order to have a rest due to the driving time it will immediately be possible to start again.

In conclusion, the next step for this Work Package the ASSET-Road is to initiate the iterative simulator study. The objective is to investigate how a driver support system should be constructed in order to increase traffic safety in general and for truck drivers in particular.

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ANNEX A – Questionnaire for study in Europe

Questionnaire on Road Safety

Introduction

The traffic volumes on European roads increase continuously and every year more than 40.000 people are killed on European roads. That's why Road safety and smooth traffic are key issues for the future..

The aim of this questionnaire is to collect information about European driver's attitudes and opinion about Road Safety and their knowledge about national Traffic Regulations and Fining Procedures.

The objective is collect information from you and design new proposals for your own safety condition and advance information concerning traffic regulations and fines when driving along the European roads.

It is not necessary to identify yourself and your answers will be treated confidentially.

Thanks for your collaboration.

Please, choose one alternative for each question (or answer when required).

Confidential data

This questionnaire is anonymous: all results of this study will be restricted to aggregate data and will not identify any individual, institution, or firm. The data will not be made available to any other individual, agency, institution, or firm.

The data collected here will be treated as strictly confidential and used only for statistical analysis carried out in this project.

Section A - Background questions

Age Sex M F Nationality ____________________

Truck driver ☐ Bus driver ☐

1. When did you get your professional driving licence? (please specify the year) ____________________
2. Where did you get your driving licence? (please specify the country) ____________________
3. How long you have worked as a professional truck/bus driver? ____________________
4. What kind of vehicle do you use to drive for work? Please specify the model according to the classification in **ANNEX A** (end of the document) ____________________

5. **Please list 3 countries where you have driven the most along the last year, in order of frequency.**

Main country ____________________

2nd country ____________________

3rd country ____________________

6. **Do you have a routine destination you drive for work?**

Yes ☐ No ☐

If yes, please specify

How many hours/days does this routine last? ____ days ____ hours

How often do you drive this routine destination?

____ times a week

____ times a month

____ times a year

7. Do you also drive to other destinations different to the routine?

Yes ☐ No ☐

If yes, how often do you deliver goods (or passengers) to a destination different from the routine/common destination?

_____ times a week

_____ times a month

_____ times a year

Never ☐

Which was your last new destination? (city/country) ____________________

8. How many countries do you usually pass through during your journeys, including the country your trip starts?

A. 1 ☐ B. 2 ☐

C. 3 ☐ D. More than 3 ☐

Which are them? ____________________

9. Do you know all national traffic regulations and the level of fines of the countries you are passing?

Yes ☐ No ☐

If no, which country is most problematic? ____________________

10. Did you ever encounter any problem in understanding foreign road signs?

Yes ☐ No ☐

If yes, in which country? ____________________

Section B – Personal opinions

1. Please answer if you are a *truck driver*: what is your highest priority for heavy vehicle transports?

A. Delivery time	☐	B. Your comfort	☐
C. Your safety	☐	D. Follow laws and regulations	☐

Other (specify) ____________________

2. Please answer if you are a *bus driver*: what is your general priority for passenger transports?

A. Time schedule	☐	B. Passenger comfort and safety	☐
C. Your safety	☐	D. Follow laws and regulations	☐

Other (specify) ____________________

3. Do you collect information about your trip? Please select which ones (on the columns) in the following table, specifying WHEN and WHERE

		A. Information on roads access restrictions		B. Weather forecast	C. Traffic conditions and congestions	D. Obligations of snow chains or winter tires
		Vehicle restrictions	Time periods restrictions			
WHEN?	Before the trip					
	During the trip					
	After the trip					
WHERE? (information	Traffic signs					
	Colleagues					
	Radio					

		A. Information on roads access restrictions		B. Weather forecast	C. Traffic conditions and congestions	D. Obligations of snow chains or winter tires
		Vehicle restrictions	Time periods restrictions			
	Television					
	Websites					
	Navigator					
	Newspaper					
	Others (specify)					

4. Do you have a route guidance with GPS navigation system

Yes ☐ No ☐

If yes, which navigation system do you use in your truck or bus?

Brand ☐ Model ☐

5. What kind of warning system do you have installed on your truck/bus? Which of them do you prefer? Which you would like to have? Please select them (multiple choices allowed) putting an "X" on the empty boxes below.

	What do you have?	*What do you prefer?*	*What you would like to have?*
Speed alert			
Information about driving time			
Obstacle and collision warning			
Blind spot monitoring			
Lane departure warning			

Real-time traffic information (RTTI)			

6. What are in your opinion the most important driving factors regarding safety on rural roads and motorways? Please fill in the boxes a ranking from 1 to 9, where 1 means the most important.

A. Using safety margins		B. Driver status (psychological status, comfort, stress, etc)	
C. Speed limits		D. Reduce risky manoeuvres	
E. Avoid accidents		F. Keep alertness	
G. Drive sober		H. Slow reactions	

Other (specify) ______________________

7. From the next adverse conditions, rank in a scale from 1 to 6, from the most to the less dangerous for a safe driving, where 1 means the less dangerous.

Bad weather condition like rain, snow,, ice, wind…		Tired or drunk driver	
Vehicle condition like old, used tires, broken lights, etcetera.		Poor road maintenance condition	
Heavy traffic		Poor light and visibility condition	

8. What is your opinion about road signing in general?

A. It is clear and complete enough (Informative content and comprehensibility)		B. Could be improved in terms of clarity and/or completeness	

Other (specify) ______________________

Section C - Questions about regulations

1. With reference to Section A, Question 5: which is the legal speed limit for the vehicle you drive on motorways, main roads, urban roads in the main country you drive most? Please select one per road type.

A. Urban roads	50		60		70		80		I don´t know	
B. Main roads	50		60		70		80		I don´t know	
C. Motorways	70		80		90		100		I don´t know	

2. With reference to Section A, Question 5: which is the legal speed limit for the vehicle you drive on motorways, main roads, urban roads in the 2nd country you drive most? Please select one per road type.

A. Urban roads	50		60		70		80		I don´t know	
B. Main roads	50		60		70		80		I don´t know	
C. Motorways	70		80		90		100		I don´t know	

3. Do you use the lighting beams of the vehicle during the daylight in the main country you drive (Section A, Question 5)?

Yes ☐ No ☐

4. For how many working hours are you permitted to drive per day in the main country you drive mostly (see Section A, Question 5)?

A. 7h ☐ B. 8h ☐

C. 9h ☐ D. 10h ☐

Other (specify) ____________________

5. For how many working hours per week are you permitted to drive in the main country (see Section A, Question 5)?

A. 36h ☐ B. 42h ☐

C. 48h ☐ D. 52h ☐

Other (specify) ____________________

6. Are the same rules valid for driving hours in the EU countries?

A. Yes ☐ B. No ☐

C. I don't know ☐

7. In which conditions are you allowed in Europe to use the hard shoulder?

A. In case of an emergency or break down ☐ B. In case of heavy tra ☐

C. To overtake a slow vehicle ☐ D. Let the other vehicle overtake you ☐

E. I do not know ☐ ☐

Only in some conditions (specify) ______________________________

8. Is it mandatory for you (as truck or bus driver) to use the seat belt in your main country (see Section A, Question 5)?

A. Yes ☐ B. No ☐

C. I don't know ☐

Only in some conditions (specify) ______________________________

9. If you're a bus driver please answer: is it mandatory for passengers to use seat belt in your main country (see Section A, Question 5)?

A. Yes ☐ B. No ☐

C. I don't know ☐

10. Who perform the ordinary maintenance (i.e. planned, not in case of malfunction) of your brakes?

You ☐ Another one (specify who/where) ______________________________

How often?

A. Daily ☐ B. Monthly ☐

C. Every week ☐

Other (specify) ____________________

11. Which cause could most probably lead to overheating the brakes?

A. Malfunction ☐

B. Vehicle overload ☐

C. Braking frequently ☐

Other (specify) ____________________

12. Tyre condition: what minimum thread depth is stipulated for heavy vehicles in Europe?

A. 1.6 mm ☐

B. 20 mm ☐

C. 10 mm ☐

D. I don't know ☐

13. Are there any limits for BAC (Blood Alcohol Concentration) to drive in your home country?

A. Yes ☐

B. No ☐

C. I don't know ☐

If yes, what is the limit? ____________________

14. Any comments about this questionnaire?

____

____

____

____

____

ANNEX A

C1	> 3.5t, < 7.5t max. 8+1 < 750 kg
C1E	> 750 kg max. 12t
C	< 750 kg
CE	> 750 kg
D1	< 750 kg max. 16+1
D1E	> 750 kg max. 16+1 max. 12t
D	< 750 kg
DE	> 750 kg

ANNEX B – Personal opinions tables

trip information - before journey - driving time related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - before journey - driving time related	0	24	15	39
		1	41	38	79
	Total		65	53	118
2,00	trip information - before journey - driving time related	0	31	31	62
		1	34	31	65
	Total		65	62	127

trip information - before journey - weather related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - before journey - weather related	0	26	29	55
		1	39	24	63
	Total		65	53	118
2,00	trip information - before journey - weather related	0	30	47	77
		1	35	15	50
	Total		65	62	127

trip information - before journey - traffic related * bustruck * lessmore Crosstabulation

Count

lessmore	bustruck 1,00	bustruck 2,00	Total

1,00	trip information - before journey - traffic related	0	42	41	83
		1	23	12	35
	Total		65	53	118
2,00	trip information - before journey - traffic related	0	47	50	97
		1	18	12	30
	Total		65	62	127

trip information - before journey - snow tyre/chain related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck		Total
			1,00	2,00	
1,00	trip information - before journey - snow tyre/chain related	0	11	20	31
		1	54	33	87
	Total		65	53	118
2,00	trip information - before journey - snow tyre/chain related	0	14	27	41
		1	51	35	86
	Total		65	62	127

trip information - during journey - vehicle related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck		Total
			1,00	2,00	
1,00	trip information - during journey - vehicle related	0	48	39	87
		1	17	14	31
	Total		65	53	118
2,00	trip information - during journey - vehicle related	0	50	48	98
		1	15	14	29
	Total		65	62	127

trip information - during journey - driving time related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - during journey - driving time related	0	46	40	86
		1	19	13	32
	Total		65	53	118
2,00	trip information - during journey - driving time related	0	41	39	80
		1	24	23	47
	Total		65	62	127

trip information - during journey - weather related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - during journey - weather related	0	33	27	60
		1	32	26	58
	Total		65	53	118
2,00	trip information - during journey - weather related	0	38	29	67
		1	27	33	60
	Total		65	62	127

trip information - during journey - traffic related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - during journey - traffic related	0	23	15	38
		1	42	38	80
	Total		65	53	118
2,00	trip information - during journey -	0	20	20	40

	traffic related	1	45	42	87
	Total		65	62	127

trip information - during journey - snow tyre/chain related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - during journey - snow tyre/chain related	0	51	36	87
		1	14	17	31
	Total		65	53	118
2,00	trip information - during journey - snow tyre/chain related	0	50	55	105
		1	15	7	22
	Total		65	62	127

trip information - after journey - vehicle related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - after journey - vehicle related	0	63	52	115
		1	2	1	3
	Total		65	53	118
2,00	trip information - after journey - vehicle related	0	60	58	118
		1	5	4	9
	Total		65	62	127

trip information - after journey - driving time related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - after journey -	0	63	52	115

	driving time related	1	2	1	3
	Total		65	53	118
2,00	trip information - after journey - driving time related	0	63	61	124
		1	2	1	3
	Total		65	62	127

trip information - after journey - weather related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - after journey - weather related	0	65	53	118
	Total		65	53	118
2,00	trip information - after journey - weather related	0	64	61	125
		1	1	1	2
	Total		65	62	127

trip information - after journey - traffic related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - after journey - traffic related	0	60	53	113
		1	5	0	5
	Total		65	53	118
2,00	trip information - after journey - traffic related	0	61	61	122
		1	4	1	5
	Total		65	62	127

trip information - during journey - snow tyre/chain related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - during journey - snow tyre/chain related	0	51	36	87
		1	14	17	31
	Total		65	53	118
2,00	trip information - during journey - snow tyre/chain related	0	50	55	105
		1	15	7	22
	Total		65	62	127

trip information - before journey - vehicle related * bustruck * lessmore Crosstabulation

Count

lessmore			bustruck 1,00	bustruck 2,00	Total
1,00	trip information - before journey - vehicle related	0	14	18	32
		1	51	35	86
	Total		65	53	118
2,00	trip information - before journey - vehicle related	0	14	20	34
		1	51	42	93
	Total		65	62	127

ANNEX C – Questionnaire version for police

Questionnaire on Road Safety

Introduction

The traffic volumes on European roads increase continuously and every year more than 40.000 people are killed on European roads. That's why Road safety and smooth traffic are key issues for the future..

The aim of this questionnaire is to collect information about European driver's attitudes and opinion about Road Safety and their knowledge about national Traffic Regulations and Fining Procedures.

The objective is collect information from you and design new proposals for your own safety condition and advance information concerning traffic regulations and fines when driving along the European roads.

It is not necessary to identify yourself and your answers will be treated confidentially.

Thanks for your collaboration.

Please, choose one alternative for each question (or answer when required).

Confidential data

This questionnaire is anonymous: all results of this study will be restricted to aggregate data and will not identify any individual, institution, or firm. The data will not be made available to any other individual, agency, institution, or firm.

The data collected here will be treated as strictly confidential and used only for statistical analysis carried out in this project.

Questionnaire

Age		Sex	M	F	Nationality	

When did you get your professional driving licence? (please specify the year)

____

1. **Please list 3 countries where you have driven the most along the last year, in order of frequency.**

Main country ______________________________

2nd country ______________________________

3rd country ______________________________

2. **Which is the legal speed limit for the vehicle you drive on motorways, main roads, urban roads in the main country you drive most? Please select one per road type.**

D. Urban roads	50		60		70		80		I don´t know	
E. Main roads	50		60		70		80		I don´t know	
F. Motorways	70		80		90		100		I don´t know	

3. **Which is the legal speed limit for the vehicle you drive on motorways, main roads, urban roads in the 2nd country you drive most? Please select one per road type.**

D. Urban roads	50		60		70		80		I don´t know	
E. Main roads	50		60		70		80		I don´t know	
F. Motorways	70		80		90		100		I don´t know	

4. **For how many working hours are you permitted to drive per day in the main country ?**

E. 7h		F. 8h	
G. 9h		H. 10h	

Other (specify) ______________________________

5. **For how many working hours per week are you permitted to drive in the main country ?**

E. 36h		F. 42h	
G. 48h		H. 52h	

Other (specify) ______________________

6. Are the same rules valid for driving hours in the EU countries?

D. Yes ☐

E. No ☐

F. I don't know ☐

7. In which conditions are you allowed in Europe to use the hard shoulder?

F. In case of an emergency or break down ☐

G. In case of heavy tra ☐

H. To overtake a slow vehicle ☐

I. Let the other vehicle overtake you ☐

J. I do not know ☐

Only in some conditions (specify) ______________________

8. Who perform the ordinary maintenance (i.e. planned, not in case of malfunction) of your brakes?

You ☐ Another one (specify who/where) ______________________

How often?

D. Daily ☐

E. Monthly ☐

F. Every week ☐

Other (specify) ______________________

9. Which cause could most probably lead to overheating the brakes?

D. Malfunction ☐

E. Vehicle overload ☐

F. Braking frequently ☐

Other (specify) ______________________

10. Tyre condition: what minimum thread depth is stipulated for heavy vehicles in Europe?

E. 1.6 mm ☐

F. 20 mm ☐

G. 10 mm ☐

H. I don't know ☐

ANNEX D – Questionnaire for study in Tanzania

1. Gender of driver male female

2. How old are you? ____________ years

3. Nationality and Tribe ___________________________________

4. In which year did you get the driver's licence for cars _______________

   trucks ______________

5. For how many years have you been driving a truck? _________ years

6. In which two countries did you drive most during the last year?

	Country 1	Country 2
	____________________	____________________
How many kilometers approximately?	_______________ km	_______________ km

7. Please tell me some facts about the truck you are driving right now:

   Brand ________________________________

   Model ________________________________

   Year of manufacture ________________________________

   Weight ________________________________

   Current odometer reading ________________________________

8. Does your truck have seat belts? no ☐ yes ☐

If yes — Do you use the seat belt? no ☐ yes ☐

Do your passengers use the seat belt? no ☐ yes ☐

9. If a bulb of the light of your truck is broken, for how many km do you normally drive before replacing it? ____________________

10. On a trip like Nairobi-Dar, Dar-Mtwara, Dar-Mbeya, Dar-Kigoma, Dar-Mwanza, how many times do you normally have to stop for technical problems? ____________________ times

11. How often does it happen that you have problems in your truck with the following:

	daily	weekly	monthly	half-yearly	more seldom
lamps					
tyres					
brakes					
___________					

12. Does the truck get regular service?

☐ No

☐ Yes, from a fundi gari — How often? ______________

☐ Yes, from an authorised workshop/garage — How often? ______________

13. Do most truckers buy original or cheap (Chinese) spare parts when there are problems with the truck? original ☐ cheap ☐

14. What changes/modifications/new systems would you want to have in your truck?

____

____

____

____

15. What changes/modifications/new systems could improve the safety of your truck?

____

____

____

____

16. For how many hours do you usually drive without rest? ________________

17. In dry weather, at which speed do you usually drive

on straight rural tarmac roads ________________ km/h

on straight rural dirt roads ________________ km/h

through villages along rural roads ________________ km/h

18. Compared to the other drivers, are you

much worse	worse	approximately average	a bit better	a lot better
☐	☐	☐	☐	☐

19. How often do you think the following happens to fellow drivers?

	almost never	sometimes	often	very often	almost always
driving when sick					
driving whentired					
distracted while driving					
driving when drunk					
driving without seat belt					
driving while talking on phone					
driving too fast					
driving with too					

heavy load					

20. Do you usually collect pre-trip information about the road for your next trip?

☐ No

☐ Yes
- ☐ from my boss
- ☐ from gas stations
- ☐ from other people
- ☐ from the radio
- ☐ ________________

21. Have you ever been involved in a crash?

☐ No

☐ Yes, in ______ cases

____ with fatalities

____ with seriously injured

____ with slightly injured

22. What are the most common causes of crashes with trucks that you have heard of?

1. ____

2. ____

3. ____

23. How could the number of crashes be reduced?

1. ____

2. ____

3. ____

24. How do the following factors influence crash risk compared to driving alone on a tarmac road during daytime?

	decrease a lot	decrease a little	no change	increase a little	increase a lot
gravel roads					
driving at night on illuminated roads					
driving at night on unilluminated roads					

other vehicles on road					
people walking on road					
animals on road					
bad tyres					
bad brakes					
too much load					
driver tired					
driver talking to passengers					
driver talking on cell phone					
driving far without rest					
driving at high speed					
not using seat belts					
driving when sick					
driving drunk					
rain/mud and slippery road					
load secured badly					