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TRACE Project. Deliverable 1.3. Road users and accident causation. Part 3: Summary report

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Deliverable 1.3
Road users and accident causation.
Part 3: Summary report

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Abstract:

This report aims to present the final results of the descriptive statistical, in-depth and risk analysis performed within TRACE Work Package 'WP1-Road Users', in order to identify the main problems and the magnitude of these problems related to accident causation and risk factors for the following five different road user groups: passenger car drivers; powered two wheelers riders; van, bus and truck drivers; pedestrian and cyclists and, finally, elderly people and gender classification.

The different analysis (descriptive, in-depth and risk) of each of these five tasks has been performed using the available European accident databases within TRACE (national, in-depth and exposure databases).

The objectives achieved in this WP are:

- To obtain the relevant macroscopic characteristics for each group of road users of road traffic accidents through the use of the available extensive databases.
- To identify the specific accident causes for each group of road users at microscopic level analysing available intensive databases.
- To estimate the risk of being involved in an accident for the different road user categories.

Keyword list:

Descriptive analysis, in-depth databases, risk factors, accident causation, road user groups, passenger cars, powered two wheelers, buses, trucks, vans, pedestrians, cyclists, elderly people, gender.

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1 Introduction

Road safety at European level constitutes one of the major social problems nowadays. Although only 1%¹ of European deaths come from road traffic accidents it accounts for 42,953 people killed in Europe in 2006². In spite of a decreasing trend of traffic accidents casualties can be observed during the last decade across the European level nevertheless, almost 1,700,000 casualties every year in Europe constitute an unacceptable social and economic cost for society. Because the reduction in road traffic injuries is a challenge, the European Community has been trying for many years to promote initiatives through the different Framework Programs in order to contribute to the safety effort. However, without a real safety target, a common commitment is not possible and the progress (in term of road safety) is difficult to evaluate.

This is why, in 2001, the European Commission published its 'White Paper' on transport policy (European Commission 2001), in which the main research axes to be improved and quantified targets are determined for road traffic safety. The short-term strategic objective is to halve the number of fatalities by 2010 compared to 2001. The medium term objective is to cut the number of people killed or severely injured in road accidents by around 75% by 2025, while the long-term vision is to render road transport as safe as all other modes. It is hoped that supporting research addressing human, vehicle and infrastructure environment could achieve this last strategic target. Research should also combine measures and technologies for prevention, mitigation and investigation of road accidents paying special attention to high risk and vulnerable user groups, such as children, handicapped people and the elderly. As it can be shown in the following figure, although the trend is decreasing, too many aspects should be applied into the road world (politician decisions, safety measures, driving training,...) to gather this important objective.

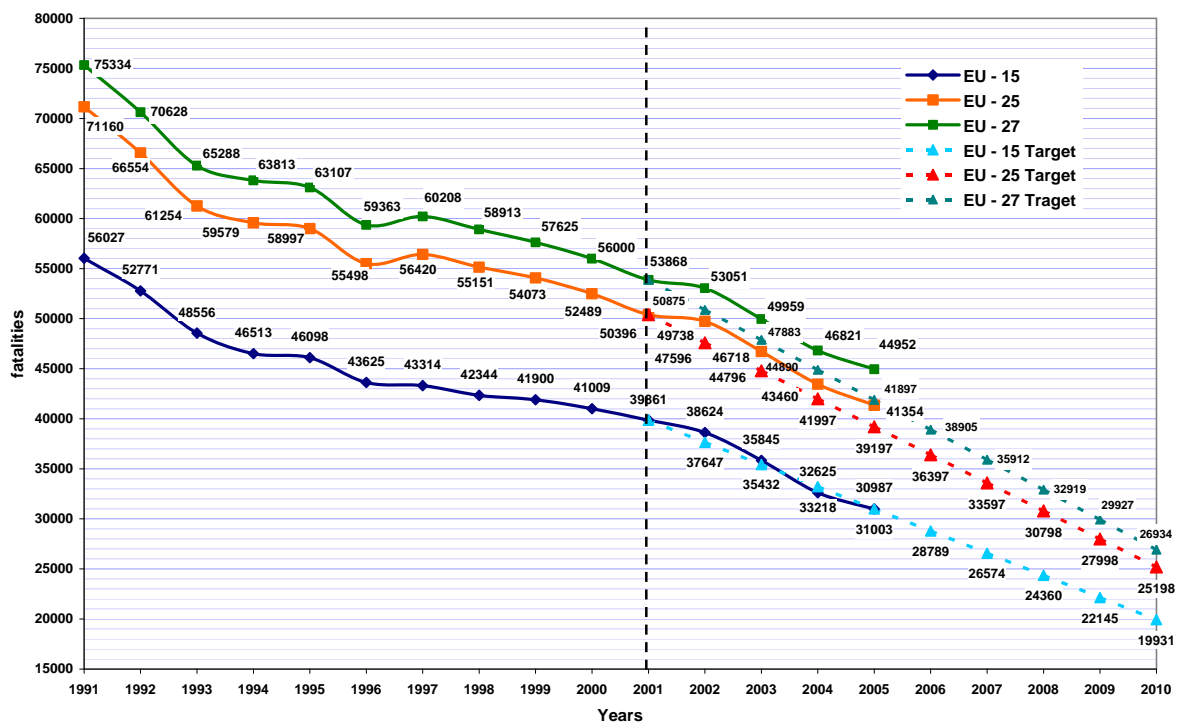


Figure 1.1.- Road Safety evolution in EU-27³.

¹ European Detailed Mortality Database, .2007. World Health Organisation.

² CARE reports: Road safety evolution in EU (December 2007).

³ CARE, IRTAD, IRF and National Databank Statistics.

Because the reduction of road traffic injuries is a challenge, the European Community has been trying for many years to promote initiatives through the different Framework Programs in order to contribute to the safety effort. The Commission has expressed two kinds of interest as regards accident analysis:

- ✓ Research in consistent accident causation analysis to gain a detailed knowledge about the real backgrounds of European traffic accidents using existing data sources.
- ✓ Research to assess the potential impact and socio-economic cost/benefit, up to 2020, of stand-alone and co-operative intelligent vehicle safety systems in Europe.

Within this context, TRACE project (TRAffic Accident Causation in Europe) is aimed at developing a scientific accident analysis encompassing two main issues:

- ✓ The **determination and the continuous up-dating of the aetiology**, i.e. causes, **of road accidents** under three different but complementary research angles: road users, types of situations and types of factors.
- ✓ The **identification and the assessment** (in terms of saved lives and avoided accidents), among possible technology-based safety functions, **of the most promising solutions that can assist the driver or any other road users** in a normal road situation or in an emergency situation or, as a last resort, mitigate the violence of crashes and protect the vehicle occupants, the pedestrians, and the two-wheelers in case of a crash or a rollover.

1.1 Objectives of TRACE Project

The **general objective of TRACE project** (TRAffic Accident Causation in Europe) is to provide the scientific community, the stakeholders, the suppliers, the vehicle industry and the other Integrated Safety program participants with **an overview of the road accident causation issues in Europe**, and possibly overseas, based on the analysis of any current available databases which include accident, injury, insurance, medical and exposure data (including driver behavior in normal driving conditions). The idea is to identify, characterise and quantify the nature of risk factors, groups at risk, specific conflict driving situations and accident situations; and to estimate the safety benefits of a selection of technology-based safety functions.

In accordance with these objectives, TRACE has been divided into the following three series of Workpackages (WP):

- ✓ The **Operational Workpackages** ('WP1: Road Users'; 'WP2: Types of driving situations and types of accident situations'; 'WP3: Types of risk factors' and 'WP4: Evaluation of the effectiveness of safety functions in terms of expected (or observed) accidents avoided and lives saved') propose three different research angles for the definition and the characterisation of accident causation factors, and the evaluation of the safety benefits of safety functions. Accident causation analysis is to be analysed from three different research angles that will allow offering an integral understanding of the different accident configurations. Those are:
 - The Road Users approach (WP1: Road Users).
 - The Situations approach (WP2: Types of Situations).
 - The Factors approach (WP3: Types of Factors).

- ✓ The **Methodologies Workpackages** ('WP5: Analysis of Human factors'; 'WP6: Determination of Safety Functions' and 'WP7: Statistical Methods') propose to improve the methods actually used in accident analysis, and to transfer these improvements to the operational Workpackages.
- ✓ And finally, the **Data Supply Workpackage** ('WP8: Data Supply') prepares and delivers to the operational Workpackages, for analysis, the data tables constituted from various European data sources.

In the following figure, TRACE objectives and structure are shown:

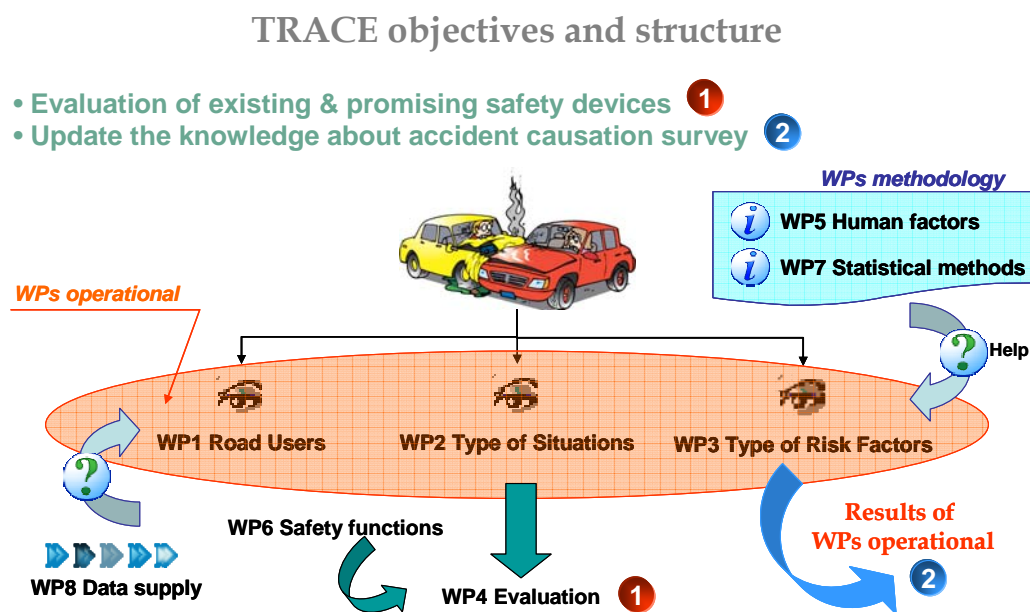


Figure 1.2.- Main TRACE objectives and structure of the different Work Packages.

1.2 'Work Package 1: Road Users'

1.2.1 WP1 description

Obtaining a better understanding of the causes of the accidents is a difficult task that needs to study many different aspects. Any detailed look at real accidents shows that very often it is not possible to establish the only cause of an accident, but it is necessary to use a holistic approach taking into account a mixture of several parameters (human factor, vehicle characteristics, environment, type of accident, situation, etc.).

In this Work Package, **the analysis of the different issues and specifications of each of the user groups (Tasks) related to accident causation is addressed.** Each one of the tasks of this WP is focused on the following specific group of road users:

✓ **Task 1.1: Passenger Car Drivers.**

This task will try to organise the acquired knowledge according to the macro - micro - risk split and to perform additional analyses specially on accident involving newer cars in order to get a prospective view of the remaining factors of accidents that we will observe 5 to 10 years ahead when all cars will be equipped with devices that already proved effectiveness.

✓ **Task 1.2: Powered Two Wheeler (PTW) Riders.**

Motorcycles and mopeds plays one of the most important roles in the traffic system. There are some specific characteristics of this user group that need to be addressed in this Task: relationship between motorcycles and other vehicles, conspicuity, rider psychological characteristics, training and education of PTW riders, road alignment and infrastructure ...

✓ **Task 1.3: Van, Bus and Truck Drivers.**

At macro level, it is intended to use intensive databases from the police records and insurance files, analysing the data with the main focus on available causation data broken down by different variables. At micro level, other parameters related to accident causation will be analysed in-depth: fatigue, alcohol, speed, visibility, distance to other vehicles, ... At last, the analysis of exposure data will allow obtaining the risk of the accident.

✓ **Task 1.4 Pedestrian and Cyclists.**

The approach to perform the work in this Task is based on the principle of improving road safety for vulnerable road users looking into the effect of safety functions on pedestrians and cyclist safety. Risk factors and situations that apply to them will also be evaluated, taking into account statistical information on accidents and in-depth studies.

✓ **Task 1.5 Elderly people and Gender related accidents.**

The objective of this task is to analyse the specificity of the difficulties encountered by these groups inside the traffic system. These two populations are commonly poorly studied, and tend too often to be analysed according to stereotypes. Their accidental problems will be examined in logic of comparison with other road users.

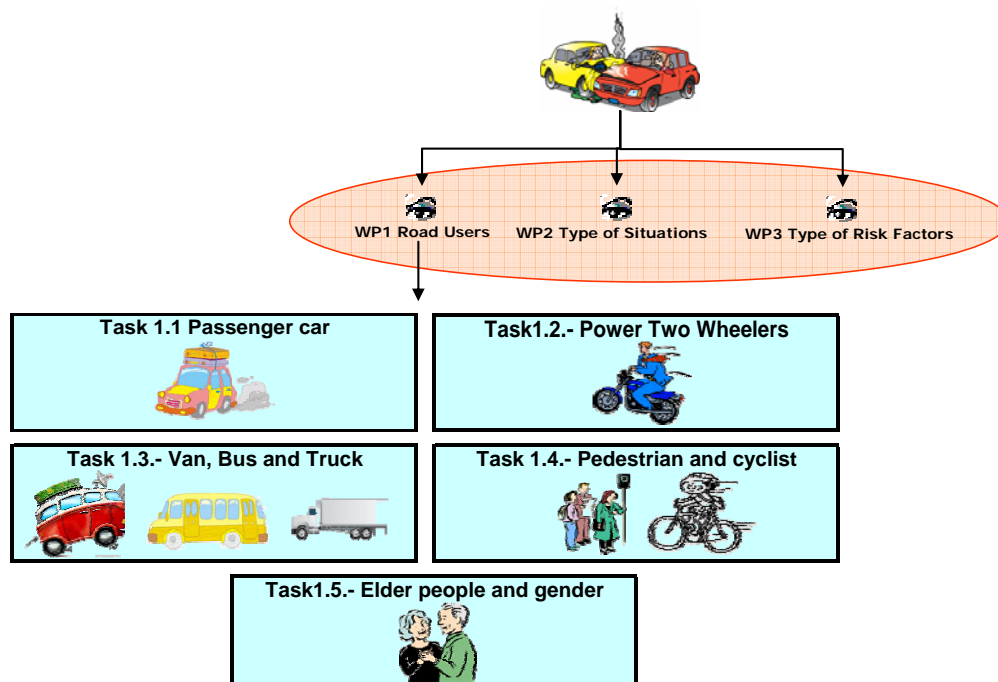


Figure 1.3.- Different road user groups (tasks) planned in WP1.

Within the framework of the first four tasks, it is intended to address the specifications of the different means of road transport and their potential influence in the causation of the accidents. However, the last task deals with the identification of the common accident causation issues for elderly people and also taking into account the differences, if any, between male and female users, without dealing with a specific mean of transport.

1.2.2 Overview of the problem

It seems reasonable that every type of road users may have a different perception of the driving task and also may tackle different difficulties when driving. The identification of the causation mechanisms for each type of road user is to allow the development of specific safety solutions addressing their particular needs. Although passenger cars represented in 2004, 87% of the total vehicles in use⁴, it can be observed in the following figures that passenger cars do not present the same percentage of road fatalities. According to that, it is worth analyzing what are the safety problems encountered by the different road users while performing the driving task.

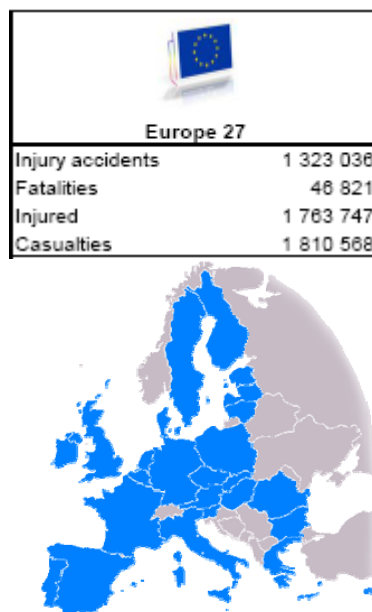



Figure 1.4.- General overview in EU-27⁵ (2004).


In the following figures, it can be shown that passenger cars represent a 52% of road fatalities, while vulnerable road users (PTWs, pedestrians and cyclists) account for 42%, while only 5% of fatalities do occur within big vehicles like trucks, vans and buses. It has to be taken into account that due to the typical dimensions and mass of big vehicles, that allow them to transmit a huge energy in the event of crash they can provoke severe injuries to other road users and, therefore, their accident causation issues are also worth being studied. Moreover, drivers do not have the same capacities across their driving life and therefore the mechanisms that induce them to commit failures might also be different according to the driver age. The following figures can provide the most current situation in EU-27⁶:


⁴ ANFAC, 2004 European Motor Vehicle Park (2006). Provided by TRACE Work Package 8.4 (Preparation and Comparison of Risk Exposure Data).


⁵ Statistics of Road Traffic Accidents in Europe and North America. United Nations, 2007. Although, until 1st January 2007 Europe there were not 27 countries in Europe, through this source it has been possible to obtain data for EU-27 in 2004 from road user point of view. Although more current data are available at EU-27, it has been decided to use year 2004 with the goal of compare with road user data (only full data available for this year 2004).

⁶ Statistics of Road Traffic Accidents in Europe and North America. United Nations, 2007.

Passenger car		
		
Fatalities in the passenger car	24 136	52%
Injured in the passenger car	1 021 273	58%
Casualties in the passenger car	1 045 409	58%

Power Two Wheelers		
		
Fatalities in the PTW	7 084	15%
Injured in the PTW	288 277	16%
Casualties in the PTW	295 361	16%

Van, Bus and Truck		
		
Fatalities in the van, bus and truck	2 229	5%
Injured in the van, bus and truck	39 174	2%
Casualties (in the van, bus and truck)	41 403	2%

Pedestrian and cyclist		
		
Fatalities (pedestrian and cyclist)	12 450	27%
Injured (pedestrian and cyclist)	326 142	18%
Casualties (pedestrian and cyclist)	338 592	19%


Elder people and gender		
		
Fatalities elder than 65 years		19%
Female fatalities		23%
Male fatalities		77%

Figure 1.5.- Overview of the problem from each road user point of view in EU-27⁷.

⁷ Statistics of Road Traffic Accidents in Europe and North America. United Nations, (year 2004).

Finally, in the following figures, the most current trends (fatalities) are shown for each road user group (the four first tasks). It can be observed that, although the whole number of fatalities is decreasing, there is a slight increase of fatalities related to the whole number of vulnerable user groups (pedestrians, mopeds, mopeds, motorcycles and cyclists).

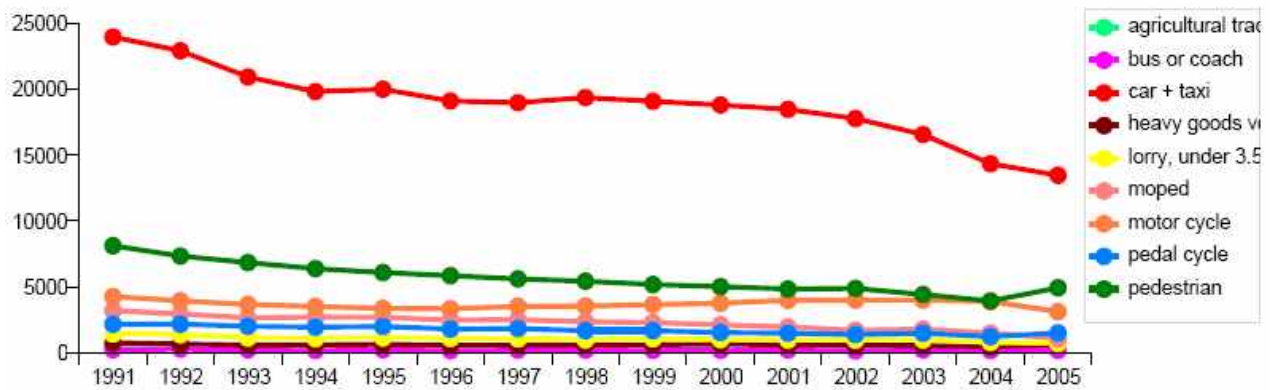


Figure 1.6.- Fatalities by transport mode in EU countries (included in CARE) – March 2008.

(Passenger car // Mopeds and Motorcycles // Vans, buses and trucks // Pedestrians and Cyclist).

1.2.3 WP1 Partners

In the following figure, the partners involved in this work package are detailed. Seven institutes were working to gather the objectives planned in this deliverable.

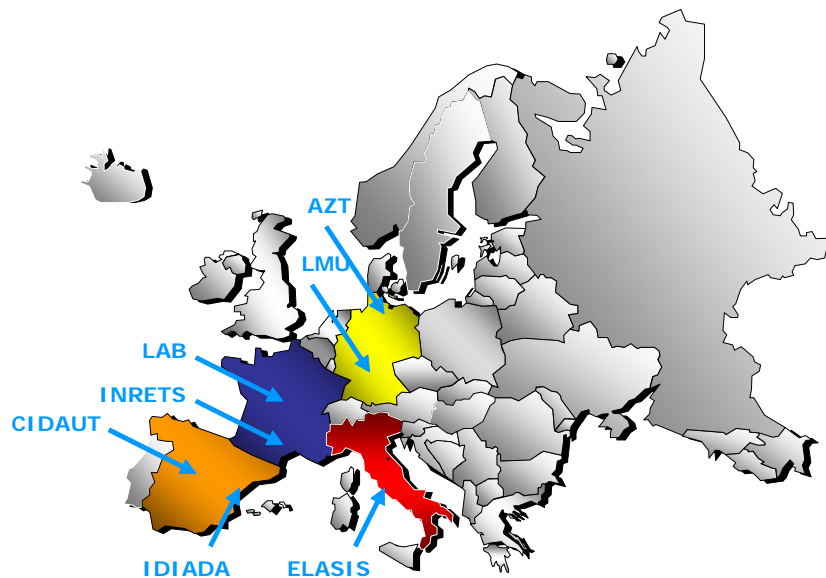


Figure 1.7.- Partners involved in WP1.

1.2.4 WPI objectives and methodology

The methodology of Work Package 1 is much related with its technical objectives that could be summarized as follows:

- ✓ To obtain the relevant **macroscopic characteristics for each group of road users** of road traffic accidents through the use of the available extensive databases.
- ✓ To identify the specific **accident causes for each group of road users** at microscopic level analysing available intensive databases.
- ✓ To estimate the **risk of being involved in an accident for the different road user** categories.

Each of the above objectives needs of different data and different analyses in order to be successfully achieved and none of them can be performed without the execution of the previous one as accident causation analysis is not a simple research issue that can be inferred from general accident statistics.

In the first place, a literature review has been made to know which are the most important aspects related to accident configurations and accidents causes from the five task points of view. Secondly, it has been intended to look at national or European data to understand the potential problems and the size of those problems (macro level analysis). In third place, in this WP an analysis of in-depth accident databases has been performed to understand the nature of the problem (micro level analysis), with a strong focus on human behaviour before and during the pre-impact phase. At last, the relative risk of being involved in an accident has been identified for the different road user groups. So, the work has been developed in four steps for each of the five tasks mentioned above:

1. Literature review.
2. Descriptive statistical analysis.
3. In - depth analysis.
4. Risk analysis.

Specifically, these four levels of steps will consist on:

1.2.4.a Literature review

The first step for Work Package 1 tasks is to perform a detailed *literature review* covering for each of the road users the following issues:

- ✓ The existing knowledge on the main accident configurations (groups of accidents that offer a number of similarities that may answer to the questions like Who?, When?, Where?, How?, gathering a relevant number of fatal and serious casualties). This previous knowledge is aimed at improving the focus of the macroscopic analysis.
- ✓ The methodologies applied for the investigation of accident causation and risk analysis and the type of data necessary to use them.
- ✓ Main causation factors already linked by research activities to the different configurations for each group of road users.

1.2.4.b Descriptive statistical analysis

The next step for Work Package 1 analysts is to perform a *macroscopic descriptive analysis* upon national accident databases (extensive databases). The main objective is to obtain the most relevant accident configurations for each road user group in terms of fatal and serious casualties together with a general description. This macroscopic analysis is to group accidents according to relevant similarities and their associated number of fatal and serious casualties. This may seem rather fast to obtain but that is not the actual case. Detailed and specific analyses have to be done upon the

extensive database in order to group the accidents properly. The main variables to be researched address the following topics:

- ✓ Where did the accident occur? (Type of road, road layout, ...) What were the conditions of the environment? (weather conditions, luminosity, possible visibility obstructions, ...)
- ✓ Who was the opponent, if any, of the road user under analysis?
- ✓ How did the accident occur? (Type of collision, driver actions, ...)
- ✓ Who was the user involved? (Age, experience, physical conditions, ...)

Cross tabulation data of the above issues are addressed within this step. The main data used for this analysis was provided by **Work Package 8 ('Data Supply')**, where all partners with access to extensive databases are able to provide the necessary information. Work Package 1 analysts defined the tables they needed to identify the accident configurations through the use of the correspondent templates created by Work Package 8. Also, during this step, '**Work Package 7: Statistical Methods**' provided an innovated methodology to extend the results at EU-27 level from the descriptive analysis over National databases available to TRACE.

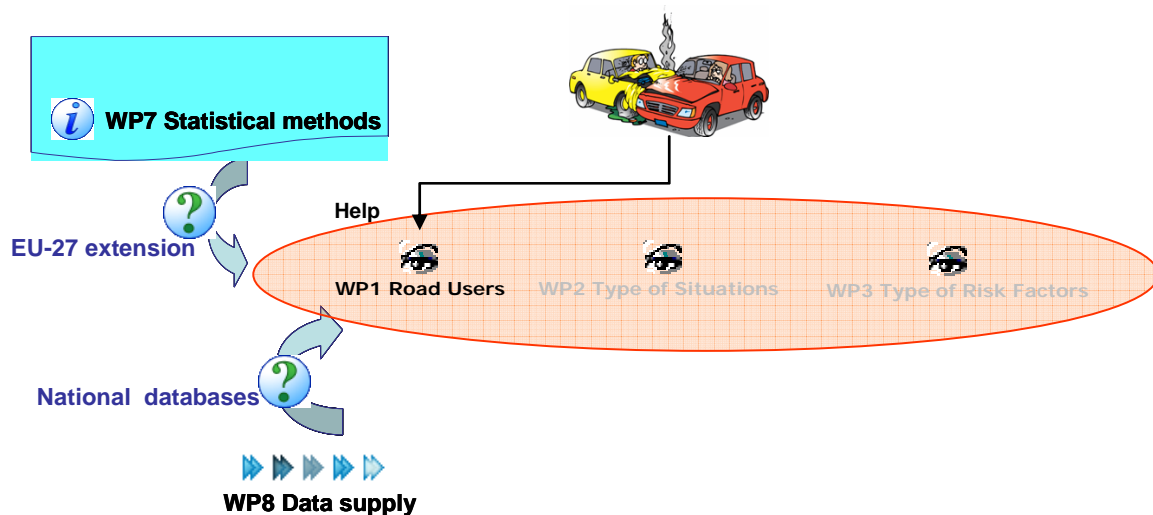


Figure 1.8.- WP8 and WP7 interaction with WP1 in Descriptive analysis.

The results of the above two first steps of this Work Package are the main issue of the first report 'Deliverable D1.1 Road users and accident causation. Part 1: Overview and general statistics' and, therefore, it does not provide any final conclusion on the accident causation mechanisms of road user groups. Nevertheless, it is able to provide the main general accident configurations for each one of the road users. This is why this report provides what the important safety problems are according to the different road user groups. All the following methodological steps were applied only analysing these configurations.

1.2.4.c In-depth analysis

The third step is the *microscopic or in-depth analysis* through a detailed analysis of microscopic databases. As the descriptive analysis is able to provide the representative accident configurations, this step is aimed at obtaining more detail on information that cannot be gathered in national police accident databases tackling those configurations. This type of information is essential to the addressing of accident causation and can only be obtained through the analysis of in-depth databases.

A similar procedure to descriptive one is to be followed so as to obtain the appropriate data from **Work Package 8** of this type of databases (intensive databases). Once the main analyst has performed a first analysis on their in-home in-depth accident database, a link is to be developed with WP8 in order to obtain similar information from other databases.

Finally, a relationship was established with methodological **Work Package 5 'Human Factors'** with the aim of applying a method to determine the possible Human Function Failures (HFF) in road accidents, and then understand in a better way how the accident happens.

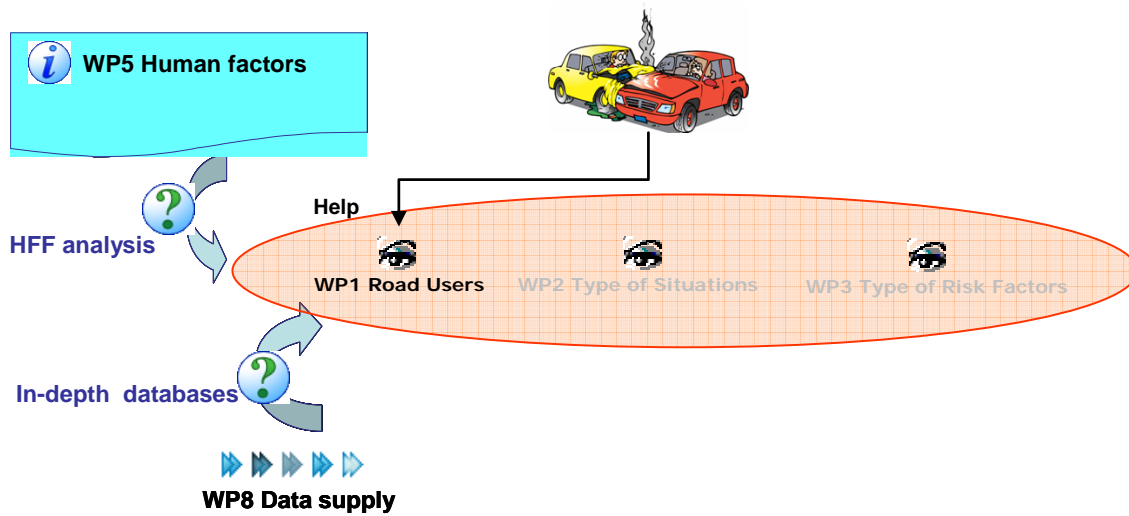


Figure 1.9.- WP8 and WP5 interaction with WP1 in the In-depth analysis.

1.2.4.d Risk analysis

Last, a *risk analysis* was performed in Work Package 1 in order to assess the risk for a road user of being involved in an accident. In this issue, exposure data (data from **Work Package 8** about the level of exposition to the different risk factors identified in the previous analyses) is a key issue as it will determine the type of statistical risk that each task is able to estimate (absolute risk, relative risk, ... explained in the 'methodological statistical reports' from the '**Work Package 7: Statistical Methods**'). On this stage, Work Package 7 played also a key role contributing to determine the appropriate statistical methods to be applied upon each kind of data.

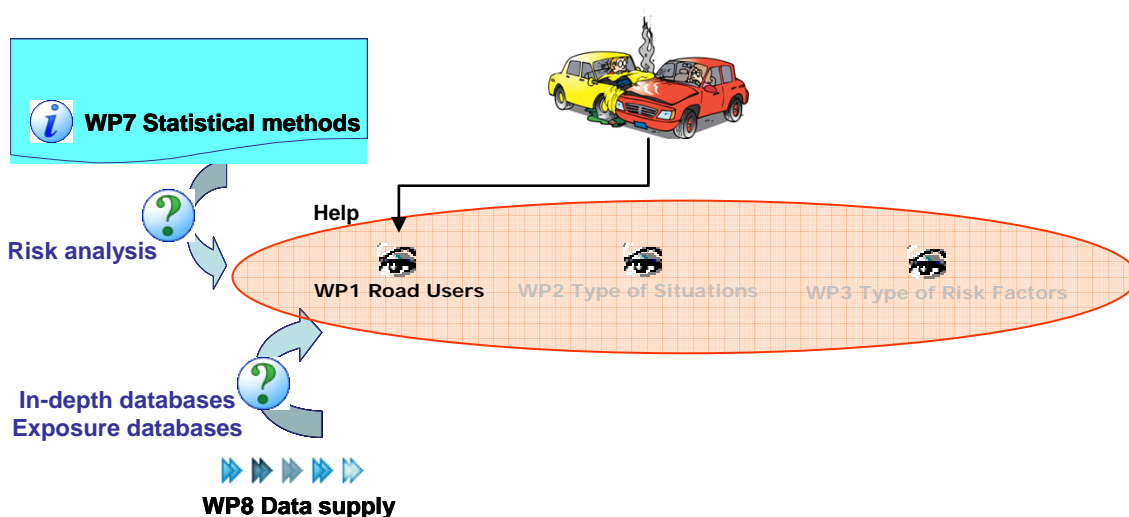


Figure 1.10.- WP8 and WP7 interaction with WP1 in the Risk analysis.

The results of the last two steps (In-depth and Risk analysis) of this Work Package 1 were covered in deliverable D1.2 'Road users and accident causation. Part 2: In-depth accident causation analysis'.

In the following figure, these four steps are shown as well as the expected outputs from each step in the Work Package 1.

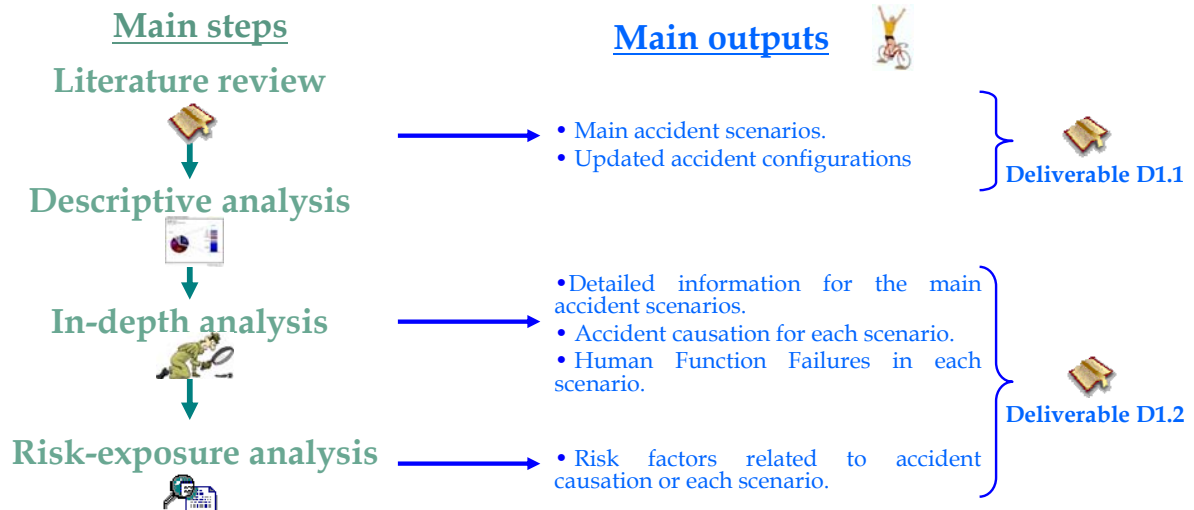


Figure 1.11.- Main steps and expected outputs planned in WP1.

1.2.5 Deliverable D1.3

The present deliverable **D1.3** will summarize the main results from the whole TRACE project related to the Work Package 1. It is important to remark that the whole methodology used in each task (road user) will not be detailed in this report, therefore for further information or details, it is recommended to consult Deliverable D1.1 and Deliverable D1.2 of this WP:

- ✓ 'Deliverable D1.1: Road users and accident causation. Part 1: Overview and general statistics'.
- ✓ 'Deliverable D1.2: Road users and accident causation. Part 2: In-depth accident analysis'.

1.2.5.a Main challenges

At the beginning of this deliverable (therefore, at the beginning of the Work Package 1), specific challenges were detected to be overcome:

- A Diagnosis of traffic safety problems at the European Level from the research angle: Road Users.
- Four aspects to study: Literature review - Descriptive statistics - 'In-depth analyses and Risk analyses.
- Rely on a set of various national, in-depth and exposure accident databases.

1.2.5.b Expected outputs

The achievement of these challenges has implied the obtaining of the expected output in this deliverable:

- Update diagnosis of road traffic safety in Europe.
- Define and update the main accident scenarios from each road user point of view (at descriptive analysis) for the following steps in 'Work Package 1' (In-depth and risk analyses).

- The main causes related to each road user.
- Identify the specific accident mechanism and the main issues from each road user accidents. To obtain a pictogram or a figure of each road user allowing to understand these accident mechanisms.
- Characterize each relevant road user scenario by risk analysis indicator.
- Understanding the main accident configurations from each road user point of view instead of from the whole accident point of view.
- This understanding will help for:
 - The determination of the most promising safety systems (interaction with 'Work Package 6: Safety Functions').
 - The evaluation of the effectiveness of existing safety devices (interaction with 'Work Package 4: Evaluation').
 - The identification of the configurations not addressed by present technologies.

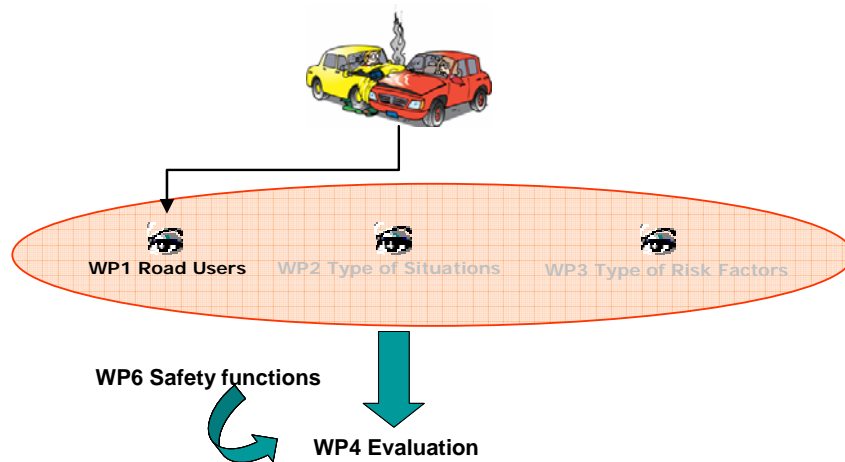


Figure 1.12.- WP6 and WP4 interaction with WP1.

1.2.5.c Structure of the deliverable

The structure of this last deliverable from WP1 will be:

- ✓ Introduction: An overview of the problem, an introduction of TRACE project and an explanation of WP1 has been given in this chapter.
- ✓ For each out of the five tasks (road user) studied in this Work Package, main results will be detailed related the four steps carried out in WP1:
 - Literature review.
 - Descriptive statistical analysis over the National accident database available to TRACE partners.
 - In-depth analysis of the main accident configurations (detected in the descriptive level).
 - Risk analysis.
- ✓ Conclusions: A brief discussion about the work done in this WP will be showed at the end of this deliverable.

2 Task 1.1: Passenger Car Drivers

Passenger car accidents represent a big issue for road safety. Indeed, the car is the most popular and used transport mode in Europe compared to bus, coach, and railway transport... The general trend shows an increase of its use of 16% from 1995 in Europe 25.

In spite of a significant work done to reduce road fatalities, it is necessary to identify the main problems and the magnitude of the problems related to the causation of the accidents involving a passenger car – as road accident is still one of the main causes of fatalities.

The intention of the descriptive statistical analysis is to obtain the situations/factors/parameters (targets) where likelihood of having an accident is high from the point of view of passenger car road user.

In Europe 27, these accidents, involving at least one passenger car, represent 81% of road injury accidents, 71% of the fatalities and 94% of the casualties.

From 2001 to 2004, in EU27, there is a reduction of road accident fatalities but the decrease of fatalities is higher in EU15 than in newly-entered countries in EU25 or EU27. We can see that fatalities in passenger cars decrease faster than the global decrease of fatalities in Europe. We can found differences between EU15 and new countries in EU27, especially in term of risk, where the risk to be killed in passenger car is more important in the new countries from EU25 and EU27.

These are the general conclusion of descriptive analysis for the issue of passenger accidents:

- ✓ Around 80% of injuries accidents and fatalities in accidents involving at least one passenger car occur in good weather conditions
- ✓ Two thirds of passenger car injury accidents occur inside urban area (no motorway) while more than half of fatalities are outside urban area (no motorway)
- ✓ Three fourth of passenger car injury accidents occur at daytime whereas one third of fatalities are during the night
- ✓ The passenger car accidents at intersection represent 45% of passenger car injury accidents, 42% of the total casualties (fatalities and injured) in passenger car accidents and 21% of the fatalities in passenger car accidents
- ✓ Two configurations of injury accidents can be distinguished and cover 40% to 60% of all injury accidents: single passenger car accidents (this accident configuration contributes at least in the 6 national databases to 25% of fatalities in passenger car accidents) and passenger car vs. passenger car (no pedestrian and no other vehicle)
- ✓ Accidents with vulnerable road users (pedestrians, bicycles, power two-wheels) are significant
- ✓ Young drivers (especially drivers aged from 18 to 25) and elderly drivers (aged from more 65) mainly contribute to road fatality. They represent from 23% to 53% in countries of EU of accidents involving at least one passenger car.

The data in the literature corroborate some of these results. Some studies have focused on passenger car accidents causations and have highlighted different issues for them like, the loss of control or guidance problems, accident in intersection, driving speed, young people, alcohol, fatigue... Some of these issues will be discussed to the next section, i.e. the in-depth data analysis.

To conclude, the analysis of in depth data provide more precise answers to the questions posed by the study of European data and we will study notably two accident configurations: single passenger car accidents and multiple collisions involving at least one passenger car.

2.1 Results from in-depth accident analysis

In relation to the questions raised by the descriptive analysis of the statistical data presented above, this part of the study presents a detailed qualitative accident analysis. The whole sample from which this in-depth investigation using WP5 methodology was performed, bringing together 1,676 road users involved in 1,067 accident cases. Among these casualties we have retained 1303 passenger cars drivers, this sample being split in two sub groups:

- ✓ The single car drivers (234 users, i.e. 18% of the whole sample),
- ✓ The passenger cars drivers involved in accident with another user (1069 drivers, representing 82% of the whole sample of passenger cars).

Our analysis dealt with observables differences inside this sample concerning the functional stages involved in the passenger cars' driving activity. The occurrence of failures leading to an accident was then studied for each sub group as a function of the elements involved in its production.

From the overall in-depth analysis carried out on the whole sample (1303 drivers), several aspects of passenger cars drivers' accident specificities can be retained.

When looked from the angle of human functional failures, it can be noted that cars drivers are particularly prone to perception errors, this category of failures being observed in 35.7% of the cases that compose the sample. The pre-accident situations that were identified the most are spread between the driving 'Stabilized' situations and the tasks to perform when managing intersection crossings ('Going ahead on a straight road' in 15.2% and 'Crossing intersection with a priority vehicle coming' in 12.7% are the most frequent pre-accident situations observed in the sample).

The study of explanatory elements also brings information on the way functional failures occur. Several elements come out ('Atypical manoeuvres from other users', 'Road over familiarity or monotony of the travel', 'Choose of a too high speed for the situation', etc.), but it can be seen that again the distribution of the elements is wide-spread.

These results shed light to the interest of looking at the data in a more relevant way than the overall one, so specificities can emerge more clearly. In line with what has been found in the descriptive analysis, two sections have been developed in order detail the analysis of two groups of passenger cars described earlier:

1. Single cars accidents
2. Cars vs. other road users.

When analysed separately, the drivers of the single car accidents sample feature a specific profile.

Firstly because their accident happens when the task to perform is quite simple: the pre-accident situations are always related to stabilized situations and more specifically to guiding the vehicle on the carriageway (either on straightway road or during curve negotiation).

Additionally, the human functional failures associated to those drivers are typical of losses of control. Here are found, in 2 cases out of 5, handling difficulties (associated with attention impairment in the case of E2 failures or external disturbance such wet carriageway or wind blast as in E1 failures). The losses of psycho-physiological capacities are also found in the same proportions (38.7%) as being the cause of the single car accident. This loss is mainly due to psychotropic intake (alcohol for the

major part of the drivers) as featured in G2 failure, but the drivers falling asleep account for 15.4% of those accidents.

At last, in 1 case out of 5, the drivers have had troubles to perform a correct evaluation of a road difficulty (T1 failure).

Those losses of control are related to changes in road situations in almost 1 case out 4 but the layout is not the only element that should be underlined here. The majority of factors listed in this section are endogenous, that is associated to drivers' states or their conditions of task realization. What is found as having an influence on the losses of control are: in one third of the cases, the alcohol intake; the speed chosen by the drivers (36.7%); the level of attention allocated to the driving task; and at last the level of experience of the road users, either concerning their driving knowledge, the familiarity they have of their vehicle or of the location of the accident.

All these explanatory elements have a role when combined one to each other until the drivers fail to perform the task, although quite simple, as if this particular association of parameters was having influence on the most rooted abilities developed in driving activity, the skill-based ones.

On the other hand, the accident mechanisms observed for the group of multi-vehicles collisions are various.

First in the tasks to realize: they cover many pre-accident situations and concern stabilized situations as well as intersection crossing of specific manoeuvres.

This heterogeneity is also found in failures and explanatory elements.

It is then with the help of the typical generating failure scenario that light is brought on the specificities of this population:

Perceptive failures are central in these kinds of accidents and they reveal the multiplicity of the problems encountered by the drivers when they interact with others:

- ✓ The visibility constraints is decisive in almost 6% of the accidents cases (P1d scenario), especially when they prevent the drivers from detecting the atypical manoeuvre of the other.
- ✓ The search for directions (P2a scenario) and the monitoring of potential conflict with others (P2d scenario) are the causes of monopolisation of the driver's attention, leading him to not detect the relevant information.
- ✓ A low level of attention devoted to the driving task has also impact on the detection of the other, especially if the task to perform is familiar and if the environment is dense and the traffic important (scenario P3b), or if the driver is lost in his/her thoughts (scenario P5a).

Misleading indications are also at the origin of some 'Processing' distortions (T4b scenario). A same indication sometimes having several meanings and being then ambiguous, the driver undertakes the wrong manoeuvre regarding the other's behaviour.

The wrong expectations concerning the others' manoeuvres are also very represented in this sample of passenger cars drivers. Although those manoeuvres are sometimes difficult to anticipate, the rigid attachment of their right of way status that the drivers develop is generally at the core of the scenarios putting forward those 'Prognosis' failures and scenarios (T5a and T6b).


2.2 Conclusion

Our analysis shows observable tendencies in terms of accidentalness among passenger cars drivers, which have been detailed in terms of human functional failures.

It also shows the interest of using a methodology based on search for 'Human Errors', i.e. a human-centred approach, so these tendencies can be differentiate and understood deeply. It then helps providing suited solutions and countermeasures if necessary.

Following such an 'Ergonomics' trend, the present study contributes to the efforts done in TRACE project in direction of a significant safety increase inside the overall driving system.

Although it is too much difficult to summarize all the results in an only 'figure', in the following one the most important findings from this road user group are showed (of course, a better explanation of all the results is the respective deliverable D1.1 and D1.2, but this figure can help the reader to summarize the results).



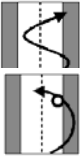
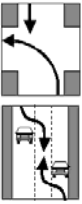
Accident Configuration				
		HFF categories	HFF	Explicative elements
	Single car accidents	<ul style="list-style-type: none"> +/- 2 cases out of 5: Guidance difficulty 	E1	→ Speed / Loss of vehicle adhesion
		<ul style="list-style-type: none"> +/- 2 cases out of 5: Loss of capacities +/- 1 case out of 5: Wrong diagnosis 	E2 G1 G2 T1	→ 2ndary task / External distraction → Falling asleep → Alcohol / Layout / Speed → Speed / Bend / Risk / Over familiarity
	Multi-vehicles collisions	<ul style="list-style-type: none"> +/- 1 cases out of 2: Perceptive failures 	P1 P2 P3	→ Impaired visibility / Manoeuvres from others → Navigation problem / Focalization / Unfamiliarity → Impaired visibility / Inattention / Over familiarity
		<ul style="list-style-type: none"> +/- 1 cases out of 5: Prognosis error 13%: Diagnosis failures 	P5 T5 T6 T4	→ Inattention / Road familiarity / Right of way status → Right of way status / Manoeuvres from others → Right of way status / Manoeuvres from others → Ambiguous indications / Road over familiarity
Multiplicity of the accidents mechanisms → An in-depth analysis that allow the identification of specific problems → Suited solutions for each targeted difficulty				

Figure 2.1.- Some of the main findings from Task1.1.

3 Task 1.2: Powered Two Wheelers Riders

The objective of this report is to summarize the main results of WPI, aimed at getting insight on the main PTWs accidents causes, human failure failures from the Human Factor point of view and risk factors of being involved in an accident.

3.1 Descriptive statistical analysis

The literature reviewed established a guideline of important factors, regarding the causation of accidents where PTWs were involved. The main points as contributing to the accident causation were: low conspicuity of motorcycle and mopeds, the fault of car driver of not giving the right of way to the PTW, alcohol and rider impairment (usually no permanent impairment), importance of accidents at intersections within urban area and run off the road accidents in bends outside urban areas, extreme risk takers, road, infrastructure hazards, mainly related to the loss of traction of the single track vehicle and braking problems, riding experience and training. On the other hand, factors as 'Speeding', 'Engine size', 'Gender' or 'Age of the rider' were pointed in some studies as influential but other studies, due to the nature of the study or the absence of clarity on its definitions, did not consider these factors as important.

The next step was to detect which were the main accident configurations at European level using different sources of data (available National database within TRACE consortium⁸). These sources were provided by WP8 ('Data suppliers') through the respective requests. Descriptive analyses of variables as type of collision, other vehicles involved in the accident, location of the accident, road layout configuration... provided a first vision of the problem. The most important PTWs accident configurations were pointed through these data and previous experts' experience.

Accident Configuration	% Fatal & Serious Accidents
1. Motorcycle single accidents: just one motorcycle on a rural road: run-offs, rollover on the carriageway and collisions with road restraint systems	27% ⁹
2. Front-side accidents in rural and urban junctions between motorcycles and passenger cars	13%
3. Side-side accidents in rural and urban non junctions between motorcycles and passenger cars	5%
4. Rear-end accidents in rural and urban non junctions between motorcycles and passenger cars.	5%
5. Moped single accidents: one moped on a rural or urban road: run-offs, rollover on the carriageway and collisions with road restraint systems.	21% ¹⁰
6. Front-side accidents in rural and urban areas (junction and non junction) between mopeds and passenger cars	30%
7. Head-on accidents in rural and urban areas (junction and non junction) between mopeds and passenger cars	8%

Table 3.1.- Distribution of accidents configurations (National databases)

⁸ National database used in task 1.2 were OGPAS Germany, CDV Czech Republic, STATS 19 Great Britain, Greek N.D. Greece, SISS Italy, BACC France and DGT Spain.

⁹ This percentage is over the motorcycles accidents, not over all PTWs accidents..

¹⁰ This percentage is over the mopeds accidents, not over all PTWs accidents.

3.2 Results from the in-depth accident analysis


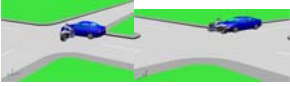

Once, the main accidents configurations have been detailed, in-depth analyses have been done over these seven configurations to obtain a better understanding of the mechanism of these accidents and therefore, their main accident causation issues. Moreover, the detection of factors that could be considered as risk factors from the point of view of increasing the risk of a PTW accident to occur. Finally, the methodologies explained in the Work Package 5 'Human Factors', allowed detecting and codifying the Human Function Failures in each accident.

The accident data used in this analysis belongs to MAIDS¹¹ database. The MAIDS project developed an extensive in-depth study of PTWs. 921 accidents were investigated in detail and comparative information on riders and PTWs that were not involved in accidents in the same sample areas was also investigated and collected in 923 controls (exposure data). This information is necessary to perform a case control study wherein the cases are compared with a non-accident population allowing the possibility to identify potential risk factors associated with PTWs accidents.

Accident causation analysis

The first step was to select the accidents occurred with the seven configurations characteristics. The next figure it shows the distribution of accidents selected within MAIDS database.

As a previous step of the risk analysis for each PTW accident configuration over the MAIDS database, this section presents a descriptive analysis of the causation factors found in the MAIDS database for each one of this configurations. Accident causations factors are coded within the databases as **Primary** or **Contributing** factors.

	Accident Configuration	Primary factors ¹²	Contributing factors (including primary)
MOTORCYCLES		<ul style="list-style-type: none"> - Motorcycle rider decision failure 31% - Motorcycle rider failure, unknown type 18% 	<ul style="list-style-type: none"> - Motorcycle rider decision failure 37% - Motorcycle rider failure, unknown type 32% - Others 16%: Too fast speed, motorcycle rider unsafe acts, inadequate speed.
		<ul style="list-style-type: none"> - Passenger car driver perception failure 60% - Passenger car driver decision failure 12% 	<ul style="list-style-type: none"> - Passenger car driver perception failure 70% - Passenger car driver unsafe acts or risk taking behaviour 31% - Motorcycle rider unsafe acts or risk taking behaviour 38%
		<ul style="list-style-type: none"> - Passenger car driver perception failure 47% 	<ul style="list-style-type: none"> - Passenger car driver perception failure > 53% - Motorcycle rider unsafe acts or risk taking behaviour 53%

¹¹ MAIDS: In-depth investigations of accidents involving powered two wheelers

¹² **Primary** (Primary contributing factor: The contributing factor which the investigator considers to have contributed the most to the overall outcome of the accident) or **Contributing** factors (Contributing factors: Any human, vehicle or environmental factor which the investigator considers to have contributed to the overall outcome of the accident. The precipitating event may or may not be considered to be a contributing factor).





	4		- Motorcycle rider perception failure 58% - Passenger car driver perception failure 25%	- Passenger car driver perception failure 33% - Motorcycle rider perception failure 58%
MOPEDS	5		- Moped rider perception failure 41% - Moped rider reaction failure 19%	- Motorcycle rider perception failure 63% - Motorcycle rider drug and/or alcohol involvement 33%
	6		- Passenger car perception failure 51% - Motorcycle rider perception failure 14% - Motorcycle rider decision failure 12%	- Passenger car perception failure 68% - Rider unsafe acts or risk taking 49% - Passenger car unsafe acts or risk taking 36%
	7		- Moped rider perception failure 41% - Moped rider reaction failure 19%	- Passenger car perception failure 38% - Moped rider decision failure 38% - Moped rider unsafe acts or risk taking behaviour 62%

Table 3.2.- Distribution of accidents causation factors (In-depth database)

Once the accident causations have been detected for each scenario, special analyses over the possible human failures are going to be show with the aim of understanding better which these failures were. This HFF analysis has been extracted from a database of 67 accidents occurred in the Salon de Provence (France) area between 2000 and 2005 (INRETS in-depth database). After applying the respective seven accident configurations detected in D1.1, the final sample has consisted in 39 accident cases.

MOTORCYCLES

- **Configuration 1:** Single accidents.
This kind of accidents represents 23% of the accidents selected (9 cases out of 39).
The pre-accident situation corresponds usually to a guidance activity (6 out of 9 refer to 'Going ahead on a straight road' or 'Negotiate a curve'), and more sporadically to intersection crossing.
The corresponding failures are mainly related to skill-based behaviours:
 - E1 failure: 'Poor control of a difficulty';
 - T1 failure: 'Incorrect evaluation of a road difficulty';
 - G2 failure: 'Impairment of sensorimotor and cognitive abilities'.
- **Configuration 2:** Front-side accidents in rural and urban junctions between motorcycles and passenger cars.
This accident configuration is small-represented in our sample (4 cases out of 39).
The failures identified in those cases show that PTW users have encountered prognosis difficulty concerning the other's behaviour (T5: 'Not expecting manoeuvre by another user' and T6: 'Expecting adjustment by another user').
- **Configuration 3:** Side-side accidents in rural and urban non junctions between motorcycles and passenger cars.
This configuration is also under represented in our database (3 cases out of 39).
In 2 out of these 3 cases, the task of the PTW rider consisted in going ahead whereas the other was undertaking a manoeuvre and didn't see the PTW.
The 3 failures connected to this configuration are:
 - P3 failure: 'Cursory information acquisition';

- P5 failure: 'Neglecting information acquisition demands';
 - T4 failure: 'Incorrect understanding of manoeuvre undertaken by another user'.
- Configuration 4: Rear-end accidents in rural and urban non junctions between motorcycles and passenger cars.
Only one rear-end accident has been identified in the sample.
The rider was realizing a critical overtaking when the accident occurred and he did not understand the manoeuvre undertaken by another user (T4 failure).
Four elements have been found to explain this failure:
- Manoeuvre over-familiarity;
 - Trivialization of the situation (potentially dangerous but treated as 'pain killer');
 - Ambiguity of clues coming from other users;
 - Atypical manoeuvres from other users.

MOPED

- Configuration 5: Single accidents.
As for motorcycles, this configuration is highly represented in the selected accidents (10 cases out of 39).
Again, those accidents mainly occurred when the rider had to deal with the guidance of the vehicle (7 tasks out of 10 refer to 'Going ahead on a straight road' or 'Negotiate a curve').
Those losses of control are related to ability to drive, would the rider meet an external difficulty (curve, wind blast...) as in T1 ('Failure to detect in visibility constraints') or E1 failures ('Poor control of a difficulty'), or would the failure originate from attention processes or psycho-physiological capacities as encountered in E2 ('Guidance problem'), G1 ('Lost of psycho-physiological ability') and G2 failures ('Impairment of sensorimotor and cognitive abilities').
- Configuration 6: Front-side accidents in rural and urban areas (junction and non junction) between mopeds and passenger cars.
This configuration is the most represented in the sample (11 cases out of 39).
8 driving tasks out of 11 were devoted to intersection crossing.
The failures identified for configuration F are mainly related to perception (P1 failure - 'Failure to detect in visibility constraints' - coded in 3 out of 11 cases) and prognosis (T5 - 'Not expecting (by default) manoeuvre by another user' - and T6 failures - 'Expecting adjustment by another user').
- Configuration 7: Head-on accidents in rural and urban areas (junction and non junction) between mopeds and passenger cars.
There is only one accident corresponding to this configuration in the sample.
It happened when the moped was going ahead on a straight road, and the rider was designated as passive so no failure has been identified for him. Consequently, there is also no explanatory element for this user.

3.3 Risk analysis

Two types of analyses were done. The first one was to achieve the risk for a PTW user of being involved in each accident scenario. The second one was focused to know factors that increase the risk of being a specific parameter is the cause of the accident (in that kind of scenario)

Risk factors of being involved in a PTW accident

After detecting the main configurations where PTW accidents occurred, a case-control analysis was performed to determinate which variables (risk factors) are associated with the accidents in each configuration.

The results of comparing the accidents group (cases) to the exposure group (controls) the variables associated for each configuration are registered in the next table.

<u>CONFIGURATION 1</u>	<u>Risk factor</u>	<u>p-value</u>	<u>Odds ratio</u>
	Vehicle year of production (5-10 years)	0.002	2.29 ¹³
	Rider age (<25 years)	0.040	2.09
	Lack of driving license	0.002	4.01
	Not resident citizens	<0.001	5.87
	Under secondary school qualification	0.001	4.05
	Not frequent use of the road	0.001	3.53
<u>CONFIGURATION 2</u>	<u>Risk factor</u>	<u>p-value</u>	<u>Odds ratio</u>
	Vehicle year of production (>2 years)	<0.001	5.25
	Motor displacement (>125cc)	0.011	1.78
	Front tread type (all weather, angle groove)	0.035	1.55
	Driveline type (sprockets, enclose chain)	<0.001	1.97
	Lack of windscreen	0.001	1.89
	Lack of right side rear view mirrors, posts equipped	0.033	2.01
	Rider age (< 25 years)	0.001	2.07
	Under secondary school qualification	0.037	1.55
	Short length of the trip (< 10 Km)	0.001	2.55
<u>CONFIGURATION 3</u>	In this configuration it was difficult to reach any significant conclusion because there were only 13 cases, which means that any kind of relationship appeared is conditioned by low frequencies.		
<u>CONFIGURATION 4</u>	This type of collisions had a low frequency within database, only 12 cases were registered; consequently a risk analysis could not be performed.		
<u>CONFIGURATION 5</u>	<u>Risk factor</u>	<u>p-value</u>	<u>Odds ratio</u>
	Lack of front position lamp	0.009	2.90
	Alcohol and/or drug use	<0.001	8.03
	Not permanent physical impairment (tiredness, ...)	<0.001	4.59
	Previous motorcycle traffic accident	0.049	2.31
<u>CONFIGURATION 6</u>	<u>Risk factor</u>	<u>p-value</u>	<u>Odds ratio</u>
	Vehicle year of production (>2 years)	0.001	5.95
	Front suspension type (no telescopic tube)	0.028	1.68
	Front suspension in bad conditions	0.009	2.26
	Head assembly type (double)	0.013	1.58
	Fuel tank type (saddle)	0.046	2.84
	Rear tread type (all weather, angle groove)	0.014	1.81
	Modified / Enhanced motor power	0.001	2.79
	Lack of driving license (no license held)	<0.001	4.04
	Not regulated training	0.026	2.03
	Not permanent physical impairment (tiredness, ...)	0.002	3.73
	Not frequent use of the road	<0.001	5.71
<u>CONFIGURATION 7</u>	In this configuration is difficult to reach any statistically significant conclusion because, as happened with other configurations, there are only 13 cases, which makes unfeasible to establish any association between contributing factors and variables.		

Table 3.3 .- Risk analysis results (case-control).

¹³ For instance, a rider younger than 25 years of age has an Odds Ratio equal to 2.29, this means that this type of motorcycle riders are 2.29 times more likely (or (129% higher) to be involved in an accident corresponding to configuration 1 than a rider from another age group.

Risk factors associated to Accident Causation Factors

Once the risk analyses were performed and the risk factors were pointed, a further step was to identify possible associations between the causation factors and some vehicle, human and environment variables. To perform this analyses the statistic procedure used was a cross-tables analysis, considerer only accidents and the contributing factors within each configuration.

	Contributing factor	Risk factor	p-value	Odds ratio
CONFIGURATION 1	1 Motorcycle rider decision failure ¹⁴	Odometer (new motorcycle)	0.046	2.92
		Rider age (< 25 years)	0.016	3.44
		Traffic violation in the last 5 years	<0.001	9.33
	2 Motorcycle rider unsafe acts	Lack of cargo rack	0.016	4.40
		Rider age (< 25 years)	0.022	2.48
		Traffic violation last 5 years	0.036	2.25
CONFIGURATION 2	1 Passenger car perception failure	Motor displacement	0.040	2.51
		Lack of front position lamp	0.026	3.62
		Front tyre, wheel original equipment	0.023	3.46
	2 Motorcycle rider unsafe acts (risk taking behaviour)	Rider age (25-40 years)	0.048	2.19
CONFIGURATION 5,15	1 Alcohol and/or drugs use	Under secondary school qualification	0.032	8.67
CONFIGURATION 6	1 Passenger car perception failure	Lack of front turn signals	0.049	2.07
		Lack of driving license (no license held)	0.030	1.74
		Not resident citizens	0.025	4.51
		Not frequent use of the road	0.015	3.96
	2 Motorcycle rider unsafe acts	Front suspension in bad condition	0.044	2.62
		Headlamp assembly type (double)	0.046	1.74
		Modified / Enhanced motor power	0.008	3.42
		Gender (male)	<0.001	3.86
		Motorcycle training	0.035	2.61
		Traffic violations in the last 5 years	0.002	2.89
Previous motorcycle traffic accident	0.002	3.05		

Table 3.4 .- Causation factors risk analysis.

¹⁴ In this configuration these were the two most common contributing factors but also it was important the presence of inadequate speed or too high speed. Seeing the results, both contributing factors were associated to rider age (younger than 25 years of age) and to had committed at least one traffic violation in the last five years. An example of the interpretation of these results should be 'in case there was an accident belonging this configuration, if the rider ages is higher 25 years old the risk of being 'Motorcycle rider decision failure' the accident causation is 3.44 times higher

¹⁵ As it happened with risk analyses, due to the low frequencies within the configurations 3, 4 and 7 it could not be possible to perform analysis apart from frequency tables.

3.4 Conclusions

PTW accidents are an important road safety problem nowadays. As it has been showed in Figure 1.6, this road user group are one of the few user groups whose fatalities have been are increasing in the last few years. This implies that all road safety community (Governments, associations, manufactures, foundations...) has to enlarge its effort to stop this insane trend.

The main objectives of this chapter were to identify accident causation factors and accident risk factors related to the road users group of powered two wheelers riders.

After finishing this task, it could be said that the work done over this project related PTW accidents have allowed gathering the following items:

- The most frequent scenarios in PTW accidents (according to National databases) have been updated.
- The causes of PTW accidents (according to MAIDS in-depth database) have been analysed.
 - ✓ In the case of accidents between a PTW and other vehicle, the most frequent human error was a failure in perceiving the PTW by another vehicle driver (associated to the traffic environment, traffic scanning error, lack of other vehicle driver attention, faulty traffic strategy or low conspicuity of the PTW).
 - ✓ As it has been said, there is also, a general behaviour problem. To decrease accidents where unsafe acts, from riders or other vehicles drivers, where present as a contributing factor, possible counter measures are to reinforce educational campaigns to highlight to all road users the importance of consider motorcyclist as a vulnerable road users and to drive taking into account that a motorcycle is more difficult to perceive, and re-educate drivers and riders through retrain courses, especially those who committed a serious traffic violation. And specific campaigns for motorcycle riders pointing that take a risk riding can cause a very serious damage for them, for motorcycle passengers and for other potential vulnerable road users as pedestrians.
 - ✓ Other variables as 'year of production', 'citizenship', 'rider age' and 'frequency of this road use' are present in most of the configurations, which implies together with the previous recommendations, is important to improve road signing to make easier driving task for no residents or drivers who do not use frequently that road.
 - ✓ Another point that should not be forgotten is the constant improvement of devices, development of new technologies to help to the driving task, to prevent accidents and to minimize injuries.
- Risk factors for each scenario and for each contribution factor have been identified. Some of them are:
 - ✓ Variable 'Year of production' is a risk factor in the main configurations.
 - ✓ Variables 'Year of production', 'frequent use of the road' and 'not resident drivers' are risk factors in the main configurations.
 - ✓ 'Motor power enhancement', 'driver license qualification' and 'alcohol and/or drugs use' are variables linked to accidents involving mopeds.
 - ✓ There are some common associations between contributing factors and risk factors, independently of which configuration they belong to. Usually, contributing factor 'motorcycle rider unsafe acts or risk taking' has associated the variables 'any traffic violation committed in the last five years' and 'rider age'.
 - ✓ 'Traffic violation in the last five years' always appeared associated to the contributing factor 'Motorcycle rider unsafe acts'.

- ✓ It has been seen how no resident motorcyclist or riders who do not know the road had a higher probability to be involved in single motorcycle accidents. It is difficult to solve this problem but maybe, an improvement of road infrastructure, including the merges and, creating a common signing (warning and information signs mainly) will help this riders to avoid or minimize unnecessary risks.

As it has done in Task1.1, it has been tried to show the most important findings from this road user group.




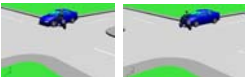
Accident Configuration		Causation factors	Risk factors	Odds Ratios
MOTORCYCLES	 25-30% of motorcycle accidents	<ul style="list-style-type: none"> - Motorcycle rider decision failure (37%). - Too fast speed, motorcycle rider unsafe acts. 	<ul style="list-style-type: none"> Vehicle year of production (5-10 years) Rider age (<25 years) Lack of driving license Not resident citizens Under secondary school qualification Not frequent use of the road 	<ul style="list-style-type: none"> 2.29 2.09 4.01 5.87 4.05 3.53
	 15-20%	<ul style="list-style-type: none"> - Passenger car driver perception failure (70%). - Passenger car driver unsafe acts or risk taking behaviour (31%). - Motorcycle rider unsafe acts or risk taking behaviour (38%). 	<ul style="list-style-type: none"> Vehicle year of production (>2 years) Motor displacement (>125cc) Lack of right side rear view mirrors Rider age (< 25 years) Short length of the trip (>10 Km) 	<ul style="list-style-type: none"> 5.25 1.78 2.01 2.07 2.55
MOPEDS	 20-25% of moped accidents	<ul style="list-style-type: none"> - Moped rider perception failure (63%). - Moped rider drug and/or alcohol involvement (33%). 	<ul style="list-style-type: none"> Alcohol and/or drug use Not permanent physical impairment (tiredness, ...) Previous motorcycle traffic accident 	<ul style="list-style-type: none"> 8.03 4.59 2.31
	 30-35%	<ul style="list-style-type: none"> - Passenger car perception failure (68%). - Rider unsafe acts or risk taking (49%). - Passenger car unsafe acts or risk taking (36%). 	<ul style="list-style-type: none"> Vehicle year of production (>2 years) Front suspension type (no telescopic tube) Head assembly type (double) Fuel tank type (saddle) Rear tread type (all weather, angle groove) Modified / Enhanced motor power Lack of driving license (no license held) Not regulated training Not permanent physical impairment (tiredness, ...) Not frequent use of the road 	<ul style="list-style-type: none"> 5.95 1.68 1.58 2.84 1.81 2.79 4.04 2.03 3.73 5.71

Figure 3.1.- Some of the main findings from Task1.2.

4 Task 1.3: Vans, Bus and Truck Drivers

Accidents in road transport count for a high part of human and material loss, for the individual, for the common, and for the business and welfare. Transport accidents on the road are lower in absolute figure as compared to other modes of traffic participation (such as car, two-wheel-vehicles, etc.), but they result in much higher average damage losses, including the responsibility for a good part of traffic congestions, because of temporal total closings, on Europe's roads. Truck and van accidents are more destructive against the unprotected, namely pedestrians, cyclists, and small passenger cars, the reasons for that become obvious thinking in terms of the biomechanical effects of different mass volumes, standing against each other. Since the goods transport on EU's roads do, and will increase rapidly, as shown by all economical figures (yearly average ton kilometres), and since the same prognoses see the road with most increase, it is a major challenge for research, business, and politics to improve safety of the road transport industry.

This chapter compares the accidents figures within the EU with respect to the state of the art parameters. It could be shown that, on the one hand, a plausible distribution of truck/van/coach accidents beneath the countries is to be found, according to the dimension of each land, by gross domestic product, ton kilometres, number of vehicles, length of road net, and others. Insofar Spain, the UK, Germany, Italy, France show higher absolute figures, namely in fatalities. Unfortunately, Spain is in the very top with fatalities, and also Portugal, as a smaller country, has high figures. This waits to get analyzed in future surveys. On the other hand, all data must be read beyond certain exposures, kilometres or ton kilometre per year in the first place. Secondly, and lamented by all experts and politicians, the great differences in law, enforcement procedures, statistical measurements, and others, hinder to get comparable data. However, the result of this descriptive level is positive, as it is for other road vehicles – accident figures for fatalities decrease, the common efforts for safety in transport vehicles do work, right now. What are still the problem fields? The descriptions in detail show the urban road the worst place for transport fatalities. The highway is, indeed the first place as compared to other modes of vehicles (severe car accidents, compared to trucks, do happen less often on highway, but more often on rural roads. But severe truck/van accidents, compared to cars, do happen more on the highway). Nonetheless: Within the truck/van/coach distribution the urban road is the list leader for severe accidents – because unprotected persons (pedestrians, cyclists) and relative weaker cars are involved. This happens in the overwhelming part in daylight. This outcome is not to misunderstand for the night not being a problem. But it shows, the urgent priority for countermeasures, e.g. by vehicle improvement and ADAS. These EU figures show, it is not the spectacular nighttime autobahn crash, it's the daytime in urban crash, which waits get deeper addressed, e.g. by turning support, crossing support, or round vision aids. All these figures are at least, with respect to statistical non-comparability, similar in the EU 27.

In details, by type of accident, by causation factors, some characteristic differences are to observe between nations. But they are simply structural, affected a lot by different modes of collecting data, they do not contradict the major factors of the certain incident in principal. So, we find a broad range of the factor "unadapted speed" or "distance" throughout Europe. But any in-depth analysis of any single case will lead to the same interaction of factors. So, the "big five" causes are prominent in our figures as well: Speed, distance, turning errors, overtaking errors, and alcohol, all of them to get addressed by improvements in vehicle safety, ADAS, and enforcement. A separate role plays alcohol and fatigue. The data forbid simple compartments. As it seems, Germany is with high figures here, but other countries do not compute alcohol as Germany does. We must not conclude, alcohol would be unimportant for truck/van/coach safety in the EU. Furthermore, intersections and single-vehicle-accidents remain an extra field to look on. Most important accident scenarios were van or coach or truck colliding with car moving along in same way, and while turning or crossing (each covering at least around 16-45% of the cases), documenting the need for break assist, turning/crossing aids. In the causation figures, the unadapted speed was found still in the top to further focus, when fighting transportation accidents in Europe.

In-depth and risk considerations were aim in this report. As to the restricted material from the EU partner country, only few own tables could be used. However, even this material, reported form Italy, Great Britain, France, exposed prominent causation factors to be responsible for accidents with casualties, with distraction and risk taking to be of crucial importance.

4.1 Vans

Van, or light trucks ($\leq 3,5$ t), count for a high part in accident figures in the transport sector, and are target of traffic safety since several years. The studies reported here could verify the prominent risk taking a leading accident causation factor. Speeding, sensation seeking (thrill seeking), failures in distance, adequate to the situation, and other lacks in proper behaviour of drivers of vans were found in the top of our data. With regard to Italy (SISS), Great Britain (OTS), and France (EACS), in-depth computations showed clearly that risk taking behaviour is still the leading factor, troubling safety on European roads. The figure below gives the distribution by type of road for Italy and Great Britain for example. Figures for risk taking may be higher in Great Britain than in Italy, but for booth, this factor counts for the most accident causation factors in all. Measures, referring to speeding and distance remain strongly to be the most important causation in light truck accident occurrence in the European Community, such as enforcement and technical vehicle solutions. This outcome is congruent with findings communicated elsewhere.

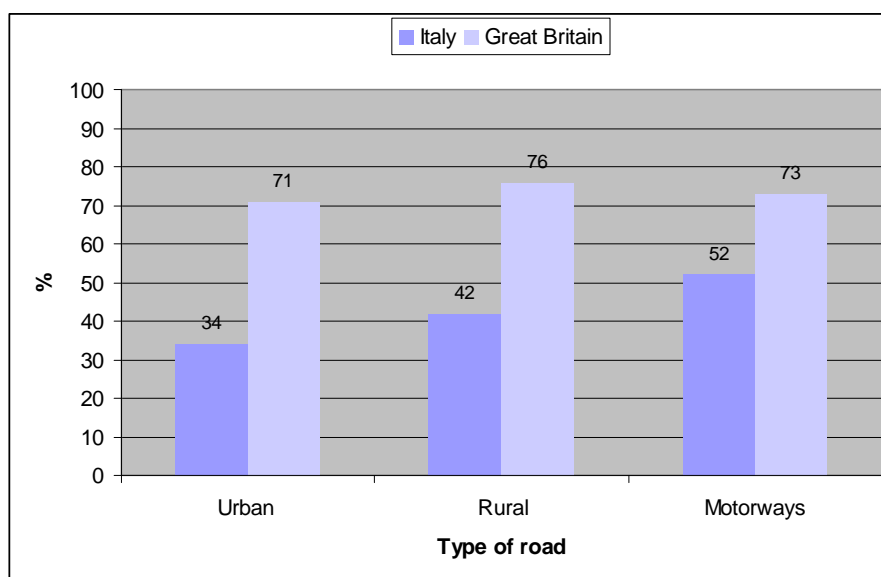


Figure 4.1.- Causation factor H6 Behaviour - Risk taking: Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs/signals/markings, thrill-seeking..., accident type collision between vehicles moving along carriageway, Italy and Great Britain

In all data, the most important causation factors for van drivers were:

- ✓ H6 Behaviour - Risk taking: Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs/signals/markings, thrill-seeking...
- ✓ H5 Behaviour - Distraction: Distraction within vehicle, outside vehicle, within user (e.g. lost in thought)
- ✓ E4 Visibility impaired: Road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc..), other vehicles, roadside objects

Beside this, other psychological factors, namely driver fatigue and emotional state, were reported partially.

Special risk indices considerations could not be performed, since comparable sets of data from all different countries were not available. Insofar, in-depth figures always lack from being restricted to selected countries and, more critical in statistical respect, to selected geographical areas covered by the in-depth data bases. Summarizing, it remains to do steps for harmonisations in accident data bases, to gain comparability over various EU countries.

4.2 Buses

Coach accidents are most tragically for human and economical implications to society in the EU. Though low in absolute figures, they do count for high costs per incident. A lot of efforts have been done the last years, in order to improve coach safety, and the casualty risk for this particular travel mode is lower than for passenger cars. Nonetheless, the expectations, done here, could replicate well known accident causation, what ever the absolute amount of accidents may be. Distraction of the driver, impaired vision out of the big vehicles, and again risk taking behaviours were in the top, as the figure below can exemplify. Urban road incidents are high for danger of distraction. Motorways are high for danger of risky behaviour such as speeding. This outcome, again, is well known from numerous studies. Countermeasures like new in-vehicle technologies for speed management, advanced vision systems, and others, and enforcement methods are in discussion to be effective.

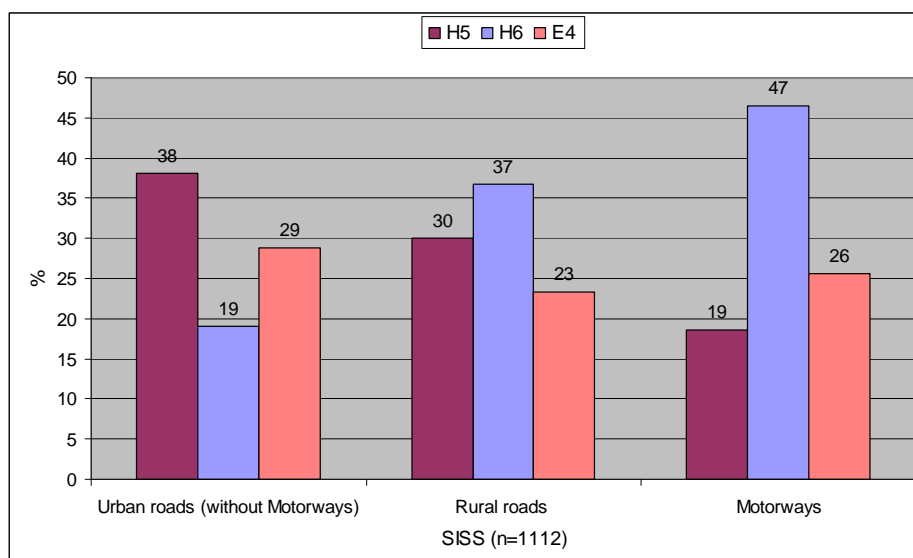


Figure 4.2.- Causation factors for bus accidents between vehicles moving along in carriageway in Italy

The most important causation factors for bus drivers, as summarized, are:

- ✓ H5 Behaviour – Distraction: Distraction within vehicle, outside vehicle, within user (e.g. lost in thought)
- ✓ H6 Behaviour – Risk taking: Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs/signals/markings, thrill-seeking...
- ✓ E4 Visibility impaired: Road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc.), other vehicles, roadside objects
- ✓ E5 Traffic guidance: Traffic signs, signals or road markings which are insufficient, poorly maintained, inappropriate or unexpected

This outcome is congruent with existing publications, but we expect this not to be disprofit of the TRACE project, since the need for countermeasure, which are most urgent in bus safety, where again demonstrated. For example, improvements of the vision out of the vehicle for the drivers remains important. Especially, for coaches, the average vehicles ages must be taken into account, means that they often lack from new technical solutions for best traffic safety.

Again, as found in van accident data, it remains to make efforts for a better comparability between the EU countries. The existing data sets were not to perform risk analogies for all member countries. The question must be, whether in-depth and risk analyses are doable on national level at all, but always must restrict on limited subsets of accident samples. Here, still methodological work has to be done.

4.3 Heavy good vehicles

Heavy Goods Vehicles (HGVs) are defined as goods vehicles of over 3.5 tons maximum permissible gross vehicle weight. Road traffic accidents involving HGVs tend to be more severe than other accidents due to the HGVs' incompatibility with other vehicles of their great size and mass. This means there is increased risk for the other road users. Data was used from 150 European cases (Spain, Slovenia, Germany, Netherlands, Hungary, France and Italy; though predominantly Spanish cases).

The most important causation factors for truck drivers, as summarized, are:

- ✓ H3 Psychological condition: Emotional (upset, angry, anxious, happy...), in a hurry, fatigue, internal conditioning of the driving task (e.g. right of way status)
- ✓ H4 Experience: Little/no/over-experience of driving/route/vehicle/driving environment
- ✓ H6 Behaviour – Risk taking: Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs/signals/markings, thrill-seeking...
- ✓ E3 Traffic condition: Traffic flow, traffic density, confusing/lack of information from other road user(s).
- ✓ E4 Visibility impaired: Road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc.), other vehicles, roadside objects

These causation factors arise primarily from the nature of job that truck drivers have: long hours often working nights, combined with lack of variation in one's route (i.e. often driving the same long distance route several times weekly or monthly). This pattern of driving results in a number of recurrent factors such as fatigue, decreased attention when in familiar and/ or unchanging surroundings (long straight carriageways).

Truck drivers have also statistically shown to have a reduced aptness for correctly interpreting the behaviour of other road users, whether due to lack of attention or experience. A truck driver's position being higher in his vehicle may be influential on this as is the over familiarity of the route and need to meet time constraints, all of which leading to concentration lapses and focus being set more in the distance rather than on the immediate and potential dangers that could unexpectedly arise in close proximity.

In summary, the next steps that should be made towards the increased reduction of HGV traffic accidents on the road, aimed specifically at addressing the main causation factors, consist of two main tasks. Firstly, the introduction of intelligent detection systems and advanced driver assist systems, to reduce scope for human error when truck drivers are on route. Secondly, more should be done into the regulation of truck drivers' hours and shifts with stricter law enforcements/ checks. Finally, Truck

drivers must made to understand the problem and sensitivity of these road safety issues, raising awareness and comprehension that neglect or disrespect of traffic regulations could result in severe or fatal implications for themselves or another road user.

As it has done in the other Tasks, it has been tried to show the most important findings from this road user group in only a figure:



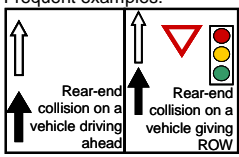
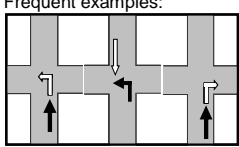


	<p align="center">Accident Configuration</p>	<p align="center">Causation factors</p>
	<p>Accidents between a van and a passenger car moving along in carriageway [40%-30%]</p> <p>Frequent examples:</p>  <p>Accidents between a van and a passenger and while turning into a road or by crossing it [45%-19%]</p> <p>Frequent examples:</p> 	<ul style="list-style-type: none"> •Behaviour – Risk taking: Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs/signals/markings, thrill-seeking... •Behaviour – Distraction: Distraction within vehicle, outside vehicle, within user (e.g. lost in thought) •Visibility impaired: Road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc.), other vehicles, roadside objects
	<p>Accidents between a bus and a passenger car moving along in carriageway [31% - 26%]</p> <p align="center">Mostly occurred on urban roads</p> <hr/> <p>Coach/Bus against a passenger car and caused by turning into a road or by crossing it [45% - 16%]</p> <p align="center">Mostly occurred on urban roads</p>	<ul style="list-style-type: none"> •Behaviour – Distraction: Distraction within vehicle, outside vehicle, within user (e.g. lost in thought) •Behaviour – Risk taking: Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs/signals/markings, thrill-seeking... • Visibility impaired: Road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc.), other vehicles, roadside objects • Traffic guidance: Traffic signs, signals or road markings which are insufficient, poorly maintained, inappropriate or unexpected
	<p>Accidents between a truck and a passenger car moving along in carriageway [44% - 28%]</p> <p align="center">Mostly occurred on rural roads</p> <hr/> <p>Accidents between a truck and a passenger and while turning into a road or by crossing it [39% - 13%]</p> <p align="center">Remarkable: high rate of rural accidents (without motorways) in comparison to vans or all road users.</p>	<ul style="list-style-type: none"> •Psychological condition: Emotional (upset, angry, anxious, happy...), in a hurry, fatigue, internal conditioning of the driving task (e.g. right of way status) •Experience: Little/no/over-experience of driving/route/vehicle/driving environment •Behaviour – Risk taking: Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs/signals/markings, thrill-seeking... •Traffic condition: Traffic flow, traffic density, confusing/lack of information from other road user(s)

Figure 4.3.- Some of the main findings from Task1.3.

5 Task 1.4: Pedestrians and Cyclists

Pedestrians and Cyclists are vulnerable road users. From review of European accident statistics TRACE has recognised the need for more attention in this area, to avoid unnecessary accidents and try to minimize as far as possible the numbers of fatalities occurring. Due to the nature and vulnerability of pedestrians and cyclists when on the road with opposing road users such as cars or motorbikes, they are a lot more susceptible to higher injury severity or fatality as a consequence of accidents.

Pedestrian Fatalities in Belgium, Luxembourg, The Netherlands and France amount to approximately 10% of all road accidents. This number is even higher in the United Kingdom, Ireland, Portugal and Greece where numbers rise to 21%, 19% and 18% for the latter two respectively. It is important to consider these statistics in percentages (taking into account country size and populations) as in fact it is Spain, the United Kingdom, Italy and France with the highest fatality rates for pedestrians overall. TRACE is therefore conducting research into the causation of these accidents and ways to avoid or reduce the number of accidents. If a definitive cause can be established for the majority of these accidents then constructive efforts can be made towards the development and improvement of pedestrian safety.

On the other hand, cyclists were representative for 4.5% of road accident fatalities in 2004, during which 1,209 road users riding bicycles were killed during traffic accidents in 14 European Union countries. Across the decade from 1995 to 2004 there was a reduction in this figure by 731 accidents, 37%, to the 1,940 fatal accidents that took place in 2005. When looking at EU statistics from 2004, the countries with the highest percentage of bicycle fatalities are Denmark, the Netherlands and Finland; in contrast Greece, Spain and Luxembourg are only representative for a small fraction of the overall accidents.

The study for pedestrian was conducted using data from the German LMU accident case reports and the Spanish IDIADA case reports. In depth human functional failure (HFF) analysis was done on these statistics

For the Cyclists the OTS database from VSRC with UK cases, and the ELASIS database with Italian cases were used. As this data was lacking of HFF statistics, the in depth analysis instead focused on the main causation factors and groups.

For both Pedestrians and Cyclists, the data was analysed by Fatal accidents and Severe Injury accidents, further split into analysis for the vulnerable road user's) i.e. pedestrian and cyclist) contributing factors, and then the opposing road user's (i.e. car) contributing factors.

Few technical papers were found concerning accident causation. In the technical documents reviewed the main relevant parameters discussed were the location of accidents (i.e. crossings, signaled intersections), the visibility of the actors and the opponent vehicles. There is no clear definition as to the most concurrent scenarios and conditions relating to pedestrian and cyclist accidents (this was conducted in TRACE). Some data from studies focused on accidents in UK, Japan and Korea has been reported. The main results found in the literature review were concerning that pedestrians differ in sizes and biomechanical response during accidents, even behaving differently while crossing the street. In these cases, old people and children are more likely to have an accident and more specifically from this old people are more likely to result severely injured after these accidents. It is also revealed that most of the vehicle opponents during pedestrian accidents reduce to a certain set of vehicle types. Through guaranteeing the effective protection in these vehicles concerned, a high number of injuries would be prevented.

Considering this situation (few papers talking about the causation of the accident and poor data in the national statistics related with the accident circumstances), TRACE is giving a new and important forward step: the definition of the most common scenarios and the study of the causation and most common human failures related with these configurations.

Studying the national statistics and using the statistical methodologies defined in the WP7, the different accident scenarios were defined:

5.1 Pedestrians

The majority accidents occur in the urban areas. There, the TRACE studied the characteristics distinguishing between when the accident occurs in an intersection and when it happens in a crossing pass. In all of these scenarios, the visibility and conspicuity associated was studied. The common scenarios regarding pedestrian accidents are:

- ✓ Car turning and pedestrian crossing the street (at corners).
- ✓ Pedestrian crossing a street with parked vehicles (reduced visibility) and vehicle approaching.
- ✓ Scholar area pedestrian accidents (young people).
- ✓ Commercial area pedestrian accidents.

5.2 Cyclists

On the one hand, accidents in urban areas are caused when a vehicle invades the lane used the cyclist or, even, when a cyclist invades a lane used by other vehicles. Other concurrent scenario is produced in the called 'illicit turning', which takes places at intersections. An example of this type of accident could be: a cyclist riding in the right lane when approaching to the junction and trying to continue straight and a vehicle driving in the centre lane which tries to turn right. At this point, the vehicle stands in the way of the cyclist or, even, runs over the cyclist.

On the other, accidents in rural areas occur mainly in manoeuvres when a vehicle drives in the same way as the cycle and tries to overtake it or approaches to it in a point with reduced visibility, as bends or hill brows.

Following the objective of TRACE to define the accident causation in Europe, the accidents were studied analysing the most representative human failures associated to the different scenarios.

In the case of the pedestrians involved in a pedestrian accident the Decision (D), Overall (G) and Perception (P) failures are the most present in the action of the pedestrians. G-failures have been associated to non homogeneous situations where the pedestrian wants to cross the road, with non specific scenarios, sometimes with alcohol or other substances involved, presenting an alteration of sensorimotor and cognitive / psycho-physiological capabilities. On the other hand, D-failures are very frequent in the scenario specified by IDIADA in urban cases, where a pedestrian is crossing the street disobeying marks or signals. Most of the conflicts of the pedestrian are against a vehicle coming from the side. This only conflict is specially repeated in urban accidents, in combination with D-failures, but can also be found other scenarios associated to G or P-failures. In most of the cases, pedestrians were marked as 'primary active', as it was their own action which unleashed the accident. At this point, G and D-failures are the most concurrent ones. While D-failures are generally related to a pedestrian willing to cross the street, G-failures can be associated to pedestrians walking along the road or pedestrians crossing the street. G-failures have also been associated to the explanatory element 'alcohol been taken above the legal limit for pedestrians'. On the other hand, D-failures are commonly

associated to 'risk taking – traffic control'. 'Risk taking – eccentric motives' has only been marked in a few cases with children involved, violating the safety rule as well.

However, in the pedestrian accident the role of the vehicle driver is also important. TRACE defined the main human failures associated to these users. The Main Human Functional Failures identified in drivers are P and T-failures. The most representative P-failure is 'non-detection in visibility constraint conditions'. T-failures are repeatedly present in urban scenarios with traffic lights. At this level, 'Expecting no perturbation ahead' often appears, followed by 'Expecting another user not to perform a manoeuvre'. Specific scenarios for urban cases, T-failures are often concurrent with 'going ahead on straight road'. Most of the T-failures were committed while going ahead on a straight road and most of the drivers with T-failures carried out this task. In general situations (including urban and interurban cases), P-failures are often concurrent with 'going ahead on straight road'. Most of the P-failures were committed while going ahead on a straight road and most of the drivers with P-failures carried out this task. Apart from 'going ahead on straight road', another common situation is 'going straight at a traffic signal intersection'. Most of the drivers were considered as 'secondary active'. This classification includes accidents where the pedestrian took the major responsibility of the accident but the driver did also lead to the accident, not evaluating the risk, driving over the speed limit or failing in the execution of the avoidance action. P-failures are generally associated to explanatory elements related to information acquisition: 'visibility impaired by other vehicles' and 'neglecting the need to search for information. On the other hand, T-failures are associated to 'Identification of potential risk about only part of the situation', sometimes, in combination with 'Risk taking – speed' but also visibility impaired. In urban cases, when visibility is impaired by other vehicles, the obstacle is a moving vehicle, which is driving in parallel, just a bit ahead of the case study vehicle and covers the pedestrians coming from the side.

A lot of the accidents with at least one cyclist involved occur due to carelessness or disregard of road signs. Drivers and cyclists alike not paying enough attention or respect to the rules of traffic. There are however some more vulnerable situations during bends and slopes, where there are a high frequency of accidents. Statistics imply that this is more than likely due to a lack of road sign in this location, however there is not enough substantial data to definitively confirm this. The problem however seems to be linked to a lack of attention and vigilance on the road, therefore drivers should be made to understand the consequences if they do not always look properly, and should be made to pay particular attention to the possibility of vulnerable road users as cyclists appearing unexpectedly. Also danger spots should be identified, sharp bends or slopes lacking clear signaling can become danger zones for cyclists, and at this stage should as a minimum be identified, so that once further studies can consolidate the prediction of this report, action can be taken to improve the safety of these areas.

Once the problem is identified, solution proposals are expected. A brief approach in this field was carried out in TRACE.

Considering the pedestrian accidents two different conditions have been identified, derived from the data acquisition analysis. In general terms, accidents with fatalities in the scene of the accident are related to interurban pedestrian accidents, while accidents with severe injured pedestrians, who might become fatal during the next 30 days, are related to urban scenarios. Urban accidents present a similar structure: a pedestrian crossing the street with no right of crossing (for different reasons) and a driver who is not expecting it. Avoiding these situations, most of the accidents would be prevented, but acting on the decisions of the pedestrian is not easy and, most of the times, impossible. In any case, measures (if found) for correcting D-failures in pedestrians will be very effective. Then, another option remains in the correction of the expectancies of the driver. A system able to detect these situations (e.g. pedestrian collision avoidance system, able to start braking the vehicle before the driver does) would be effective. The problem in urban accidents is the parameter 'time to collision'. As the common scenario is a pedestrian intersecting the trajectory of the vehicle, the time between the interference

starts in both trajectories and the impact is produced is very short. In this case, a very fast response system is needed. Warning systems might not be very successful. In urban cases, T-failures for drivers are very concurrent. This means that the driver actually notices the pedestrian, but he makes a mistake when interpreting his future action. Self-acting fast response systems would be more effective. In interurban accidents there is not a specific scenario, but the number of pedestrians suddenly crossing into the trajectory of the vehicle is lower. There are also some pedestrians walking along the road. The number of G-failures for the pedestrian is high, but as commented in urban accidents, it is not easy to avoid these circumstances. The number of P-failures for the driver is also important. These P-failures include a lack of perception by the driver. In opened roads, distances and times to collision are bigger and there are more escape zones. Then, systems able to detect dangerous situations as soon as possible and warn the driver would be more effective at this point and probably would not be as annoying as acting systems. Other issues have been identified in urban accidents. The common scenario configuration leads to the typical approach done in passive safety for pedestrian protection. This approach tries to improve the level of protection for pedestrians impacting against the front of the vehicle at speeds up to 40 km/h. The data analyzed here shows that improving the level of protection with this method is representative and may benefit the real cases. On the other hand, protecting the pedestrian in interurban accidents is more difficult, due to the higher speeds. Then, the benefit should come only from the avoidance of the accident.

Considering the cyclist accidents from the data available not many conclusions or recommendations can be made at this point in time. The problem however seems to be linked to a lack of attention and vigilance on the road, therefore drivers should be made to understand the consequences if they do not always look properly, and should be made to pay particular attention to the possibility of vulnerable road users as cyclists appearing unexpectedly. Also danger spots should be identified, sharp bends or slopes lacking clear signaling can become danger zones for cyclists, and at this stage should as a minimum be identified, so that once further studies can consolidate the prediction of this report, action can be taken to improve the safety of these areas. The main recommendation is that more data collection and consequent analysis is required in this area.

5.3 Conclusions

However the work for the reduction of casualties and accidents for the pedestrian and cyclists is not finished yet. For the pedestrians, the main causes in urban and interurban zones have been defined and commonly associated to drivers and pedestrians failures. It has been found that the most useful ways to avoid these accidents is by correcting the human failures. Several systems have been proposed to improve human actions. So, it is necessary to check the capabilities of these proposed systems, develop and tune them and define testing methods which are representative of the established failures. For the cyclists, the important next step here is to ensure that more data collection is done and that the data collection is more thorough covering more aspects of the accidents. Also, some sort of compatibility/ uniform data collection method should be devised, ensuring that data collection in different places is done following the same specification and format. From the conclusions it could be said that Road environment seems to be the biggest cause of accidents and that perhaps this should be reassessed in terms of upkeep in areas of high danger. Looking into the placement of road signs in the dangerous areas i.e. bend and slopes. However, these are huge developments that would require a lot of time, planning and money. For this reason, it is perhaps most important and useful to focus on the data collection and confirm that these are indeed the highest risk areas, and also deduce the reason why if possible. This sort of data collection and further analysis will help improve the safety of cyclists more, rather than utilizing the budget on suspected target areas only to find in later studies that the data was not sustained. Education of cyclists and opposing road users may also be considered; however as with the maintenance of roads and signs, it is advised that a solid cause for the recurrence of these factors can be determined first, to ensure that

these are not happening as a result of some other outside factor that has not been considered in this study.

As it has done in the other Tasks, it has been tried to show the most important findings from this road user group in only a figure:

For the pedestrians...

The 3 most common scenarios regarding pedestrian accidents are:

- Car turning and pedestrian crossing the street (at corners).
- Pedestrian crossing a street
- Pedestrian walking along the road



For the cyclists...

- Urban areas: the vehicle invades the lane used the cyclist or, even, when a cyclist invades a lane used by other vehicle (intersection – non-intersection)
- Rural areas: the vehicle drives in the same way as the cycle and tries to overtake it or approaches to it in a point with reduced visibility, as bends or hill brows.



Pedestrians involved in pedestrian accidents:

Decision (D), Overall (G) and Perception (P) failures are the most present in the action of the pedestrians.

- Associations;
- D-failures: generally a pedestrian willing to cross the street
 - G-failures: can be associated to pedestrians walking along the road or pedestrians crossing the street.
 - D-failures: commonly 'risk taking – traffic control'.
'Risk taking – eccentric motives' has only been marked in a few cases with children involved, violating the safety rule as well.

Drivers involved in pedestrian accidents:

Main Human Functional Failures identified in drivers are P and T-failures.

- P-failure: most representative is 'non-detection in visibility constraint conditions'.
- T-failure: repeatedly present in urban scenarios with traffic lights.
'Expecting no perturbation ahead' often appears, followed by
'Expecting another user not to perform a manoeuvre'.

Cyclists and drivers involved in cyclists accidents:

The problem is linked to a lack of attention and vigilance on the road,

→ Drivers should be made to understand the consequences if they do not always look properly, and should be made to pay particular attention to the possibility of vulnerable road users as cyclists appearing unexpectedly.

→Also danger spots should be identified, sharp bends or slopes lacking clear signaling can become danger zones for cyclists, and at this stage should as a minimum be identified, so that once further studies can consolidate the prediction of this report, action can be taken to improve the safety of these areas.

Figure 5.1.- Some of the main findings from Task1.4.

6 Task 1.5: Elderly people and Gender related accidents

This chapter devoted to 'Elderly People and Gender-Related Accidents' addresses the issue of analyses of the accidents for these two demographic parameters that are age and gender.

6.1 Elderly people

6.1.1 Statistical trends

Over the next 30 years, a 40% increase in people over 65 is expected among the European population member and associate countries and the proportion of those over 80 will double. This trend is associated with a cohort effect: as the level of health increases, the elderly continue to drive actively longer than before. It has to be stressed that driving a car is a guarantee of physical, social and psychological autonomy for the elderly. And more than for other users, autonomy for elderly people depends on consequential safety. It is therefore of utmost importance to look into the safety of the elderly at the wheel in the perspective of adapting the driving system appropriately.

The question of excess risks among elderly drivers is a subject of debate. This population is often presented as having less accident par inhabitant but more per km than other. But this excess risk is only in the case with the occasional elderly driver with low mileage. However, most elderly people become physically fragile and vulnerable, making this population more susceptible to being injured or killed when involved in accidents.

Some pathologies linked with age can impair driving behaviours and accident occurring. They shouldn't be mixed with driving difficulties linked with normal ageing. The latter leads to a progressive alteration of human functions at different levels: motor, cognitive and sensorial. But elderly people use compensatory strategies to prevent the effects of age on their driving behaviour, by limiting their exposure to external difficult driving conditions, and by adopting a specific behaviour in a reduction in the chosen travel speed, and the fewer tendencies to overtake other vehicles, to swerve and to break traffic laws.

Some general conclusions can be drawn from statistical data:

- ✓ The situation that appears to pose the greatest problem to elderly drivers (and more specifically to elderly women) is driving at intersections, especially without right-of-way, and left-turn situations.
- ✓ Concerning the environmental context, the risk of elderly road users' accidents is higher in rural areas (2.6 times higher than for other drivers) than in urban areas (1.3 times higher).
- ✓ Elderly users are more injured or killed at daytime, during the week and on dry roads, this being probably the result of their avoidance strategy (i.e.: limiting their exposure to external difficult driving conditions, as driving at night).
- ✓ The presence of passengers is considered to increase the risk of accidents among elderly drivers, except during night-time driving.
- ✓ Depending on the degree of severity of the casualty, the elderly road users are more or less prone to be involved in accident. Indeed, we observe that the relative rate of injury is less

important (between 0.33 and 0.62 times less) for users over 65 than for the younger. Inversely, we find that elderly users are more concerned by fatal accidents than the young ones.

- ✓ Those accidents occur mainly for elderly car drivers. But over 65 years old users are also identified more often than younger in crashes involving bicycles and pedestrians. This last result is true for injury as well as fatal accidents. A special mention can be brought on female pedestrians who seem to be the most represented category.
- ✓ When looking at accidents configurations, several parameters seem to go toward the same direction: the seniors' accidents usually involve 'Two vehicles' or 'One vehicle and a pedestrian'; they are occurring mainly at intersection and more precisely when not having the right-of-way; at last, lateral - and rear - collisions are over represented in the data when compared to the younger users' crashes. All those trends are even more important when the results come to fatalities.

Such data need to be further investigated through and in-depth accident analysis in order to find out the specific difficulties elderly people meet on the road, the driving situations in which they meet these difficulties and the human errors they produce consequently.

6.1.2 Results from In-depth accident analysis

In keeping with the analysis of the literature and in relation to the questions raised by the descriptive analysis of the statistical data presented in TRACE report D1.1, this second part of the study presents a detailed qualitative accident analysis applying WP5 methodology on a sample of 128 drivers aged 65 years and over, compared to a 'control group' of 1,546 road users under 65 (n=1,546), from INRETS EDA database.

The data analysis shows a plurality of mechanisms which determine accidentalness among seniors. Thus, we can observe two main levels of accidentological mechanisms characterising elderly drivers: one refers to failures in the field of the individual's abilities ("overall failure"), while the other refers to failures in terms of functions.

6.1.2.a Overall failures

- ✓ This kind of failure appears very specific to a certain group of elderly accidents: it concerns overwhelmed cognitive abilities leading to the disorganisation of the activity, which spreads throughout the functional chain involved in driving and affects the various sequences in the accident process all the way to the emergency situation. In most of these cases, it causes the driver to become completely "overwhelmed" when he interacts with other users, and in other cases the driver performs abnormal (sometimes odd) manoeuvres even though the task does not appear to present any particular difficulties.
- ✓ This overall failure corresponds to 25% of accident-causing problems among elderly people vs. only 7% among other drivers. We can observe a number of elderly drivers in unknown locations and seeking directions. It is probable that the breakdown in shared attention with age (Hakamies-Blomqvist, 1996) has a particular impact on this type of breakdown.
- ✓ The realization of abnormal manoeuvres is often connected with a situational time constraint related to the context of the moment. Elderly drivers appear to suffer from pressure here (whether explicit or not) brought about by the presence of other users on the road, leading them to undertake their manoeuvre without verifying its feasibility.
- ✓ These overall failures, in terms of abilities, also typically call into question pathologies related to ageing (Van Elslande, 2003a). These pathologies, such as dementia, in fact tend to accelerate

the "normal" ageing process (Angley, 2001), leading to a concomitant breakdown in various cognitive, sensory and motor functions.

- ✓ Furthermore – and this is one of the innovative points of this study compared with the data in the literature – it is interesting to make the connection between overall failures and the distance driven annually by elderly drivers: it has been observed that seniors who drive infrequently show not only more but also different patterns of accidents. Driving infrequently leads to a loss of expertise which have significant repercussions on the accident risk.

6.1.2.b Failure of a function

- ✓ A second set of accident-producing mechanisms, closer to the control group, also emerges from the analysed cases: elderly drivers make errors at specific levels in their information acquisition, in the diagnosis of the situation, but also some errors in prognosis concerning other users' manoeuvres.
- ✓ Perception errors among seniors account for 39% of all their failures. Three main mechanisms underlie them: difficulties in sharing attention resources, cursory information acquisition and negligence in information acquisition related to a low level of attention from the driver. In most accident cases resulting from a perceptive failure, the elderly driver is in an intersection in an unknown area. Elderly people tend to limit their driving to known itineraries, which usually enables them to compensate for the alteration of their abilities (Davidse, 2006). But it appears that when they drive outside their habitual context and are confronted with a difficulty (a complex intersection, for example), their abilities fail them. We must mention that the infrastructure often is not neutral in the occurrence of these failures: layout or pre-signalling problems appear to give elderly drivers a poor representation of the site and potential manoeuvres by other users. Under these conditions, it can be complicated to foresee actions undertaken by others.
- ✓ As a whole, we find fewer diagnosis errors than perception errors among elderly drivers (14%), but their diagnostic difficulties testify to a particular mechanism among them: evaluating a time gap for safely merging into the traffic flow. This is mainly the case when crossing an intersection where the driver does not have the right-of-way, showing the difficulties that seniors have in assessing a gap for crossing (or merging), i.e. the speed at which the priority vehicles are approaching and the distance separating them. This poor assessment is of course linked with the alteration of movement perception (Guerrier et al., 1999) and an attention deficit in peripheral vision (Ball et al., 1993) related to ageing. But we shall point out once again the question of subjective pressure related to the presence of other vehicles waiting near or behind the elderly driver's vehicle: elderly drivers appear to be more sensitive than other users to all pressure, whether real (horn, etc.), or implicit (pressure felt by the elderly driver due to the presence of other vehicles), which makes their assessment task all the more difficult.
- ✓ Although relatively rare among elderly drivers, errors in prognosis, show one mechanism specific to them: the erroneous expecting adjustment by another user. Driving experience acquired throughout their lifetime and their knowledge of the itinerary explains their strong trust in right of way feeling and the neglect of attention arising from the trivialisation of the situation by certain elderly drivers.

6.1.2.c Context and elements favouring their failures

- ✓ Most accidents involving elderly drivers occur in intersections (nearly 50% of cases), and more when they do not have the right-of-way. The difficulty for the elderly driver thus consists in detecting the oncoming intersection, quickly seeking his directions, verifying his manoeuvre's feasibility and undertaking it. It turns out that, in many accident cases involving elderly drivers, a lack of knowledge of the location is a major criterion: the elderly driver appears to

have problems in sharing his attention resources among all of the necessary tasks when seeking to find his way. At the opposite extreme, we can also observe various accident cases in which the elderly driver is very familiar with the manoeuvre or location and is surprised by the unexpected behaviour of another user. These two cases have in common a problem of adapting to new situations.

- ✓ The most recurrent factor in failures among elderly drivers is their slow reaction. This element appears to have a systematic influence on failures in this population in situations where they are crossing an intersection without the right-of-way. In these cases, it is certainly their slow motor actions when undertaking their crossing – even though the decision has been taken – that fails. This factor is very often combined with infrequent driving. One may suppose that these elements have a reciprocal influence on each other, and a combined influence on the appearance of failures.

It has been tried to show the most important findings from this road user group in only a figure:


	<p>Elderly drivers: a critical issue</p> <p>Over the next 30 years, a 40% increase in people over 65 is expected and twice more of over 80</p>	
<p>Statistical trends</p>	<ul style="list-style-type: none"> • Problematic situations: <ul style="list-style-type: none"> -Intersections, especially without right-of-way -Left turns • More involved in accidents as pedestrians (especially for women) or riding bicycles 	
<p>In-depth results</p>	<ul style="list-style-type: none"> • Overall failures <ul style="list-style-type: none"> → overwhelmed cognitive abilities → the drivers perform abnormal manoeuvres 	<ul style="list-style-type: none"> → 25 % of accident-causing problems → Feeling of time constraint related to the context → In question: the influence of pathologies related to ageing on these failures → A specific pattern of failures for infrequent Elderly drivers
	<ul style="list-style-type: none"> • Failure of a specific function 	<ul style="list-style-type: none"> → Accident-producing mechanisms closer to the Younger → Perceptive errors: 39%, mainly while manoeuvring on unknown intersection → Impaired evaluation of a gap (9%): trouble in assessing the speed of the others → Prognosis failure: heavy influence of right of way experience → Most recurrent factor: behavioural slowness

Figure 6.1.- Some of the main findings from Task1.5 (Elderly).

6.2 Gender Issues

6.2.1 Statistical trends

Driving an automobile is an activity mainly performed by men even if driving behaviour among women in Europe has changed in the last few decades. There still are important differences in terms of miles driven and accident rates depending on gender: women less frequently have driving licences, drive less and have fewer accidents than men. These elements appear to be at the origin of a least study of driving activities among women compared to men.

The following statements can be drawn from descriptive statistical analysis on the involvement of men vs. women in traffic accidents:

- ✓ Men are more prone to traffic accidents than women
- ✓ In the seven European countries studied, where the proportion of men is 48.7%, there is a variance in traffic accident victims between men and women: men account for 67.9% of those injured and 80.7% of those killed on the road. Men and women are most frequently involved in accidents in cars. When motorcycles are looked, it can be seen that men are involved 5.7 times more often and killed 7.9 times more often than women.
- ✓ The most common pre-accident situations
- ✓ Loss of vehicle control is a phenomenon that happens more often to men than to women: the number of fatalities varies between 1.1 times more and 3.4 times more for men than for women according to the country considered.
- ✓ Women are more often involved than men in accidents at intersections and when performing manoeuvres.
- ✓ The most common conditions encountered
- ✓ 64.8% of men are injured in accidents in urban areas and 65.1% are killed in rural areas. Women are more often injured in urban areas (69.9%) and less often killed in rural areas (56.9%) than men.
- ✓ Moreover, men are more often injured than women in accidents occurring at night, on dry roads and at week-ends.
- ✓ More than 6 accidents out of 10 involve 2 vehicles and women are involved in these accidents more often (47.4% vs. 45.1%).
- ✓ In the average of 7 European countries, men have 1.4 times more accidents and 1.5 times more fatalities than women in accidents involving a single vehicle.
- ✓ As for the types of collisions, men are involved on average 1.1 times more in frontal collisions than women. Women on average have 1.4 times more rear-end collision accidents than men.
- ✓ Concerning the type of transport, women are injured more as drivers of cars, and secondly as pedestrians (16.1% of women's accidents are as pedestrians vs. 9.1% for men). This figure rises to 35.0% when speaking of women killed as pedestrians vs. 14.1% for men. Consequently, more than one-third of women killed on the road are pedestrians.
- ✓ Women appear to have excess risk on wet carriageways. On the other hand, the literature indicates that they have a tendency to avoid difficult driving situations. What might the causes of the excess risk be: is it a stress situation that causes them to react poorly, a lack of experience in these situations, excessive speed, a lack of appreciation of stopping distances in such conditions, etc. All these questions need to be further investigated taking into account not only their mileage, but also their travel patterns, social roles, and so on.

Gender issues in accidents through literature and statistical facts show all the complexity which can be hidden behind an apparently simple dichotomist factor. Analysing the role of gender from a too simple point of view would be neglecting this complexity, and thus leads to a misleading understanding of the differences between men and women as roads users and accidents victims. That is why, in the frame of this Task 1.5 contributing to TRACE project, the analysis will be completed by the In-depth study of accident data allowing going deeper in the comprehension of the role of gender.

6.2.2 Results from in-depth accident analysis

In keeping with the analysis of the literature and in relation to the questions raised by the descriptive analysis of the statistical data presented in TRACE D1.1, this part of the study presents a detailed qualitative accident analysis. The whole sample from which this in-depth investigation using WP5

methodology was performed, bringing together 1,676 road users involved in 1,067 accident cases. Among these casualties we have retained: - 1,229 male road users, the "Male" group being 73% of the whole sample; -445 female road users, the "Female" group being 27% of the whole sample.

Our analysis dealt with observable differences between drivers of both sexes concerning the functional stages involved in their driving activity. The occurrence of failures leading to an accident was then studied for each gender as a function of the elements involved in its production.

6.2.2.a Pre-accident situation.

No overall differences are shown between men and women's accidents when considering their context of occurrence. Indeed, no elements are found to clearly differentiate them from the angle of pre-accident driving situations or the level of involvement of each individual in the accident process.

6.2.2.b Errors and error factors among drivers.

The studies carried out to date on the influence of gender on driving behaviour, and more particularly on accidentality, have commonly focused on the types of collisions, the seriousness of accidents and young drivers. Moreover, given the higher accident rates among men, most of the studies have focused on this group of users.

Our analysis dealt with observable differences between drivers of both sexes concerning the functional stages involved in their driving activity. The occurrence of failures leading to an accident was then studied for each gender as a function of the elements involved in its production. Already, we can consider that the errors that stand out among men come more from diagnosis (T1 and T4 failures), expecting the absence of obstacles (T7), deliberate violation of a safety rule (D2) and the alteration of abilities (G2). Among women as compared with men, on the other hand, we observe a large share of perceptive errors (P1, P2 and P3), problems of actively expecting adjustment by another user (T6), vehicle steering fault problems (E2) and, lastly, overwhelmed cognitive abilities (G3).

- Errors in perception

Perceptive errors mainly occur among women (41.2% vs. 31.9% for men; $\chi^2=13.97$; $p=0.002$). For women, they mainly occur in intersections with a loss of right-of-way and are mainly characterised by information acquisition focused on a partial component of the situation. These failures are related to the common involvement of women in habitual itineraries, causing them to assign less of their attention resources to their manoeuvres. Men are more concerned with negligence toward information acquisition demands, leading to late detection of a slowdown or simply getting too close to the vehicle ahead, which can be explained by a low level of attention and low vigilance.

- Errors in diagnosis

Diagnostic errors are mainly found among men (14.2% vs. 10.4% for women; $\chi^2=4.7$; $p=0.03$) and are mainly made by young people of both sexes. Low driving experience, a lack of knowledge of the location and high speeds are recurring elements. Diagnostic errors among men consist in a poor understanding of a manoeuvre undertaken by another user and underestimating a temporary difficulty related to the infrastructure (notably a bend in playful contexts). Women tend more to be victims of overestimating a gap for merging related to excessive confidence in the signals emitted to others and situational time constraints. In these cases, they delegate processing the situation to other users.

- Errors in prognosis

Prognostic error rates are fairly similar for both sexes (16.3% for men vs. 15.0% for women). In both groups we observe speeds that are excessive for their respective situations, but the mechanisms underlying these failures differ. Women are mainly concerned by erroneously expecting a correction in the trajectory of a vehicle on the road. As for perceptive errors, we can see a strong influence of women's exposure to "habitual" itineraries, leading to a low level of attention and trivialisation of the situation, explaining their surprise when another user performs an unusual manoeuvre. For men, the failure consists in foreseeing no obstacle, notably the absence of vehicles in a bend with no visibility. Like women, they know the itinerary well (leisure itinerary in a playful context) and are insufficiently attentive to their driving, even in locations where visibility is limited (due to the infrastructure) and the carriageway is narrow.

- Errors in decision-making

Decision-making errors mainly occur among men (10.5% vs. 5.6% for women; $\chi^2=10.86$; $p=0.001$) and especially concern deliberate violations of safety rules by men, particularly young men with little driving experience. This type of error can be explained by high speed and risky driving on a leisure itinerary where the driver trivialises a potentially dangerous situation. These data thus agree with the literature on the question of overestimating one's personal skills and high risk-taking by young male drivers. Among decision-making errors, we observe a slight tendency among women to perform violations under the constraint of characteristics of the situation, which can be seen in their undertaking a manoeuvre despite visibility that is restricted (by the infrastructure or a temporary interference) in unknown locations.

- Errors in execution

The rates of execution errors are relatively low and concern slightly more women than men (8.0% vs. 6.2%). For women, the failure corresponds to an interruption in guiding after turning their attention toward a secondary task, notably related to a low level of experience with driving and the vehicle. These results are thus in line with the vehicle handling difficulties mentioned by Laapotti and Keskinen (2004) concerning women. Men are more concerned with poor controllability when faced with an external disturbance, combined with high speed and risky driving on leisure itineraries.

- Overall errors

The rates of overall errors concern both sexes quite similarly (8.3% for men vs. 8.8% for women), but gender differences appear depending on the type of failure. Most women with an overall failure have overwhelmed cognitive capacities leading them to perform abnormal manoeuvres (such as stopping in an acceleration lane coming out of a toll booth). These drivers tend to be elderly, drive infrequently and are overwhelmed while looking for directions in unknown locations. Men are characterised here by an alteration of their sensory-motor and cognitive abilities due to excessive alcohol consumption ($<0.5g/l$) and thus encounter difficulties in guiding their vehicle. This alcohol consumption leads to excessive speeds and risky driving under conditions of reduced de visibility. It may be combined with low vigilance. The population concerned by this failure and therefore by alcohol is mainly male and young.

6.2.2.c Emergency situation.

The emergency situation is the phase in which there is a sudden increase in time and dynamic demands. Men are slightly more concerned by unavoidable accidents than women (53.1% vs. 46.9%). It is interesting to observe that, for these men, 35.1% of unavoidable accidents involve young people (under 25). Women are more concerned by an absence of detection of the danger (29.1% vs. 18.6% for

men). They are particularly involved in the total absence of detection of danger in cases of cursory information acquisition (P3 failures: 25.1%), but also cases of overwhelmed cognitive abilities (G3 failures: 12.8%).

It has been tried to show the most important findings from this road user group in only a figure:

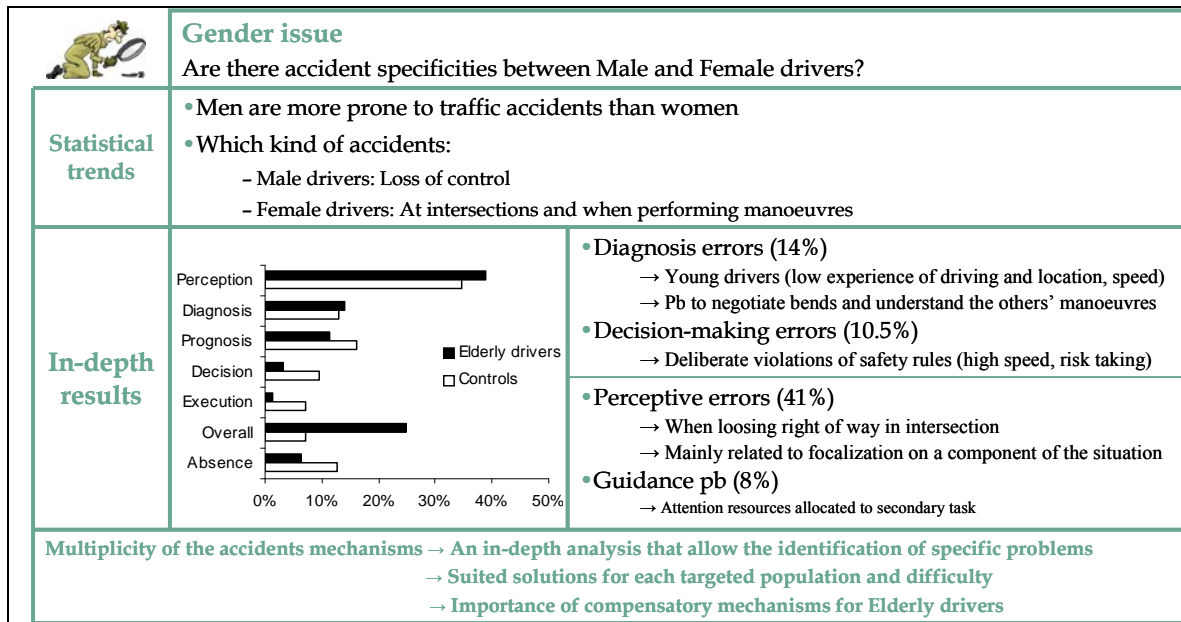


Figure 6.2.- Some of the main findings from Task1.5 (Gender).

7 Conclusions

The general objective of the TRACE project is to provide the scientific community, the stakeholders, the suppliers, the vehicle industry and other Integrated Safety program participants with an overview of the **road accident causation** issues in Europe, and possibly overseas, based on the analysis of any current available databases which include accident, injury, insurance, medical and exposure data (including driver behaviour in normal driving conditions). In accordance with these objectives, TRACE has been divided into 3 series of technical Workpackages:

- ✓ The Operational Workpackages (WP1 Road Users – WP2 Types of driving situations and types of accident situations – WP3 Types of risk factors – WP4 Evaluation of the effectiveness of safety functions in terms of expected (or observed) accidents avoided and lives saved).
- ✓ The Methodologies Workpackages (WP5 Analysis of Human factors – WP7 Statistical Methods – WP6 Determination of Safety Functions).
- ✓ The Data Supply Workpackage (WP8).

Related to 'Operational Workpackage', 'Work Package 1: Road Users' has been aimed to update **accident causation knowledge from a road user point of view** (Passenger Car Drivers; Powered Two Wheeler Riders; Van, Bus and Truck Drivers; Pedestrians and Cyclists and, at last, Elderly people and Gender related accident).

Firstly, TRACE has proposed a common methodology for the analysis of each road user maximizing the use of existing databases and their limitations. This integrated methodology can be summarized as follows:

1. What knowledge has already been obtained for each road user? → **LITERATURE REVIEW**
2. What are the most relevant accident configurations at European level? → **DESCRIPTIVE ANALYSIS**
3. Why accidents of those configurations take place? → **IN-DEPTH ANALYSIS**
4. Which factors increase the risk of each accident configuration? → **RISK ANALYSIS**

Each task has followed the above method in order to study the different road users groups. The main achievements, apart from the specific results on each task, make reference to the following facts:

- Innovative statistical methods, developed by WP7, have been applied as much as possible in order to provide data at EU27 level related to the magnitude of the accident figures for each road user group although this was an initial target of the project. When available, these figures have been combined with exposure data in order to provide general risks estimations.
- Relevant & specific accident configurations have been detected and describing for each road user group at macroscopic level. This means that safety solutions addressing these configurations would benefit to larger groups of road users.
- Contributory factors have been identified through microscopic analysis in order to detect what aspects have contributed to the accident. This is what topics should new safety systems would be addressing. The WP5 methodology to identify Human Functional Failure has been applied in this step allowing the identification of the human decisions mechanisms that did not perform positively in each accident configuration.

- Last but not least, the different risk analyses performed allow deciding which new systems should be prioritized as they address factors that induce a higher level of risk for each road user.

TRACE differs from other accident research project both on the methodology used and the collating of almost all the relevant accident databases at European Level both at macroscopic and microscopic level.

Nevertheless, this does not mean that everything is achieved in accident causation. This project has also encountered some relevant difficulties that should help the research community to identify the next actions to be taken:

- There is not enough data to perform all the ideal risk analyses in accident causation. Sometimes there is a lack of data related to the detail of accident information and sometimes it is not possible to get the necessary exposure data to perform risk. For example, combining data from different in – depth accident databases has required a great effort in developing common concepts that could be analysed in each database, taking into account they are designed with different structures.
- The quantity and quality of information is not the same for all road users. Those less represented in the different vehicle circulating parks could be improved their level of safety by a higher level of detail in the information that accident data offers.
- If a common accident investigation methodology is applied in the future, this will allow performing a new updating of the accident causation knowledge under this approach.

All potential users of the results of this work package should not only consider the different percentages and specific conclusions of each road user but also the methodology followed to obtain each result. Both objectives of developing and applying the methodology for the updating and accident causation have been achieved within this work package from the point of view of road users.

From this study realized in WP1, just completed after the in-depth and risk analyses showed in this report, it has taught us many several things concerning with the initial challenges, expected outcomes and objectives can be summarized in the following analysis:

Strengths

- The concept of accident causation. Through the analysis of in-depth database, a better understanding of how the accidents happened has been gathered. Through this knowledge, accident causation has been detailed for each road user group.
- Through the interaction with other Work Package, the following actions have been gathered:
 - Work Package 5 'Human Factors': Detection and codification of the Human Function Failures present in the accidents, through the methodology developed in this Work Package.
 - Work Package 6 'Safety Functions': Feedback to this WP of the main findings and results obtained from the analyses of National, In-depth and Exposure databases.
 - Work Package 7 'Statistical Methods': Use of statistical techniques explained and developed in this Work package for the analysis of accident information.
 - Work Package 8 'Data Supply': Use of the most current information from National accident databases, In-depth and exposure databases.

Weaknesses

- The main accident configurations for each road user were done in the descriptive analyses (Deliverable D1.1) on available countries from TRACE project (essentially in West part of Europe where the road traffic safety is now is a "standard"). This fact could be considered as not enough representative of the EU27, but, on the other hand, for some tasks (example PTWs) the TRACE National databases used have been the ones concerning the countries with highest PTW parc, so the extrapolation of results can be done in an appropriated way. Also, for some aspects, extrapolation methods developed in Work Package 7 have been applied to main results to extend them at EU27 level.

Opportunities

- Update diagnosis of road traffic safety in Europe and provide some general descriptive and exposure figures at EU27 level.
- Original approach: 3 different axes to overview the accident (WP1, WP2 and WP3).
- Update knowledge of main accident scenarios. Define the main scenarios from each road user point of view.
- A better understanding of how the accidents happen, which will help for:
 - The determination of the most promising safety systems (interaction with 'Work Package 6: Safety Functions').
 - The evaluation of the effectiveness of existing safety devices (interaction with 'Work Package 4: Evaluation').
 - The identification of the configurations not addressed by present technologies.
- Giving innovating findings to the scientific community related accident causation and risk analysis for each road user group.
- The lack of data in some activities can be a good opportunity to other projects (as Safetynet) to complete its definition of the real needs for both descriptive and exposure data.
- The integration of all the information from different National and In-depth databases needs of a good harmonization of variables at different level. This fact can help to purpose possible future research in Road safety Data Collection, Transfer and Analysis of this kind of information at different levels.
- Information from this project can help to different observatories (ERSO and each European Safety Observatory) to propose different policies and strategies for the road safety improvement, that, at the end it must be the final general objective.

Threats

- The lack of some accident and exposure data at the European level does not allow providing a more complete picture not only on EU27 general situation, neither at TRACE level because some information for specific analyses is not available.

8 Acknowledgement

The Trace Partners have had access to national and in-depth accident databases. The results presented in this report are based on the work performed by the according organizations keeping the databases.

From the National point of view, special gratitude to the following databases:

- ✓ **STATS19 Data from Great Britain:** National Accident Data for Great Britain are collected by police forces and collated by the GB Department for Transport. The data are made available to the Vehicle Safety Research Centre, Ergonomics and Safety Research Institute, at Loughborough University by the GB Department for Transport. The Department for Transport and those who carried out the original collection of the data bear no responsibility for the further analysis or interpretation of it.
- ✓ **SISS – Sistema Integrato Sicurezza Stradale - Data from Italy:** Accident Data are collected and collated for local administrations by police across Milan province, Mantova province, Naples city, Sorrento city and Salerno city (Italy) . The data are made available to ELASIS and to National Institute of Statistics by local administrations. The local administrations and who carried out the original collection of the data bear no responsibility for the further analysis or interpretation of it.
- ✓ **EDN (Traffic Accidents Registration) Data from the Czech Republic:** National Accident Data for the Czech Republic are collected by the Czech Police forces. The data are made available to CDV (Transport Research Centre). CDV bears no responsibility for the further analysis or interpretation of it.
- ✓ **BAAC (Bulletin d'Analyse des Accidents Corporels):** National accident database for France collected by police, CRS and Gendarmerie forces and provided by ONISR (Observatoire National Interministériel de Sécurité Routière). The data are made available to the Laboratory of Accidentology, Biomechanics and human behaviour PSA Peugeot-Citroën, Renault.
- ✓ **Spanish Road Accidents database** is carried out by a public organisation called DGT (Dirección General de Tráfico), dependent of the Ministry of the Interior. Information contained in DGT Spanish Road Accidents Database is collected by police forces, when an accident occurs. The data are made available for CIDAUT since 1993. The Department for Transport and those who carried out the original collection of the data bear no responsibility for the further analysis or interpretation of it.

From the Intensive point of view, special gratitude to the following databases:

- ✓ **'MAIDS' database and ACEM:** MAIDS is the most comprehensive in-depth data currently available for Powered Two-Wheelers (PTWs) accidents in Europe. The investigation was conducted during 3 years on 921 accidents from 5 countries using a common research methodology. TRACE acknowledges the help given to CIDAUT partner by MAIDS project, through ACEM ('Association des Constructeurs Européens de Motocycles'), in analysing this 'in depth' accident database.
- ✓ **'On The Spot' database:** The OTS project is funded by the UK Department for Transport and the Highways Agency. The project would not be possible without help and ongoing support from many individuals, especially including the Chief Constables of Nottinghamshire and Thames Valley Police Forces and their officers. The views expressed in this work belong to the authors and are not necessarily those of the Department for Transport, Highways Agency, Nottinghamshire Police or Thames Valley Police.
- ✓ **'DIANA' database:** CIDAUT counts with spanish accident investigation teams in the region of Valladolid (Spain) that travel immediately to the accident scene to perform an 'in-depth

investigation', in close cooperation with police forces, medical services, forensic surgeons, garages and scrap yards. All information gathered is stored in an own ORACLE database (called DIANA) for further exploitation jointly with access to other accident databases, as for example the national one coming from the DGT (Dirección General de Tráfico) which provide information on every injury accident.