TRACE Project. Deliverable 1.2. Road users and accident causation. Part 2: In-depth accident causation analysis

A. Molinero, J. M. Perandones, T. Hermitte, A. Grimaldi, J. Gwehengerber, D. Daschner, J. M. Barrios, A. Aparicio, S. Schick, P. van Elslande, et al.

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Road users and accident causation. Part 2: In-depth accident causation analysis

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Author(s): Aquilino Molinero, José Miguel Perandones, Thierry Hermitte, Alfonso Grimaldi, Johann Gwehengerber, Dieter Daschner, José Manuel Barrios, Andrés Aparicio, Sylvia Schick, Pierre Van Elslande, Katel Fouquet.

Participant(s): CIDAUT, LAB, ELASIS, ALLIANZ, IDIADA, LMU, INRETS.

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Abstract:

This report aims to present the final results of the descriptive statistical, in-depth and risk analysis performed within the first 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 main output of this report are (from each road user point of view):

- A summary of the descriptive analysis done in a previous report (D1.1) with the main characteristics of the accidents gathered in different extensive databases, from the road user's point of view.
- The understanding and identification of the accident causes by means of micro level analyses.
- The estimation of the risk of being involved in an accident for these five user categories.

Keyword list:

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

Table of Contents

1 Executive Summary 5

1.1 Main results for each road user point of view 10

1.1.1 Task 1.1: Passenger Car Drivers. 10

1.1.2 Task 1.2: Powered Two Wheeler Riders. 12

1.1.3 Task 1.3: Van, Bus and Truck Drivers. 14

1.1.4 Task 1.4: Pedestrian and Cyclists. 16

1.1.5 Task 1.5: Elderly People and Gender related accidents. 18

2 Introduction 23

2.1 Objectives of TRACE Project 24

2.2 'Work Package 1: Road Users' 25

2.2.1 WP1 description 25

2.2.2 Overview of the problem 27

2.2.3 WP1 Partners 29

2.2.4 WP1 objectives and methodology 30

2.2.5 Deliverable D1.2 32

3 Task 1.1: Passenger Car Drivers 34

3.1 Main results from deliverable D1.1 34

3.2 In-depth analysis 34

3.2.1 Data selection 34

3.2.2 Results from overall in-depth analysis 34

3.2.3 Single passenger car drivers' accidents analysis 38

3.2.4 Multi-vehicles accidents analysis 44

3.3 Discussions 54

3.4 Conclusions 56

4 Task 1.2: Powered Two Wheelers Riders 57

4.1 Introduction 57

4.2 Main results from the Deliverable D1.1 58

4.3 In-Depth analysis 61

4.3.1 Methodology 61

4.3.2 Database 62

4.3.3 Accident causation analysis 63

4.3.4 Human Function Failure 66

4.3.5 Risk analysis 68

4.4 Conclusions 75

4.5 References 77

5 Task 1.3: Vans, Bus and Truck Drivers 78

5.1 Main results from deliverable D1.1 78

A.- Vans 80

5.2 In-depth analysis 80

5.2.1 Method 80

5.2.2 Available data 80

5.2.3 Involved countries and geographical areas 80

5.2.4 List of used causation factors ... 80
5.2.5 Causation factors ... 81
5.3 Conclusions ... 85

B.- Buses ... *86*

5.4 In-depth analysis ... 86
5.4.1 Causation factors ... 86
5.5 Conclusion ... 90
5.6 References ... 90

C.- Trucks ... *91*

5.7 Main results from Deliverable D1.1 ... 92
5.7.1 Main results from the literature review ... 92
5.7.2 Main descriptive analysis results ... 93
5.8 In depth analysis ... 93
5.8.1 ETAC project ... 93
5.8.2 Expected results in TRACE analyses ... 96
5.8.3 TRACE 'In-Depth' Analysis ... 102
5.9 Result analysis ... 105
5.9.1 Global ... 106
5.9.2 Scenarios and Main Accident types ... 108
5.9.3 Scenarios and main factors ... 116
5.10 Conclusions ... 123
5.10.1 General database statistics ... 123
5.10.2 Main study results ... 125

6 Task 1.4: Pedestrians and Cyclists ... *128*

6.1 Main results from deliverable D1.1 ... 130
6.1.1 Main literature review results ... 130
6.1.2 Main descriptive analysis results ... 131

A.- Pedestrians ... *132*

6.2 In depth analysis ... 132
6.2.1 Data used for the in-depth analysis ... 132
6.2.2 Human functional failure (HFF) analysis ... 135
6.3 Discussion ... 152
6.3.1 LMU ... 152
6.3.2 IDIADA ... 154
6.4 Conclusions ... 156
6.4.1 Comments related to the available data ... 156
6.4.2 Conclusions for pedestrians involved in pedestrian accidents ... 157
6.4.3 Conclusions for drivers involved in pedestrian accidents ... 157
6.4.4 Recommendations for improving safety ... 158
6.4.5 Difficulties found and lacks to be solved ... 158
6.4.6 Next steps ... 158
6.5 References ... 159

B.- Cyclists ... *160*

6.6 In depth analysis ... 160
6.6.1 Data used for the in-depth analysis ... 160

6.6.2 Data analysis 160
6.7 Discussion 168
6.7.1 VSRC (OTS) 168
6.7.2 ELASIS 168
6.8 General Conclusions 168
6.8.1 Recommendations for improving Safety 168
6.8.2 Difficulties found and lacks to be solved 169
6.8.3 Next Steps 169
6.9 References 169

7 Task 1.5: Elderly people and Gender related accidents 171

A.- Elderly people 171

7.1 In-depth investigation of accident patterns among elderly drivers using the TRACE WP5 methodology 171
7.1.1 Pre-accident situation 172
7.1.2 Level of involvement in the accident 173
7.1.3 Errors and error factors among the elderly: overall analysis 174
7.1.4 Errors and error factors among the elderly: fine analysis 176
7.1.5 Failures among elderly people in emergency situations 191
7.1.6 Discussion 192

B.- Gender issues 196

7.2 In-depth investigation of accident patterns according to gender using TRACE WP5 methodology 196
7.2.1 Error production context: pre-accident situation and level of involvement ... 196
7.2.2 Errors and error factors among drivers: overall analysis 196
7.2.3 Errors and error factors among drivers: detailed analysis 198
7.2.4 Discussion 213
7.2.5 Conclusions 215

8 Conclusions 216

9 References 219

10 Acknowledgement 220

11 Annex 1: Tables and figures 222

11.1 Annex 1.1: Passenger car drivers 222
11.2 Annex 1.2: Powered Two Wheelers 260
11.3 Annex 1.3: Vans, Bus and Truck Drivers 260
11.4 Annex 1.4: Pedestrian and Cyclists 261
11.4.1 Pedestrians 261
11.4.2 Cyclists 272
11.5 Annex 2.5: Elderly people and Gender related accidents 273
11.5.1 Elderly people 273
11.5.2 Gender issues 282

1 Executive Summary

Two thirds of the road casualties occur in developing countries according to the World Health Organization and other sources. In 2006, there were 1,277,126 accidents involving injured casualties at EU27 [1] level where 42,953 people were killed and 1,678,474 people were injured. Therefore, enhancement of safety at pan European level still constitutes a main social concern despite the several efforts developed during the last decades to improve the level of safety in vehicles. Many experts agree that the prevention of accidents and recovery in case of emergency situation approaches are to be brought forward in order to continue with this positive safety trend. Although existing data sources cannot provide the analysis that Europe may need at this moment, they can contribute to give a better understanding of accident causation and to evaluate the effectiveness of some on-board safety functions with the final purpose of improving road safety.

The European Commission set the ambitious aim of halving the number of road traffic fatalities by 2010 in its White Paper 'European transport policy for 2010: time to decide' of 2001. The European Road Safety Action Programme of 2003 underlines the fact that this target is a 'shared responsibility' and can thus only be achieved with the joint effort of all stakeholders. Since these papers were published, much progress has been achieved. According to the EC's evolution report (published in December 2007) **fatalities in the EU-27 have been reduced by 18,8%** between 2001 and 2006[2] (from 53,909 to 45,296) or even, based on the last available data (by May 2008), fatalities in **EU-27 have decreased 2% during the last 12 months**[3].

Although these reductions are very important, there is still a difference between the actual result and the target of halving the number of deaths on the roads by 2010. Nevertheless, current **safety policies** and **research projects** focused on these subjects are helping to achieve this goal. The following figure shows the most update situation in EU-27 taking also into account the population for each country. In this figure, countries from south seem to have lower rates than from north (possibly due to historical backgrounds).

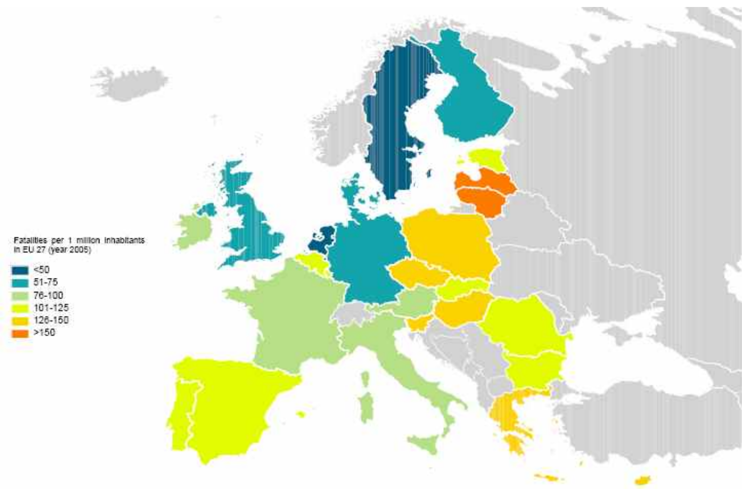

Figure 1.1.- Road fatality rates: fatalities in Europe per million of habitants

(Sources: EUROSTAT 2005, Safetynet 2007).

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.

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[1] CARE reports: Road safety evolution in EU (December 2007).

[2] CARE database: Road safety evolution in EU countries. December 2007.

[3] CARE database: Quick Indicator latest data. May 2008.

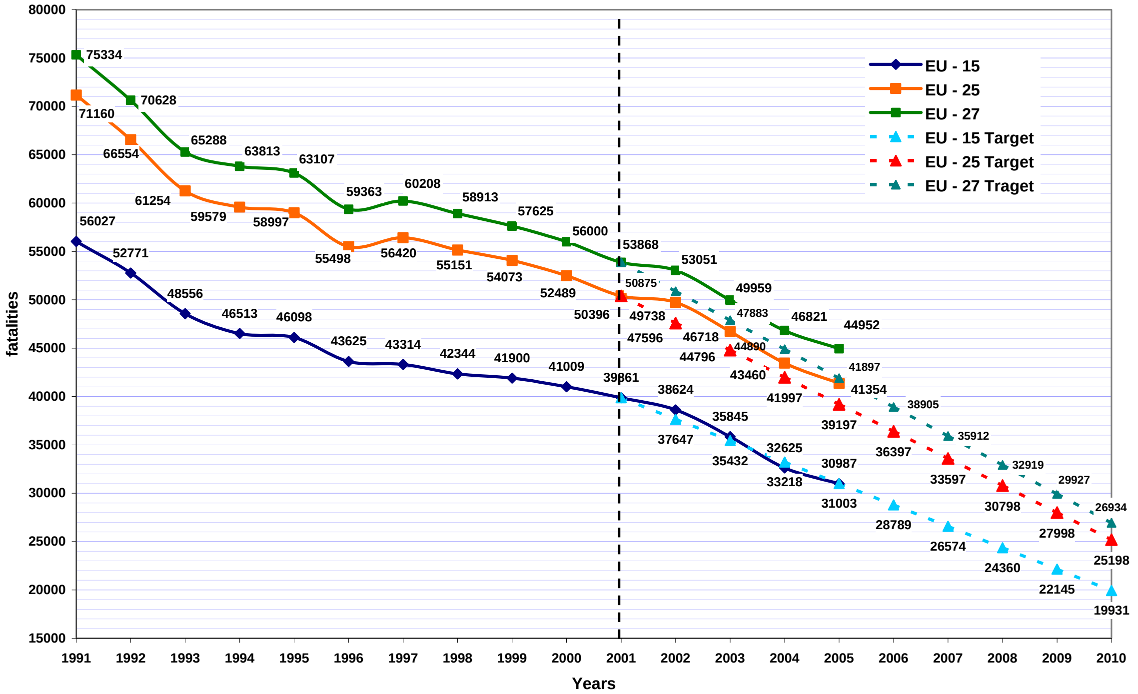


Figure 1.2.- Road Safety evolution in EU-27[1].

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 (**TR**affic **A**ccident **C**ausation in **E**urope) 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 a 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.

TRACE analyses on the accident causes are developed through reliable exposure, accident and injury data systems. Therefore, the safety diagnosis provided by TRACE is based on available, reliable and accessible existing and on-going databases.

Accident causation is a topic that deserves more than only statistical tables. Current knowledge needs to be structured and linked to specific research angles and analysed according to specific methodologies to avoid misleading and to allow a clear view of what accident causation is. Therefore, TRACE proposes **three different research angles** to cover accident causation issues:

[1] CARE, IRTAD, IRF and National Databank Statistics.

- The **Road user approach**: it allows specific causation factors for specific road users (it will be dealt in Work Package 1 'Road User').
- The **Types of situation approach**: as the road user can be confronted with different driving situations that can develop into different emergency situations that deserve specific analysis regardless the road user type (it will be dealt in Work Package 2 'Type of situations').
- The **Types of factors approach**: factors can be identified and observed according to an innovative split: the social and cultural factors, the factors related to the trip itself and the factors related to the driving task (it will be dealt in Work Package 3 'Human factors').

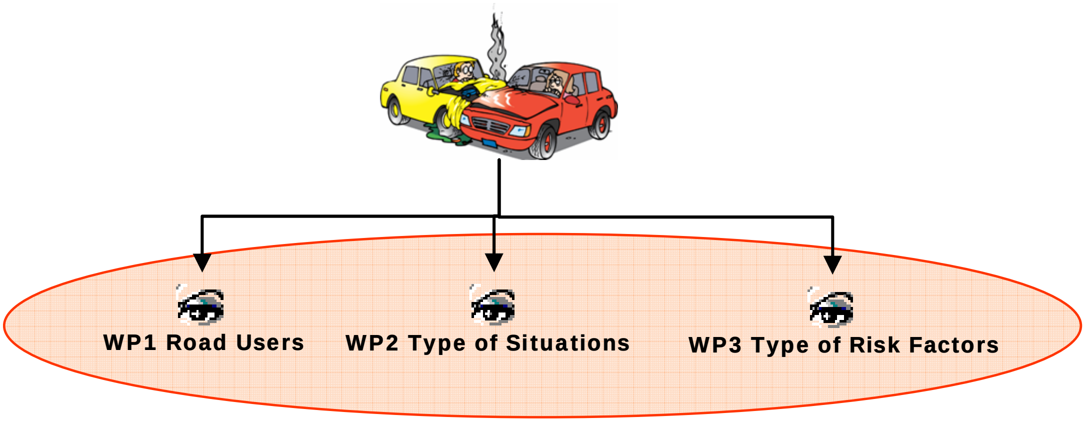


Figure 1.3.- Three different research angles to cover accident causation in TRACE.

Within this context, WP1 (Road Users) is addressing the **analysis of the different accident causation mechanisms of each of the road user groups**. The work package is divided in five different tasks:

- **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 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.

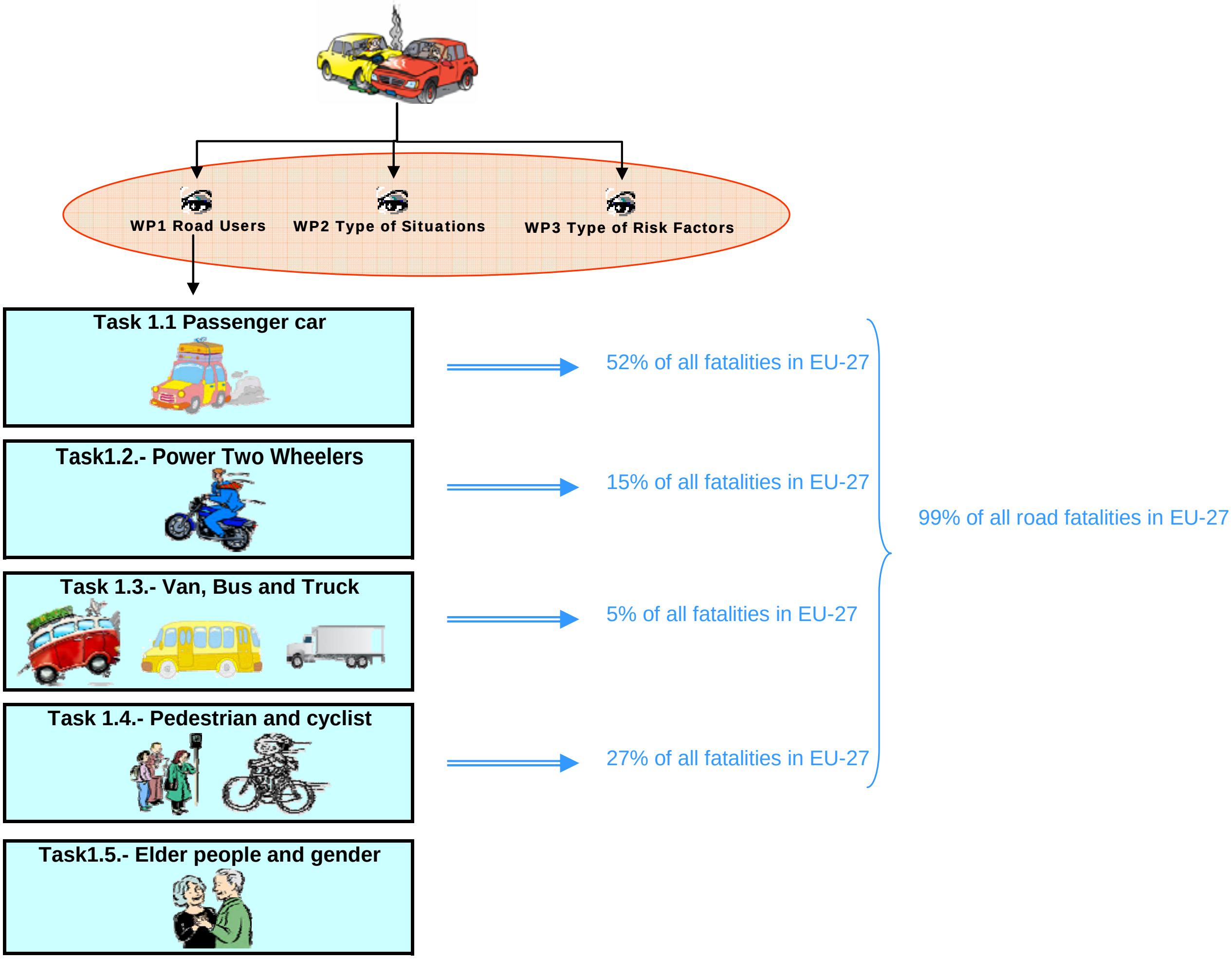


Figure 1.4.- Different road user groups (tasks) planned in TRACE (2004)[1].

The above tasks main objective is to identify the accident causation aspects through three different kinds of analyses:

1. A **macroscopic** statistical analysis aimed at describing the main problems of each road user group (Descriptive Analysis).
2. A **microscopic** analysis aimed at describing the accident mechanisms with the use of in – depth data (In – Depth Analysis).
3. A **risk analysis** aimed at quantifying the risk factors in terms of risk, relative risk and, where possible, attributable risks.

[1] Statistics of Road Traffic Accidents in Europe and North America. United Nations (2007).

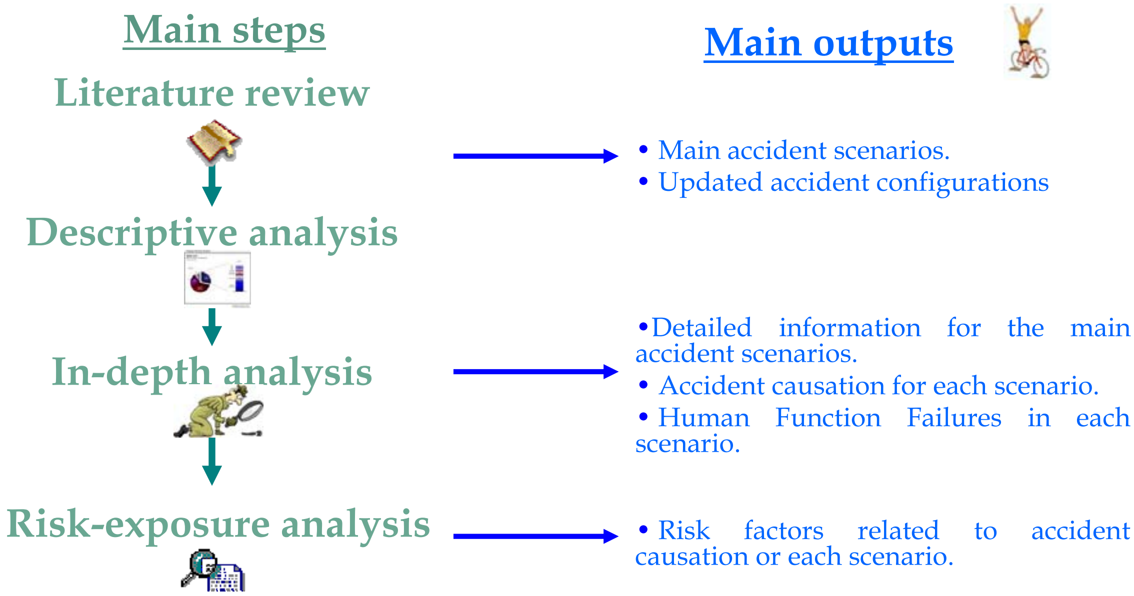


Figure 1.5.- Steps planned in WP1 for the detection of the accident causation and risk factors.

The present deliverable **D1.2** will cover the last two types of analyses within WP1 (**In-depth and Risk analysis**) for each one of the different road users groups, corresponding to the activities of each task. Based on the results from the 'Deliverable D1.1: Road users and accident causation. Part 1: Overview and general statistics', these analyses will be done over the main accident scenarios (from each road user point of view) detected in this first deliverable. During the present deliverable D1.2, main results from D1.1 will be mentioned in order to remember them.

After these remind results, the 'in – depth analysis' over TRACE intensive databases (from '**Work Package 8: Data Supply**') will provide the main accident causation mechanism for each of the identified problems at macroscopic level. Microscopic accident databases will provide information able to tackle the three basic pillars of safety: the driver, the environment and the vehicle. Only looking at the whole picture of each accident with deep detail it can be stated what set of factors can be considered as causes of the accident. Therefore, what 'in-depth analysis' will provide to TRACE project is the possibility of detecting which the main 'contributing factors' are in accidents, this would mean the way to know all the accident causations, from different point of view. The big difference between analyzing information from 'National databases' or from 'In-depth databases' is the possibility to obtain more precious information from the last one. This is the main reason 'In-depth' analyses will be done over the most frequently accident scenarios detected in 'National database' analysis.

Also, an important output of this report from the 'In-depth' database analyses to be done will be the determination of the main human function failures existing in the accidents. The Human methods developed in the '**Work Package 5: Human Factors**' will be applied to each user group.

At last, 'risk analysis' will be done to estimate what is the risk of being involved in an accident for each of the different road users groups taking into consideration the exposure to the different causation mechanisms identified in the in – depth analysis. A deeper explanation of this activity would help to understand that, through respective statistical analysis (odds-ratio values, logistics regressions,… explained in the 'methodological statistical reports' from the '**Work Package 7: Statistical Methods**') over specific variables coming from exposure data, risk factors will be detected. In fact, these risk factors will be variables (coming from exposure data) that can be considered as influential in the occurrence of an accident. Of course, these risk factors are supposed to be statistically related to contributing factors in each scenario, so that, when a risk factor exists during the previous phase to an accident, this can mean that a contributing factor can appear (due the relation between risk factors and contributing factors) and therefore the accident is more likely to happen. The study of these risk factors will also help to answer questions related to aspects as over-representation of specific variables in accidents (a phenomenon of excess risk for those variables or simply depending on exposure).

1.1 Main results for each road user point of view

In the five following subchapters, it could be shown which main findings to keep in mind TRACE has gathered after the in-depth and risk analyses done, this means, what main issues TRACE analyses have obtained and what new knowledge and innovations WP1 brings to scientific community.

1.1.1 *Task 1.1: Passenger Car Drivers.*

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).

This 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 or 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).

1.1.2 Task 1.2: Powered Two Wheeler Riders.

Once the seven main PTW configurations were detected in D1.1, the respective in-depth and risk analyses show the following results:

1. The first configuration was the motorcycle single accidents involving one motorcycle on a rural road (run-offs, rollover on the carriageway and collisions with road restraint systems). These type of accidents occurred mostly to riders who did not have experience driving along that road or that area. The lack of driving license increased notably the risk of being involved in an accident of these characteristics. 'Motorcycle rider decision', 'motorcycle rider unsafe acts' and 'inadequate speed' were the most common contributing factors in this configuration; and these contributing factors were associated to 'rider age category under 25' and 'to had committed at least one traffic violation in the last five years'. This lead to point to a pattern of this type of accidents could be:

- ✓ Young rider, probably without an appropriate license, travelling at inadequate speed suffered a run off of the road or lost the control and rollover on the carriageway.
- ✓ And other group of these type of accidents could be a rider from another area or being new user of that road did not perceive the layout (or signing) correctly and had a run off of the road or lost the control and rollover on the carriageway.

Related risk factor analyses, it has been found for this first configuration that:

- ✓ If the vehicle year of production is 5-10 years old, this means the risk of being involved in this kind of accidents is 2.29 times higher.
- ✓ Rider age (<25 years): 2.09 times higher.
- ✓ Lack of driving license: 4.01 times higher.
- ✓ Not resident citizens: 5.87 times higher.
- ✓ Under secondary school qualification: 4.05 times higher.
- ✓ Not frequent use of the road: 3.53 times higher.

2. Front-side accidents in rural and urban junctions between motorcycles and passenger cars are the second accident configuration. In the majority of them the main contributing factor was a perception failure from the passenger car driver. These accidents seem to happen, in urban junctions, during short distance trips, when a passenger car confronts a junction and the driver do not perceive a motorcycle and collide with it. Sometimes, the riders contributed to the accident by 'unsafe acts or taking risks' but mostly this was not the primary cause of the accident.

Related risk factor analyses, it has been found for this first configuration that:

- ✓ If the vehicle year of production is higher than 2 years old, this means the risk of being involved in this kind of accidents is 5.25 times higher.
- ✓ Motor displacement (>125cc): 1.78 times higher.
- ✓ Lack of right side rear view mirrors: 2.01 times higher.
- ✓ Rider age (< 25 years): 2.07 times higher.
- ✓ Under secondary school qualification: 1.55 times higher.
- ✓ Short length of the trip (>10 Km): 2.55 times higher.

3. The third configuration registered side to side accidents in rural and urban non junctions between motorcycles and passenger cars. Due to the low frequencies could not be possible to perform any kind of analysis apart from the descriptive ones. Nevertheless, contributing factors 'passenger car perception failure' and 'motorcycle rider unsafe acts' were presented in most of the cases. So, these accidents could happened when one of the vehicles was changing lanes or overtaking and the other

one start a manoeuvre invading the space occupied by the other vehicle, without seen it. Typically, the motorcyclist is overtaking the passenger car and passenger car changes lanes without seen the motorcycle (blind spot in rear view mirrors or not expecting another vehicle in the other lane).

4. Rear-end accidents in rural and urban non junctions between motorcycles and passenger cars. This fourth configuration for motorcycles is like the previous one (low frequencies). Its contributing factors were 'passenger car perception failure', 'motorcyclist perception failure' and 'motorcycle rider unsafe acts or risk taking'. The typical accident within this configuration is when one of the vehicles slows down (sometimes suddenly) and the driver/rider of the other one does not perceive that manoeuvre and collide.

5. Most of the accidents which involved just one moped on a rural or urban road (run-offs, rollover on the carriageway and collisions with road restraint systems) were the consequence of a rider who had consumed alcohol/drugs or who had a no permanent impairment (tiredness, drowsiness, hunger…). Both factors increased notably the risk of being involved in a single moped accident.

It has been found for this first configuration that:

- ✓ If the vehicle has front position lamp equipped, this means the risk of being involved in this kind of accidents is 2.90 times higher.
- ✓ Alcohol and/or drug use: 8.03 times higher.
- ✓ Not permanent physical impairment (tiredness, …): 4.59 times higher.
- ✓ Previous motorcycle traffic accident: 2.31 times higher.

6. Front to side collisions between mopeds and passenger cars. The majority of these accidents occurred in urban areas. The main risk factors were 'Lack of driving license (no license held) and 'no frequent use of the road' which increased the risk notably. As it happened with the front to side accidents between motorcycles and passengers cars, 'perception failure' from the driver was present in more than half of these accidents.

It has been found for this first configuration that:

- ✓ If the vehicle year of production is higher than 2 years old, this means the risk of being involved in this kind of accidents is 5.95 times higher.
- ✓ Front suspension type (no telescopic tube): 1.68 times higher.
- ✓ Front suspension in bad conditions: 2.26 times higher.
- ✓ Head assembly type (double): 1.58 times higher.
- ✓ Fuel tank type (saddle): 2.84 times higher.
- ✓ Rear tread type (all weather, angle groove): 1.81 times higher.
- ✓ Modified / Enhanced motor power: 2.79 times higher.
- ✓ Lack of driving license (no license held) : 4.04 times higher.
- ✓ Not regulated training: 2.03 times higher.
- ✓ Not permanent physical impairment (tiredness, …): 3.73 times higher.
- ✓ Not frequent use of the road: 5.71 times higher.

7. The last configuration studied was head-on accidents between mopeds and passenger cars. There was a tendency in the variable 'time travelling' because three out of five moped riders who were driving more than an hour had an accident. From the descriptive analysis the contributing factors within this configuration were 'motorcycle rider decision failure', 'passenger car driver perception failure' and motorcycle rider unsafe acts or risk taking'. These accidents seem to occur when one of the vehicles is overtaking another vehicle and misinterpreted the traffic situation and does not have enough time to finish the manoeuvre and collide with the vehicle travelling in the other direction; other stereotypical accident of this configuration type is when one of the vehicles invade the opposite

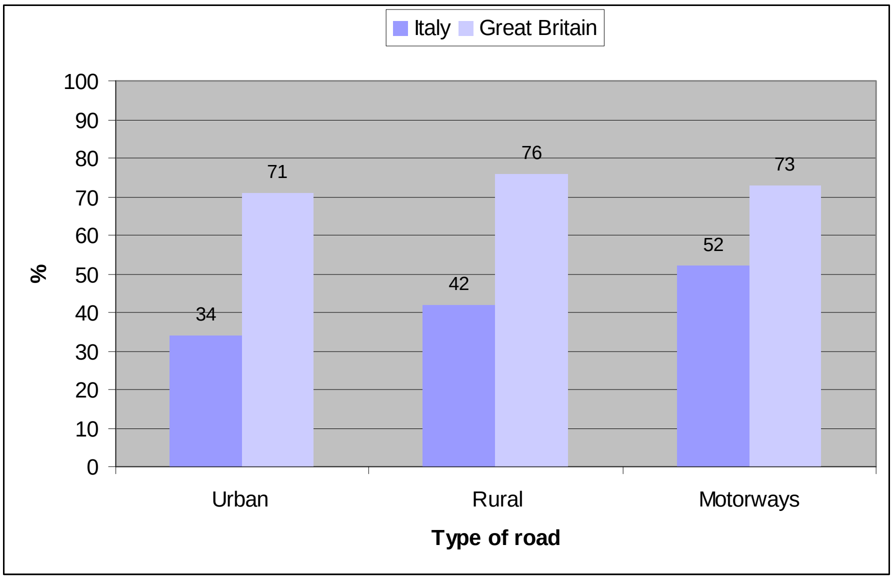
lane due to high speed on a bend or a distraction and collide with the vehicle travelling in the other direction.

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'.

1.1.3 Task 1.3: Van, Bus and Truck Drivers.

Vans

Van, or light trucks (≤ 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.



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:

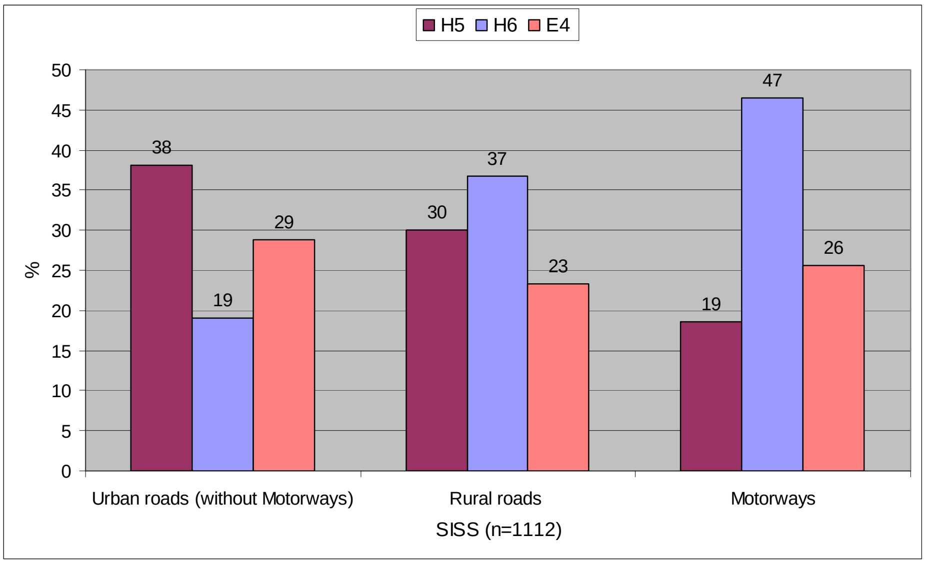
- ✓ H6 Behaviour – Risk taking: Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs/signals/markings, thrill-seeking…
- ✓ H5 Behaviour – Distraction: Distraction within vehicle, outside vehicle, within user (e.g. lost in thought)
- ✓ E4 Visibility 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 perform, 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.

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.



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.

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.

1.1.4 Task 1.4: Pedestrian and Cyclists.

The analysis of these accidents is particularly sensitive due to the vulnerability of the road users in question, meaning that there are often high severity levels or increased fatalities in the event of an accident. Accident cases were studied with respect to both the vulnerable road user and the driver of the opposing vehicle respectively.

Pedestrians

Pedestrians involved in pedestrian accidents:

- ✓ Decision (D), Overall (G) and Perception (P) failures are the most present in the action of the pedestrians.
  - o 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.
  - o On the other hand, D-failures are very frequent in the scenario where a pedestrian is crossing the street disobeying marks or signals.
- ✓ Most conflicts are against a vehicle coming from the side. This conflict is specially recurrent in urban accidents
  - o Linked with mainly D-failures, but also G and P-failures.
- ✓ 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. 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.

Drivers involved in pedestrian accidents:

- ✓ 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'.
- ✓ Most drivers were considered as 'secondary active'. (Accidents where the pedestrian took major responsibility of the accident but the driver also lead to the accident, not evaluating the risk, driving over the speed limit or failing in the execution of the avoidance action).
- ✓ 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 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.
- ✓ 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.

Causes of pedestrian accidents in urban and interurban zones have been defined and commonly associated to drivers and pedestrians failures. It is found that the most productive ways to avoid these accidents is by correcting the human failures. Several systems have been proposed to improve human actions. It is still necessary to check the capabilities of these proposed systems, develop and tune them and define testing methods which are representative of the failures established failures.

Cyclists

Data from VSRC (UK) showed that the main cause for cyclist traffic accidents was:

- ✓ Error or Reaction - 'failure to look properly'

Data from ELASIS (Italy) showed the main causes to be

- ✓ Behaviour – Careless Driving
- ✓ Road Environment
- ✓ Injudious Actions

A lot of the accidents with cyclists take place as a result of carelessness or disregard of road signs when driving. Drivers and cyclists alike are not paying enough attention or respect to the rules of traffic.

There are however some particularly vulnerable road layout situations during slopes and (hairpin, large radius and normal) bends, which represent 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 at this time to definitively confirm this.

It remains to make better comparability and analysis with regard to HFF analysis, which at present is not possible due to the lack of specific statistics available: therefore a full analysis as performed for the pedestrians has not been achieved and will require further data collections and studies in order to obtain concrete conclusions.

1.1.5 Task 1.5: Elderly People and Gender related accidents.

Analysis over elderly people and gender related accidents are summarized in the following results.

Elderly people

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.

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 no only more but also different patterns of accidents. Driving infrequently leads to a loss of expertise which have significant repercussions on the accident risk.

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.

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.

Gender Issues

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 observables 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.

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.

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 observables 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; χ^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; χ^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.

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%).

2 Introduction

Road safety at European level constitutes ones 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 2006[2]. 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 word (politician decisions, safety measures, driving training,…) to gather this important objective.

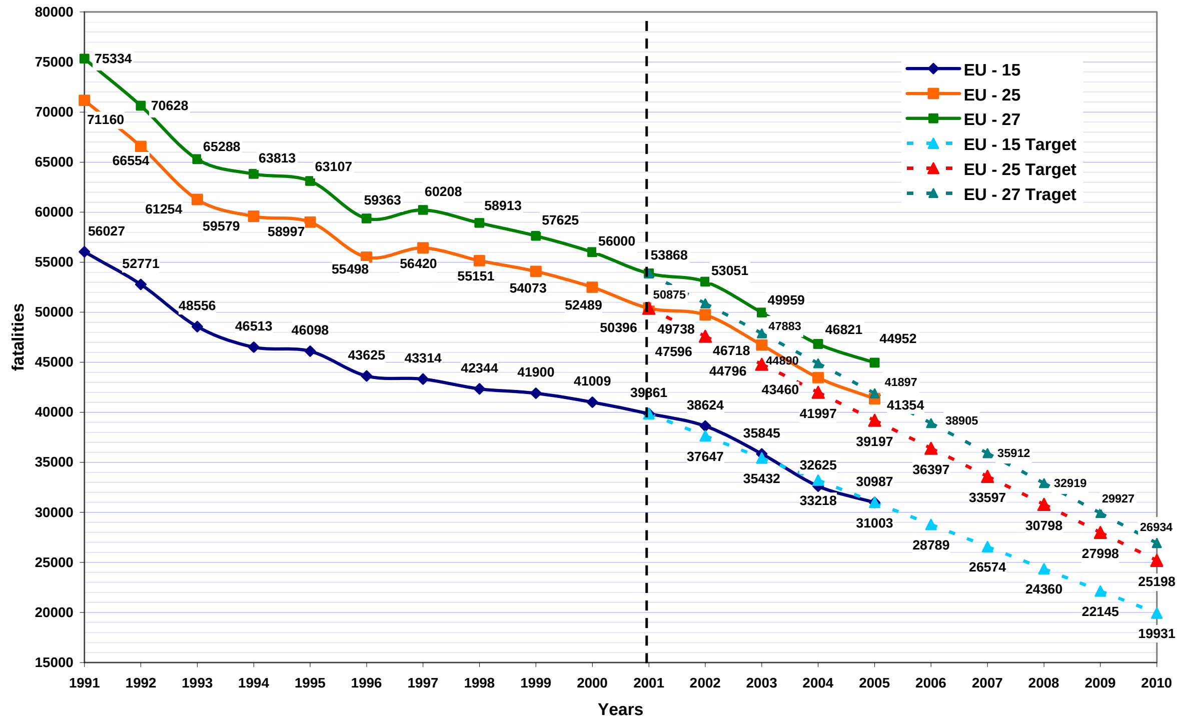


Figure 2.1.- Road Safety evolution in EU-27[3].

[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 (**TR**affic **A**ccident **C**ausation in **E**urope) 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 a 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.

2.1 Objectives of TRACE Project

The general objective of TRACE project (**TR**affic **A**ccident **C**ausation in **E**urope) 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:

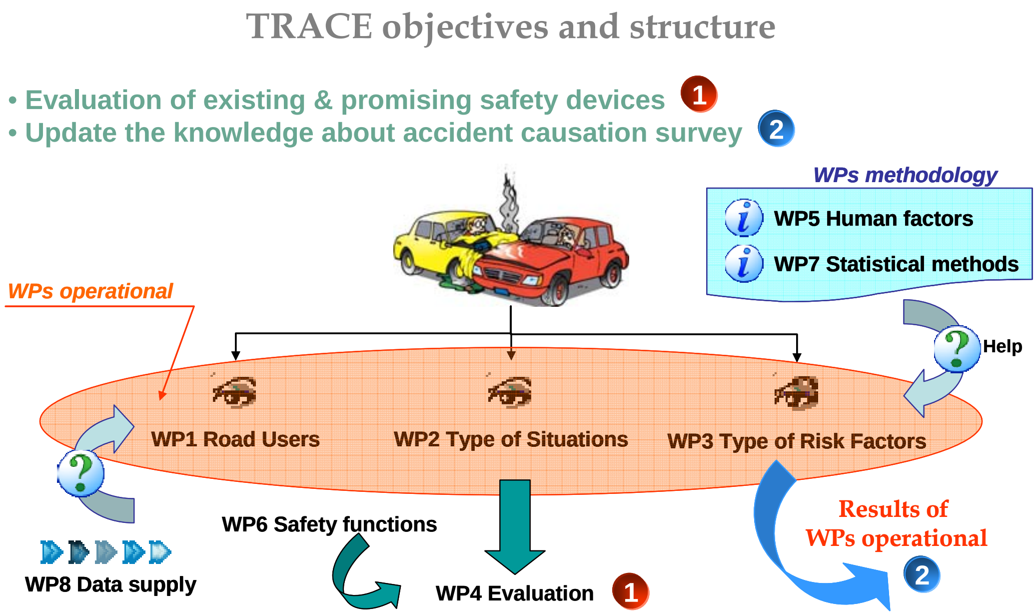


Figure 2.2.- Main TRACE objectives and structure of the different Work Packages.

2.2 'Work Package 1: Road Users'

2.2.1 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.

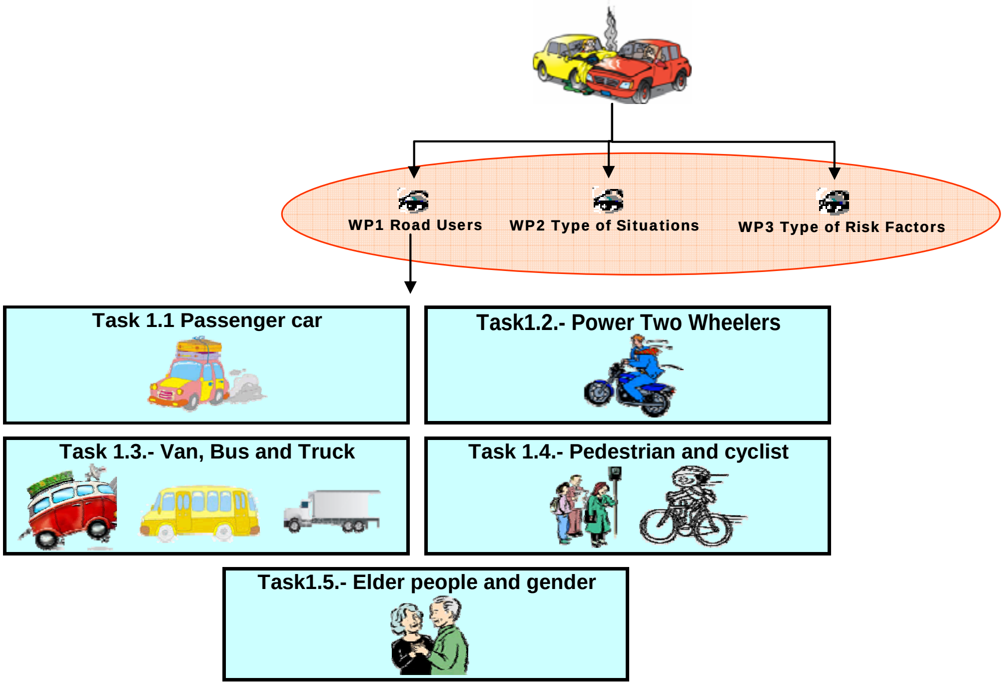


Figure 2.3.- Different road user groups (tasks) planned in WP1.

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.

2.2.2 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 use[1], 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.

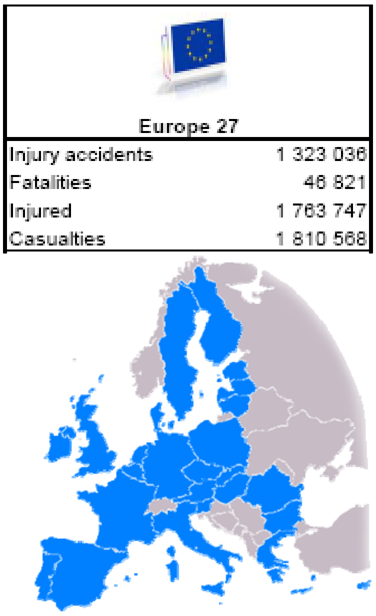


Figure 2.4.- General overview in EU-27[2] (2004).

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-27[3]:

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

[2] 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).

[3] 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 2.5.- Overview of the problem from each road user point of view in EU-27[1].

[1] 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 show 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, motorcycles and cyclists).

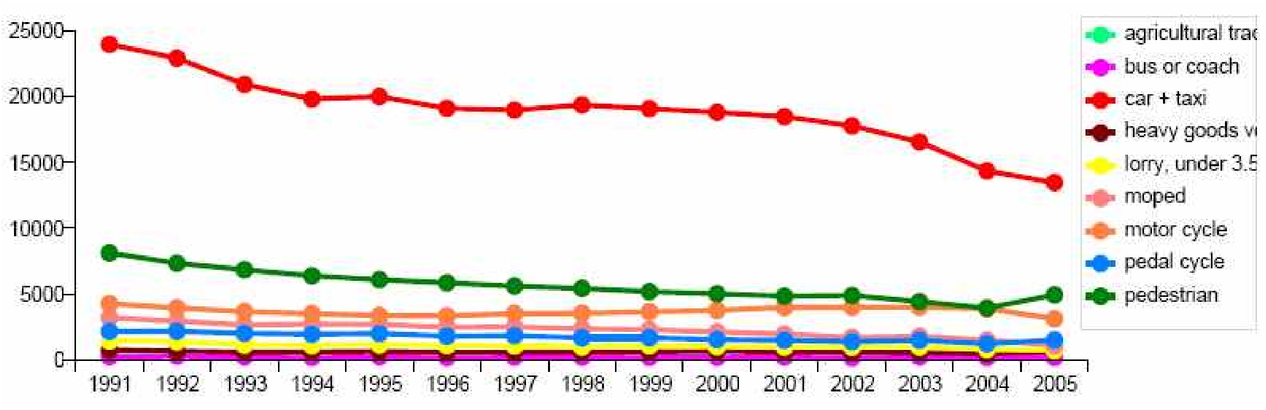


Figure 2.6.- Fatalities by transport mode in EU countries (included in CARE) – March 2008.

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

2.2.3 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.

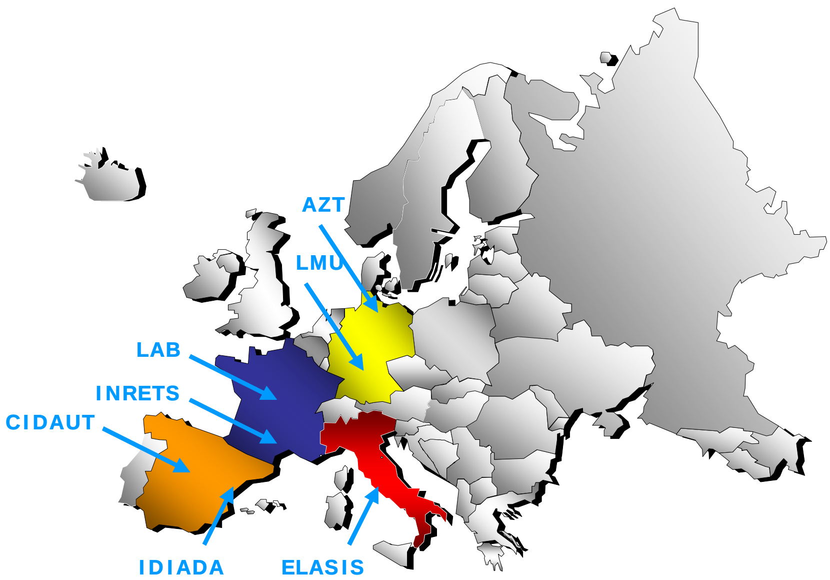


Figure 2.6.- Partners involved in WP1.

2.2.4 WP1 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:

2.2.4.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.

2.2.4.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.

The results of the above two first steps of this Work Package are the main issue of the report Deliverable D1.2 '*Road users and accident causation. Part 2: In-depth accident causation analysis*' 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 will be applied only analysing these configurations.

2.2.4.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 will be 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.

2.2.4.d Risk analysis

Last, a ***risk analysis*** will be 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 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 will play also a key role contributing to determine the appropriate statistical methods to be applied upon each kind of data.

The results of the last two steps (In-depth and Risk analysis) of this Work Package 1 will be covered by the present 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.

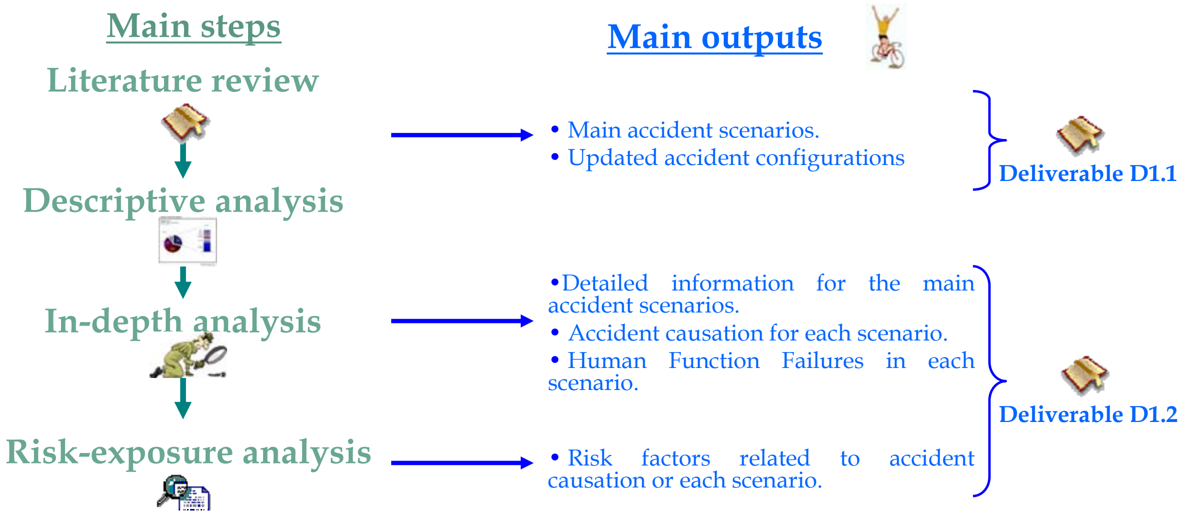


Figure 2.7.- Main steps and expected outputs planned in WP1.

2.2.5 Deliverable D1.2

The present deliverable **D1.2** will cover the last two type of analysis within WP1 (**Microscopic and Risk analysis**) for each one of the different road users groups, corresponding to the activities of each task. Based on the results from the 'Deliverable D1.1: Road users and accident causation. Part 1: Overview and general statistics', these analyses will be done over the main accident scenarios (from each road user point of view) detected in this first deliverable. During the present deliverable D1.2, main results from D1.1 will be mentioned in order to remember them.

2.2.5.a Main challenges

At the beginning of this deliverable (therefore, at the beginning of the last two steps of the Work Package 1: 'In-depth analyses' and 'Risk analyses'), specific challenges were detected to be overcome:

- A Diagnosis of traffic safety problems at the European Level from the research angle: Road Users.
- Two aspects to study: 'In-depth analyses' and 'Risk analyses'.
- Rely on a set of various in-depth accident databases.

2.2.5.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.
- Update knowledge of main accident scenarios.
- 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 will help for:
  - The evaluation of the effectiveness of existing safety devices.
  - The determination of the most promising safety systems.
  - The identification of the configurations not addressed by present technologies.

2.2.5.c Structure of the deliverable

The different sections for each chapter (task) will be:

- ✓ Introduction: The magnitude of the problem will be detailed.
- ✓ Descriptive statistical analysis: In this part, main results showed in the D1.1 will be resumed (The most important literature review results, the most important accident situation from the descriptive analysis).
- ✓ In-depth analysis: The main aim of this part is to obtain the causes of the main accident configurations (detected in the descriptive level) by looking at in-depth databases. In this chapter, each task will detail:
    - The list of accident configurations studied from the D1.1 (descriptive analysis) over each task is going to 'do' the in-depth analysis
    - The In-depth databases used (showing the relation with WP8).
    - The statistic methods used (showing the relation with WP7).
    - The relevant accident contributing factors detected from each accident situation. This list should differentiate the factors coming form the human part, the layout, the traffic in interaction and the vehicle.
    - The Human Function Failure detected in each accident situation (showing the relation with WP5).
    - Comparison between accident causation obtained from descriptive database analysis and in-depth analyses to know if the use of intensive databases has been useful.
- ✓ Risk analysis: Once the causes of the accidents have been detected, each task will detail the risk of being involved in an accident taking into account the causes from the 'in-depth' level (this means, the risk of being involved in an accident under the presence of the problematic factors detected).
- ✓ Conclusions: A brief summary is to be showed related to the results from the analysis done. The same way, next steps in the Work Package after these results will be detailed.
- ✓ References: References used during the analysis of each task are going to be listed. Most of them are European references due to the purpose of the project.
- ✓ Annex: Additional information about each task is included in the different annexes of this report.

The report will be concluded with a final chapter presenting some discussions and the global conclusions.

3 Task 1.1: Passenger Car Drivers

3.1 Main results from deliverable D1.1

This section is the second part of the analysis devoted to **passenger cars**. As it has been said in the 'Introduction' part of this report, the first part (literature review and descriptive analysis) has been provided in D1.1 and enlightened several types of accidents:

- ✓ **Single passenger cars accidents**
- ✓ **Passenger cars vs. passenger cars accidents, with special mention to intersection-located collision.**

This dichotomy will pave the way of the D1.2 outline, in which overall data analysis has been nevertheless added.

The analysis carried out in this section of D1.2 is underlined by the methodology developed in the work package 5 (cf. D5.1, D5.2 and D5.3). In this methodology the concepts of Human Functional Failure, explanatory elements, pre-accident situations and at last Typical Generating Failure Scenarios are central and are to be identified in the light of in-depth data. Level of involvement of the road users, a notion close to 'responsibility', is also to be taken into account. The present chapter of D1.2 will then issue the results related to those different parameters and to their interactions when identified for passenger cars drivers.

3.2 In-depth analysis

3.2.1 Data selection

In this section, all the data used here come from the Accidents Studies database provided by INRETS Department of Accident Mechanisms (Salon de Provence).

The whole sample gathers 1676 road users involved in 1067 accident cases.

Among these casualties, we have retained:

- ✓ 1303 drivers of passenger cars drivers for whom the case analysis was concluded.
- ✓ In this group, 14.4% drivers have been identified as 'Passive' drivers, meaning that no Functional Failure could be addressed to them (no participation to the accident occurrence but only being at wrong place at the wrong moment).
- ✓ 1115 drivers are then retained for the in-depth analysis.

For this study, data have been weighted with European data, regarding the age, the gender and the road environment (rural/urban).

3.2.2 Results from overall in-depth analysis

3.2.2.a Pre-accident situations

A first light that can be shed on specificities of cars drivers' accidents is the task that put them into trouble (Figure3.1Figure 3.1.-).

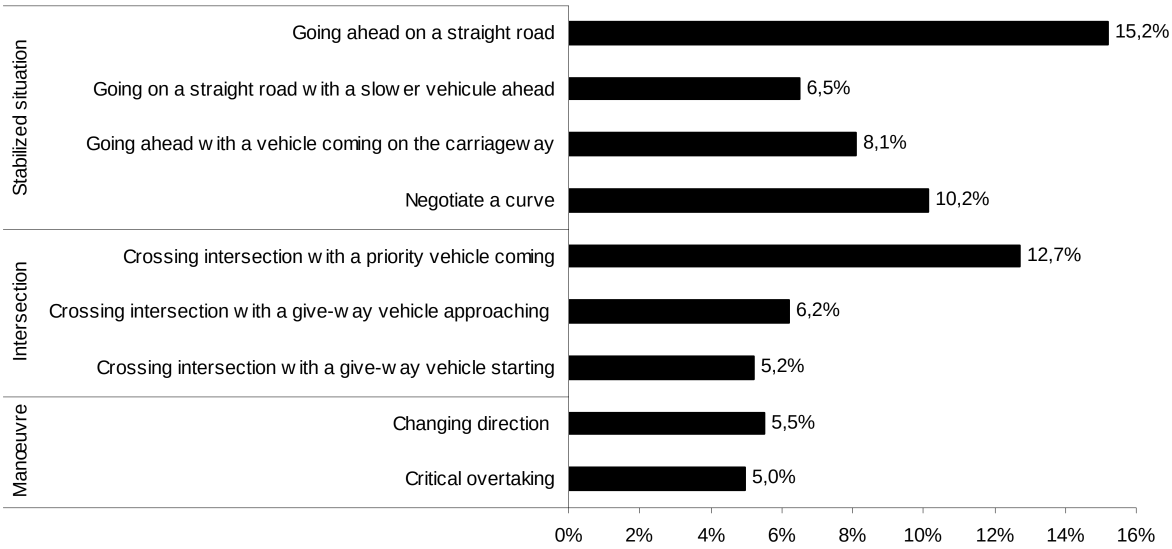


Figure 3.1.-Distribution of main pre-accident situations for passenger cars drivers.

The situations the most represented are grouped[1] under the label 'Stabilized situations' that correspond to tasks such as 'Going straight' or 'Negotiate a curve' (53.9%). Then comes the situations connected with tasks in intersection (30.3%), and at last specific manoeuvres undertaken by the driver (13.8%).

3.2.2.b Degree of involvement of the drivers in the accident

Following the TRACE WP5 methodology, the level of driver involvement in accidents will not be analysed in terms of responsibility, but rather in terms of degree of behavioural contribution to the breakdown of the situations, so as not to confuse an ergonomically-focused accidents analysis with a penal approach to accidentalness (cf. TRACE D5.1 and D5.5).

A distinction is made among 4 degrees of driver involvement:

- Primary actors: designates drivers who "cause the disturbance", who have a decisive functional involvement in producing the accident: they are directly at the origin of the destabilisation of the situation.
- Secondary actors: these drivers are not at the very origin of the disturbance, but they still take part in producing the accident. They contribute to the non-resolution of the problem through their lack of foresight as to how the situation will develop.
- Reactive: these drivers are confronted with another person's atypical manoeuvre that is hard to foresee, no matter whether or not it is in contradiction with the legislation. They are not considered active because they were unable to foresee the other person's failure.
- Passive: These are drivers who were not involved in the destabilisation but who were an integral part of the system. Their only role consisted in being present and they cannot be blamed for the disturbance.

The distribution of passenger cars drivers' level of involvement is as in Figure 3.2:

[1] The figure features only the situations the most observed, so the results presented in this paragraph are more important than the sum of the results showed in the figure.

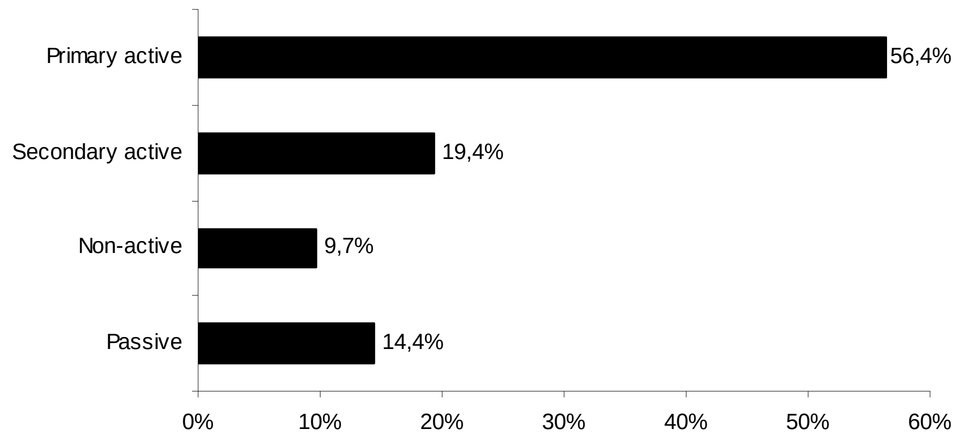


Figure 3.2.-Distribution of degree of involvement for passenger cars drivers.

It can be observed that most of the time, car drivers are 'Primary active' (56.4% of the cases) which means they are at the origin of the accident. They also show an important proportion of lack of regulation of the situation ('Secondary active' identified for 19.4% of the drivers) and of 'Passive' degree (14.4%).

3.2.2.c Categories of human functional failures

When failures are delineated in categories, the most represented category (see Figure 3.3) is the one related to perception errors (35.7%). Except for this category observed for more than a third of the road users, the other categories are gathered in more or less the same bracket of percentage, between 10 and 15%.

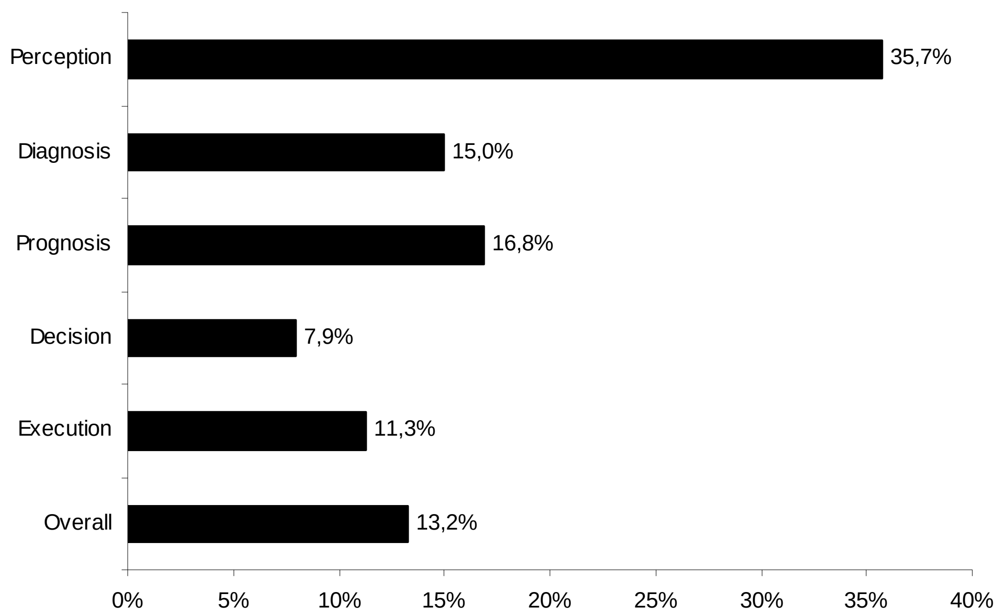


Figure 3.3.-Distribution of categories of functional failures for passenger cars drivers.

3.2.2.d Detail of human functional failures

More information is provided when looking at the functional failures in detail (see in Annex).

It can be noted that the most represented human functional failure for passenger cars' drivers is the 'Failure to detect in visibility constraints' (13.1%). Although the perception category of failure is important, the second failure identified the most is related to prognosis and more precisely to 'Expectation of adjustment by another user' (9.2%). Then come other perceptive failures: 'Focalized acquisition of information' (8%) and 'Cursory information acquisition' (7.7%).
The rest of the distribution is spread on all the other functional failures, meaning that difficulties met by passenger cars' drivers are various.

3.2.2.e Explanatory elements of human functional failures

The main explanatory factors of those functional failures can be listed (see in Annex). It has been found that failures of passenger cars' drivers are especially affected by:

- Atypical manoeuvres from other users, in 26.6% of the cases. This factor is found to have an influence on the driver's functional failure when the manoeuvre undertaken by another user puts the driver in difficulty.
- The road over familiarity or the monotony of the travel (24.2%); this explanatory element is thought to have an effect on the attention level of the driver, leading him most of the time to not paying enough attention to all the 'objects' of the driving scene.
- The choose of a too high speed for the situation, for 20.8% of the drivers;
- The rigid attachment to their right of way status (17.6% of the cases); this factor is usually associated with wrong prognosis of the evolution of the situation. When the driver features such an element he may not anticipate correctly the possibility of crossing of an intersection by another user not having the right of way.
- The insufficient level of attention they allocate to their driving task (for 16% of the drivers);
- And by impaired visibility generated for example by sun glare or other vehicle of the environment (15.9%).

3.2.2.f Conclusion of the overall in-depth analysis

From this first part of the in-depth analysis, 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 other cases are distributed more or less equally among the other functional failures.

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 (D1.1, Task 1.1), the following sections will detail the analysis of two groups of passenger cars:

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

The outline of these two sections will be the same than the ones optioned for the overall analysis, but a section dedicated to the typical failure generating scenarios will be added.

3.2.3 *Single passenger car drivers' accidents analysis*

The analysis developed below takes into account 234 passenger cars drivers, who represent 18% of the whole sample.

3.2.3.a Pre-accident situations in single car accidents

When analysed separately, it appears that most of the pre-accident stabilized situations in fact relate to single car accidents (Figure 3.4). Results show that when the failure occurs the drivers were mainly either going ahead on a straight road (50.5%) or negotiate a curve (39.7%).

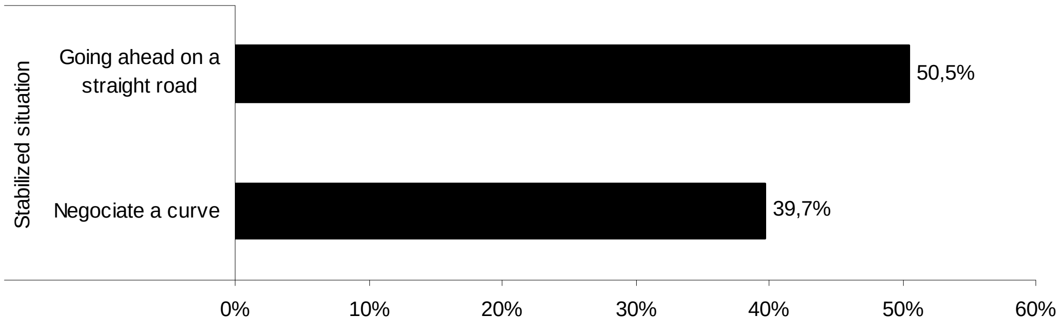


Figure 3.4.-Distribution of main pre-accident situations for single passenger car drivers' accidents.

This seems coherent with what is usually found concerning single car accidents: the task to perform at the time of the loss of control is low demanding, mainly consisting in guiding the vehicle on the carriageway.

3.2.3.b Degree of involvement of car drivers in single accidents1

The result inherent to this section is tautological as a driver who would have an accident by himself would automatically be the only one involved in the accident and then would be necessarily Primary active, meaning the one at the origin of the accident.

3.2.3.c Human functional failures for car drivers in single accidents

As shown in Figure 3.5, the failures featured in single accidents relate to several mechanisms:

- The guidance of the vehicle (E1 and E2 failures, respectively 18.2 and 21.1%). In those cases, the handling of the vehicle is disrupted either because of an external perturbation, or because of the attention level the driver devote to the driving task.
- The overall failures are also much represented (G1: 15.4%, G2: 21.3%, G3: 2.5%). When coded, they reveal the driver's loss of capacity, such as falling asleep, loss of psycho-physiological ability or exceeding cognitive ability. In all those cases, the driver is no longer able to handle his/her driving task and this leads to a loss of control of the vehicle.
- Lastly, it can be noted the over representation of the incorrect evaluation of a road difficulty (T1 failure), observed in 20% of the single accident cases.

[1] See in section 1.3.2.2. Degree of involvement of the drivers in the accident for detailed description of this variable

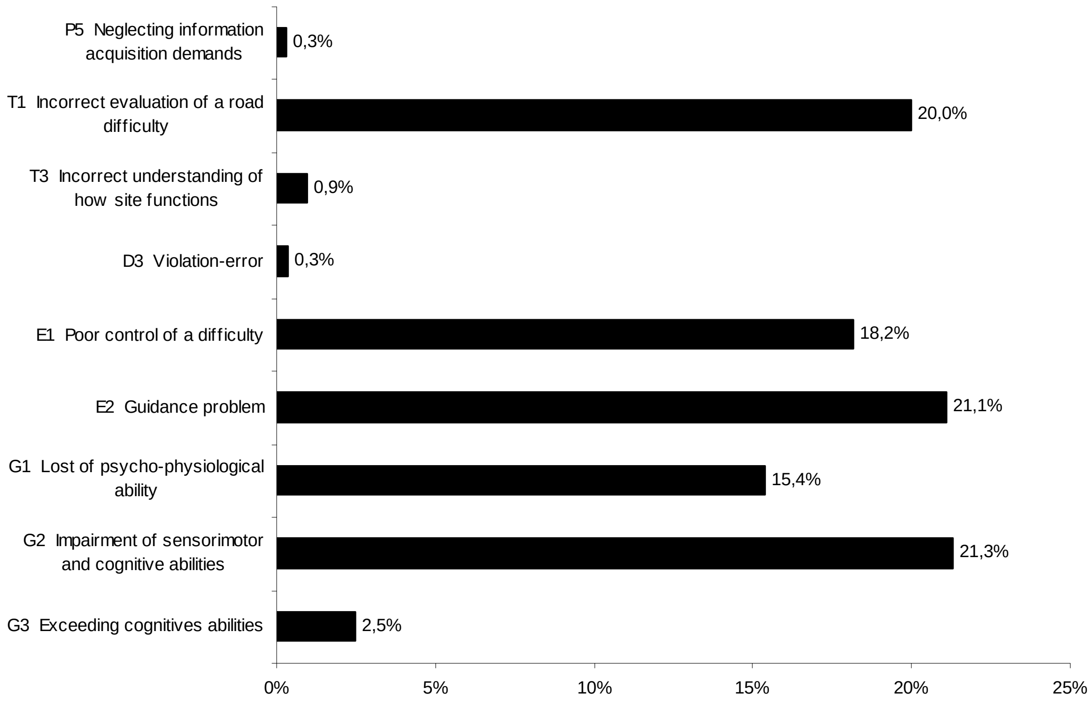


Figure 3.5.-Distribution of human functional failures for single passenger car drivers' accidents.

The other failures are anecdotic and refer to loss of control issued from neglected information acquisition (P5 failure), incorrect understanding of how a site functions (T3 failure) or violation-error. Whatever the difficulty met, it leads to inadequacy between the driver's capacity and the dynamic constraints.

3.2.3.d Explanatory elements of human functional failures for car drivers in single accidents

Presented below (Figure 3.6) are the factors that explain the failures described earlier.

- The first of them is the speed chosen by the drivers despite the demands of the task (guidance of the vehicle on the road or curve negotiation).
- It appears that in 36.7% of the cases, this speed was too high. For more than a quarter of the car drivers (26.3%), the presence of alcohol had a central influence. It has to be underlined that for losses of control, this influence almost exclusively correlates with a high level of intoxication (average of BAC).
- One of the main explanatory elements for single car accidents is the difficulty met by the driver in the environment. In 23.5% of the cases, the loss of control occurs when the driver has to negotiate a small radius bend. In those cases, this difficulty is the point of rupture of the accident.
- A main factor to be remembered is the attention impairment. When grouped, the elements that relate to this sphere are observed in 54% of the cases. The road over familiarity and/or the monotony of the journey is one of those factors (20.1%). The low level of attention associated to this element impairs the driver in his/her capacity of environment monitoring, avoiding the detection of the relevant information that could prevent the accident. It is also true for drivers for whom a low level of attention resources is assigned to the driving activity (18.1%). This attention impairment is susceptible to be identified when the driver declares that he was just thinking of something else than the road, being more or less "absent" of the driving task. Internal and external distractions (5.2% and 10.6% respectively), realization of a secondary task (8.4%) are also registered under this category.

– In the same way, vigilance is at the core of the problem of losses of control. If vigilance impairment is considered from its ultimate side (falling asleep) to levels more or less fluctuating (low vigilance, fatigue, tiredness, drowsiness), it represents 31.2% of the failures explanation.
– At last, single accidents are much influenced by the inexperience of the driver, would it concern the experience of the driving itself (12.1%) as for new driver, the road/area/site unfamiliarity (10%) or the vehicle (8.5%).
– It can be noted that contrary to what is usually associated to loss of control, loss of vehicle adhesion is not central in the mechanism of single accident. Let's remind the reader that in the present analysis the loss of vehicle adhesion (due to windblast, puddles…) refers to the mechanism at the origin of the rupture phase and not to its consequence.

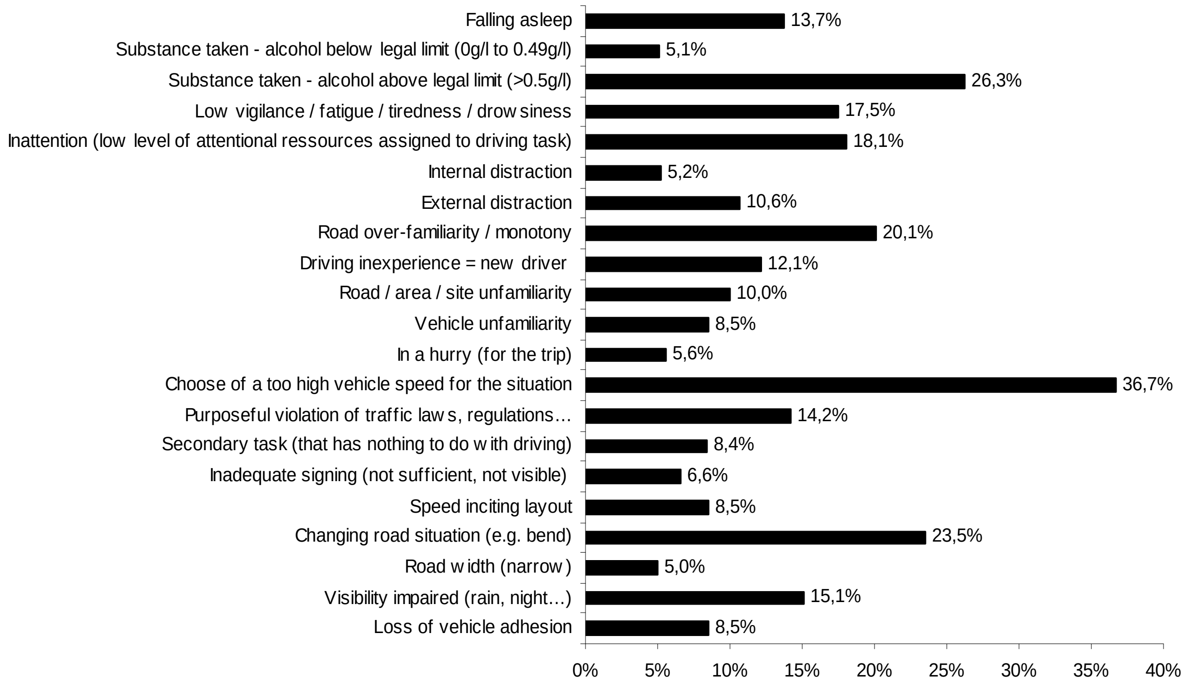


Figure 3.6.-Distribution of explanatory elements for single passenger car drivers' accidents.

To sum up, it seems that factors behind single cars accidents are various and numerous, leading consequently to the interest of analysing them from the angle of their associations through the use of Typical Generating Failure Scenario. In addition, this tool will also allow to integrate the parameter studied earlier, i.e. the pre-accident situations and of course the failures.

3.2.3.e Typical Generating Failure Scenarios for single passenger cars accidents

In order to illustrate all the mechanisms involved in the single car accidents, the most represented scenario(s)[1]associated with each of the main failures described earlier will be presented in this section. It then covers the action failures (E1 and E2), the overall failures (G1 and G2) and the diagnostic failure (T1).

[1] Figures of explanatory elements associated to scenarios and prototypical scenarios graphs are detailed in Annex.

✓ **Scenario E1B: "Encountering a more or less foreseeable external disturbance" (2.4% of the total sample of the passenger cars drivers population)**

This scenario accounts for 72.5% of E1 failures observed for passenger cars drivers in loss of control.

- This scenario mainly includes men (58.9%), with a medium age of 35.8 years (between 18 and 56 years).
- At the time of the accident, the drivers were in a risky situation: approaching a bend requiring an adjustment in speed and trajectory, or driving in a straightaway during a storm or being dazzled by headlights.
- Excessive speed for the situation, detected in almost half of the cases (see in Annex), sometimes combined with a blood alcohol level greater than the legal level in 12.6% of the cases), serious fatigue (9.7%) or risky driving (12%), create a context that keeps the driver from dealing with a disturbance even if it is more or less foreseeable. Their weak state of vigilance makes these drivers unable to develop the sensorimotor skills necessary to deal with the situation.
- In this scenario we can also observe the influence of vehicle-related factors such as the poor state of the tyres (16.5%), a lack of pressure (11.7%) sometimes causing a loss of vehicle adherence on a deteriorated surface (49.5%).
- All of these accident occurred outside urban areas (87%), in the countryside or on a motorway where the type of road is conducive to higher speeds.

✓ **Scenario E2a: "Interruption of guidance after turning attention toward a side task" (2.3% of the total sample of the passenger cars drivers population)**

This scenario accounts for 60.0% of E2 failures observed for passenger cars drivers in loss of control.

- These accidents related to driver distraction occur in 57.9% of cases in the daytime. 88.5% of these accident cases occur in the countryside on straightaways or in easy bends, often known to those involved for various reasons (errands, work, work-home, leisure, etc.). The monotonous, habitual itinerary lets the driver become distracted:
  - either by performing a side task (picking up a bottle in the car, filling in the delivery book, putting CDs in the glove box, adjusting the radio, etc.), the driver takes his eyes off the visual scene and then takes a hand off the steering wheel;
  - or by a discussion or event requiring the driver to turn or at least to take his eyes off the visual scene (turning to talk to children or passengers, checking that the stand has been entered correctly on a moped, etc.).
- In both of these situations, the guidance activity is interrupted and the distraction makes the drivers unable to notice the drift in the vehicle's trajectory. When they realise this, either it is too late to avoid the accident, or they panic and in 47.8% of cases their recovery manoeuvre is undertaken with the right intention but is incorrectly carried out due to heavy constraints.
- This prototypical scenario affects drivers of all ages (15 to 53 years; average 31.7 years), both men and women (37.4% men and 63.6% women)[1], with various professions (delivery driver, beautician, plumber, soldier, etc.).
- We can observe (in Annex) that 48.1% of those involved are just distracted at the time of the accident, and 81.8% of those involved are both inattentive and distracted. These inattentive drivers are concerned with a personal problem (divorce, a loved one in jail, family problem, etc.), a professional worry (quitting their job, etc.), a passing worry (thinking about the plates on the back seat which could break, etc.), or simply not very attentive to the driving task without really being able to determine why. Lost in their thoughts, these drivers are probably more sensitive to distraction.

[1] For more information about the influence of gender in accident scenarios, please refer to TRACE report D1.2.5.

Thus, this scenario illustrates how distraction can have serious effects on the execution of the driving task and lead to the loss of control or running off the road with often dramatic consequences for those involved, as the driver becomes aware of the situation too late.

✓ **Scenario G1a: "Loss of psycho-physiological abilities after falling asleep" (2.5% of the total sample of the passenger cars drivers population)**

This scenario involves drivers whose general characteristics are presented below. This analysis will show the need to refine the scenario into 5 subsets to extract the most relevant accident-causing elements for each subgroup of drivers (see…).

- Scenario G1A accounts for 89.4% of the losses of psycho-physiological abilities. It mainly affects men (70.5%) of all ages (between 19 and 58 years) whose reason for travelling is either professional or a home/work itinerary. Nearly all of these accidents (88.2%) occurred outside urban areas where the driving task can be summed up as following a straightaway with no greater demand than guiding the vehicle.
- In this scenario, few explanatory elements (in Annex) are involved in the failure (1.67 on average), since, in 100% of the cases, falling asleep explains the loss of psycho-physiological abilities.
- Falling asleep may be linked to a state of excessive fatigue (mental or physical) (17.7%), alcohol consumption (17.4% and 9.6% for major and small BAC respectively) or taking medication (6.2%).

✓ **Scenario G2a: "Alteration of abilities to follow a trajectory" (1.8% of the total sample of the passenger cars drivers population)**

This scenario accounts for 46.5% of G2 failures observed for passenger cars drivers in loss of control.

In this prototypical scenario, the accident occurs when the driver encounters a difficult or changing road situation.

- This scenario mainly involves men (73.7% of men for 36.3% of women), between the ages of 18 and 53 (average 30.8), whose travel may be for leisure, professional or home/work travel reasons. In 81.5% of the cases, these accidents occur outside urban areas.
- The key element in this scenario is the high level of alcohol intoxication found in these drivers. This element was identified in 100% of cases comprising this scenario.
- In the majority of cases (see in Annex), the accident can be explained by the combination of a difficult or changing road situation (75.9%) and by excessive speed for the situation (42.7%), sometimes associated with risky driving (21.1%). In 22.8% of the cases, reduced visibility conditions (at night, for example) and a state of low vigilance are an added factor along with the driver's surprise. We can also observe in the occurrence of this type of accident that there is a misunderstanding of the location (5.2%), little driving experience (10.3%) and impatience, irritation or stress (9.9%).

✓ **Scenario G2b: "Alteration of guiding abilities" (1.8% of the total sample of the passenger cars drivers population)**

This scenario accounts for 48.3% of G2 failures observed for passenger cars drivers in loss of control.

Unlike those which make up scenario G2a, 74.3% of these accidents occur in a straightaway (see the scenario G2b, in Annex) with no other demand than guiding the vehicle.

- This scenario mainly concerns men (85.9% of men), with an average age of 35.7 years (19 to 73), whose reason for travelling is leisure travel (46.9%).
- As shown in Annex, in 90.9% of the cases, a high degree of alcohol intoxication explains this type of accident.
- In most cases, the high blood alcohol level is accompanied by other endogenous explanatory elements such as a low level of vigilance (fatigue) (27.4%), excessive speed for the situation

(15.4%) or risky driving (13.3%). Furthermore, in 9.1% of cases, the driver is also highly intoxicated with medication.
- G2 failures can also be co-explained by exogenous elements. In fact, nearly one-quarter of the cases occurred under conditions of reduced visibility (night, rain, etc.).

✓ **Scenario T1b: "Underestimating the difficulty of known bend" (1.4% of the total sample of the passenger cars drivers population)**

This scenario accounts for 37.6% of T1 failures observed for passenger cars drivers in loss of control.
- In this prototypical scenario, the drivers are usual users of the location where the accident occurs, so much so that their knowledge of the itinerary leads them to drive in automatic mode and to reduce their attention level. In 100% of cases, when coming to a bend requiring speed adjustment, the drivers misevaluate the difficulty even though it is known or predictable. These accidents generally occur in the daytime (76.1%) and in the countryside (93.2%); their speed is too high for the situation in 93.2% of cases and is largely responsible for the loss of control (see in Annex).
- Along with the speed effect, there is often an additional exogenous element related to the condition of the vehicle (soft tyres, in poor condition, mechanical problem, size of the vehicle), of the carriageway (carriageway in poor condition, wet, oily) or traffic conditions (rain, wind). The low level of experience with the vehicle and/or driving may also explain the loss of control.
- Drivers paying little attention do not evaluate the difficulty correctly, do not adjust their speed when coming into the bend and are late to realise their situation. Thus, for 25.0% of those involved, the accident is inevitable and in 60.2% of the cases an attempt to retrieve the situation is made, but incorrectly so given the heavy situational constraints.
- The vast majority of the drivers involved in this scenario are women (65.9% women, 34.1% men), with an average age of 26.5 (18 to 42).
- These drivers drive this itinerary, which they know very well (home-work, daily professional travel) in automatic mode and without really paying attention to what they are doing (inattention observed in 31.8% of the cases). But on the day of the accident, for various reasons (concerns, irritation, in a hurry to get home at the end of the day, etc.), they drive faster than usual or do not adjust their speed to a new traffic situation (wet carriageway, lighter trailer load than usual). Thus, they are surprised by a difficulty and lose control.

✓ **Scenario T1C: "Underestimation of the difficulty of a bend in a playful context" (1.1% of the total sample of the passenger cars drivers population)**

This scenario accounts for 31.8% of T1 failures observed for passenger cars drivers in loss of control.
- Those involved in this type of accident are mainly men and are young (between 18 and 47 years old, 25.3 on average).
- No similarity is observed in the professional and personal lives of those involved in this type of scenario.
- At the time of the accident, the drivers were going around a bend requiring an adjustment of speed and trajectory. As shown in Annex , the sudden change in the road (61.7% of the cases), combined with the consumption of alcohol or a lack of sleep, caused those involved to underestimate the dangerousness of the bend and not to slow down enough. In 88.6% of the cases, the drivers were driving too fast. These excess speeds were caused either by a layout conducive to speed or by the adoption of risky or playful behaviour by the driver.
- 32.2% of these accidents occurred at night in the countryside. The ambiance in the car was often festive with passengers.

3.2.3.f Conclusion of the single car accidents analysis

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 or 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 and are often 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.

3.2.4 Multi-vehicles accidents analysis

In order to realize this last analysis, 1069 drivers have been selected. This sample gathers 82% of the concerned population, i.e. the passenger car drivers.

The following sections will develop the same parameters as shown earlier: pre-accident situations, failures, explanatory elements, and at last the most typical scenarios found for this sample of road users.

Unlike the losses of control for which the analysis of the degree of involvement was unnecessary[1], the multi-vehicles accidents analysis will look at this variable.

3.2.4.a Pre-accident situations in multi-vehicles accidents

The first result collected from Figure 3.7 is the high number of accident situations being observed for passenger car drivers involved in accidents with other users. It seems that difficulties occur from many kinds of pre-accident situations, and more or less all the driving tasks are found in the figure (tasks related to stabilized situations, intersections and specific manoeuvres).

[1] See section 1.3.3.2. Degree of involvement of car drivers in single accidents

This is especially true for the drivers who have to cross intersection with a priority vehicle coming as this task has been observed in 15.4% of the cases gathered here.

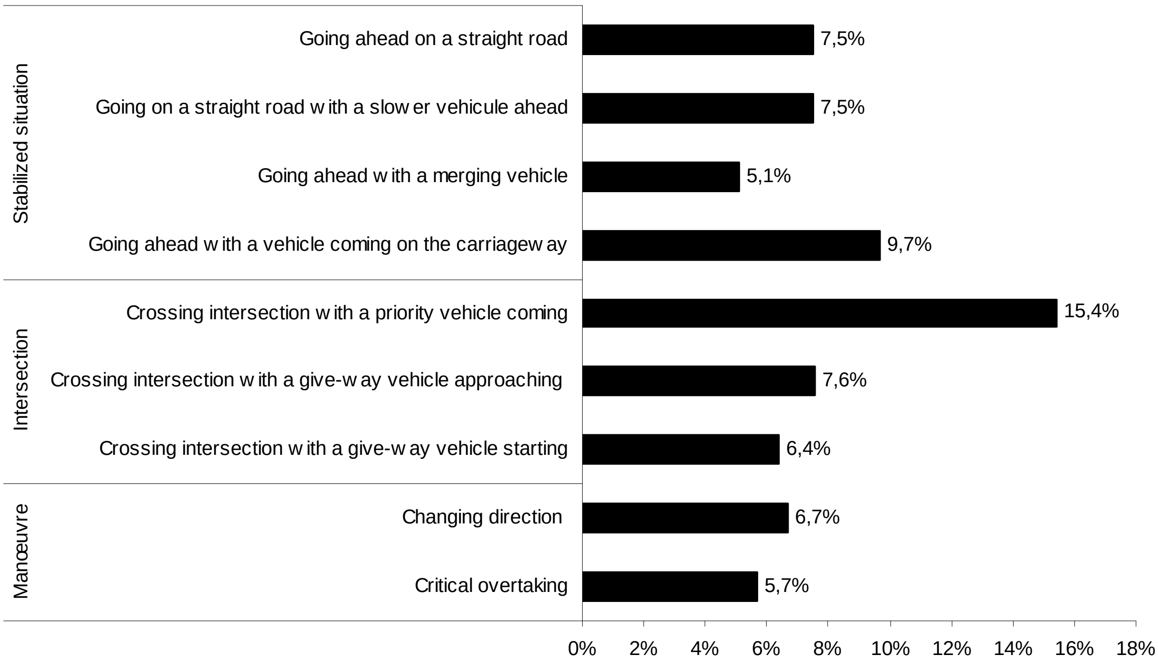


Figure 3.7.-Distribution of main pre-accident situations for passenger cars drivers involved in multi-vehicles collisions.

It is then hypothesized that the mechanisms behind those situations will also be numerous and various as soon as passenger car drivers are considered in interaction with others.

3.2.4.b Degree of involvement of the drivers in multi-vehicles accidents[1]

In this paragraph, the levels of involvement of the passenger cars drivers are described (Figure 3.8).

In almost half of the cases the passenger car drivers are primary active (47.2%), meaning that they are at the origin of the breakdown of the situation.

They are then secondary active, in 23.5%, i.e. they did not regulate the situation whereas they have indications at disposal to do so (side indicator of the other, vehicle approaching intersection too fast, etc.).

Passenger cars users are also related to non active status (in more than 1 case out of 10) which concerns drivers having not access to the information so who can not react appropriately.

At last, there are a considerable proportion of passive drivers (17.6%) who have been present and involved in the accident scene but who have no participation to its occurrence (being hit on the rear, stopped at a traffic light, etc.).

[1] [1] See in section 1.3.2.2. Degree of involvement of the drivers in the accident for detailed description of this variable

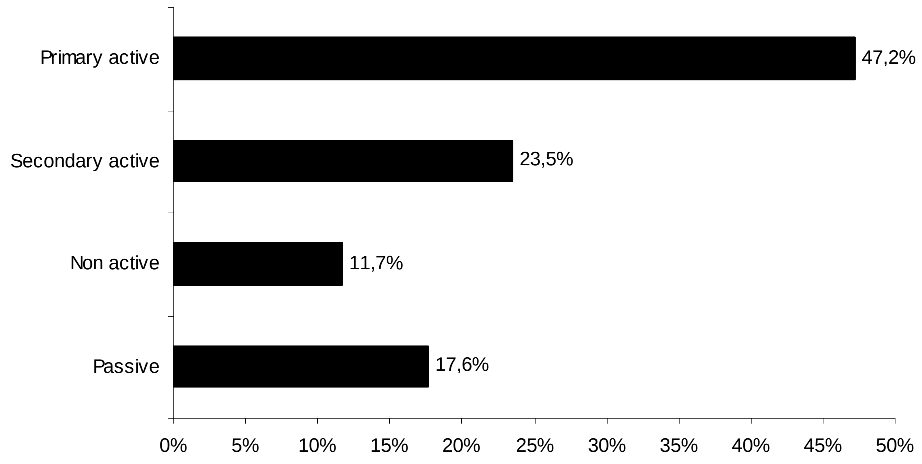


Figure 3.8.-Distribution of degree of involvement for passenger cars drivers involved in multi-vehicles collisions.

These data will be re examined further according to their relevance with typical scenarios.

3.2.4.c Human functional failures for car drivers in multi-vehicles accidents

✓ **Categories of human functional failures**

Presented below is the distribution of the human functional failures categories for passenger cars drivers involved in accidents with other users (Figure 3.9).

The 'Perception' category is the most represented with 45.2% of the cases, being at least twice more observed than the others. The 'Diagnosis', 'Prognosis', 'Decision' and 'Execution' categories as well as 'Overall' failures are more or less equally distributed (between 21.3% and 3.8%).

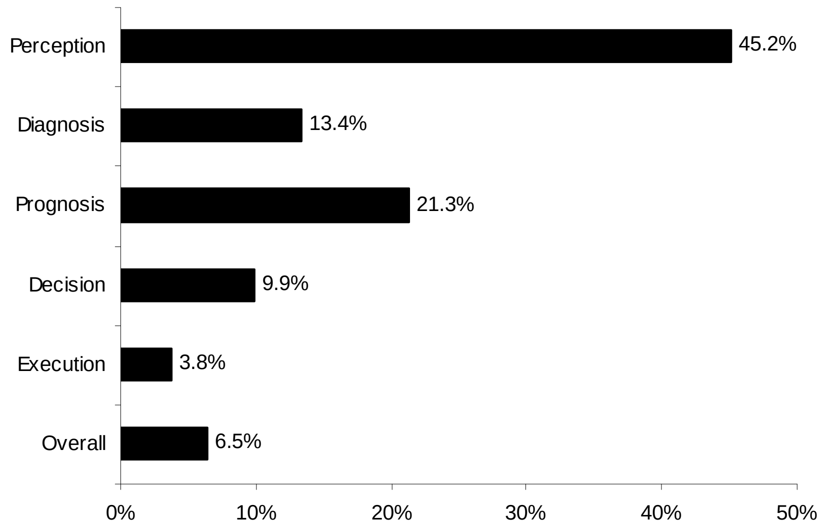


Figure 3.9.-Distribution of categories of functional failures for passenger cars drivers involved in multi-vehicles collisions

✓ **Detail of human functional failures**

As detailed in Figure 3.10, several functional failures can be retained as specific to passenger cars drivers:

- P1 failure (16.6%): in these cases the drivers have failed to detect the useful information because of the visibility constraints. Bad visibility conditions such as night or bad weather, other vehicles, or elements of the infrastructure are usually the cause of these difficulties.

- T6 failure (11.6%): this level of failure, identifiable at this anticipated information processing stage, deals with the expectancy of a regulation from the part of another user who the driver is in interaction with. On the basis of his erroneous expectations, based on what he is used to and has experienced, and despite observing disturbing signs, the driver rules out the possibility of a critical evolution of the interaction situation encountered and, as a result, does not execute a preventive driving strategy adapted to that predictable critical evolution.

- P2 failures (10.1%): this group of detection problems refers to a question of information acquisition 'strategy'. It deals with drivers who encounter a particular problem during their journey and who focus their eyes and attention on that, which results in their not detecting another crucial element of the scene, such as an oncoming vehicle (or other hazard). Such a detection failure can be induced by elements such as task complexity, poor signalisation, and multiplicity of potential events, profusion of stimuli, and every element which can induce a difficulty in the repartition of attention resources.

- P3 failure (9.7%): this other type of poor organisation of information acquisition strategy has involved drivers who reduce to a minimum the time and attention they devote to the search for information, whether because of the routine nature of a manoeuvre or because they experience a situational pressure (with time constraint, workload, incitation from a third part, etc.).

- P5 failure (7.3%): In a situation of limited constraint, drivers' attention becomes so diffused that they fail to identify an element of interference up to the moment it becomes an 'obstacle'. In these accident cases, we don't notice a real annex activity, apart from a strictly cognitive activity ('thinking'). This failure of information gathering function can involve different kinds of explicative elements. So, a strong knowledge of the journey, coupled with a time constraint can lead to a higher speed without stimulating a stronger attention. The same result can be induced by a feeling of right of way to the point of ignoring totally an opponent vehicle up to the moment when it becomes inevitable. To keep in mind, this failure seems to intervene principally when confronting with a non priority vehicle at intersection or when getting closer to a slower vehicle.

- T4 failure (6.5%): this type of understanding failure, specifically devoted to the behaviour of another road user can arise as a result of the other user not properly signalling his manoeuvre, or his giving of ambiguous signals, or of the driver making a cursory assessment of the interaction and going no further than identifying an impediment to his progress. Clarifying the situations of interaction by any means would be the main trend to follow in order to counteract such failures.

- T5 failure (5.5%): in the absence of cues to the contrary, drivers who have the priority at an intersection do not expect a non-priority user who is stationary to start moving forward and is surprised by this unexpected manoeuvre. So this failure corresponds to 'pitfalls' situations for anticipation, just in the same way as P1 for detection. Such a 'failure' of anticipation function is easily explained by external elements (i.e. the very fact that the other user don't behave in an expectable way).

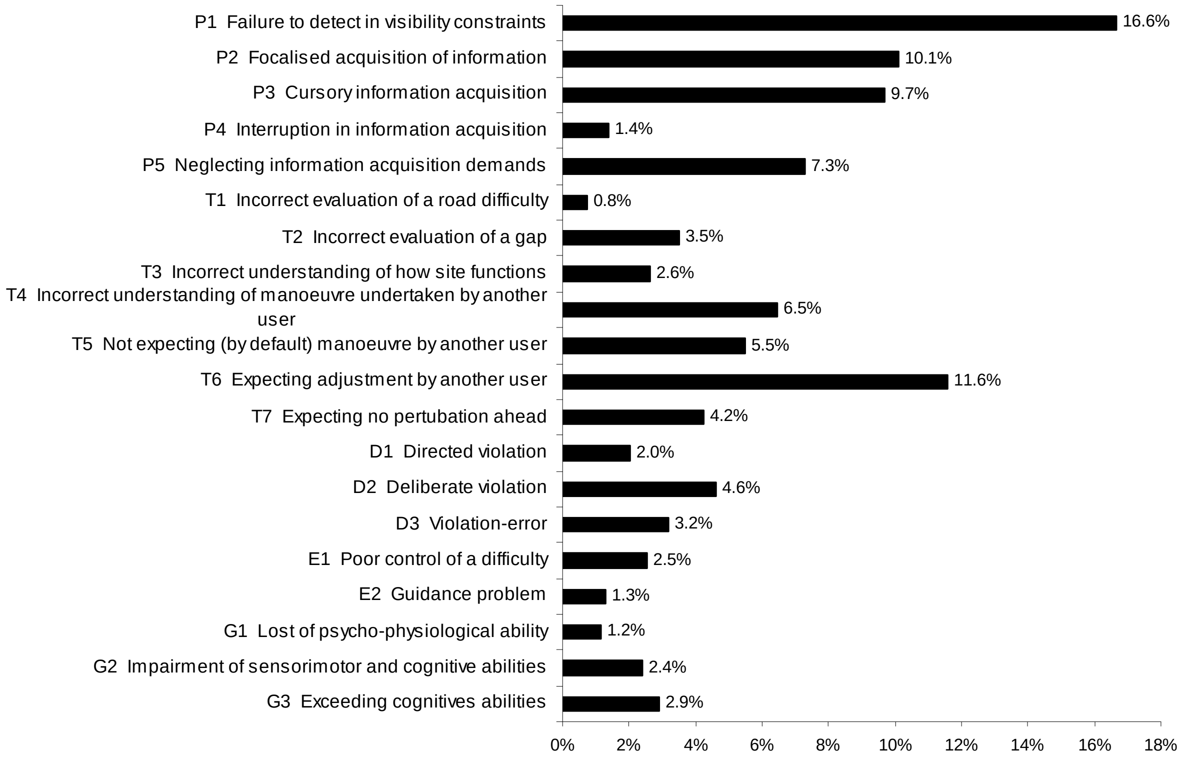


Figure 3.10.-Distribution of functional failures for passenger cars drivers involved in multi-vehicles collisions

The scenarios associated to those failures will be developed in the section following the analysis of explanatory elements identified for the whole group of passenger cars drivers involved in accidents with other users.

3.2.4.d Explanatory elements of human functional failures for car drivers in single accidents

Now are listed the main explanatory elements revealed by the analysis (Figure 3.11). As for the pre-accident situations and the failures, they are numerous and heterogeneous:

- In a third of the cases, the drivers had to deal with the manoeuvre of another user that put them in difficulty. This manoeuvre is described as atypical, or even not allowed such as not respecting the right of way at intersection.
- The road over-familiarity or its monotony has also impact on the multi-vehicles collisions, being directly connected to the attention level the drivers devote to their driving task. It has been identified in 25.4% of the cases but it has to be noted that this low level of attention is also at play in factors such as 'Inattention' (15.4%), 'Manoeuvre over-familiarity' (9.6%) and 'External distraction' (5.1%).
- In more than one case out of 5, the drivers were aware of their right-of-way status and developed a rigid attachment to it, leading them most of the time to not react despite the indications they have at disposal and concerning the other eventually undertaking a manoeuvre.
- Impairment of the visibility is also to be put as major. The sources of this impairment are various (infrastructure, mobile element of the environment, weather conditions, etc.) and always draw to the same conclusion: because of the visibility mask, the detection of the relevant information has not been possible.

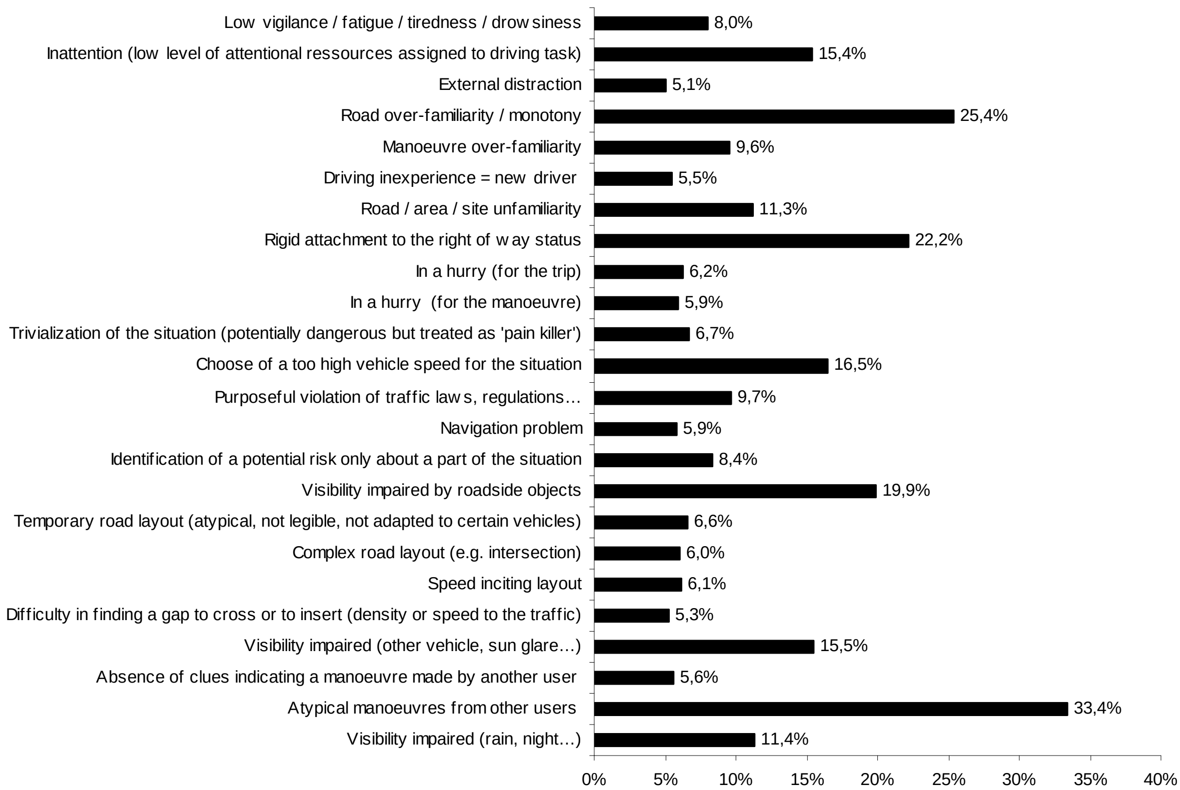


Figure 3.11.-Distribution of explanatory elements for passenger cars drivers involved in multi-vehicles collisions.

Again, the heterogeneity and the important amount of items found bring to light the diversity of mechanisms at play in the multi-vehicles accidents involving passenger cars drivers. It also leads to the study of the typical generating failure scenarios, able to gather the parameters analysed earlier according to relevant criteria.

3.2.4.e Typical Generating Failure Scenarios for multi-vehicles accidents

Only the scenarios[1] corresponding to the most frequent failures exposed earlier will be analysed further below. Those scenarios have been organized according to the sequential theoretical chain of human functions, i.e. 'Perception', 'Processing' and 'Predicting'.

✓ **Scenario P1d: Driver surprised by the manoeuvre of a non-visible approaching vehicle (5.8% of the total sample)**
  This scenario accounts for 51.4% of P1 failures (see in appendix for detail of the scenario).
  - Circulating in stabilized situation, the drivers are suddenly confronted with a vehicle on their trajectory, which they had not detected previously.
  - This late detection is explained by limitations in visibility (37.3%) as well as by a defect of lighting of this vehicle when the accident occurs at night (10.8%).
  - In certain cases the contribution of endogenous element to the functional failure, such as priority feeling (although justified) (33.3%) or strong experience of the site (16.6%), can have contributed to the fact that the driver did not take particular precaution in this situation without visibility.

[1] Figures of explanatory elements associated to scenarios and prototypical scenarios graphs are detailed in Annex.

- But in every case the atypical character (79.5%), sometimes close to violation, of the manoeuvre engaged by the other explains the difficulty for the driver to anticipate the possible emergence of a difficulty. The drivers hit the vehicle which crosses the road, mostly having hardly the time to put the foot on the brake pedal.
- This scenario involved mostly men (62.8%). This result can appear conflicting to the one found in D1.2.5 (Gender issue) as, in this report, this P1d scenario is found as specific to female road users. It has to be reminded that in D1.2.5, the population is wider than in the present document and takes into account the female pedestrians, who happen to be especially concerned by this scenario.
- P1d scenario takes mainly place in urban area (only 6.4% of them have been located out of rural zones).
- Even if the users try to avoid the accident, in 67.3% of the cases they do not have enough space and time to succeed in this attempt

✓ **Scenario P2a: "Focalisation on a directional problem" (2.2% of the total sample)**

This scenario accounts for 32.6% of P2 failures (see in appendix for detail of the scenario).

This scenario mainly occurs in 3 situations:

- Firstly, in situations of crossing intersections, the users are so busy trying to find their way that they momentarily forget the demands of information acquisition on the main roadway before pulling out.
- Secondly, a variant of this mechanism can be observed in a road link on an unknown itinerary, where the driver seeks to turn off toward a destination for which the sign directions and the readability of the location do not help to identify easily. He focuses on his directional problem and can adopt behaviour that is a nuisance to other users. The driver then undertakes his manoeuvre (left-hand turn into a private residence or making a U-turn) without acquiring information on the surrounding traffic. This may, for example, cause him not to detect another user who is overtaking him or who is driving along the lane being crossed.
- Lastly, one final, rarer variant concerns drivers who look left and right many times seeking cues to help them to understand where they are going (signs, street names, buildings) and do not notice that the vehicles ahead of him are slowing down or that a motorcycle is merging in front of them.
- This accident scenario affects 68.4% men and 31.6% women. 54.0% occur in urban environments and 46.0% outside urban areas.
- Here, the navigation problem (100% of cases as shown in Annex) appears to take up all of the attention resources of drivers faced with a new situation where they lack experience.
- 26.8% of the drivers have had their driving license for less than 5 years. This over-representation of drivers with few years of experience shows that these inexperienced drivers are vulnerable in mentally costly situations such as seeking directions (trying a street, making a U-turn, forks in the road, turning back, etc.).
- 94.2% of the drivers are primary actors and 5.8% of the drivers are secondary actors. These drivers constitute a potential risk for other users.

✓ **Scenario P2d: "Focalisation on an identified source of danger" (1.4% of the total sample)[1]**

This scenario accounts for 20.3% of P2 failures (see in appendix for detail of the scenario).

Coming up against a potentially conflicting interaction with an interfering user in a situation monopolises the driver's attention. His attention being drawn toward this vehicle, which he watches out for, the driver does not detect another vehicle with which he is suddenly confronted.

- This scenario mainly involves women (55.2% women and 44.8% men) of all ages (17 to 60). 65.7% of the drivers are primary actors, in other words they are the ones who cause the disturbance, and 34.3% are secondary actors, contributing to the breakdown of a situation that is already accident-causing.

[1] Figures of explanatory elements associated to scenarios and prototypical scenarios graphs are detailed in Annex.

- These accidents mainly occur in urban areas (87.3%) and 72.9 of these accidents occur in the daytime. For 42% (see in Annex) of the cases, over-experience of the itinerary or manoeuvre is clearly identified by our investigators as having contributed to an overall decrease in attention to the road scene as a whole.
- In this type of accident scenario, it is not a navigation problem that is in cause in the competition for attention, but rather an erroneous selection of information in relation to their knowledge of the site and the possible interactions between vehicles.

✓ **Scenario P3b: "Cursory search for information when crossing an intersection" (3.8% of the total sample)**

This scenario accounts for 58.2% of P3 failures (see in appendix for detail of the scenario).

- In this scenario, the low level of attention given to the driving task leads to cursory information gathering which does not allow the driver to detect a vehicle with right-of-way when crossing an intersection. In 74.4% of cases (see details in Annex), visibility is restricted (infrastructure, another vehicle) which also reduces the necessary information acquisition and requires additional attention efforts.
- Usually, the user at the origin of the accident looks but does not see the oncoming vehicle, not detecting it until the time of impact. Having a hard time finding room for crossing because of high-density traffic also accentuates this effect. The driver will focus his attention on a distant vehicle and will not detect a closer vehicle with which he collides when trying to cross. Consequently, he does not attempt any emergency manoeuvre.
- These accidents affect people of all ages, from 18 to 76 (average age: 43.3), men as much as women (54.3% men and 46.7% women) from a variety of professions (secretary, mason, nursing assistant, nurseryman, retiree, etc.). We can see that 31.0% of those involved can be considered young drivers (with licenses for less then 5 years) and 37.4% experienced drivers (with licenses for more than 20 years).
- The low level of driver attention can be connected to the fact that these accidents occur on well-known itineraries which may even be driven daily by those involved. In fact, in 40.6% of cases, the manoeuvre is very familiar to the user involved. Thus, on these itineraries, the drivers appear to be deep in their personal or professional thoughts (for example, the nurseryman concerned by his flooded land, the elderly person concerned by his wife's health, etc.).

These drivers' failure when seeking information can be explained by habitually making the manoeuvre that leads to a reduction of attention resources allocated to the task, combined with a particular traffic or infrastructure element.

✓ **Scenario P5a: "Late detection of the vehicle ahead slowing down" (2.5% of the total sample)**

This scenario accounts for 51.2% of P5 failures (see in appendix for detail of the scenario).

- These accidents usually occur on roadways that are straightaways, monotonous and/or well known to the user (57.9%) as shown in Annex. 70.3% of these accidents happen in the daytime and usually in the countryside (75.5%). Thus, these easy itineraries tend to cause a drop in attention among those involved.
- These drivers are then surprised by a slower vehicle, one that is preparing to make a turn or slowing down in front of them (in some cases, the vehicle ahead has been followed for some time, making the itinerary all the more monotonous and encouraging driving in automatic mode). The inattentive driver realises too late that he is in difficulty. The accident is then inevitable in 65.2% of cases despite emergency braking.
- A problem relative to the vehicle or road condition (wet carriageway, soft tyres) can be an additional factor in the driver's delayed reaction, making retrieval of the situation impossible.
- The drivers involved in this scenario are on average 39.9 years old (20 to 72) and are mostly men (74.5% men, 25.5% women) who, in 13.9% of cases, are driving too fast for the situation. In 83.9% of cases, these drivers are primary actors in the accident.

In all of these accident cases, the driver's inattention, whatever the reason (personal or professional concerns), is such that he is unable to detect an event occurring directly in his field of vision, this late detection of the difficulty making the situation irretrievable.

✓ **Scenario P5b: "Late detection of a user without right-of-way entering an intersection" (2.0% of the total sample)**

This scenario accounts for 40.5% of P5 failures (see in appendix for detail of the scenario).

- The users included in this scenario (see in Annex) are also inattentive due to their knowledge of the itinerary (49.4%) Upon reaching an intersection where they know they have the right-of-way and are rigid in their attitude about this status (77.4%), these drivers are not concerned about what could happen in sections without right-of-way and which could cause a difficulty.
- There attention being focused on the road ahead, they are not able to detect the alarming cues (approaching movement by another vehicle on the crossing road) which could have allowed them to envisage this vehicle's possible crossing and consequentially to undertake the appropriate adjustment. These drivers are surprised by an atypical manoeuvre (usually against the law) by another user (85.4%).
- Thus, in 52.1% of cases, the accident is inevitable because no adjustment is undertaken, and in 35.6% the driver involved does not detect the interfering vehicle until the time of impact.
- In this prototypical scenario, only 8.4% of those involved are primary actors, whereas 91.6% are considered as secondary actors here, in other words they are not at the actual origin of the breakdown but are nonetheless fully involved in the production of the accident.
- These accidents generally occur in the daytime (85.8%) in countryside (58.6%) as much as in urban areas (41.4%).
- This scenario concerns both men (49.8%) and women (50.2%), with an average age of 38.2 (20 to 72). We can see that 15.3% of those involved have their driving licenses for less than 5 years. This scenario concerns thus the mainly experienced drivers.

The extra driving experience combined with good knowledge of the location (some drive this itinerary every day) and a strong feeling of having the right-of-way cause a major decrease in the attention applied to the driving task and the inability to detect a possible disturbance.

✓ **Scenario T4b: Mistaken understanding of the other's manoeuvre related to the polysemy of their signals (1.9% of the total sample)**

This scenario accounts for 43.4% of T4 failures (see in appendix for detail of the scenario).

- It is typical of daylight accidents (80.2% of them occur during the day) and concerns male as well as female (58.9% and 41.1% respectively).
- Confronted with a vehicle which gets ready to start a diverse manoeuvre (forking, about to turn, or stop), the driver is taken in by the ambiguous character of the indications (80.2% as shown in Annex) that he/she has at his/her disposal and expects a manoeuvre different from the one that the other vehicle realizes effectively. Three types of situations and associated indications seem ambiguity-generating:
  - Overtaking on a double lane (12.1%) behind a vehicle which gets ready to turn: the indicator of the other one is only interpreted in the sense of an overtaking signalisation and the driver is not prepared for the slowing down of the other one.
  - The stop of a vehicle at an unexpected place (31.4%): the stop lights activation of the previous vehicle is interpreted as a simple slowing down while it announces an intention to stop on the road.
- Although they are based on situational ambiguities, these errors of interpretation often bring in a low degree of attention from the driver, coming from inattention (34.7%), internal distraction (8.9%) or road over familiarity (41.5%). He then limits his analysis to the most evident and adopts a way of driving which does not allow any latitude to a possible regulation.

✓ **Scenario T5a: Expecting a non priority vehicle not to undertake a manoeuvre in intersection (2.6% of the total sample)**
This scenario accounts for 71.0% of T5 failures (see in appendix for detail of the scenario).

- Several parameters describe this scenario: it mostly happens during the day (86.5%) and in countryside (73.4%).
- The analysis of the cases brings to light that it was very difficult for these drivers to envisage the critical interference of the other vehicle on their trajectory, in the absence of any warning indication of their manoeuvre.
- Hypothesis is made concerning this indication which would have been able to question the expectation of the respect for the priority in this situation. These drivers thus are 'trapped' by the unexpected manoeuvre engaged by the other (in 95.9% of the cases, see in Annex).
- In all the cases (100%), the expectation concerning the other's manoeuvre is lowered by the rigid attachment the driver has on his right of way. When this critical interference occurs, these users cannot face it considering a ratio distance/time too short to act, without reckoning with the effect of surprise and fear engendered by this totally unexpected operation.
- In 88.6% of the cases, the manoeuvre of the other is so unexpected, that there was, because of this ratio distance/time, no way they could avoid the collision.
- The configuration of the accident makes those users Secondary active in 95% of the situations, as the other is the one who creates the perturbation.

✓ **Scenario T6b: Erroneous expectation of the stopping of a non priority vehicle approaching intersection (4.2% of the total sample)**
This scenario accounts for 53.2% of T6 failures (see in appendix for detail of the scenario and for the description of explanatory elements of the scenario).

- As for the T5a scenario, it occurs mainly during daytime (86.4%).
- Arriving at an intersection in which they have right of way, all these drivers were confronted with a vehicle in movement on the secondary road, approaching their way. With a strong sense of their right of way status (94.1%), the drivers do not pay particular attention to the situation and do not envisage the eventuality of a precaution to be taken, in spite of obvious alerting cues. Persuaded that the other vehicle in movement is going to stop, they are totally surprised at the moment when this vehicle crosses the junction just in front of them (96.3%).
- The expectation failure is besides aggravated by the low level of attention allocated to the driving task, this being connected mainly to the over experience the drivers has of the site (39.2%), and by the speed chosen which is in one quarter of the cases (24.5%) too high for the situation.
- The configuration of the accident makes those users Secondary active in 95.9% of the situations, as the other is the one who creates the perturbation.

3.2.4.f Conclusion of the multi-vehicles accidents analysis

In this section the same parameters as in single car drivers' accidents have been developed: pre-accident situations, failures, explanatory elements, and at last the most typical scenarios found for this sample of road users. Yet, unlike the losses of control for which the analysis of the degree of involvement was unnecessary[1], the multi-vehicles accidents analysis has been taken this variable into account.

The accident mechanisms observed for this group of passenger cars drivers are various.

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[1] See section 1.3.3.2. Degree of involvement of car drivers in single accidents

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 play a major role 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' impairment (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).

3.3 Discussions

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 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).

This 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 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 (D1.1, Task 1.1), two sections have been developed in order detail the analysis of two groups of passenger cars described earlier:

- ✓ Single cars accidents
- ✓ 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 or 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).

3.4 Conclusions

This 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.

4 Task 1.2: Powered Two Wheelers Riders

4.1 Introduction

Motorcycle and moped vehicles riders can differ in an important way of driving from other more common vehicles like passenger cars, for instance. Despite their dimensions, much smaller than other types of vehicles, those who choose to ride a PTW (Powered Two Wheeler) do not always buy it just 'because they need it'. Due to their size they may become not easy to be detected by other users (PTW conspicuity), they give a freedom feeling to the rider who is much more directly exposed to hypothetic collision energy than a passenger car driver. Moreover, as they only have two wheels their dynamic is completely different, most of all in braking maneuvers and curves approaching. Therefore, relevant questions like When?, How? and Why? a motorcyclist rides different than other road users are essential to address their specific accident causes.

PTW use has increased in last years. On the one hand, the number of mopeds in use in 2005 (also known as the "park") was 13.2 million across the EU-27[1]. In 1998 the ratio of new moped deliveries to mopeds in use was 1:9; by 2005 it had fallen to 1:19. This is largely down to the fact that modern machines are of a higher quality and have an extended lifetime, so changes in the annual number of new moped deliveries are not directly mirrored by a reduction in total mopeds in use. By contrast, the number of motorcycles in use has continued to raise in each of the EU 27 countries and reached over 17 million in 2005, an increase of nearly 50% on 1998. Combined with a more stable level of new motorcycle registrations, the overall ratio of new motorcycles against total motorcycles in use being 1:10 in 1998 and 1:13 in 2005. Again the longevity of modern motorcycles will tend to reduce the replacement rate, but the significant growth of motorcycles in use (which was already well established since before 1998) is a clear indication of their growing popularity.

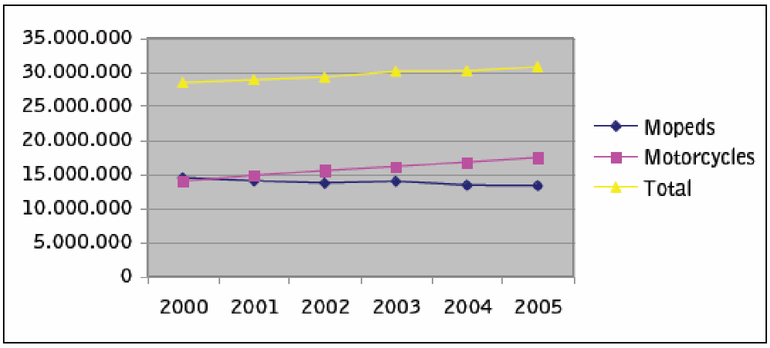


Figure 4.1.- PTWs in use in EU-27.

On the other hand, and opposite to what happens with other users, PTWs accidents do not show such a clear decreasing trend during last years as it can be observed in the figure 2.6 (in the 'Introduction' chapter).

[1] Year book (2007). ACEM.

In total number of percentage, the most current data available offers the following situation related to PTWs fatalities: **18% of the total road fatalities come from PTWs (in EU countries included in CARE, 2006)**, although this percentage increase in the case of inside urban fatalities (22%)[1].

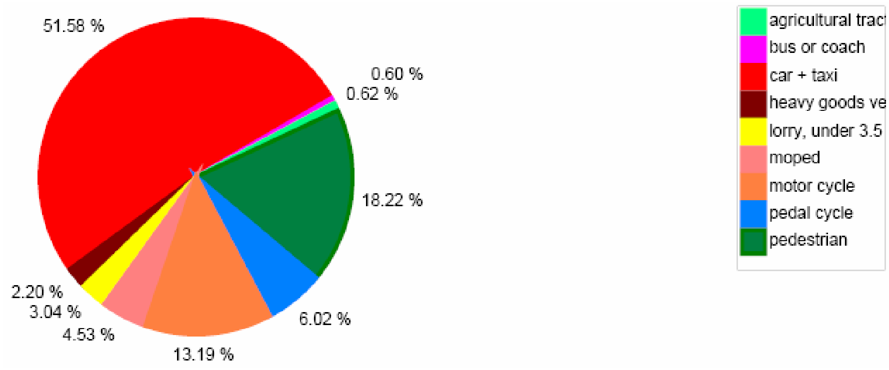


Figure 4.2.-Comparions between PTW fatalities and other transport modes (EU countries included in CARE, 2006).

The objective of this report is to get insight on the main PTWs accidents causes, human behavior related possible human failure from the rider point of view and risk factors of being involved in an accident, continuing the analyses performed in 'Deliverable D1.1: Road users and accident causation. Part 1: Overview and general statistics'. To achieve this aim, different variables and parameters were analyzed (interaction between motorcycles and other vehicles, conspicuity, rider psychological characteristics, training and education of PTW riders, vehicle conditions, … .) As it has been said, this part could be considered as the sequel of the mentioned report D1.1, due to some of the main results regarding literature review and descriptive analyses were taken into account in this step.

4.2 Main results from the Deliverable D1.1

The literature review established a guideline of important factors, regarding PTWs accident causation factors, as a background input in order to analyze national, in-depth databases and exposure data. The main points highlighted in almost all the studies concerning motorcycles and mopeds as contributing to the accident causation were:

- ✓ The low conspicuity of motorcycle and mopeds.
- ✓ 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.

[1] The most current percentage available for the whole EU-27 shows that 15% of fatalities come from PTWs (2004), as it was shown in Figure 1.3.

On the other hand, factors as 'Speeding', 'Engine size', 'Gender' or 'Age of the rider' were pointed in some studies as influential, although other studies (due to the nature of the study or the absence of clarity on its definitions) did not consider these factors as relevant.

The next step done in D1.1 was to detect which the main accident configurations were for these road users and also to investigate the factors at European level using different sources of data (available National database within TRACE consortium). These sources were well-provided by WP8 ('Data suppliers') through the respective requests.

The first target was achieved using seven National databases available to TRACE project. It is important to mention two aspect, the first one is that all these databases, except Italian one, have gathered all the accidents happened in the respective country, so from a 'statistical point of view' the results are representative. The second, and perhaps the most important aspect, is the fact that four out of the seven National databases used in this descriptive analysis belong to the four countries with higher 'parc' of PTWs. This is an important fact from the point of view of the results from this Task. The extrapolation of the results obtained in this task from the six National databases to the whole EU-27 level could not be considered as inappropriate.

In the following image, the location of these databases is detailed, as well as, the proportion of PTW parc.

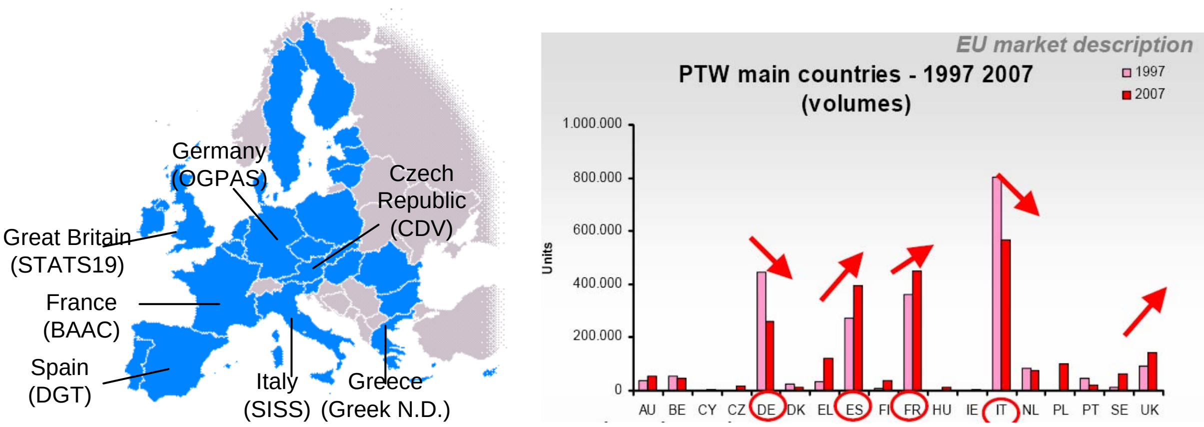


Image 4.1.- National databases used in Task 1.2 and European countries with higher PTW parc[1].

The most relevant PTWs accident configurations in terms of fatal and serious accidents were pointed through these data and previous experts' experience. These configurations (over the in-depth and risk analyses have been done) are detailed below in table 4.1.

[1] 1997-2007 European PTW Market Trends (ACEM, 2008)..

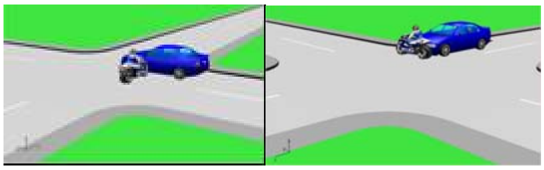
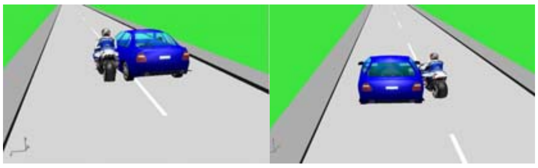
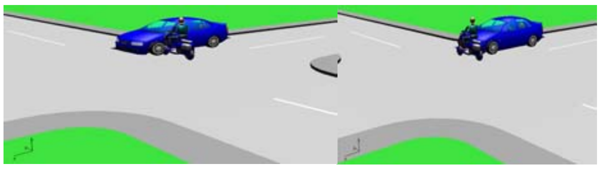
Accident Configuration	% Fatal & Serious Accidents	Illustration
1. Motorcycle single accidents: accidents which involved just one motorcycle on a rural road: run-offs, rollover on the carriageway and collisions with road restraint systems.	27%[1]	
2. Front-side accidents in rural and urban junctions 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: Accidents which involved just one moped on a rural or urban road: run-offs, rollover on the carriageway and collisions with road restraint systems.	21%[2]	
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 4.1.- Distribution of accidents configurations (National databases)

These seven configurations represent more than 50% of the total fatal and serious motorcycle accidents and almost 60% of the total fatal and serious moped accidents within the national databases analyzed. More details related to the description of these configurations can be found in 'D1.1'.

[1] This percentage is over the motorcycles accidents, not over all PTWs accidents.
[2] This percentage is over the mopeds accidents, not over all PTWs accidents.

4.3 In-Depth analysis

Once, the main accidents configurations have been detailed, in-depth analyses have been done over these seven configurations to obtain, mainly, a better understanding of the mechanism of these accidents and therefore, the accident causation of them. Also, other objective of these analyses was to detect which factors could be considered as risk factors from the point of view of increasing the risk of being involved a PTW user in an accident. Finally, the methodologies explained in the Work Package 5 'Human Factors', as allowed detecting and codifying the Human Function Failures in each accident.

4.3.1 Methodology

Traffic accident causation is a complex issue that needs to be investigated from different points of view. That is the reason why Work Package 7 provided a compilation of analysis methods for accident involvement and risk factors studies. The methodology used to perform this study applied two approaches[1]:

- ✓ **Direct approach**. Descriptive procedures to detail distributions of contributing factors registered by experts' judgement.
- ✓ **Indirect approach (statistical)**. Risk analyses performed through odds ratios and logistic regression. In this study, one of the techniques used to detect risk factors has been a case-control analysis. This type of study has been able to be performed because the in-depth data used (see in the following chapter) has available exposure data (motorcycles who had not suffered an accident), which is a requirement for risk analysis.

The research followed this guideline:

1. Selection of accidents which belongs to one of the seven configurations selected in the D1.1.
2. **Accident causation analyses**: With the purpose of knowing the mechanism of the accident, and therefore, the accident causation, analyses over this information was done in each one out of the seven configurations.
3. **Human Function Failure**: Once , the mechanism of the accidents have been understood and therefore the accident causation, the methodology used in Work Package 5 (about how to detect and codify the Human Function Failures (HFF)) has been applied in a sample of accidents from other In-depth database different to MAIDS (INRETS database has been used).
4. **Risk analysis**:
    a. **Case-control analyses:** For each accident configuration, information from accidents (cases) and information from non-accidents (controls) were used to calculate 'Odds Ratios'. This means, the risk for a PTW user of being involved in each accident scenario was calculated. Therefore, this could be called **'Risk analyses of being involved in a PTW accident'**.
    b. **Test χ^2 and Odds ratio analyses**: Once the main accident causations were detected in each scenario, statistical analyses were done with the aim of knowing which factors are related to each accident causation detected in each scenario. Of course, only accidents from each scenario were used, so the conclusions obtained from these analysed will be focused to know which factors increase the risk of being a specific parameter is the cause of the accident (in that kind of scenario). Cross-tables have

[1] The two approaches and all methodology used is properly defined in 'Deliverable 7.3: Analysis Methods for accident and injury risk studies' of TRACE project.

been used. When the factor had only two categories 'Odds ratio' analyses, while test χ^2 have been used for all the cases. Therefore, this could be called **'Risk factors related to each accident causation'.**

4.3.2 Database

The accident data used in this analysis belongs to MAIDS[1] database. The MAIDS project developed an extensive in-depth study of PTWs accidents during the period 1999-2000 in five sampling areas located in France, Germany, Netherlands, Spain and Italy. 921 accidents were investigated in detail (approximately 2000 variables being coded for each accident) 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). For a description of the MAIDS project, data collection methods and description of database see (*MAIDS: In-depth investigations of accidents involving powered two wheelers. Final report,* 2003).

The way of proceeding in this task has been different to the majority of TRACE analysts (for the Accident causation and risk analyses). Instead of asking for specific tables (queries) to all the 'in-depth suppliers' from WP8, Task 1.2 leader has had full access to all the information gathered in one of the widest in-depth database in Europe related PTW accidents: 'MAIDS database' (from the FP5 MAIDS project 'Motorcyclist Accidents In-Depth Study'). In the following image, countries participant in this project (in-depth accidents suppliers) are shown:

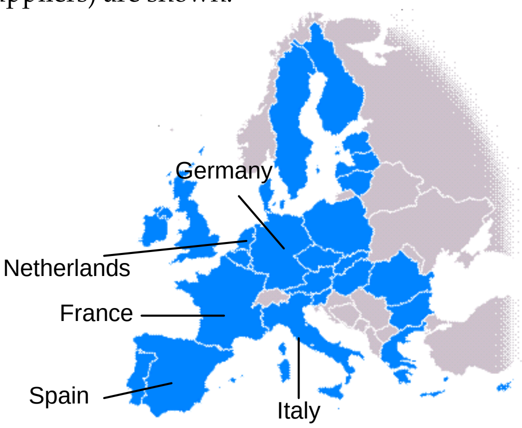


Image 4.2.- In-depth databases used in Task 1.2

Two experts from Task 1.2 leader were analysing at ACEM´s facilities, in Brussels, all the information gathered in MAIDS database. Through the specific statistical software, analyses were done over the 921 PTW cases gathered. The main results from this analysis are the determination of the causes (primary factors and precipitating factors) in each out of the seven main PTW scenarios detected from the descriptive analysis in the previous step.

According to the seven configurations selected in D1.1, 469 cases were selected, representing more than 50% of all accidents registered in MAIDS.

Exposure data is constituted of a sample of non accident data with the characteristics of the PTW and PTW rider population riding within each sampling area. This information is necessary to perform a case-control study where the cases (i.e., the accidents) are compared with a non-accident population

[1] MAIDS: In-depth investigations of accidents involving powered two wheelers.

(i.e., the circulating riding population within the sampling area), allowing the possibility to identify potential risk factors associated with PTWs accidents.

All exposure data (923 controls) were selected for all configurations selected just dividing them depending on the legal category (motorcycle or moped), because all riders drove along all kind of road layout configurations and inside and outside urban areas.

The following concepts are some definitions explaining terms that are used along this report:

- ✓ **Perception failure**: The investigator determines through reconstruction analysis or contributory factor analysis whether or not the PTW rider or the OV driver failed to detect the dangerous condition based upon the strategy that he was using to detect dangerous conditions. For example; the OV driver fails to check his side view mirrors and moves into adjacent lane, striking the PTW that was in the adjacent lane.
- ✓ **Decision failure**: The investigator determines through reconstruction analysis or contributory factor analysis if the PTW rider or the OV driver failed to make the correct decision to avoid the dangerous condition based upon his strategy. For example; the PTW rider observes yellow caution lights and continues on same path of travel at same speed based on the PTW rider's decision to continue through the intersection. The PTW rider hits the side of a passenger car moving perpendicular to direction of the PTW.
- ✓ **Risk factor** – A hypothetical causal factor for accidents or injuries.
- ✓ **Overrepresented value** – a value which occurs with a statistically significant greater frequency than would be expected, assuming there were no differences associated with that value (i.e., the difference in frequencies cannot be explained by random variation).

4.3.3 Accident causation analysis

This section presents the analysis done over the accident causation factors found in the MAIDS database for each one of these configurations.

Before showing the results it is important to explain the way of gathering the information in this in-depth database related accident causation. Accident causations factors are coded within the databases as **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*). In some cases some contributing factors cannot be coded as primary factors but might be usually correlated to specific primary factors. For instance, the factor 'motorcycle rider drug and/or alcohol involvement' cannot be coded as primary factor within this database but in some configurations is usually present linked to 'Motorcycle reaction failure'.

Another relevant issue to be mentioned is the proportion of MAIDS accidents that were relevant to one of the seven configurations selected, taking into consideration that in-depth databases might be some times biased and therefore can only be considered representative under some assumptions. This fact is shown in figure 4.3.

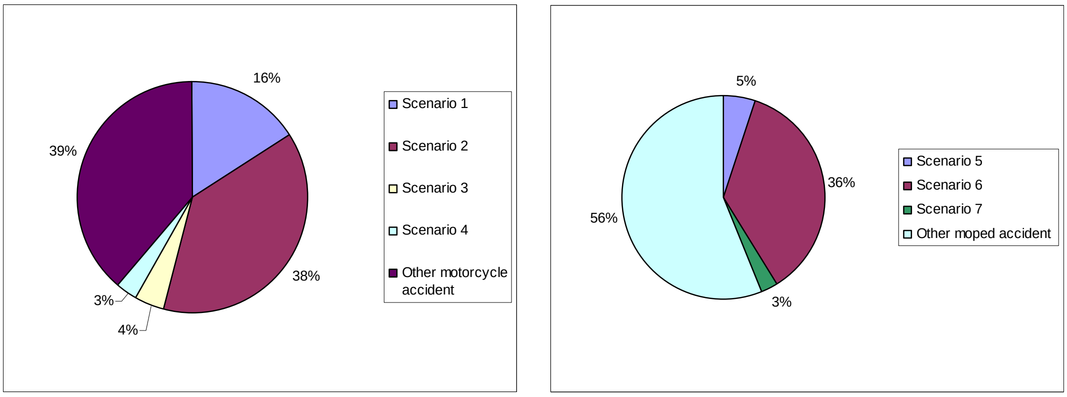


Figure 4.3.- Distribution of accidents configurations (In-depth database MAIDS).

As it can be seen, these accidents represented more than 50% of all accidents within MAIDS database, and the main configurations are: motorcycle single accidents, front-side accidents in rural and urban junctions between motorcycles and passenger cars and front-side accidents in rural and urban areas (junction and non junction) between mopeds and passenger cars. Of course, this must not be interpreted as a lack of representativiness, it only indicates the number of cases considered in each analysis. In the next table 4.2 are summarize the frequency of each configuration in national databases and in-depth database. As it is logic to think, the higher number of accidents (cases) for each configuration, the better for the statistical power of the analyses.

Configuration	1	2	3	4	Other motorcycle accident	5	6	7	Other moped accident
% accidents National databases	27%	13%	5%	5%	50%	21%	30%	8%	41%
% accidents In-depth database	16%	38%	4%	3%	39%	5%	36%	3%	56%

Table 4.2 .-Distribution of accidents frequencies (National and In-depth databases)

As it can be seen, the distribution of accidents is different between the national databases and the in-depth databases. This difference does not make conditional the analysis because the aim is not to asses if the in-depth database is representative but, once the main configurations were located trough national databases (which are representative), the aim is to analyze them deeply trough in-depth database.

The following table 4.3 presents the results of this analysis over the selected configurations, through it can be known how the accidents happen. For most of them, some factors clearly showed to be present as primary factors, whereas in other cases there were no prevalent primary factors.

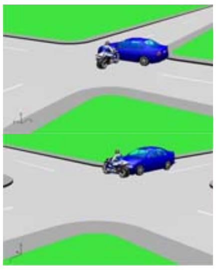
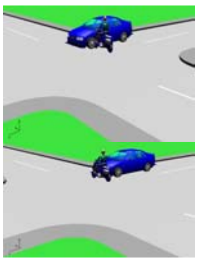
		Accident Configuration	Primary factors	Contributing factors Contributing factors (including primary)
MOTORCYCLES	1		- Motorcycle rider decision failure (31%) - Motorcycle rider failure, unknown type (18%)	- Motorcycle rider decision failure (37%) - Motorcycle rider failure, unknown type (32%) - Others 16%:Too fast speed, motorcycle rider unsafe acts, inadequate speed.
MOTORCYCLES	2		- Passenger car driver perception failure (60%) - Passenger car driver decision failure (12%)	- 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%)
MOTORCYCLES	3		- Passenger car driver perception failure (47%)	- Passenger car driver perception failure (53%) - Motorcycle rider unsafe acts or risk taking behaviour (53%)
MOTORCYCLES	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%)
MOPEDS	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%)
MOPEDS	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 4.3 .-Accident causation in PTW accidents

4.3.4 Human Function Failure

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.

4.3.4.a 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' (3 cases);
- T1 failure: 'Incorrect evaluation of a road difficulty' (1 case);
- G2 failure: 'Impairment of sensorimotor and cognitive abilities' (1 case).

The most occurring elements explaining those single accidents from PTW are:

Major BAC – Blood Alcohol Content (>0.5g/l)	2
Road over-familiarity / monotony	2
Rigid attachment to the right of way status	2
Choose of a too high vehicle speed for the situation	2
Excessive speed (above limitation)	4
Purposeful violation of traffic laws, regulations…	2
Difficult plan (small curvature radius…)	2
Atypical manoeuvres from other users	2

✓ 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').

When dealing with the explanatory elements, the following were found:

Driving inexperience = novice	1
Rigid attachment to the right of way status	4
Obstruction to visibility (other vehicle, glare…)	1
Absence of clues indicating a manoeuvre made by another user	1
Atypical manoeuvres from other users	3
Being dragged (by a passenger, by a vehicle ahead starting …)	1

✓ 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'.

The explanatory elements are quite apportioned, showing the variety of potential causes behind such a scenario:

Internal distraction	1
Road over-familiarity / monotony	1
Manoeuvre over-familiarity	1
Global time constraint (for the trip)	1
Trivialization of the situation (potentially dangerous but treated as 'pain killer')	1
Excessive speed (above limitation)	1
Problems in equipment (atypical, not legible, not adapted to certain vehicles)	1
Difficulty in finding a gap to cross or to insert (density or speed to the traffic)	1
Obstruction to visibility (other vehicle, glare…)	1
Absence of clues indicating a manoeuvre made by another user	1
Atypical manoeuvres from other users	1

✓ 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.

4.3.4.b Mopeds

✓ Configuration 5: Single accidents.
As for motorcycles, this configuration is quite represented in the selected accidents (10 cases out of 39).
Again, those accidents mainly occurred when the rider has 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').

The main explanatory elements are listed below:

Road over-familiarity / monotony	3
Choose of a too high vehicle speed for the situation	4
Purposeful violation of traffic laws, regulations…	2
Inadequate signing (not sufficient, not visible)	2
Difficult plan (small curvature radius…)	2
Bad visibility conditions (rain, night…)	2
Loss of vehicle adhesion	2

✓ 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' - are measured in respectively 3 and 2 cases).

The following elements are found to explain the most the failures exposed earlier:

Road over-familiarity / monotony	2
Rigid attachment to the right of way status	6
Choose of a too high vehicle speed for the situation	2
Excessive speed (above limitation)	2
Purposeful violation of traffic laws, regulations…	3
Equipment inciting to speeding	3
Obstruction to visibility (other vehicle, glare…)	4
Atypical manoeuvres from other users	7

✓ 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.

4.3.5 Risk analysis

As it has been showed previously, 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)

4.3.5.a 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.

Two steps were followed in order to carry out this case – control analysis:

✓ **Cross tabulations procedure**: First, all the variables were studied independently, without taking into consideration its likely correlation with the other factors. This was performed for each selected configuration. The result provides the variables that can be potentially considered as risk factor. To perform this study it was used a cross tabs analysis procedure which outcome was a p value based on chi-square distribution, 'Odds Ratio' estimation when the variable had only two categories and their Confidence Intervals. Exposure data with this methodology is represented by controls. These are those motorcyclists interviewed that did not have an accident but were supposed to be exposed to the potential risk factors. Over than 60 variables were studied related to environmental factors, mechanical factors and human factors.

✓ **Multinomial logistic regression**: In a second step, a multinomial logistic regression model (where it was possible) was performed. After detecting which variable(s) is risk factor for each contributing factor, a multinomial logistic regression was done to study the 'propensity toward' the categories of this variable(s) for each contributing factor within each configuration.

There was performed a completed analyses from MAIDS researchers using all data (not configurations as this study). From a general point of view, MAIDS researchers found:

- *The main primary contributing factors were (human failures coming from) the PTW rider (37.1%) and the OV driver (50.4%).*
- *In 10.6% of all cases, PTW rider inattention was present and contributed to accident causation.*
- *In 36.6% of all cases, the primary contributing factor was a perception failure on the part of the OV driver.*
- *27.7% of PTW riders and 62.9% of OV drivers made a traffic-scan error which contributed to the accident.*
- *32.2% of PTW riders and 40.6% of OV drivers engaged in faulty traffic strategies which contributed to the accident.*
- *A difference in speed compared to the surrounding traffic was identified as a contributing factor for PTWs in 18.0% of all cases and a contributing factor for the OV in 4.8% of all cases.*
- *The weather was a contributing factor or precipitating event for the PTW in 7.4% of cases.*
- *3.7% of cases involved a PTW tyre problem and 1.2% a brake problem.*
- *Unlicensed PTW operators who were illegally riding PTWs that required a licence, were also found to be at greater risk of being involved in an accident when compared to licensed PTW riders.*
- *Travelling and impact speeds for all PTW categories were found to be quite low, most often below 50 km/h. There were relatively few cases in which excess speed was an issue related to accident causation.*
- *The data demonstrated that the use of alcohol increased the risk of being involved in an accident, although the percentage was lower than in other studies.*

Focusing in this research, the main results of comparing the accidents group (cases) to the exposure group (controls) the variables associated for each configuration are to be shown.

Just clarify that only statistically significant variables are included in the tables, this means that it was taken as reference p-values greater than 0.05 and all the confidence intervals of the odds ratios did not contain the reference value 1.

CONFIGURATION 1: Single motorcycles run-off accidents.

The following table shows the results obtained from the risk analysis done:

Risk factor	p-value	Odds ratio
Vehicle year of production (5-10 years)[1]	0.002	2.29
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

Table 4.4 .- Risk analysis results from configuration 1

[1] Although each factor is easy to understand what it means, the whole definition of each factor can be found in 'MAIDS project (2003). *In-depth investigations of accidents involving powered two wheelers. Report on the Methodology and Process'.*

As it can see, several risk factors have been detected as relevant from a statistic point of view. For a better understanding of these results, the following interpretation shows how these factors affect motorcycle user related to the probability of suffering an accident:

- ✓ For instance, a rider younger than 25 years of age has an Odds Ratio equal to 2.09, this means that this type of motorcycle riders are 2.09 times more likely (or (109% higher) to be involved in an accident corresponding to configuration 1 than a rider from another age group.
- ✓ Single run off motorcycle accidents occurred mostly to riders who did not have experience driving along that road or that area. The lack of driving license increased notably the risk of being involved in an accident of these characteristics.
- ✓ From this accident configuration point of view (Single run off motorcycle accidents), is necessary en enforcement of laws or policies against riders who has no license, because it has been concluded that riders without driving (motorcycle) license are 4.01 times more likely to suffer this type of accidents.
- ✓ 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.

CONFIGURATION 2: Front-side accidents in rural and urban junctions between motorcycles and passenger cars.

Case-control study over this type of accidents shows the following results:

Risk factor	p-value	Odds ratio
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

Table 4.5 .- Risk analysis results from configuration 2

As well as in the previous configuration, it has been possible to perform a reliable logistic regression analysis due to enough data in all categories of the variables.

After modelling with logistic regression models procedure, the analysis of this configuration showed new findings as that motorcycles with more than 125cc motor displacement, front tyre wheel no original equipment and without front position lamp had a propensity toward to be involved in motorcycles front side accidents. Again motorcycle riders younger than 25 years of age and riders under secondary school qualification appeared as risk groups.

<u>CONFIGURATION 3</u>: Side-side accidents in rural and urban non junctions between motorcycles and passenger cars.

In this configuration it was difficult to reach any significant conclusion because there were not many cases (only 13 cases), which means that any kind of relationship appeared is conditioned by low frequencies. Nevertheless, the main results obtained from comparing exposure data to side to side collisions between motorcycles and passenger cars cases are:

- Motorcycles with front suspension in bad conditions are overrepresented.
- Motorcycles without left side mirrors view posts are overrepresented.

<u>CONFIGURATION 4</u>: Rear-end accidents in rural and urban non junctions between motorcycles and passenger cars.

Case-control study revealed some associations between this configuration and the variables 'front crash bars equipped?' and 'windscreen equipped?'

This type of collisions had a low frequency within database, only 12 cases were registered; consequently a risk analysis could not be performed.

However, there was an interesting trend with the variable 'does the license held qualify the rider for driving the accident vehicle?' because 2 out of three riders without a qualifying license had a collision. But, anyway this result just came from data descriptive analysis, so is not possible to conclude anything related to causation factor or risk factor with this information.

<u>CONFIGURATION 5</u> : Single moped accidents run off accidents.

The analysis of this configuration showed the following association:

Risk factor	p-value	Odds ratio
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

Table 4.6 .- Risk analysis results from configuration 5

The risk factors 'Alcohol and/or drug use' and 'not permanent physical impairment' increased notably the propensity toward to be involved in a single moped accident. In addition, these two factors are clearly correlated, meaning that most of the times when one of them is present the other one is present too, i.e.: alcohol and drowsiness.

CONFIGURATION 6: Front-side accidents in rural and urban areas (junction and non junction) between mopeds and passenger cars.

Data from these accidents shows association between this configuration and the next variables:

Risk factor	p-value	Odds ratio
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

Table 4.7 .- Risk analysis results from configuration 6

The case control study shows the risk factors 'Vehicle year of production', 'Lack of driving license (no license held) and 'no frequent use of the road' as the ones which increased the risk the most.

Once again the variables 'Lack of driving license (no license held) and 'no frequent use of the road' appeared as risk factors, so there is an special need to improve in this directions. Some countermeasures could be reinforcing the laws to do not allow on the road riders without license held or improve signing to make easier the driving task to drivers who do not use the road frequently.

A logistic regression procedure was performed to these data and the results for this configuration showed that no resident drivers, without license held, driving a moped equipped with motor power enhancement and without right side posts rear view mirrors had a propensity toward to be involved in front side mopeds accidents.

CONFIGURATION 7: Head-on accidents in rural and urban areas (junction and non junction) between mopeds and passenger cars.

Finally, in this last configuration studied, case-control analysis revealed some associations between this configuration and the variables 'right side rear view mirrors, posts equipped?' (Category 'yes' is overrepresented) and 'motor power enhancement equipped?' (Category 'yes' is overrepresented).

There was a tendency in the variable 'time travelling' because three out of five moped riders who were driving more than an hour had an accident.

Unfortunately, in this configuration is difficult to reach any statistically significant conclusion because, as happened with other configurations, there are only 12 cases, which makes unfeasible to establish any association between contributing factors and variables.

4.3.5.b Risk factors related to each accident causation

Once the risk analyses were performed and the risk factors were pointed, a further step was to identify possible associations between the most common accident causation factors in each configurations (out of the seven detailed from the beginning of this chapter) 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.

CONFIGURATION 1 FACTORS

The following table shows the results obtained.

Contributing factor	Risk factor	p-value	Odds ratio
1 Motorcycle rider decision failure	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

Table 4.8 .- Risk analysis results of contributing factor within configuration 1

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.

From these results, a countermeasure which could help to reduce this type of accidents could be educational campaigns point to young riders to highlight that take a risk riding can cause a very serious damage for them and for other vulnerable users, and re-educate riders through retrain courses, especially those who committed a serious traffic violation.

CONFIGURATION 2 FACTORS

The following table shows the results obtained.

Contributing factor	Risk factor	p-value	Odds ratio
1 Passenger car perception failure	Motor displacement	0.040	2.51
	Lack of front position lamp[1]	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

Table 4.9 .- Risk analysis results of contributing factor within configuration 2

[1] Front position lamp means without using the lamp, not the position where the lamp was.

According to the contributing factor 'passenger car perception failure' the variables associated to it are: 'motor displacement' (category more than 125cc is overrepresented), 'front position lamp equipped?' (In this variable category 'no' is overrepresented), 'front tyre, wheel original equipment?' (Category 'no' is overrepresented) and 'rear tyre, wheel original equipment?' (Category 'no' is overrepresented).

This result confirmed the conspicuity problem associated to perception failures; some solutions could be to use reflecting clothes, to install obligatory lamps, and/or to implement side reflectors[1].

There is only one variable clearly associated to contributing factor 'motorcycle unsafe acts or risk taking', within this configuration, which is 'rider age'; and the category overrepresented is motorcyclist between 25 years old and 40 years old.

CONFIGURATION 3 FACTORS

As it happened with risk analyses, due to the low frequencies within this configuration it could not be possible to perform any kind of analysis apart from the descriptive ones. Nevertheless, contributing factors 'passenger car perception failure' and 'motorcycle rider unsafe acts' were presented in most of the cases.

CONFIGURATION 4 FACTORS

This configuration is like the previous on, low frequencies. Its contributing factors were 'passenger car perception failure', 'motorcyclist perception failure' and 'motorcycle rider unsafe acts or risk taking'.

CONFIGURATION 5 FACTORS

The following table shows the results obtained.

Contributing factor	Risk factor	p-value	Odds ratio
1 Alcohol and/or drugs use	Under secondary school qualification	0.032	8.67

Table 4.10 .- Risk analysis results of contributing factor within configuration 5

The most interesting finding is that contributing factor 'alcohol and/or drugs use' is associated to 'educational status' and obviously to 'alcohol or drugs' as a risk factor. So the typical moped single run off or roll over accident where 'motorcyclist alcohol and/or drug use' was contributing factor seems to occur in urban areas to people who had 'no formal schooling or formal education prior to college'.

[1] There is a recent research which deals with the conspicuity issue in PTWs. 'Industry Conspicuity Research Status and Next Step', ACEM

CONFIGURATION 6 FACTORS

Contributing factor	Risk factor	p-value	Odds ratio
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 4.11 .- Risk analysis results of contributing factor within configuration 6

The analysis of the contributing factor 'passenger car perception failure' revealed that the variables associated are: 'front turn signals equipped?' (Category 'no' is overrepresented), 'driver license qualification' ('no license held' is overrepresented), 'Citizenship' (Category 'no resident' is overrepresented) and 'frequency of this road use' (Category 'frequent' is overrepresented).

The second contributing factor analyzed within this configuration was 'motorcycle rider unsafe acts or risk taking' and the variables which had an association with it are: 'Front suspension condition' (bad condition mopeds are overrepresented), 'headlamp assembly type' (Category double is overrepresented), 'left side rear view mirrors, posts equipped?' (Category 'no' is overrepresented), 'motor power enhancement equipped?' (Category yes is overrepresented), 'gender' (Category male is overrepresented), 'motorcycle training' (Category 'no training' is overrepresented), 'any traffic violations in the last 5 years?' (Category 'yes' is overrepresented) and 'any motorcycle traffic accident?' (Category 'yes' is overrepresented).

CONFIGURATION 7 FACTORS

From the descriptive analysis the contributing factors within this configuration were 'motorcycle rider decision failure', 'passenger car driver perception failure' and motorcycle rider unsafe acts or risk taking'. It is impossible to perform a risk analysis due to low frequencies.

4.4 Conclusions

PTW accidents are an important road safety problem nowadays. As it has been showed in Figure 2.6, 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.

As it has been explained, for the realization of these analyses, the most seven main scenarios from D1.1 have been selected and through one of the biggest PTW in-depth database (MAIDS), the accident causation and risk analyses have been done for each configuration.

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.
  - ✓ The main cause of the collisions was a human failure.
  - ✓ 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.

4.4.1.a Considerations

Also, some considerations could be taken into account related these analyses

- ✓ TRACE project has solved the problematic of the studies which used national database without detail information about accident causation using national database to identify the main configurations where the PTW accidents occurred and in depth database to investigate deeply risk factors and accident causation.
- ✓ During the realization of this research, one of the main problems that it was found was the lack of reliable data. Not only reliability but is necessary to harmonize the databases to reach more ambitious objectives and studies.
- ✓ Another difficulty found is the lack of some cases related to specific accident configuration. Perhaps the way of solving these problems could have been to request information from these configurations to Work Package 8, but the harmonization of variables would have been a worse solution.
- ✓ During the whole risk analyses done in this chapter, all the results have been showed from the point of view of 'Which categories can increase the risk of been involved in a PTW accident?', therefore, if we desire to know which factors decrease the risk of being involved, the way of obtaining will be interoperating the results from the opposite point of view.
- ✓ Although all the factors considered as statistically relevant, only for the most striking factors there has been an interpretation of the results. The most striking results have been selected in base of two criteria: the lowest value of p-value or the highest value of the Odds Ratio.

4.5 References

The following references have been used to determine the main outcomes of literature review. This activity has been focused on literature related only with accident causation, especially from European literature:

ACEM (2006). *ACEM´s view on PTW fatality statistics in Europe*. Brussels.

ACEM (2007). *Year Book*.

ACEM (2008). *1997-2007 European PTW Market Trends.*

MAIDS project (2003). *In-depth investigations of accidents involving powered two wheelers. Report on the Methodology and Process'*.

MAIDS project (2003). *In-depth investigations of accidents involving powered two wheelers. Final report.*

5 Task 1.3: Vans, Bus and Truck Drivers

This task is to study the road transport accidents in Europe. Vans, busses, and trucks an urgent to study, since they contribute for a high part to the average loss in terms of personal and material damages. Though not the highest in absolute figures, road transport vehicles count for the most severe accidents as to the effects of the impacts. High masses lead to higher severe impacts, namely for the unprotected (pedestrians, cyclists, two-wheel-drivers), and the lower mass vehicles (small cars). The importance of the road as mode for transportation will increase in terms of ton kilometers in the whole EU. Insofar, transportation accidents by van, bus, and truck must be kept in mind, when targeting road safety in Europe and the aim to show the EU road fatality figure.

The main outcomes to report in this chapter are the identified most important causation factors for the three most frequent accident scenarios for vans, buses and trucks.

For the in-depth analysis of van accidents data from Italy (SISS), Great Britain (OTS) and EACS (France) are available. Significant for this in-depth investigation is only the information from SISS and partly from OTS. All further data are based of a too low number of cases.

For the in-depth analysis of bus accidents data from Italy (SISS) and Great Britain (OTS) are available. Significant for this in-depth investigation is only the information from SISS; OTS data are based of a too low number of cases.

This chapter will be divided in three subchapters. The first one will be focused on **vans,** the second one on **buses** and the third one on **truck** drivers issues.

5.1 Main results from deliverable D1.1

In the following, it is given a short summary of the main outcomes of the descriptive analysis related to the investigation of van, truck and bus accidents.

The three most important accident scenarios for vans:

- **Accidents between a van and a passenger car moving along in carriageway [40% - 30%]**
  In general, these accidents are rear-end collisions and collisions between oncoming vehicles. Mostly, the accidents occurred on urban and rural roads (without motorways) caused by insufficient safety distance, unadapted speed or overtaking.
- **Accidents between a van and a passenger and while turning into a road or by crossing it [45% - 19%]**
  These accidents mostly happened on urban roads caused by a failure to observe the priority rules. These accidents happened on junctions or gateways.
- **The single vehicle accident (Driving accident) of vans [58% - 0%, but not consistent]**
  These accidents happened without an influence of another road user, such as skidding. The accidents mostly happened on rural roads by the cause of unadapted speed or/and influence of alcohol.

The three most important accident scenarios for trucks are:

- **Accidents between a truck and a passenger car moving along in carriageway [44% - 28%]**
  Mostly, the accidents occurred on rural roads including motorways, caused by insufficient safety distance, unadapted speed and mistakes made when entering the flow of traffic.
- **Accidents between a truck and a passenger and while turning into a road or by crossing it [39% - 13%]**

Remarkable is the relative high rate of rural accident (without motorways) in comparison to vans or all road users. Main causations are failures to observe the priority rules and partly influence of alcohol.

- **The single vehicle accident (Driving accident) of trucks [60% - 0%, but not consistent]**
  The main location of these accidents is rural and motorways in connection with the causations unadapted speed and over fatigue.

Three most important accident scenarios for coach and bus are:

- **Accidents between a bus and a passenger car moving along in carriageway [31% - 26%]**
  The main part of these accidents happened clearly on urban roads (except France). The most important accident causations are unadapted speed, overtaking and insufficient safety distance
- **Coach/Bus against a passenger car and caused by turning into a road or by crossing it [45% - 16%]**
  The main location for buses involved in turning accidents is in urban areas. In general terms, the main causation shown for these accidents is priority
- **Coach/Bus involved in driving accidents [48% - 0%, but not consistent]**
  These accidents happened without an influence of another road user, such as skidding. It is difficult to establish strong conclusions, as there is no homogeneous data for the analysed countries. Factors included here are turning in crossings, fatigue, alcohol, speed and distance. They are not concurrent for all the countries but most of them include human errors and even some carelessness.
- **Accidents between a bus and a pedestrian**
  Quit all accidents occurred on urban roads. Related to this scenario the most important causations are improper behaviour towards pedestrian, mistakes made when turning and unadapted speed.

In comparison of this outcomes with older literature documentations of transport accidents it became clear that isolated knowledge from isolated countries, often out of Europe (USA, Australia), is indeed applicable to the EU 27 situation. Beside all statistical trouble, the leading causing and contributing factors that result in transport fatalities or severe injuries, are to verify in our data, if unadapted speed, alcohol, fatigue, turning/crossing errors, or distance. Secondly, the differentiated look of this chapter could add to the existing national studies, which special focus should be done, compared to the other EU countries, since some factors are common, others are more special or unimportant.

In final conclusion, this descriptive study show severe transport accidents on urban roads in daylight, special at intersection against smaller cars, pedestrians, and motorized and unmotorized two-wheelers, are to address most, when planning countermeasures.

Safety improvements can be reached by vehicle safety, such as ADAS in crossing, turning, and lane keeping (since single vehicle and fatigue accidents count for a good part to accident figures). This result became obvious form the comparison of light conditions, type of road, and type of accident. But unadapted speed and alcohol must find further measurements, namely in enforcement.

This result is congruent with other findings, but as mentioned, here the EU wide necessity was verified. All countries, which were compared, show similar structural problems with transport fatalities and assure similar measures to be effective in reducing these fatalities.

Nonetheless, it remains a lot to work on EU level, to reach full comparability in accident figures. Statistical methods, record policy, and categorization of causations are not optimal in all countries. This is contra productive in computing comparable risk indices.

A.- Vans

5.2 In-depth analysis

5.2.1 Method

The in-depth analysis relating causation factors for vans and busses was made for the three most important accident scenarios of each road user, which was identified in the descriptive analysis. The conducted data request to WP8 asked about the most frequent causation factors for each scenario. As expected, only a few answers for vans and busses were available for such detailed questions.

5.2.2 Available data

Only Great Britain and Italy are able to prepare in-depth data regarding accidents causation factors of buses as required for TRACE. With respect to the causation factors for van drivers additionally France can provide spare information. It seem that it is not possible to arrange an in-depth analysis (and risk analysis) on the European level as it is desired of TRACE at least for vans and buses.

5.2.3 Involved countries and geographical areas

France EACS supplied by CEESAR: Region Salon-de-Provence

Great Britain OTS supplied by VSRC: Midlands & South-East regions of England

Italy SISS supplied by ELASIS: Milano Province, Mantova Province, Naples City, Salerno City and Sorrento City

5.2.4 List of used causation factors

Code	Causation Factor Groups	Examples of Causation Factors included in this group
H1	Human - Physical/Physiological condition	Medical condition, pre-existing impairments
H2	Human - Substances taken	Alcohol, drugs, medication
H3	Human - Psychological condition	Emotional (upset, angry, anxious, happy…), in a hurry, fatigue, internal conditioning of the driving task (e.g. right of way status)
H5	Human - Behaviour (Distraction)	Distraction within vehicle, outside vehicle, within user (e.g. lost in thought)
H6	Human - Behaviour (Risk taking)	Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs/signals/markings, thrill-seeking…
H7	Human - Behaviour (ERROR)	monitoring error, guidance error,,,
H8	Human - Behaviour (UNDERSTANDING)	Diagnostic, prognostic
E1	Environment - Road condition	Surface contaminants (wet, flood, snow, ice, frost, oil diesel, sand, gravel), surface defects, surface type)
E2	Environment - Road geometry	Bends, slopes, camber, traffic calming, confusing layout, speed-inciting
E3	Environment - Traffic condition	Traffic flow, traffic density, confusing/lack of information from other road user(s)

E4	Environment - Visibility impaired	Road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc..), other vehicles, roadside objects
E5	Environment - Traffic guidance	Traffic signs, signals or road markings which are insufficient, poorly maintained, inappropriate or unexpected.
E7	Environment - Hazards	Obstacles/hazards in road (animal, debris from previous accident, discarded load) or in roadside (e.g. car on fire), roadworks, level crossings...
V2	Vehicle - Maintenance	Windscreen chipped, broken, cracked, misted, and dirty. Tyres (tread depth, air pressure, blow-out, incorrect type). Exterior/interior lights not working, broken, incorrect.

Table 5.A.1.-List of causation factors.

5.2.5 Causation factors

Without considering a specific accident situation, the following figure illustrates the most frequent and important causation factors for injury accidents caused by vans. The factor "risk taking" (H6) such as speeding (illegal or inappropriate), driving too close to vehicle in front, purposely disobeying signs/signals/markings, thrill-seeking and so on is the most famous causation factor in regard to accidents with injured persons caused by vans. The second most important causation is associated with Distraction (H5) within vehicle, outside vehicle, within user (e.g. lost in thought). The in-depth data presents another frequent causation factor namely impaired visibility (E4) such as road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc..), other vehicles, roadside objects.

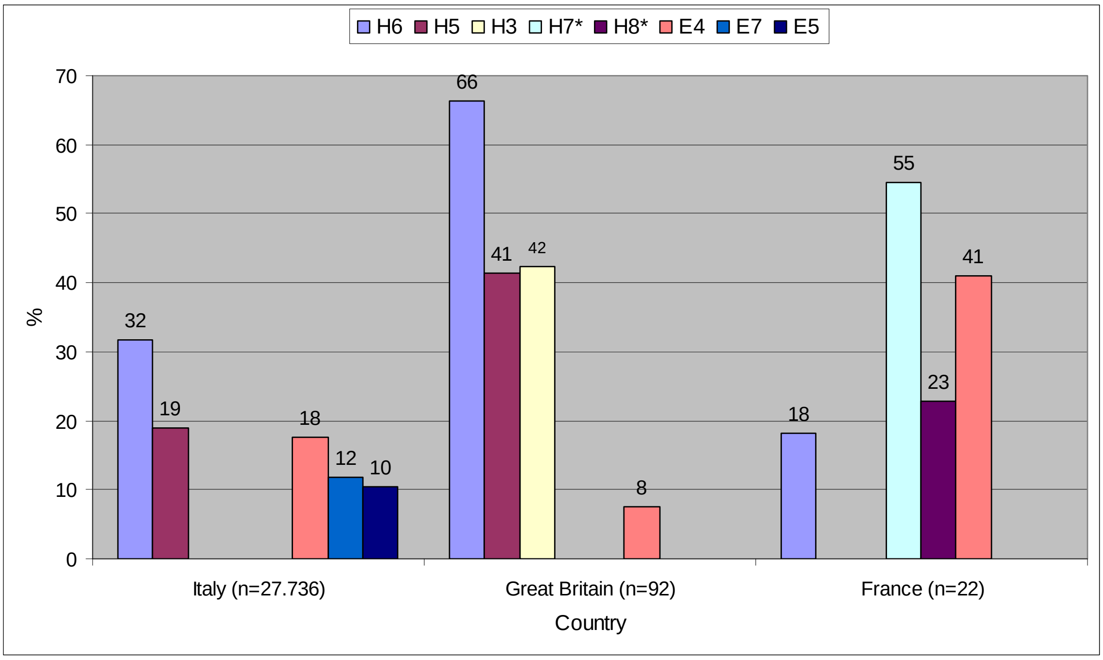


Figure 5.A.1.-Overview causation factors for van accidents with injured persons in Italy, Great Britain and France.

5.2.5.a Van accidents between vehicles moving along in carriageway

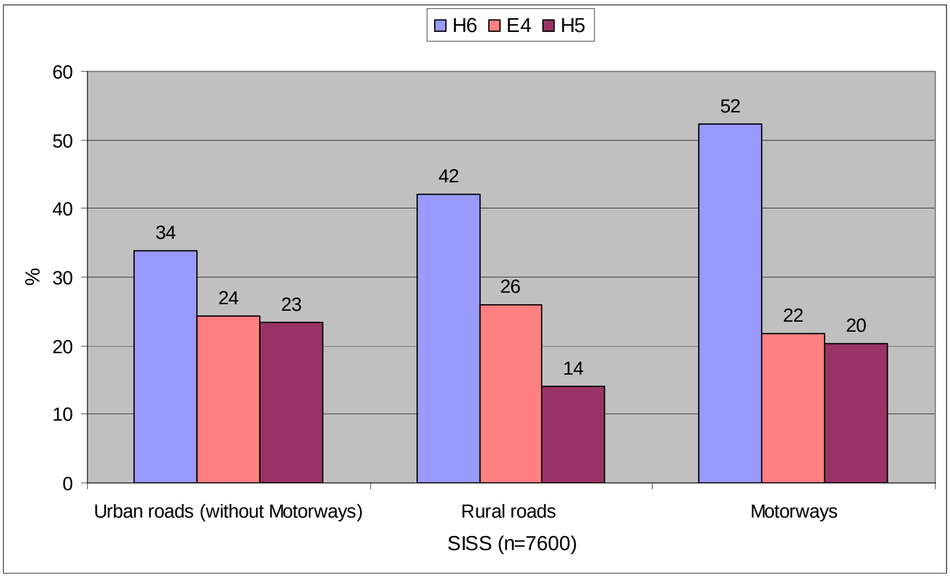


Figure 5.A.2.-Causation factors for van accidents between vehicles moving along in carriageway in Italy.

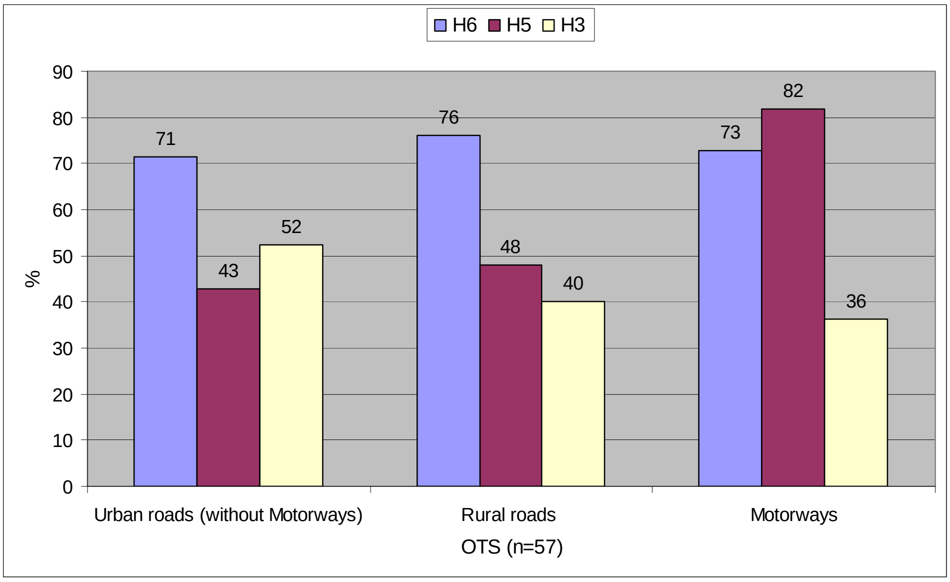


Figure 5.A.3.-Causation factors for van accidents between vehicles moving along in carriageway in GB.

In conformity of both countries risk taking (H6) such as speeding (illegal or inappropriate), driving too close to vehicle in front, purposely disobeying signs/signals/markings, thrill-seeking is the most important causation factor for the most frequent accident scenario of vans. The figure 5.2 shows that the factor risk taking (H6) gains in importance with rising speed in Italy. As already shown in the overview, distraction (H5) and. impaired visibility (E4) are also relevant for accidents between vehicles moving along in carriageway. A particularity in GB for this accident configuration is the factor "psychological condition" (H3) such as emotional (upset, angry, anxious, happy…), in a hurry, fatigue, internal conditioning of the driving task (e.g. right of way status).

5.2.5.b Van accidents caused by turning off, turning into or by crossing it

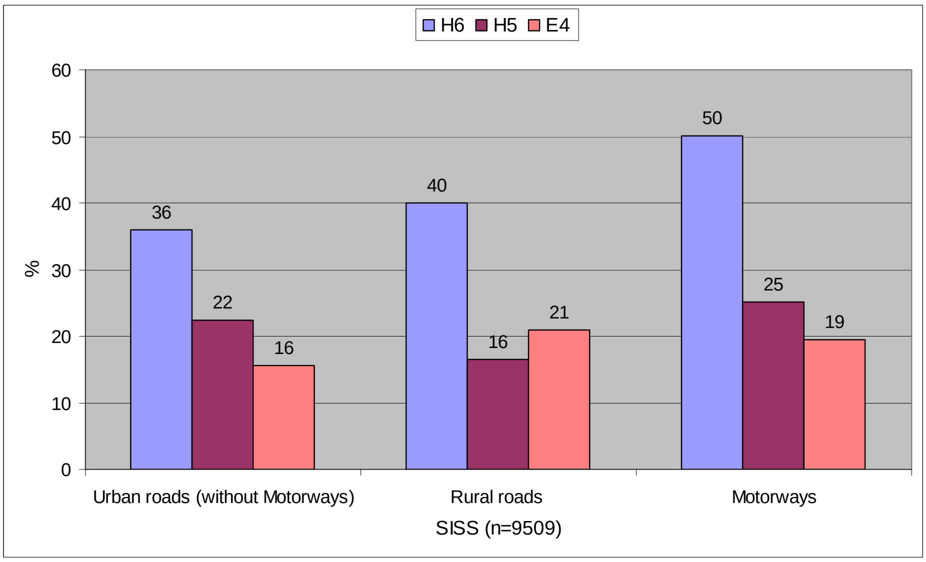


Figure 5.A.4.-Causation factors for van accidents caused by turning off, turning into or by crossing the street in Italy.

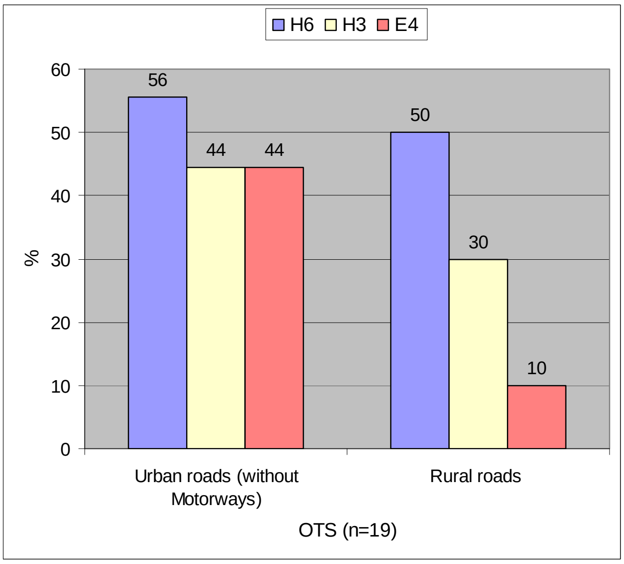


Figure 5.A.5.-Causation factors for van accidents caused by turning off, turning into or by crossing the street in GB

As apparent in the figures above, the most important causation factor in both countries is risk taking (H6) such as speeding (illegal or inappropriate), driving too close to vehicle in front, purposely disobeying signs/signals/markings, thrill-seeking is the most important causation factor for turning accidents. Also an important role plays in both countries the factor impaired visibility (E4). A particularity in GB for this accident configuration is the factor "psychological condition" (H3) such as emotional (upset, angry, anxious, happy…), in a hurry, fatigue, internal conditioning of the driving task (e.g. right of way status) as it is also bee shown in connection with the first scenario of vans, accidents moving along in carriageway. Furthermore a relevant causation factor for turning accidents of vans in Italy is distraction (H5).

5.2.5.c Van has lost control

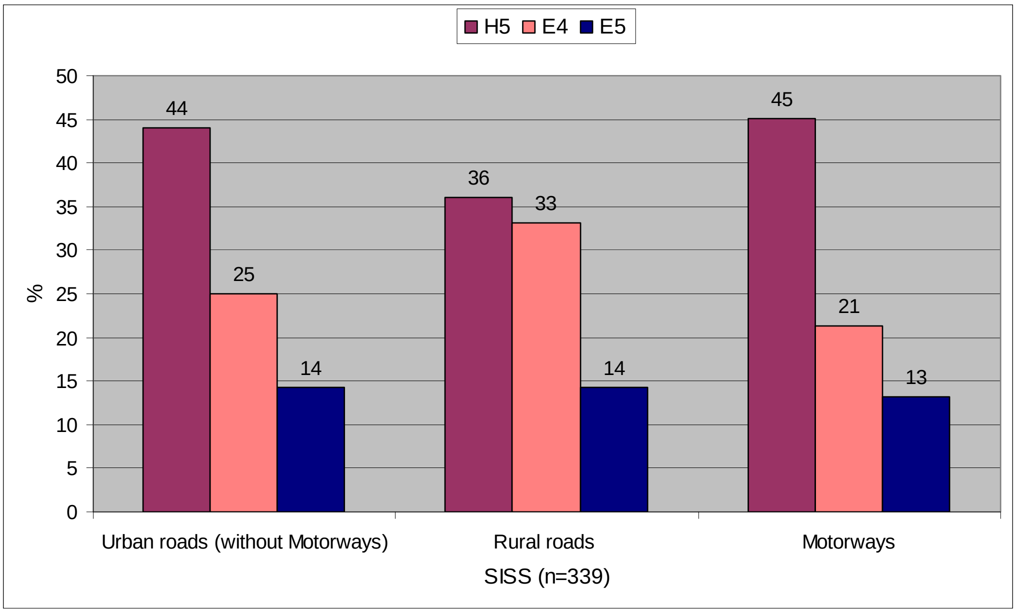


Figure 5.A.6.-Causation factors for van accidents caused by losing control in Italy

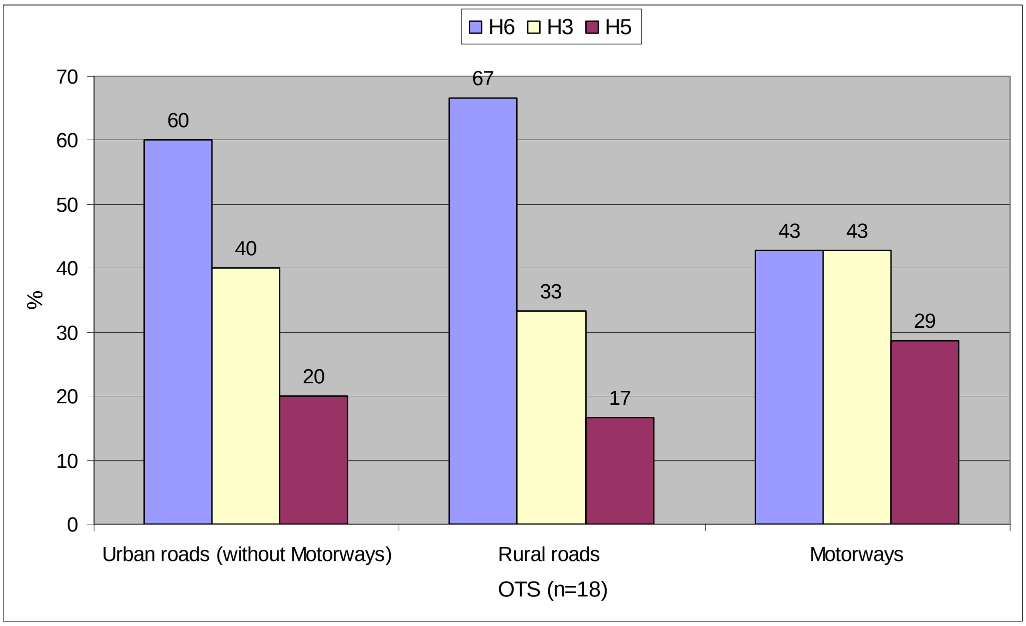


Figure 5.A.7.-Causation factors for van accidents caused by losing control in GB

Whereas in Italy the most frequent causation factor is distraction (H5), in Great Britain it is risk taking (H6). The two figures obviously show country specific causation factors. In Italy it seems that there is a problem with impaired visibility (E4), e.g. sun glare, weather conditions, etc. and with traffic guidance (E5) such as insufficient, unexpected or poorly maintained traffic signs, signals or road markings.

5.3 Conclusions

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

The most important causation factors for van driver:

- ✓ 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

Risk considerations were hardly to perform without comparable sets of data from different countries. Germany data showed van having the lowest risk compared to other modes of vehicle use per one billion kilometres driven per year. It can be concluded that we must not only restrict on type of road and type of accident, when discussing, which countermeasure do fit best.

B.- Buses

5.4 In-depth analysis

The analysis relating busses is based on the same method and data bases than vans.

5.4.1 *Causation factors*

As already done with busses, the following figure illustrates the most frequent and important causation factors for injury accidents caused by busses. The factors distraction (H5) and risk taking (H6) are the two famous causation factors for accidents with injured persons caused by busses but in an inverted order in comparison to vans. The in-depth data from SISS presents other frequent causation factor namely impaired visibility (E4) such as road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc..), other vehicles, roadside objects, Hazards (E7) on road and Traffic guidance (E5).

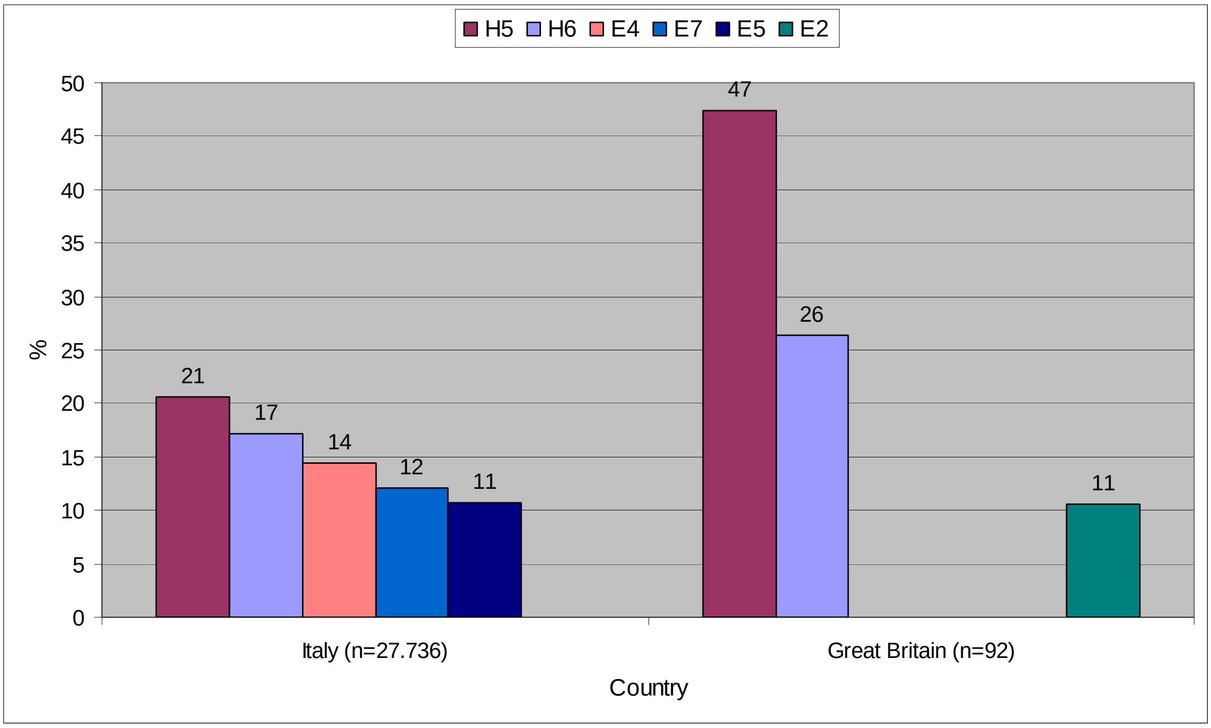


Figure 5.B.1.-Overview causation factors for bus accidents with injured persons in Italy and GB

5.4.1.a Bus accidents between vehicles moving along in carriageway

For the in-depth analysis of the bus accident scenarios data from Italy (SISS) and Great Britain (OTS are available. Significant for this in-depth investigation is only the information from SISS. Further analysis counts only on data of SISS, OTS data are based of a too low number of cases.

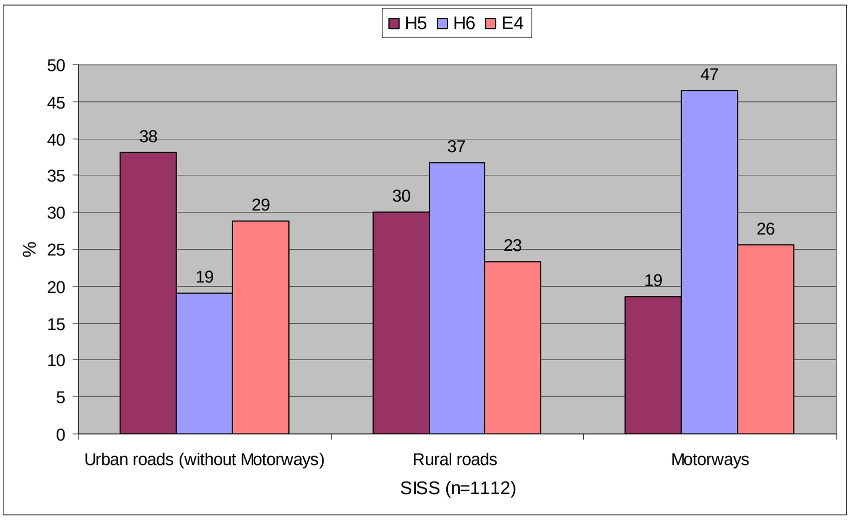


Figure 5.B.2.-Causation factors for bus accidents between vehicles moving along in carriageway in Italy

Risk taking (H6) such as speeding (illegal or inappropriate), driving too close to vehicle in front, purposely disobeying signs/signals/markings, thrill-seeking is the most important causation factor for the most frequent accident scenario of busses, namely accidents between vehicles moving along in carriageway. As already shown in the overview, distraction (H5) and impaired visibility (E4) are also relevant for accidents scenario.

The figure above shows that the factor distraction (H5) becomes less important with rising speed. By contrast, risk taking (H6) gains in importance with rising speed. However, impaired visibility (H4) is independent of the type of road and therefore also from the speed.

5.4.1.b Bus accidents caused by turning off, turning into or by crossing it

For the second frequent accident scenario or busses/coaches, namely turning accidents, risk taking (H6) and distraction (H5) are the most important causation factors. Conspicuously, with rising speed of the road traffic, risk taking becomes more importance for bus driver. Except on motorways, traffic guidance (E5), e.g. traffic signs, signals or road markings which are insufficient, poorly maintained, inappropriate or unexpected, is a relevant causation factor. On motorways also impaired visibility (E4) also plays a role in this accident scenario.

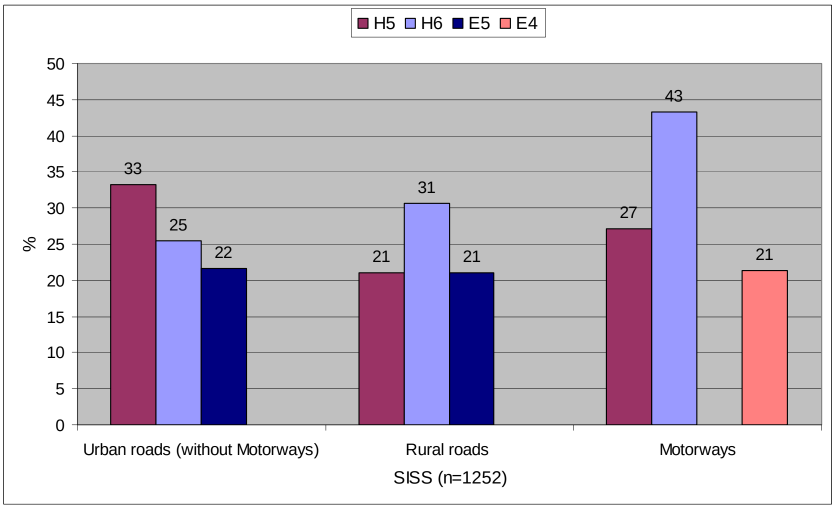


Figure 5.B3.-Causation factors for bus accidents caused by turning off, turn into or by crossing the street in Italy

5.4.1.c Bus accidents involved pedestrians

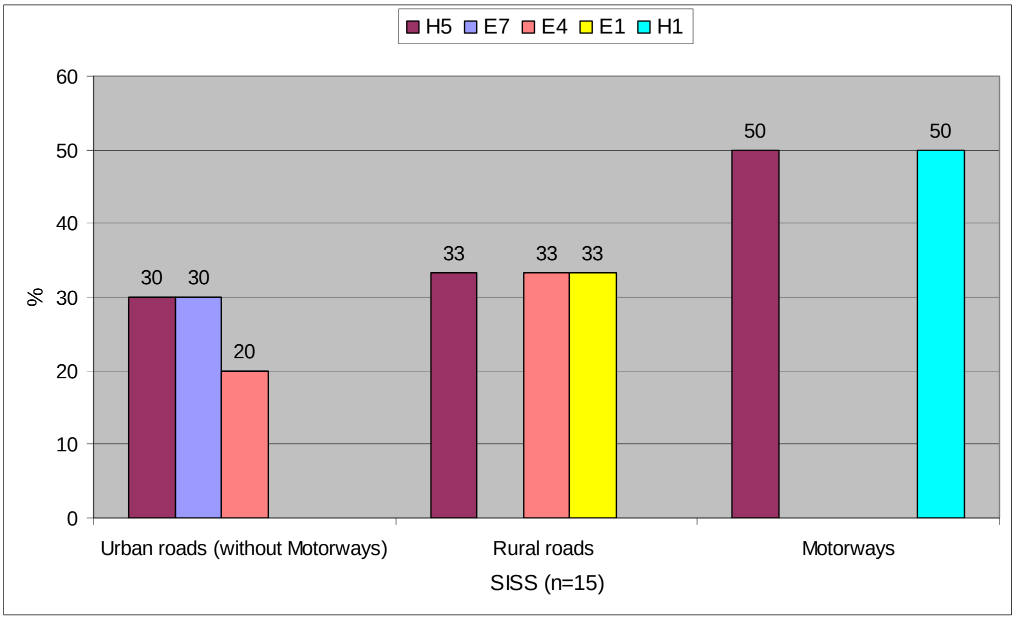


Figure 5.B.4.-Causation factors for bus accidents involved pedestrians in Italy

For the third frequent accident scenario or busses/coaches, namely accidents involved pedestrians, distraction (H5) is the most important causation factors on all road types. Except on motorways, impaired visibility (E4 was detected as an important causation factor for bus accidents involved pedestrians. On motorways also impaired visibility (E4) also plays a role in this accident scenario. Unlike the other accident scenarios the factor risk taking (H6) plays a role only on urban roads. Road condition (E1) is a specific feature for accidents happened on rural roads. The same for motorways is Physical/Physiological conditions (H1). It must be pointed out that the total number of bus accidents involved pedestrians is 15. For statistic verified statements the number of accidents would be to low.

5.4.1.d Other In-Depth and Risk Considerations (German data)

In traffic safety research, risk indices are defined by incidents per reference group. Reference may be population, vehicles, street kilometres, ton kilometres, or others, of which some of them are defined as exposure (to risk). The rate provides the likelihood of a certain event to happen, e.g. a fatality of senior drivers per 100,000 inhabitants of that age group. Commonly, the index accidents per kilometres driven is reported (Hautzinger, Stock, & Schmidt, 2005; OECD, 2001). Additional statistical methods help to compare groups against each other, by computing the frequency distributions and percentages (e.g. chi-square, odd-ratio). Here, comparable subsets of data are required (e.g. truck drivers with and without diseases). Data, which fulfil the needs for statistical in-depth, were not to gain on an EU level, but restricted on regional studies. For Germany, Hautzinger, 2005, offered a comparison of risks by using kilometres driven as exposure mass (Table 5.1, Figure 5.12). The risk compartment clearly shows truck-, coach- and van (Truck ≤3,5 t) drivers against all other vehicle users to have the lowest probability for any causality, no matter if at-fault or not.

Casualties of vehicle user per 1 billion kilometres driven									
		Moped	Motor-cycle	Car	Coach	Truck ≤3,5 t	Truck >3,5 t	Other vehicles	All user
Fatality	At-faults	23	46	6	1	2	2	5	6
	Others	11	29	1	1	1	1	3	2
	All	35	75	7	3	3	3	8	8
Severe Injured	At-faults	628	541	50	53	22	23	39	58
	Others	459	435	24	41	11	7	30	32
	All	1087	975	74	94	33	30	69	90
Slightly Injured	At-faults	1620	841	157	321	73	54	163	166
	Others	2058	1257	257	764	97	50	218	265
	All	3678	2098	414	1085	170	104	381	432
All casualty	At-faults	2271	1428	212	375	98	79	206	231
	Others	2529	1720	282	807	108	58	251	298
	All	4799	3148	495	1182	206	137	457	529

Table 5.1: Casualties per 1 Billion km driven by mode of vehicle for at-fault and not at-fault participants in casualties, Germany, 2002

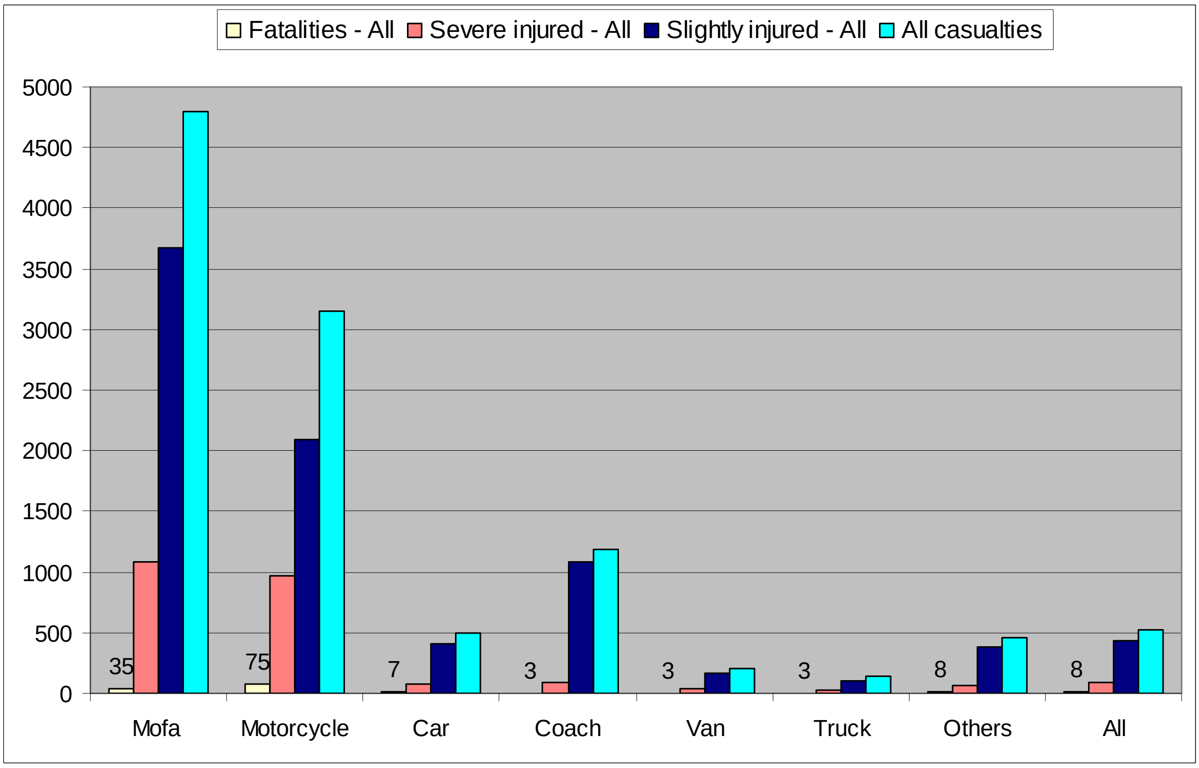


Figure 5.12: Casualties per 1 Billion km driven by mode of vehicle, Germany, 2002

5.5 Conclusion

In-depth and risk considerations were aim in this chapter related buses. The most important causation factors for bus driver:

- ✓ 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

Though the methodological WPs tried to help with offering a common causation table, it remains critical, for coach to gain comparability over various EU countries. This is to read from the figures above, when having a deeper look to the human factors, which are simply not registered matchable in Europe. Here, the EU has a high demand in harmonization.

5.6 References

Hautzinger, H. Stock, W., & Schmidt, J. (2005). Fahrleistungserhebung 2002 – *Inlandsfahrleistung und Unfallrisiko [Domestic driving performance and accident risk]. Berichte der Bundesanstalt für Straßenwesen [Reports of the Federal Highway Safety Board, Germany]*. Report # V 121.

C.- Trucks

Why is TRACE studying the accidents of the Heavy Good Vehicles?
Incompatibility with other vehicles / severe consequences: Heavy Goods Vehicles (HGVs) are defined as goods vehicles of over 3,5 tons maximum permissible gross vehicle weight. Road traffic accidents involving Heavy Goods Vehicles (HGVs) tend to be more severe than other accidents because of the great size and mass of these vehicles (high risk for the other users).

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

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

Table 5.C.1.-Fatalities in accidents involving Heavy Goods Vehicles, 1996-2005
Source: CARE Database / EC Date of query: November 2007.

accidents involving	HGVs fatalities	
HGV occupant	**469**	**13%**
Bus or Coach occupant	10	0%
Car occupant	1.986	54%
Light GV occupant	204	6%
Moped rider	120	3%
Motorcycle rider	238	7%
Pedal cyclist	174	5%
Pedestrian	377	10%
Other/unknown	69	2%
All	3.648	100%

Table 5.C.2.-Fatalities in accidents involving HGVs by road user type, EU-17, 2005.

High risk being killed per million of population in Eastern Countries. The risk of being killed in one of these accidents can be compared for each Member State using the rate of deaths per million population.

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

Table 5.C.3.-The fatality rates per million population in accidents involving HGVs, 2005

5.7 Main results from Deliverable D1.1

5.7.1 *Main results from the literature review*

5.7.1.a Main causes per scenario

- ✓ **HGV – vulnerable (road user):** These crashes are the result of blind spots on the right side in the case of trucks (left side for the United Kingdom). Although the pedestrians made in the most accidents the fault, perhaps the accident could have been avoided with an electronic system installed in the truck. The problem is that the most cyclists or pedestrians could not estimate the behaviour of the truck. They do not know how trucks react in a turning or a crossroad. (Niewöhner, 2004; Gwehenberger & Bende, 2004).
- ✓ **Single HGV accidents:** Often the truck is tilting to the side or rollover, because the speed in the bend was too high. The final consequence of the accident is that the cap is seriously deformed. Drivers not wearing safety belts constitute one of the most important problems in terms of injury consequences of the accident. On account of the impact they would be flying out the windscreen or the side screen and would be seriously injured. For falling asleep at the wheel there are several causes. These would be a shift-work, too long working hours and lack of sleep. (Assing, 2004; Gwehenberger, 2002; Horne & Reyner, 1999; Gander et al., 2006).
- ✓ **The truck/other vehicle accidents:** This configuration has a high potential of serious injury for the occupant (compatibility problems). Clear statements regarding accident causation could not be taken from the literature. Because most reports refer on police data, the real causes are often not mentioned for not accusing themselves (truck drivers). From presumptions of different literature sources reveals the most frequent causations distraction or inattentiveness and over fatigue.

5.7.1.b Other general issues

Countries, like Germany, in the middle of Europe and with a good road network, has a higher number of accidents than the other located on the sides. There is not a great difference in the number of accidents between rural and urban around Europe. However there are countries like Spain where there is a great difference (4,463 rural and 924 urban accidents). The casualties on the country are higher in the city. The most frequent opponent is the passenger cars. The kind of collisions are different, but the rear-end collision accounts for a high amount of these accidents. Especially crashes with unprotected road users have serious consequences for the weak party (right turning accidents have severe consequences for pedestrians and cyclists).

5.7.2 Main descriptive analysis results

The main accident configurations detected in the descriptive analysis are:

- ✓ **Accidents between a truck and a passenger car moving along in carriageway** [44% - 28%]

  The most important accident scenario for Trucks is against a passenger car moving along in carriageway. This means that the accident was caused by a conflict between road users moving in the same or opposite direction. Mostly, the accidents occurred on rural roads including motorways, caused by insufficient safety distance, unadapted speed and mistakes made when entering the flow of traffic.

- ✓ **Accidents between a truck and a passenger and while turning into a road or by crossing it** [39% - 13%]
  The next important accident scenario for Trucks is against a passenger car and caused by turning into a road or by crossing it. This means that the accident was caused by a conflict between a road user turning into a road or crossing it and having to give way and a vehicle having the right of way at crossings, junctions, or exits from premises and car parks. On the next step this configuration was investigated after the location and causation. Remarkable is the relative high rate of rural accident (without motorways) in comparison to vans or all road users. Main causations are failures to observe the priority rules and partly influence of alcohol.

- ✓ The single vehicle accident (Driving accident) of trucks [60% - 0%, but not consistent]
  The 3rd frequent accident scenario for Trucks is the Driving accident. This scenario represents 60% and 0% of the accidents involving Trucks depending on the country analysed. Taking absolute numbers, it can be justified as a frequent scenario. The main location of these accidents is rural and motorways in connection with the causations unadapted speed and over fatigue.

5.8 In depth analysis

For the in-depth investigation the cases from the ETAC (European Truck Accident Causation) study database were analysed. In the following chapter is described the methodology and relevant accident contributing factors analysed in this study launched by the European Commission (EC) and the International Road Transport Union (IRU).

5.8.1 ETAC project

The aim of the study was to identify the **main causes of accidents involving trucks.** The detailed objectives of the study are presented below:

- ✓ To identify the **main cause** and the causal sequence of accidents involving trucks,
- ✓ To develop a **scientific, widely accepted and internationally benchmarked methodology**,
- ✓ To have **expert teams** investigating over 600 truck accidents,
- ✓ To make **results available to the research community and other relevant parties**,
- ✓ To **recommend actions** that could reduce truck accidents and/or their seriousness,
- ✓ To develop European homogeneous database:
  - Focussing on truck accidents,
  - Investigating in depth into the accident sites,
  - Identifying truck accident causation.

The results of the study were put together in a database containing road accident causation criteria and a final report. They were established in a scientific, unbiased, independent manner which enables the identification of truck accident causation. The advantage of this new accident data collection is that the study focuses on truck accidents and allows an in-depth accident investigation, using the same methodology and data codification in many European countries.

Nowadays, the ETAC database is the most important representative database of the HGV accidents in Europe. Three of the TRACE partners (TNO, CIDAUT and IDIADA) were involved in the ETAC study. TRACE has used this data to identify the main risk factors for the different configurations in accidents where at least one HGV is involved.

5.8.1.a ETAC project: Period of data

624 truck accident cases have been collected over a 2 ½ years period. Data collection started on the 1 April 2004 and finished on the 30 September 2006.

5.8.1.b ETAC project: Accidents considered in the study

Each studied accident involves at least one truck (commercial vehicle of Gross Weight >3.5t), the accident configurations are presented below:

- A single truck (rollover, against a fixed obstacle…). The proportion of accident cases examined which involves one truck to the exclusion of any other vehicle(s) shall not exceed 10% of the cases studied by each truck accident investigation team. This limit is benchmarked to the national statistics.
- A truck and another vehicle (truck, car) or
- A truck and a vulnerable road user.

All accidents involve at least one injured person. The ETAC study has chosen only severe accidents (as one of the criteria is that the accident involves at least one injured person) because if we want to save the life of road users, it is necessary to focus on only injured accident in order to well understand the specific mechanism of occurrence.

On-spot investigation of the accident, possible if:

- The vehicles are still in their final position.
- The collection of information on infrastructure, vehicles and people involved in the accident (all together, they cover around 3000 parameters) can be fulfilled.
- The accident is studied in depth, covering both passive and active safety.
- All these conditions must be fulfilled otherwise the accident won't be investigated.

All truck accidents are investigated using the same methodology. This one has been proposed and developed by all the teams and approved by the European Commission and the International Road transport Union:

- Truck accidents are collected from sample areas which are statistically representative of the national truck accident situation (urban area, non urban area, highway, inter-urban road…),
- All accident cases are investigated on the spot as quickly as possible by a team composed of accidentology and data collection experts.

5.8.1.c ETAC project: Involved countries and covered geographical area

The following table presents a complete summary of all accident collected and coded for the ETAC project by each teams.

Accident distribution per country	Number
CEESAR	26
CIDAUT	60
DEKRA	174
IDIADA	37
IBB	127
REKONSTRUKCIJA	140
TNO	40
PAVIA	20
Total	624

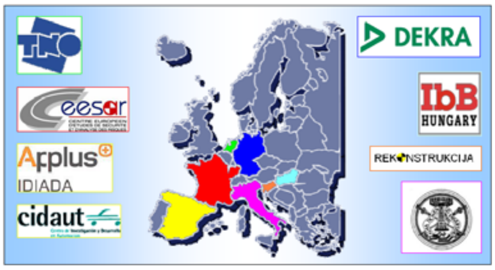


Table 5.C.4.-ETAC database case sources.

5.8.1.d ETAC project: Methodology

An accident investigation procedure was defined for the study and database compilation; all the researchers should follow the same protocols. The accident investigation procedure covered the investigation on the scene of the accident, the analysis of the collected information and the reconstruction. This procedure is summarised in the following chart:

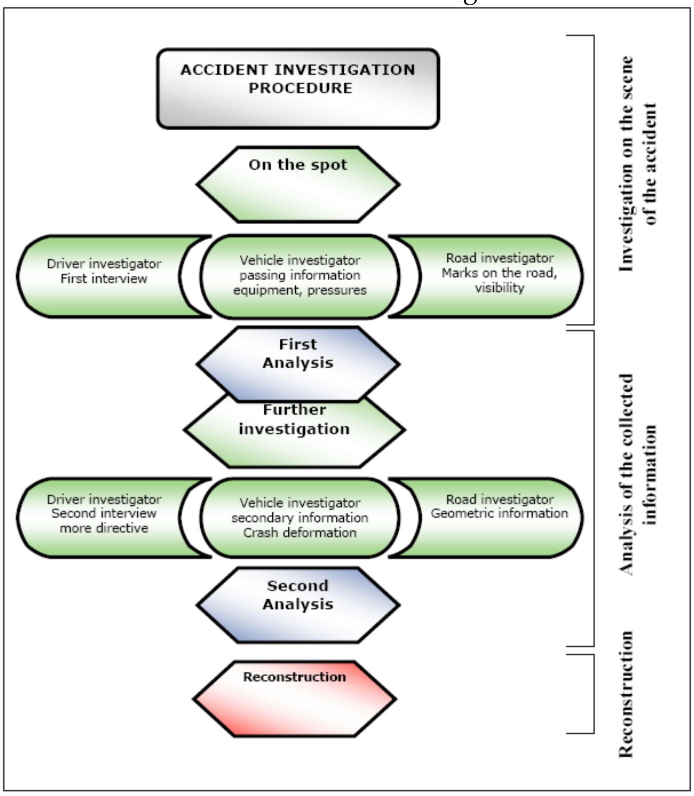


Figure 5.C.1.-ETAC database 'accident investigation procedure'.

5.8.1.e ETAC project: The results

One of the objectives of the ETAC study was to identify the **main cause** and the causal sequence of accidents involving trucks. Looking at all accidents, the main accident cause is linked to human error in 85,2% of all cases. The other factors play a minor role within 4,4%, 5,1% and 5,5%.

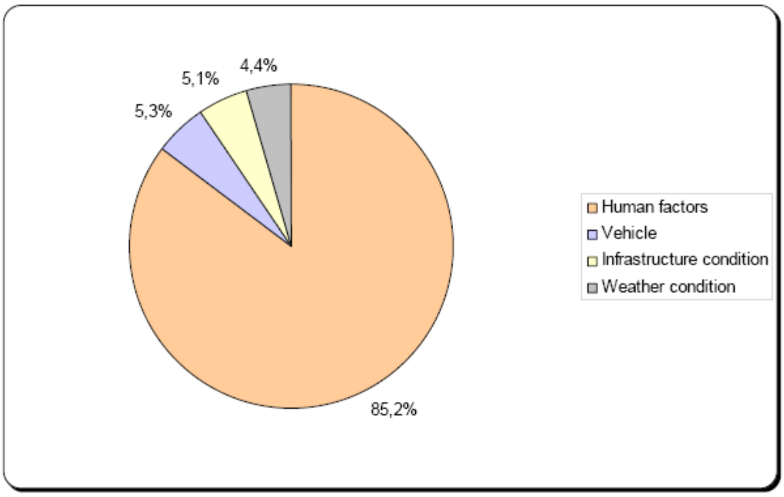


Figure 5.C.2.-Main causes of the accidents.

The top 3 of the main causes for accidents between a truck and other road users are:
1- Non-adapted speed
2- Failure to observe intersection rules
3- Inattention
However, these 3 main causes only show a tendency and the main cause of an accident for all road users varies according to the accident configuration. To target those causes with effective counter measures, it is necessary to look at the main causes of the accidents with various configurations.

Accident configuration

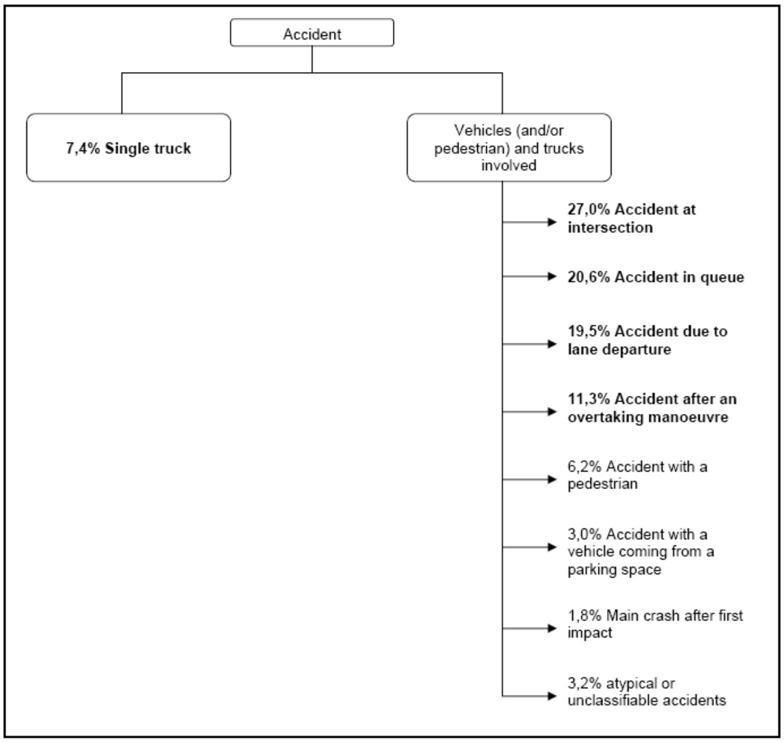


Figure 5.C.3.-Accident configurations.

5.8.2 Expected results in TRACE analyses

Once, the ETAC project has been showed, there are two ways in presenting expectation of the findings. The 'in depth' study will deliver as to the causations of truck accidents. The first is to address the popular opinion or supposition of the population and consequently a prediction can be made by taking into consideration known statistic of the more general factors and characteristic in HGV accidents.

5.8.2.a Public Opinion

Trying to gauge the general opinion of the population can be problematic as obviously there is never just one view point. However, when considering news reports, insurance claim policies and online debate forums there are several main recurring factors that seem to fit the interpretation of the majority of the public.

It is known that HGV drivers are often working to meet a deadline, it is therefore supposed that the pressure of achieving this may lead to driving at higher speeds, in turn making the handling of the HGV more difficult and increasing the chance of a collision. Deadlines for delivery are not the only issue thought to potentially exacerbate handling; also the goods being transported by the HGVs and whether or not these are sometimes in excess to the load intended for the vehicle are of concern. It is then further known that truck drivers generally work long hours and often through the night so as to avoid traffic, these factors resulting in reduced visibility and increased fatigue also further augment the likeliness of an accident. The main reasons for HGV accidents therefore, as supposed by the population, are:

- Pressure to meet delivery time restraints/ deadlines.
- Exceeding the permitted maximum load when transporting goods.
- Extended driving without the recommended sleep or rest needed.
- The size of the vehicle and neglect of the driver to leave sufficient space for manoeuvres that may need to be carried out.
- Unsatisfactory vehicle maintenance resulting in brake failures or worn out parts.
- Over experience and lack of variation in trajectories or surroundings therefore relaxing/ reducing the drivers' alertness.
- Influence of alcohol intoxication to the driver.

It is worth noting that, in some way or another, the vast majority of the public considers the driver of the truck to be one of the most probable causes for an accident.

5.8.2.b Statistical View

Based on the general statistics found in TRACE WP1 D1.1 (Deliverable D1.1: Road users and accident causation. Part 1: Overview and general statistics) another more educated estimation can be made as to the expected results that this study will achieve. Still maintaining consideration for the view of the public, but aiming to support or disprove these predictions with some evidence.

A starting point for this hypothesis is to look at the main scenarios derived from the statistical data and then consider what kind of things may have caused these scenarios to occur.

The three most important accident scenarios for trucks were defined as:

Scenario1:

"Accidents between a truck and a passenger car moving along in carriageway [44% - 28%]
Mostly, the accidents occurred on rural roads including motorways, caused by insufficient safety distance, unadapted speed and mistakes made when entering the flow of traffic."

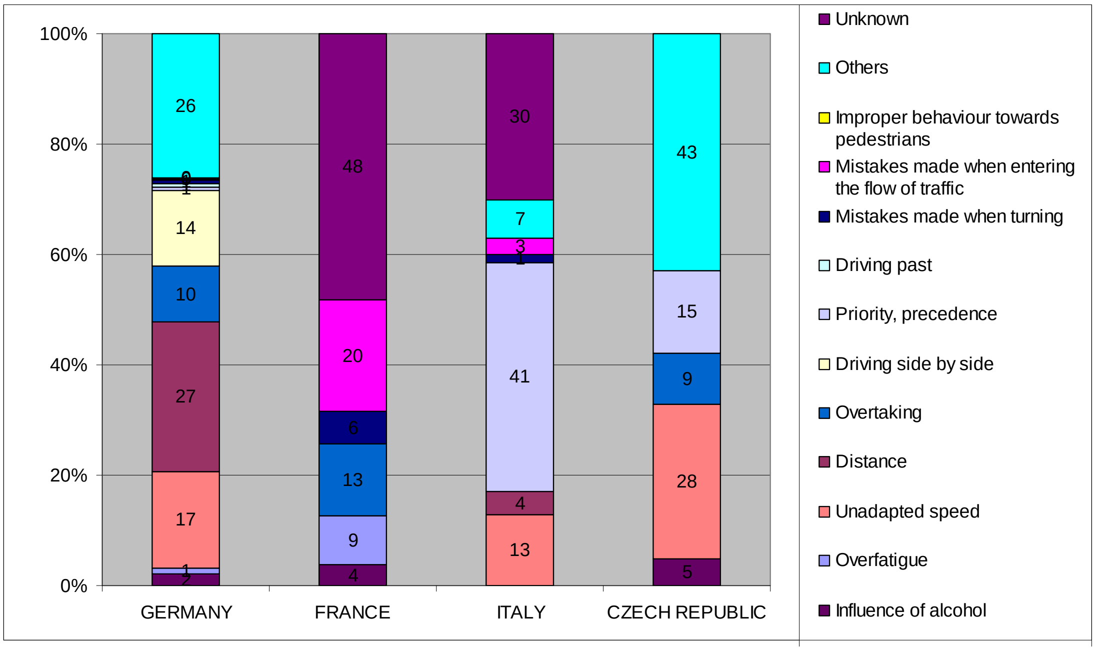


Figure 5.C.4.-Distribution of trucks accidents between road users moving in the same or opposite direction, by cause.

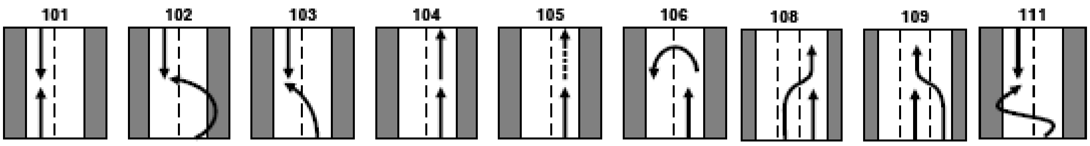
When reviewing the possible causation factors that could be linked to this scenario the human behaviour of the drivers seems to be a major factor. Fatigue perhaps due to long distances covered, inattention due to over experience or over familiarity with the route.

The unadapted speed scenario could be related with the lack of conscientiousness that the truck is fully loaded/ unloaded, i.e. considerations for varying breaking distance allowances are not made. This scenario could be also related with time restraints and the drivers negligence or lack of desire to observe all road traffic rules due to the need to be somewhere within a fixed hour.

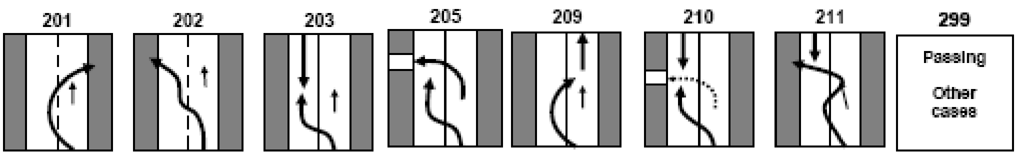
In order to make data collection easier and all data compatible with scenarios. The accidents types were placed into scenarios with respect to the groupings they were given.

Scenario 1 includes the following accident types as defined by ETAC:

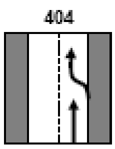
- ✓ Vehicle/ vehicle (car/ truck/ two-wheelers):



- ✓ Passing:



- ✓ Leaving a parking space or crashing a parked car:



Scenario 2:

"Accidents between a truck and a passenger car and caused while turning into a road or by crossing it [39% - 13%]

Remarkable is the relative high rate of rural accident (without motorways) in comparison to vans or all road users. Main causations are failures to observe the priority rules and partly influence of alcohol."

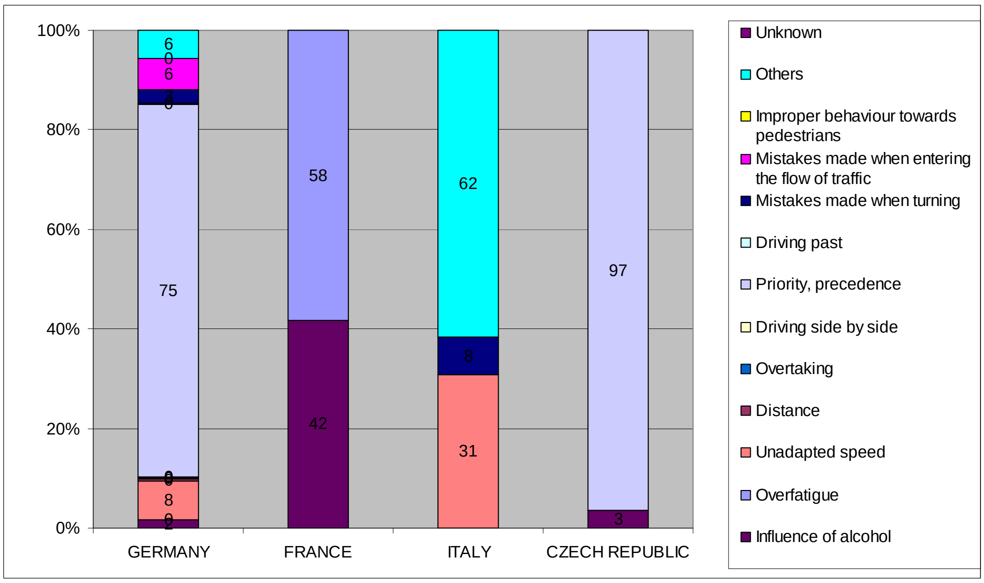
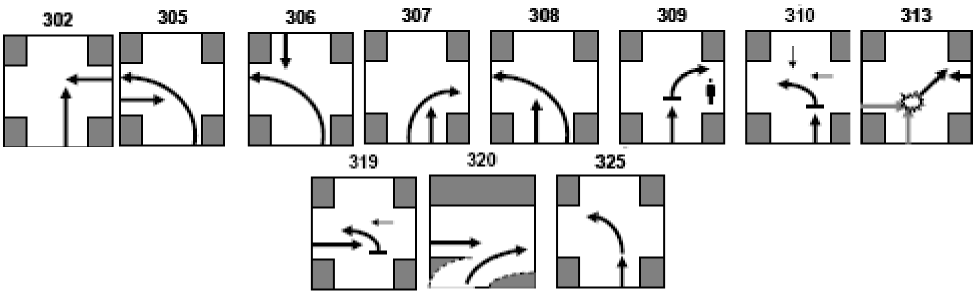


Figure 5.C.5.-Distribution of Trucks in turning accident scenario by cause.

Expected results therefore would be supposed to reflect this showing that in the cases where the truck driver was at fault it was either due to the general behaviour when driving, e.g. a driver with rigid right-of-way status, neglecting a stop sign, etc. In the cases where these aspects of human behaviour don't apply, fatigue would be predicted as a main factor, probably related with long hours driving long distances or driving through the night. It could also be expected that in the remaining cases often alcohol intoxication or another such substance is involved.

Scenario 2 includes the following accident types as defined by ETAC:

- ✓ Junctions:



Scenario 3:

"The single vehicle accident (Driving accident) of trucks [60% - 0%, but not consistent]

The main location of these accidents is rural and motorways in connection with the causations unadapted speed and overfatigue."

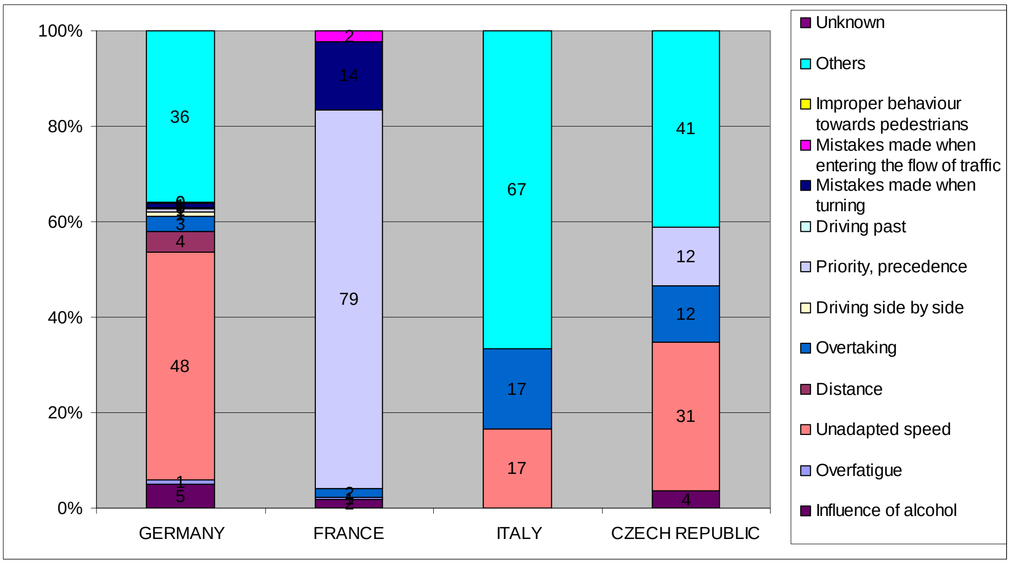
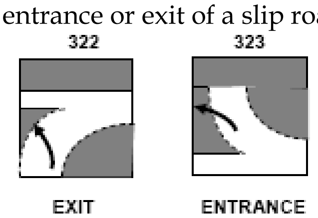


Figure 5.C.6.-Distribution of Trucks in driving accident scenario by cause.

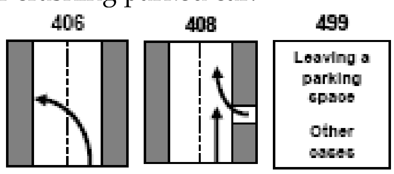
As stated the expected results for these types of accidents would show that long trajectory routes, over experience on known roads, or simple straight motorways and unchanging roads result in either fatigue, unadapted speeds or mistakes during standard manoeuvres i.e. overtaking and turning. Therefore it would be expected that these results of this scenario would be represented by similar causation factors showing the routes where these accidents occur to be familiar ones.

Scenario 3 includes the following accident types as defined by ETAC:

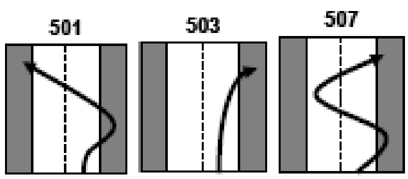
- ✓ Trucks tip over and rollover: entrance or exit of a slip road:



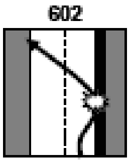
- ✓ Leaving a parking space or crashing parked car:



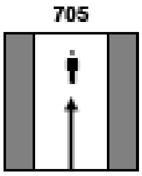
- ✓ Loss of control



- ✓ Main Crash after 1st impact:



- ✓ Special Cases:



Looking at general results gathered in D1.1 and the accident type distribution further helps a more general hypothesis to be made. Figures 7 and 8 in this chapter show the main trends overall for accidents involving Trucks:

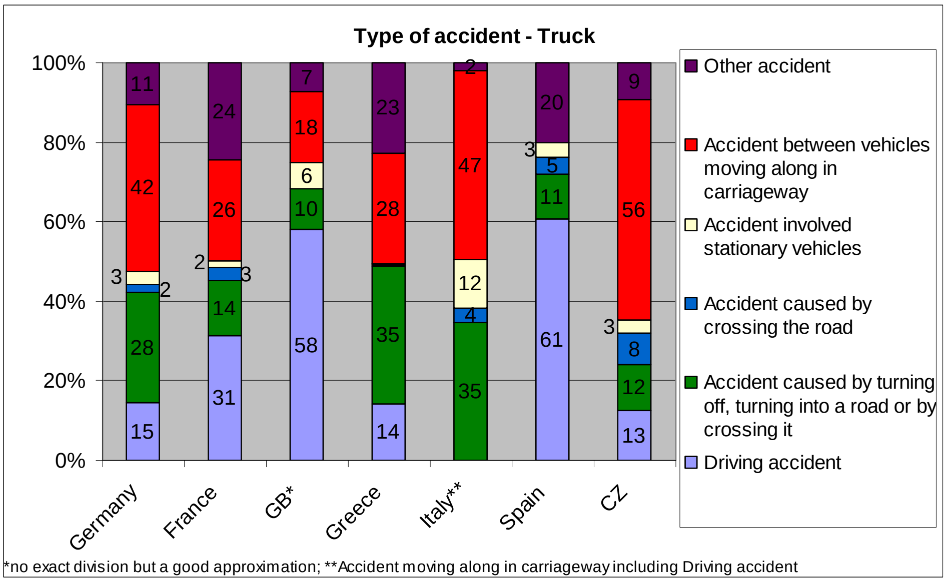


Figure 5.C.7.-Truck accidents categorised by type of accident (Accidents with personal damage; Time period: 2001 to 2004)

Figure 7 reveals that many accidents seem to be errors in the driving. Expected causation to be responsible for these results might show that 'Accident between vehicles moving along in carriageway' would due to influence and interaction with other drivers predominantly i.e. the other road user may be at fault, traffic may be dense or unexpected. However, the high figures for driving accidents and turning accidents data suggests that there may be a lack of attention involved resulting in trivial driving errors while making familiar journeys or driving long hours,

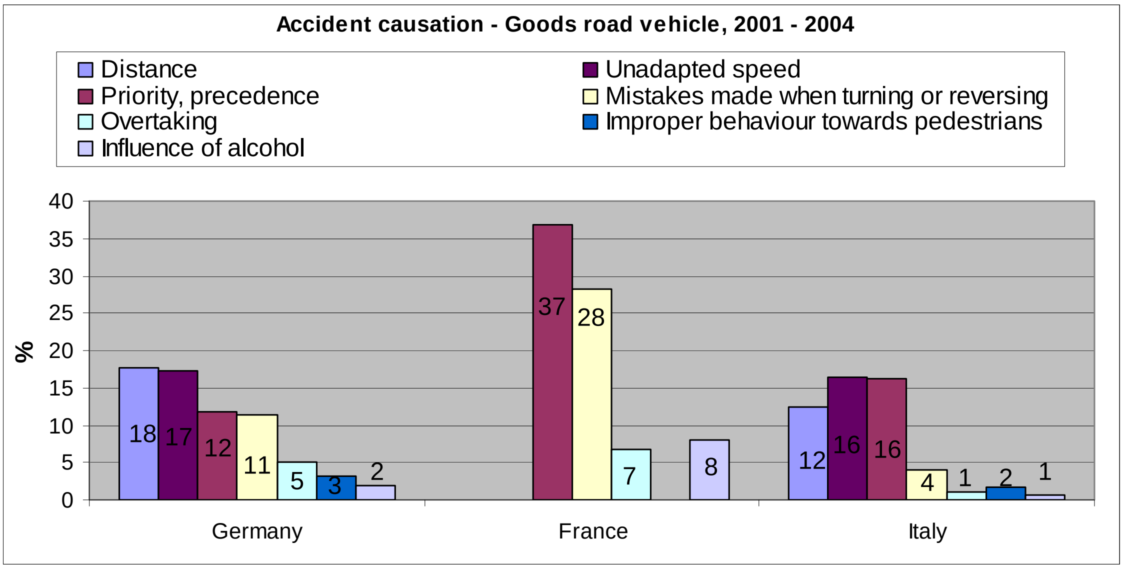


Figure 5.C.8.-Goods road vehicle accidents categorised by accident causation (Accidents with personal damage; Time period: 2001 to 2004)

Past causation analyses also further support this supposition, showing that distance, unadapted speeds and mistakes while turning and reversing are often causes for accidents. Putting this confirmation combined with the previous deductions, it is fair to predict that a lot of the accidents will be due to fatigue, long distances covered and over experience; all these factors would help to contribute to the results shown in figure 7.

5.8.3 TRACE 'In-Depth' Analysis

The special in depth analysis was conducted in TRACE over ETAC database a time period of one year and allowed full interpretation of the causations for accidents of the cases reviewed.

5.8.3.a Data Sample Used

The database of Truck accidents available for analysis consisted of 624 cases in total. Of these cases 96 were accidents based in Spain. Due to the time consumption of analysing each case individually and also due to heavy workloads, not all the cases in the database could be assessed for causation. Therefore priority was taken over the Spanish cases and a 10% sample was made of each of the remaining countries with data available. Resulting in the assessment of a total of 150 cases as shown in the table below:

Country	Data Source	Prefix	Cases available	Cases used
Spain	IDIADA	SI	36	36
	CIDAUT	SC	60	60
Slovenia	Rekonstrukcija	SR	140	14
The Netherlands	TNO	NT	40	4
Italy	PAVIA	IP	20	2
	IDIADA	EI	1	1
Hungary	IbB	HI	127	13
Germany	DEKRA	DD	174	17
France	CEESAR	FC	26	3
TOTAL			**624**	**150**

Table 5.C.5.-Breakdown of Accident cases reviewed

5.8.3.b Methodology

The methodology for analysing each individual accident case was derived from the TRACE deliverable 5.3 with the main aim to categorise each accident into one of the following causation factors:

Modified categorisations based on WP5

Code	Causation Factor Groups	Examples of Causation Factors included in this group
H1	Human - Physical/Physiological	Medical condition, pre-existing impairments
H2	Human - Substances taken	Alcohol, drugs, medication
H3	Human - Psychological condition	Emotional (upset, angry, anxious, happy…), in a hurry, fatigue, internal conditioning of the driving task (e.g. right of way status)
H4	Human - Experience	Little/no/over-experience of driving/route/vehicle/driving environment
H5	Human - Behaviour	Distraction within vehicle, outside vehicle, within user (e.g. lost in thought)
H6	Human - Behaviour (Risk tasking)	Speeding (illegal or inappropriate), driving too close to vehicle in front, purposely disobeying signs/signals/markings, thrill-seeking…
E1	Environment - Road condition	Surface contaminants (wet, flood, snow, ice, frost, oil diesel, sand, gravel), surface defects, surface type)
E2	Environment - Road geometry	Bends, slopes, camber, traffic calming, confusing layout, speed-inciting
E3	Environment - Traffic	Traffic flow, traffic density, confusing/lack of information from other road user(s)
E4	Environment - Visibility impaired	Road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc..), other vehicles, roadside objects
E5	Environment - Traffic guidance	Traffic signs, signals or road markings which are insufficient, poorly maintained, inappropriate or unexpected.
E6	Environment - High winds	
E7	Environment - Hazards	Obstacles/hazards in road (animal, debris from previous accident, discarded load) or in roadside (e.g. car on fire), roadworks, level crossings...
V1	Vehicle - Electro-mechanical	Defects in steering, braking, engine, suspension, electrical/electronic systems.
V2	Vehicle - Maintenance	Windscreen chipped, broken, cracked, misted, dirty. Tyres (tread depth, air pressure, blow-out, incorrect type). Exterior/interior lights not working, broken, incorrect.
V3	Vehicle - Design	Blocking visibility (e.g. a-pillars, steering wheel, mirrors), Auditory warnings confusing, display and controls confusing/too small/incorrectly placed.
V4	Vehicle - Load	Heavy or uneven load. Visibility obstructed by a load on or within the vehicle.

Table 5.C.6.-Categorisation for accident causations

As can be seen in the table, there are three main types of causation factor: Human, Environmental and vehicle. These then are split into further more specific sub groupings which can help to clearly define the reasons for the accident occurrence.

Each of these sub groupings further have their own scenario description and accident mechanism, to explain with more clarity under which circumstances this grouping would apply. These include specific accident types which are typically linked to the causation, i.e. for specific scenario P3B as described in D5.3. A paragraph description is provided to explain the type of situation taking place when there is *'Cursory search for information while crossing intersection'*, this description is then further supported with an accident mechanism following the structure as shown below. To be able to directly compare to the accident case under review to known patterns by first relating the image of the crash type to a known accident mechanism and then considering all the possible causes this mechanism includes and the ones that are reciprocal to the above defined causation factors[1].

[1] It should be noted that the codes for accident types used in the database differ to those in the Trace deliverable, it was therefore a necessary extra step to relate the two documents regarding images for accident types –these have been defined based on their groupings during the predicted results

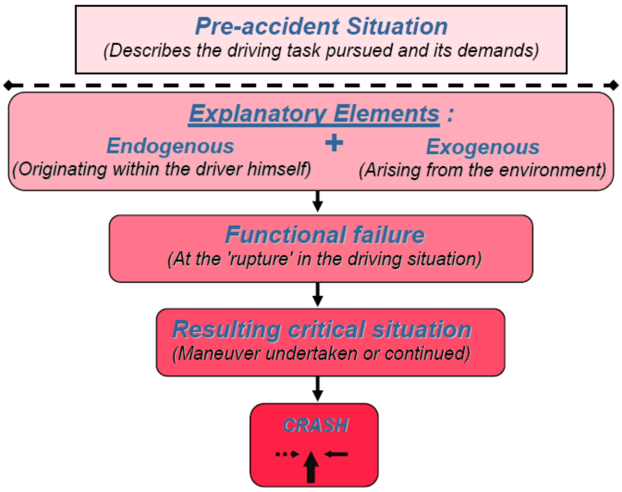


Figure 5.C.9.-Structure of a typical failure-generating scenario

As can be seen from the Figure there are several things that must be observed between this scenario description and the cases. There are the characteristics of the driver that may relate to his state of mind before the crash, his reason for the trip, over/ under experience of the route, any medication being taken, etc. It is important to adopt an appropriate methodology for this process so as to be consistent and representative of all the data provided about the accident, looking at the influencing factors and then making these correspond with the most appropriate scenario in a structured way. Looking at all the potential causes and influencing factors, it may be easy to apply several scenarios. The methodology however, is in place to ensure that each accident's causation is defined by the most appropriate scenario and to try and avoid it being a human opinion without any support, this can be troublesome when there is data missing and the information is limited.

The first step in methodology used, was therefore to place all the relevant data in the same location. An excel spreadsheet was created into which all the basic data of each accident and any 'other' observation that may differ from the expected/ standard norm i.e. alcohol intoxication, overloaded vehicle, driver comments, vehicle maintenance etc.

Spain SI (Idiada Cases)	Accident Number:		
	SI004		
	Vehicle 1	Vehicle 2	Vehicle 3
	Passenger Car	Truck	Truck
General Circumstances			
Fatalities	5		
Injuries	0		
Uninjured	2		
Time of Day	8:10		
Day of Week	Friday		
Weather	Twighlight or Dawn without public lighting		
Location	Outside Urban Area		
Reason for journey	Disco, Dance, Local Air, fes	Professional Trip	Professional Trip
Frequency of Route	First Time	Daily	Several Times a year
Driver Health		Influenza/ Cold/ Fever	-
Medication		No	-
Driver Status	Student	Working	Working
Driver State of mind before accident	-	Normal	Normal
Other	New driver, temporary license		
	Borrowed Car		
Responsibility?	Fully Responsible	Not Responsible	Not Responsible
Accident type	**211**		

Table 5.C.7.-Initial data collecting format

The data was presented as shown in the example Table above, to maximise ease of data use. The database software containing the data, otherwise required switching through different display screens and folders in order to gather all the data. Although this method of accessing data was used to complete the excel spreadsheet, it was impractical to do this while considering the accident cases, as it left room for human error and the overlooking or omission of potential important data when considering influences.

The next step in the process after having all the basic data from the accident consisted of going through the photos on file of the accidents, the surrounding environment, plus any available sketches of the collision and/ or reconstruction. This involved studying each image and looking out for any other indications of possible cause for crash whether further supporting already stated influences such as weather conditions, or making apparent other influences such as road geometry and condition, visibility (i.e. trees blocking road signs), etc. while still keeping in mind the data recorded into the excel table.

Combining the information from the database, images, accident types and accident scenarios the relevant causation factor(s) is then selected from the list. It is important at this stage to apply causation factors that were responsible for the accident and not just potential causes. This process was repeated for each of the accidents considered.

In difficult cases it was easier to highlight the potential causation factors in the excel first, then review more closely the accident mechanisms and scenarios as defined in D5.3, in order to be able to settle on the actual cause of the accident.

The main order of steps therefore for each case was to:

1. Gather data and accident type and record into excel
2. Associate crash type (image) with potential scenario mechanisms (from D5.3) that could apply.
3. Define scenario type, i.e. scenario 1, 2 or 3 as described in predicted results.
4. Review accident description
5. Study images included in case file
6. note down possible causations for the crash
7. Review these causes with the accident mechanism and determine the relevant causation that served as the main cause(s) for the crash.
8. Store data causation factor(s) as one of the category types listed in table 3.

Once this was completed for the maximum number of cases possible within the time restrictions, data was ordered and put into tables so that graphs and further analysis could be conducted.

5.9 Result analysis

As the results amount to a lot of data to process, it is important to clearly define the manner in which the final analysis shall be performed. This shall be in several stages, starting from a more general view and then looking more closely at the specific results and findings of the study.

Global results, is the first thing to assess, that is to say that comments shall be made based upon what the general overall results tell us, i.e. the frequency of each causation factor and each causation group, i.e. Human, environment and vehicle. Stating any initial trends and observations made.
Hereafter the scenarios shall be reviewed, looking at trends created by the three TRACE defined main scenarios.

Next the focus will go towards the larger results table, which will include information linking the frequency of each causation factor to each scenario and the accident types within those scenarios. As this data shall be presented in a table, a two dimensional approach shall be used to process the data:
First each TRACE scenario shall be assessed, observing the frequency of causation factor. The column of the table shall then be analysed again, but splitting them further into ETAC accident types (selecting the most accident types in each scenario). This is to say, that after seeing which causation factor is the most common for a scenario, it can be determined whether or not this is a property of all the accident types within this scenario, or that there is a dominant accident type that is influencing the overall scenario findings.

Next the scenarios shall be reviewed again; this time looking across the table at the trends in causation factors. Similar to the assessment of the accident groups, determining whether or not they reflect the results of the scenario as a whole, or if there are certain causation factors with higher weighting creating greater influence.

5.9.1 Global

The initial step in obtaining the results is to gain a general overview of the data obtained, from this it is then possible to determine which data should be reviewed more closely to give a deeper insight as to the causation factors of the accidents considered.

The Final results were collected and tabulated as follows:

		H1	H2	H3	H4	H5	H6	E1	E2	E3	E4	E5	E6	E7	V1	V2	V3	V4
	SI	1		6	5	5	6	2	1	8	2	2			1	1		
Spain	SC			7	5	6	14		3	26	8	2		3		3		
Slovenia	SR		3	1	4		1	1		2	2	2						
Germany	DD		1		1	1	4		1	12	3		1					
Netherlands	NT			1		3				1								
Hungary	HI			1	2					7	2		2					
France	FC			1				1		2								
	IP	1			1													
Italy	EI								1									
Total		2	4	17	18	15	25	4	6	58	17	6	3	3	1	4	0	0
	%	**1,1**	**2,2**	**9,3**	**9,8**	**8,2**	**14**	**2,2**	**3,3**	**32**	**9,3**	**3,3**	**1,6**	**1,6**	**0,5**	**2,2**	**0**	**0**
		44,26%						53,01%							2,73%			

Table 5.C.8.-Distribution of Causation factors in different countries

From this table it is possible to see the main trends and most common causation factors that occurred. Vehicle malfunctions and maintenance are only representative causes for a minimal number of accidents, suggesting that these are rare occurrences and that overall the tucks themselves on the roads are not the reason for occurring accidents. Environmental effects and human behaviour however are the main causes, revealing that accidents either occur due to a fault of the truck driver, the opposing vehicle's driver, or some outside disturbance.

As the number of accidents reviewed in different countries is disproportional to one another, comparing the accidents by country would be unjustified for this degree of review. Although Spain would have enough data to be able to consider all the different causations, it is not fair to do this for the other countries as the sample of accidents chosen, although representing occurrences in HGV accidents on the whole, may not be typically representative for that specific country.

The next step therefore in considering the study's global results is to focus on the Accident Scenario types, rather than the location. Each accident type as stated in the ETAC database is classifiable into one of the three main scenarios for truck accidents. Therefore it is useful to present as much of the data in one table, to get a general overview of not only the frequency of each accident scenario, but to then also see the breakdown of causation factors and accident types in order to have a better understanding and point of direction for further analysis.

	Scenario 1 Accidents between a truck and a passenger car moving along in carriageway																	Scenario 2 Truck and a passenger car while turning into a road or by crossing it												Scenario 3 Single vehicle accident (Driving accident)									
Accident type	101	102	103	104	105	106	108	109	111	201	202	203	205	209	211	299	404	302	305	306	307	308	309	310	313	319	320	325	499	322	323	406	408	501	503	507	602	705	Total
H1			1																																			1	2
H2		1		1														1																				1	4
H3			4	4	3		1											1	2																1	1			17
H4	1		1	1	1					1								3	2	2	1		1						1				1		1				17
H5			4	2	2	1									1	1		2														1		1					15
H6		1		4	3			1	1			1	1	1			1	5	1	1		1				1	1				1								25
E1			2															1	1																				4
E2			3																1											1	1								6
E3			17	14	1		2	2		1		1				1	1	8	1	3	1				1	1	1	1										1	58
E4			2	4							1							3				1		1		1	1		1									2	17
E5	1				1		1										1			1				1															6
E6																																							0
E7			2	1	1			1		1																													6
V1			1																																				1
V2		1	2																																		1		4
V3																																							0
V4																																							0
Total causations	2	3	39	31	12	1	4	4	1	3	1	2	1	1	1	2	3	24	8	7	2	2	1	2	1	3	3	1	2	1	2	1	1	1	2	1	1	5	182
Nr of accidents	**1**	**3**	**35**	**25**	**11**	**1**	**3**	**3**	**1**	**2**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**18**	**5**	**5**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**4**	**150**
% per grouping	**55,33**																	**24,67**												**2,67**									

Table to show the distribution between each causation factor and the three main scenario types. Accident types included are as defined in the ETAC database

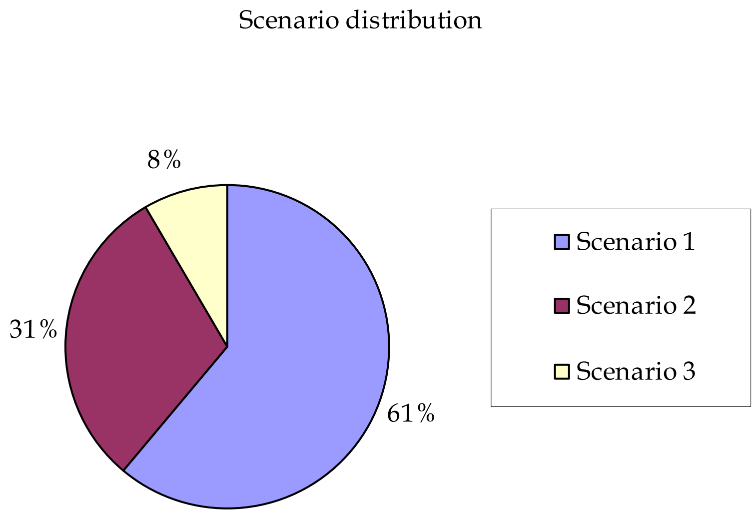
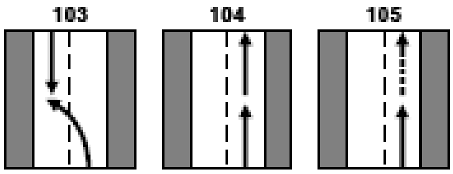


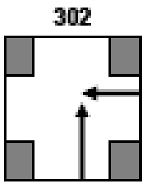
Figure 5.C.10.- Scenario distribution

From this chart and table after viewing the main scenarios visually, it is useful to be able to see that within each scenario, there are certain accident types that occur most frequently, i.e.

- ✓ **Scenario 1**: accidents involving another road user either drifting into the opposite lane, or traffic situations in which one vehicle is following another and impacts to the rear.



- ✓ **Scenario 2**: impacts occurring at a junction as the two vehicles approach each other.



This further reinforces what was deducted from the initial table, as it shows that it is most often the influence of/ interaction with other road users that causes the truck to crash.

5.9.2 Scenarios and Main Accident types

Looking more closely at the factors and their distribution between the main scenarios is important to gain a higher level of understanding as to when these accidents are likely to occur. The following table directly relates each scenario to its causation factors and their frequency.

	Scenario 1	Scenario 2	Scenario 3	total	%
H1	1	0	1	2	1,1
H2	2	1	1	4	2,2
H3	12	3	2	17	9,3
H4	5	10	2	17	9,3
H5	11	2	2	15	8,2
H6	14	10	1	25	14
E1	2	2	0	4	2,2
E2	3	1	2	6	3,3
E3	40	17	1	58	32
E4	7	8	2	17	9,3
E5	4	2	0	6	3,3
E6	0	0	0	0	0
E7	6	0	0	6	3,3
V1	1	0	0	1	0,5
V2	3	0	1	4	2,2
V3	0	0	0	0	0
V4	0	0	0	0	0
Total	111	56	15		
%	61,0	30,8	8,2		

Table 5.C.9.-Causation factor frequency and distribution for each scenario type

Initial observations

Scenario 3: The initial distribution of the scenario frequencies shows that this is clearly an overall minority in truck accidents; this contradicts the original suppositions made in the predictions by public opinion, as these are the accidents where the truck driver would always be at fault. It would have been expected therefore that to support the hypothesis, this scenario would have represented a higher proportion of the accidents.

Now looking more closely at the distribution of the causation factors in the following figure, overall E3 is clearly the most common causation factor, amounting to almost 40% of all accidents. However, it should be noted that E3, Environment – Traffic, was often selected due to the influence of opposing drivers in impacts: *Traffic flow, traffic density, confusing/lack of information from other road user(s)*. In other words, when it was the fault of the car that cut off the truck driver without warning, this was categorised into E3 as an unanticipated special manoeuvre made by the opposing road user. This aside though, E3 being the most common factor also shows that truck drivers seem to have the most difficulties/ higher chance of crash when in a busy situation surrounded by other road users and dense traffic.

The next most common scenarios are H6 (14%), H4 (9.9%), H3 and E4 (9.3%). These too are dependant on human errors and environmental effects, though the exact reasons for the frequency of these reoccurring shall be assessed more thoroughly in the consequent further analysis.

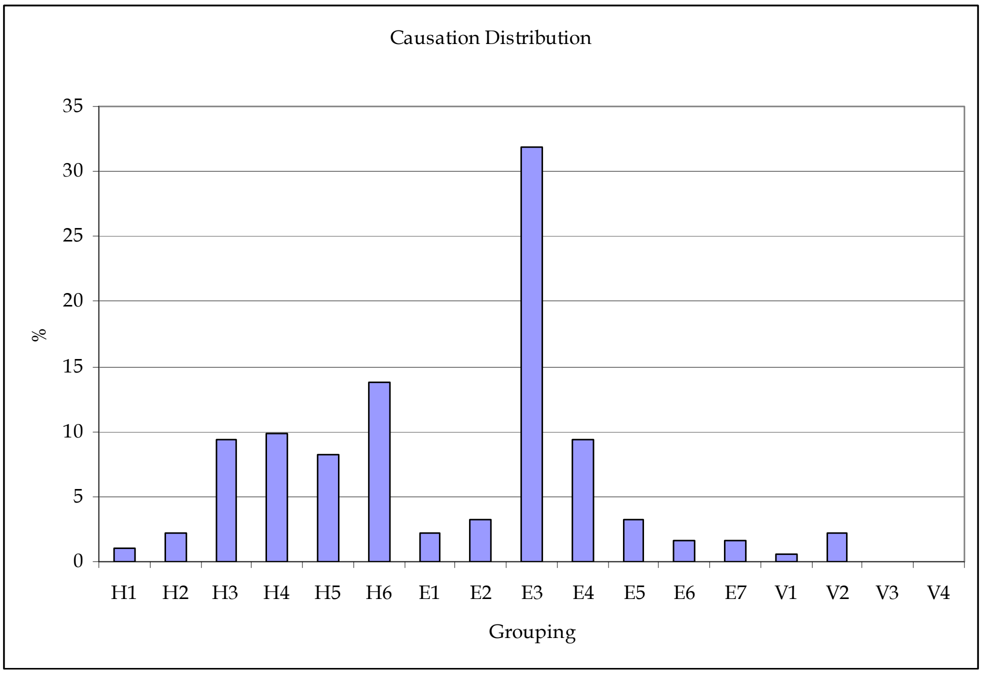


Figure 5.C.11.-Causation Distribution

Looking at each scenario more closely:

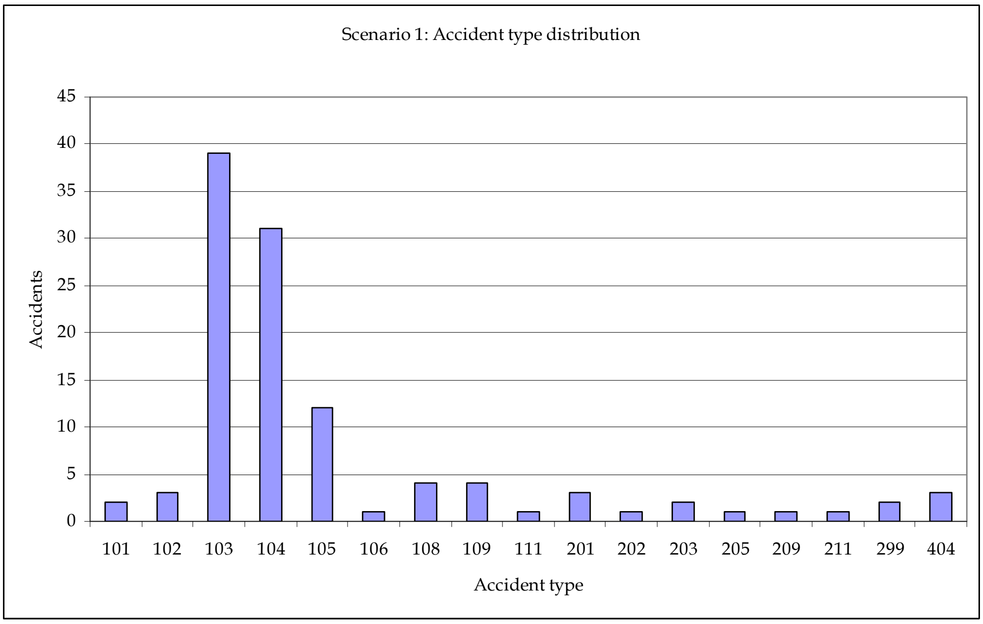


Figure 5.C.12.-Scenario 1 Accident Distribution

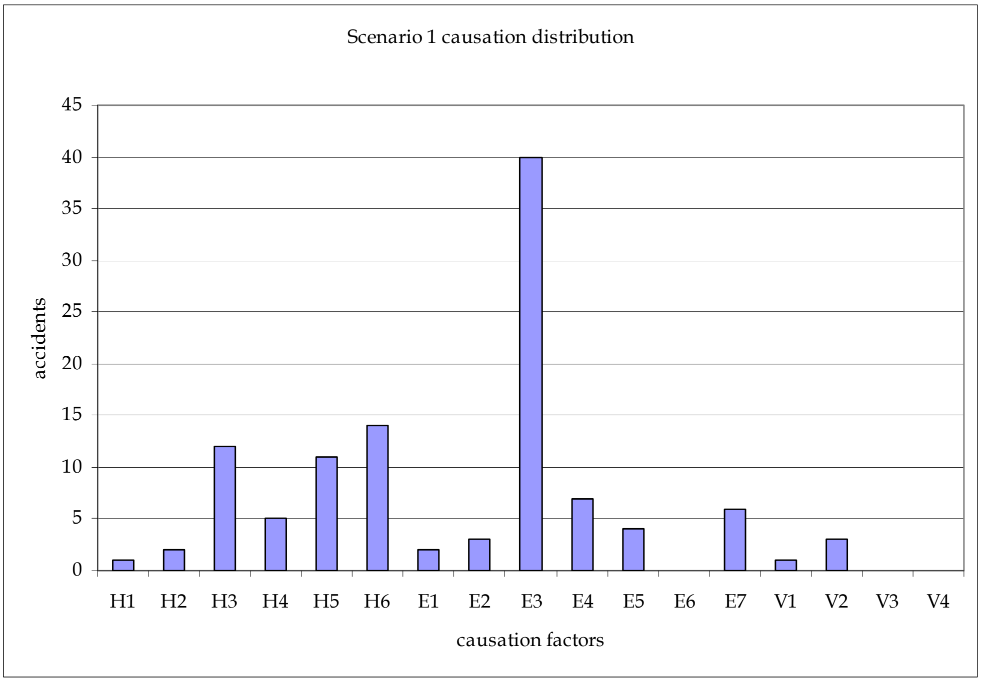


Figure 5.C.13.-Scenario 1 Causation Distribution

Scenario 1 follows the same general causation factor distribution trends as the overall causation factor distribution as would be expected seeing as this scenario is representative to more than half of the accidents realised.

From these two graphs it would be expected that the most common accident types i.e. 103, 104 and possibly 105 will reflect the causation distribution and display E3 as a dominant factor for the cause of these types of crash.

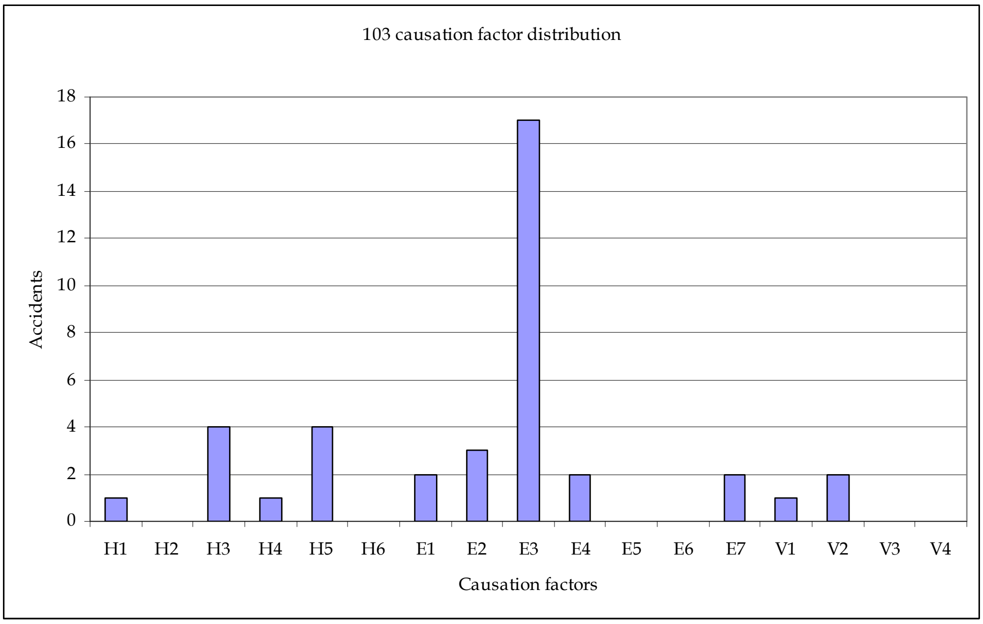


Figure 5.C.14.-103 Causation Distribution

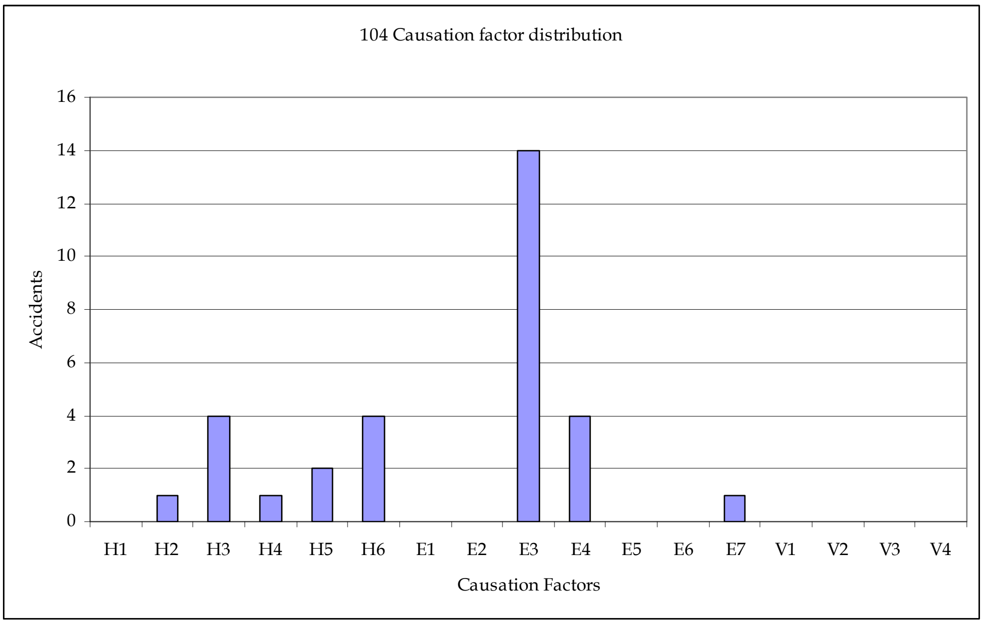


Figure 5.C.15.-104 Causation Distribution

103 and 104, are both similar accident types classified in the same group (vehicle/ vehicle accidents), and they also follow the general trend of the scenario as a whole. From the graphs it is clear that causations for these accidents don't differ too much from the representation of the scenario as a whole and generally are dependant upon the same cause.

The truck driver is not always completely responsible for the accidents;
'Traffic flow, traffic density, confusing/lack of information from other road user(s)' suggests that the surrounding environment can have a great influence. Busy dense areas therefore are more susceptible for accidents. Situations where the truck drivers must think fast to anticipate the manoeuvres of other road users, this could lead to blame in the other road users' recklessness, but also could be due to decreased reaction time and attention linked to the long hours and distances a truck driver needs to travel.

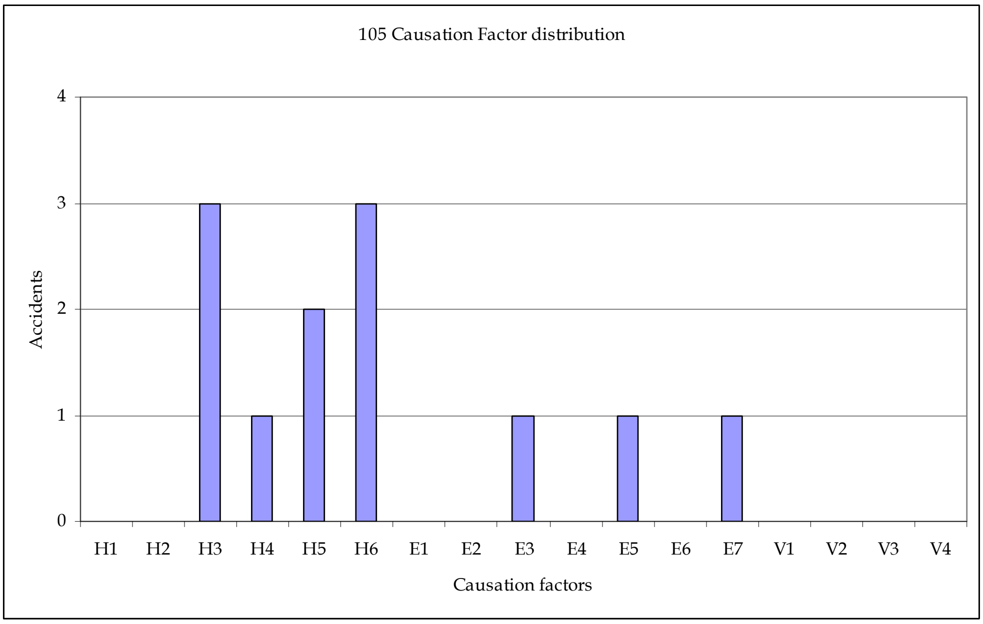


Figure 5.C.16 -105 Causation Distribution

Accident type 105 has more human causations on the whole, resulting from situations requiring adaptation of speed and the anticipation of other drivers' behaviour. H3 and H& are the dominant causation factors, H3 representing the element of fatigue in truck drivers and/ or being in a hurry trying to conform to time restrictions. H6 represents the tendency truck drivers have to drive too closely behind other cars/ too quickly (i.e. speeding), which incidentally comes as a consequence of the afore mentioned main causations in H3. For this reason that it is in this instance easier to view the 'Human' causation factors as a group seeing as the causes and consequence from one to the next are linked.

On the whole the accident type distribution in Scenario 1 is represented by the 104 and 105 accident type as these individually have similar results to the scenario on the whole. It is interesting however to realise that the next most common accident type in this scenario is predominantly due to the fault of the truck driver and his behaviour. Due to the type of hours and pressures the truck drivers have in association with their jobs.

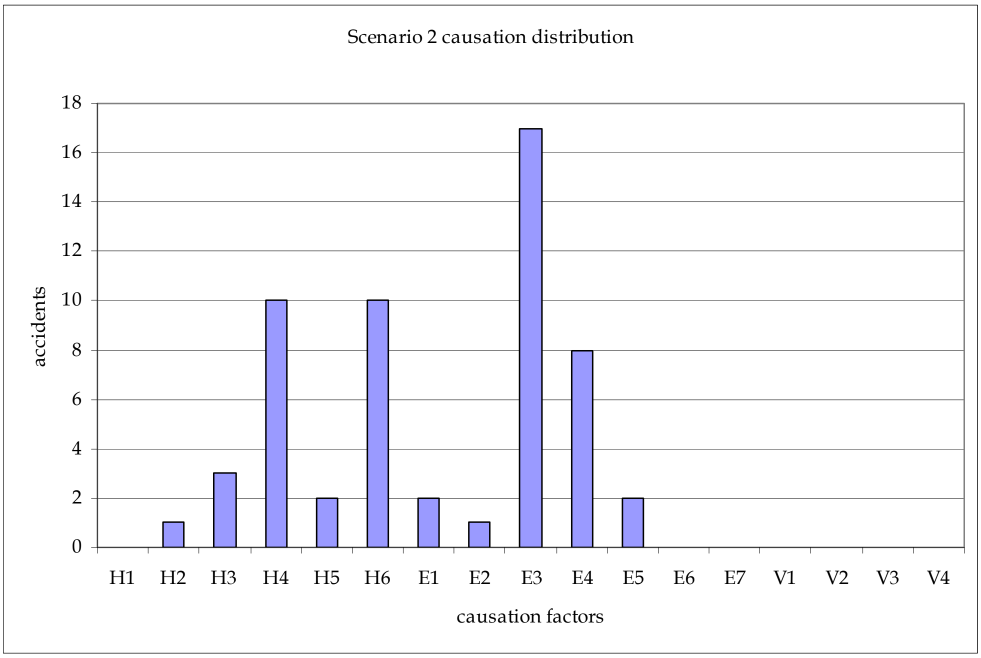


Figure 5.C.17.-Scenario 2 Causation Distribution

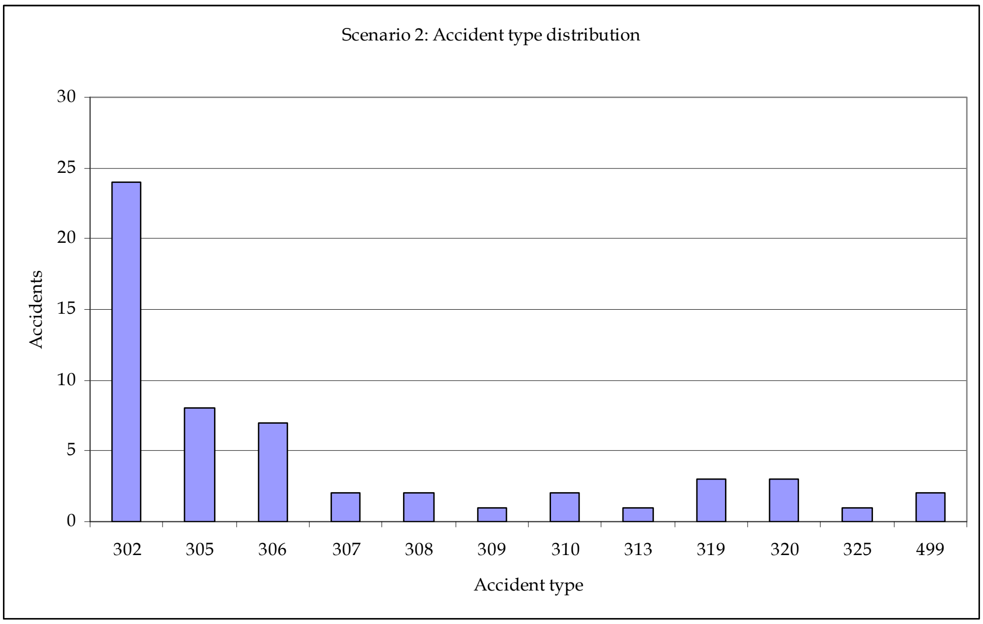


Figure 5.C.18.-Scenario 2 Accident Distribution

From these two graphs it would be expected that 302 follows the structure of the scenario a whole seeing as 302 is clearly the dominant accident type.

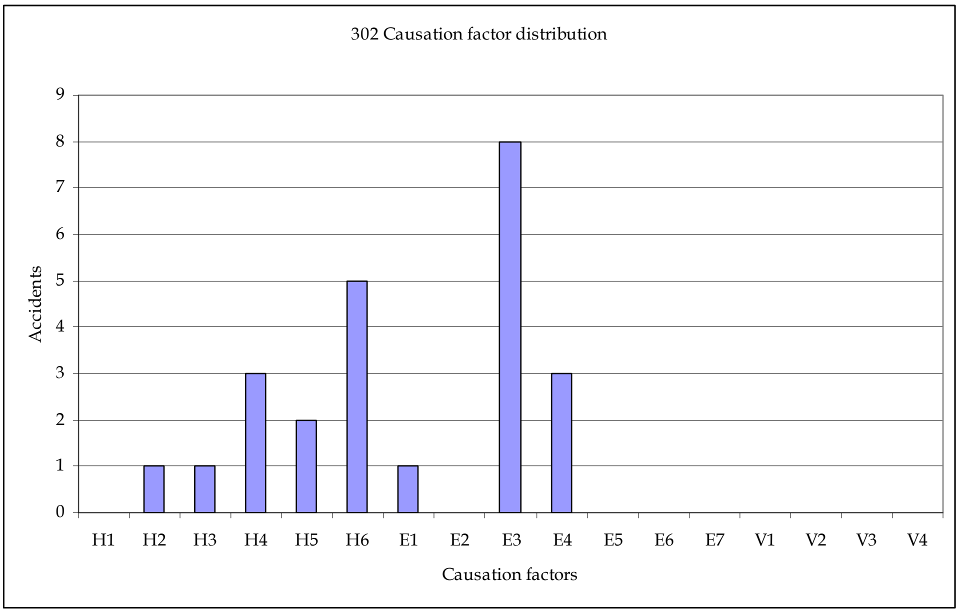


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Figure 5.C.19.- 302- Causation Distribution

From this graph E3 is also the main cause as in scenario 1, although it is to be noted, should we disregard this (due to the knowledge that not all of these were caused by the trucks), the main type of causation factors for the accidents caused belong to the Human Behaviour group, primarily H6: 'Speeding (illegal or inappropriate), driving too close to vehicle in front, purposely disobeying signs/signals/markings, thrill-seeking…' this suggests that the pressure truck drivers are under to meet time restraints and deliver their goods on time may well affect the way they drive and their level of respect to driving etiquette when on the road, leading them to drive less carefully, focussing more on their job than their responsibilities as a road user. This trend is comparable to those shown also in accident types 103 and 104, but not as clearly.

The reason for this happening is most likely due to the location of accident occurrence, the trucks must slow down more at junctions than in a carriageway and therefore neglect to adapt speed would have a more influential effect in these types of areas. The familiarity that the truck drivers have with their routes is the reason for reluctance to always drive as safely as possible, assuming from past journeys that it can be done safely at a slightly higher speed.

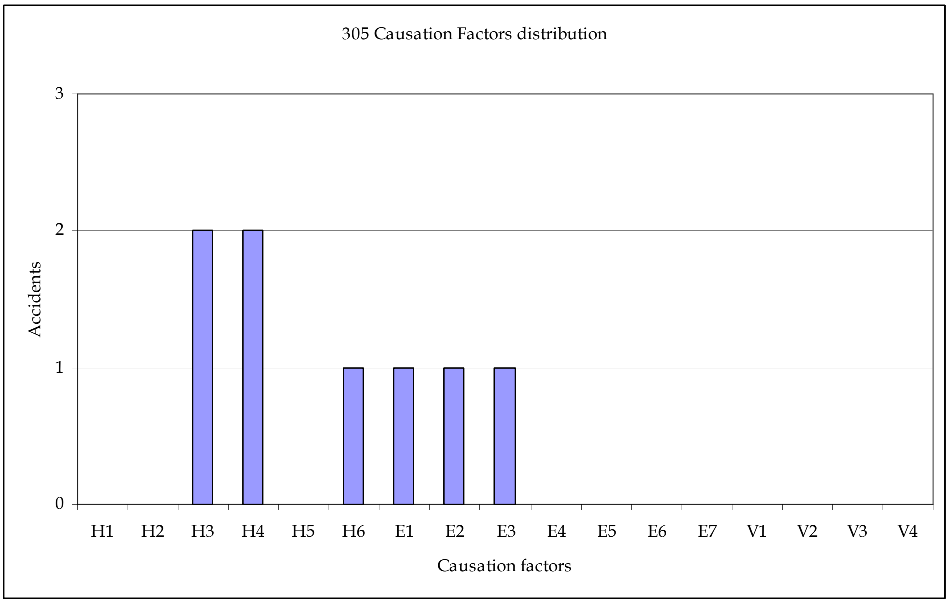


Figure 5.C.20.-305 - Causation Distribution

305 and 306 combined reflect the overall scenario results also. 305 tends slightly more towards the Human influence for causation factors and 306 to the Environmental. Both accident types are quite similar, and it is therefore hard to say why one would have a different causation distribution to the other, therefore considering them together is a more suitable approach. From this we can understand why H4 might be more dominant: a driver's over experience with a route will decrease his attention levels and reduce the focus that should be apparent when turning on such junctions. Taking a wide corner that will unavoidably block another lane for a certain amount of time increases the probability of a crash and should always be given the full amount of attention needed. E3 in these accident types applies the same way, however from the perspective of the other road user.

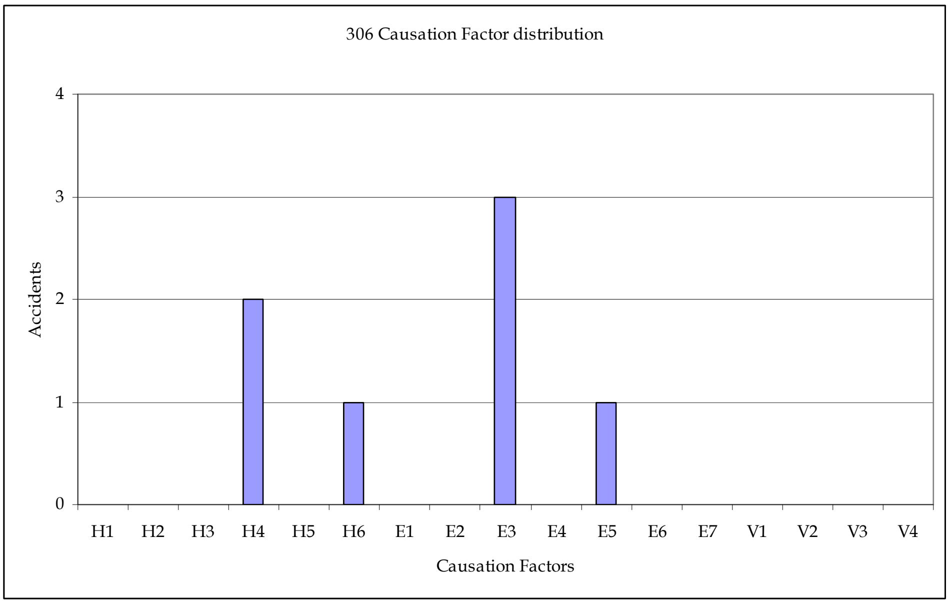


Figure 5.C.21: 306 - Causation Distribution

Overall, scenario 2 also still follows the main composition of the overall accidents and has E3 as its most common causation factor. It is worth noting also that none of the *vehicle* causation factors resulted in this scenario; this is logical as if the malfunction is due to the maintenance or condition of the truck it would be expected that this would take place over a long journey due to over endurance and higher speeds, not at low speeds when the truck is turning.

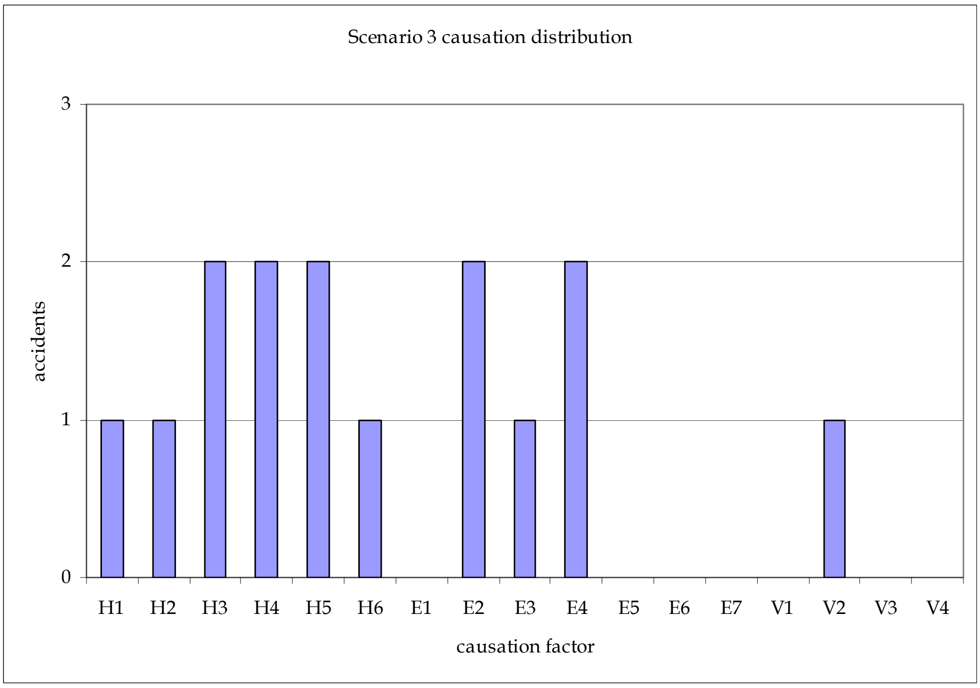


Figure 5.C.22: Scenario 3 Causation Distribution

Scenario 3 does not follow any particular structure. As mentioned before this is most likely due to the rare occurrances of these types of accident, the low frequency of accidents matching this scenario do not provide a big enough data sample to form any concrete conclusions on the most influencial factors. The main conclusion therefore is simply that scenario 3 is not as regular or consistent a scenario as 1 and 2.

However, it is important to mention here, that the ETAC database limits the statistics for single truck accidents to 5%. For this reason perhaps, there is not sufficient data available to perform the full analysis desired in this area.

5.9.3 Scenarios and main factors

As the purpose of this study is to determine the main factors responsible for truck accidents, it is important to next assess each of the most common causation factors individually and establish the reasons for their repeatability.

5.9.3.a E3 Environment - Traffic (39%):

*Traffic flow, traffic density, confusing/**lack of information from other road user(s)**.*

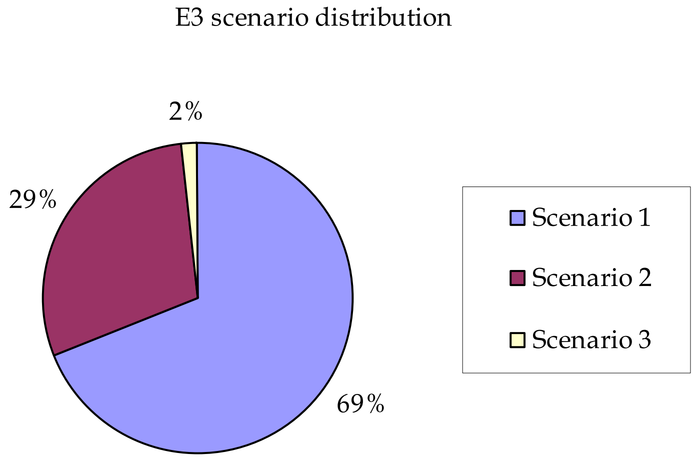


Figure 5.C.23.- E3 scenario distribution

From the chart above, it can be seen that the main scenario in which E3 is responsible is Scenario 1. This is logical as Scenario 1 is representative for accidents occurring on carriageways between a truck and a car. Knowing that truck drivers often have to travel long distances to transport and deliver goods, it is fair to say that the majority of time that a truck is on the road and in transit it will be on a carriageway as opposed to driving through junctions etc. However, the fact that there is still a high number of accidents occurring at junctions due to E3, implies that junctions can be difficulty zones for truck drivers, probably due to the size of their vehicle and the density of traffic combined.

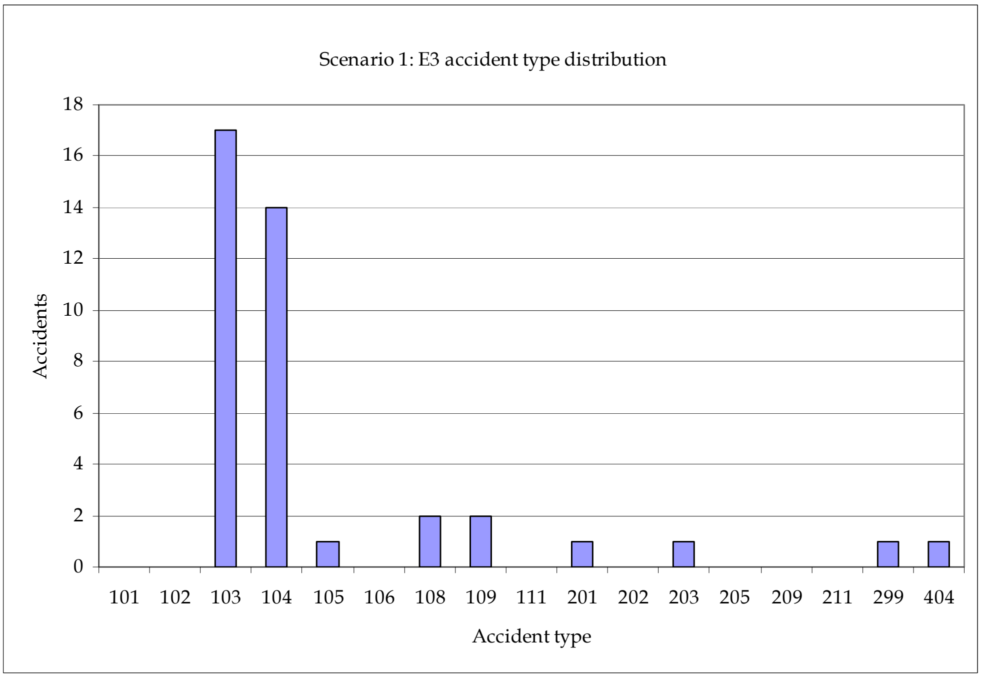


Figure 5.C.24.- E3. Scenario 1- accident type distribution

Considering each scenario further with respect to E3 as a causation factor and taking a look at the specific types of accidents that occur, in scenario 1, 103 and 104 are the main accident configurations. Both these graph reinforce the previously presented data relating 103 and 104 to accident causation as E3 was a clear majority:

103, represents a vehicle leaving its lane and impacting with an oncoming vehicle. This accident mechanism fits in with E3 as a causation factor due to the truck driver having to deal with an unexpected manoeuvre made by the oncoming car. This shows that in fact the majority of these incidents are not a result of a fault that the truck driver himself has made, but more due to the inability to react in time. This deficiency in time to react is most often caused by one of three things: fatigue of the driver, meaning reaction time to avoid the collision is insufficient; lack of time to break or manoeuvre away from the oncoming vehicle, due to the weight of the load and size of the truck meaning it is not as easy to rapidly change course as it might be for a smaller road user such as a car or a motorbike; and finally, the oncoming vehicle may simply appear too late not leaving the possibility for the truck to adapt its driving in any way before the collision.

104 represents two vehicles moving in the same direction in the same lane, this coincides with E3 as a causation when considering the traffic density and flow. The main two causes therefore in this case would be either the truck driver misinterpreting the movement of traffic and impacting on a car due to unsatisfactory adaptation of speed or inability to adapt driving behaviour as the traffic increases. This is related to the duration for which truck driver are driving, and the fact that they are often under pressure to arrive at their destination within a specified time scale. This sense of urgency can translate itself into the driving behaviour of the driver and in combination with fatigue or simply lack of attention due to the regularity of the journey, resulting in reduced concentration and perception in busy traffic. The second type of accident where 104 would occur is a car colliding into the back of a truck, this would happen due to the reduced vision of a following driver not being able to anticipate the slowing of traffic ahead, consequently unable to adjust their speed in enough time if the truck breaks unexpectedly.

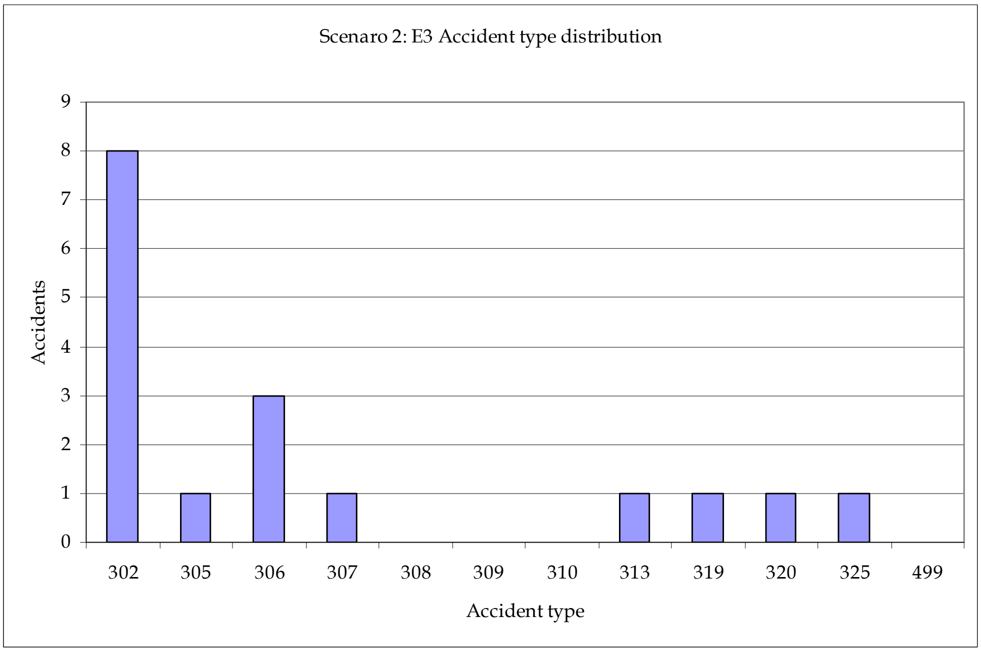


Figure 5.C.25.-E3. Scenario 2 - accident type distribution

Scenario 2 also shows one main recurring accident type caused by E3, again supported by the graphs presented during accident type analysis (however amounting to a smaller number of accidents than scenario 1). 302, when two vehicle meet at a junction in a cross road. This is linked with the confusion at junction and lack of information / misinterpretation of another road user's intentions. The high occurrence of this accident type is most likely due to the change of surroundings from the familiar carriageway to an area requiring more attention from the truck driver and a higher level of alertness to the other vehicles on the road. The handling of the truck being harder at junctions and requiring more attention than a car, due to the size, but also the truck drivers' not always taking this into consideration.

There is not enough data to warrant graph for scenario 3 as there was only one case within the scenario caused by E3, which was a special case involving a collision with a drunk pedestrian entering the path of the truck unexpectedly too late for the truck driver to react.

5.9.3.b H6 Human - Behaviour (Risk tasking) (14%):

Speeding (illegal or inappropriate), driving too close to vehicle in front, and purposely disobeying signs / signals / markings, thrill-seeking…

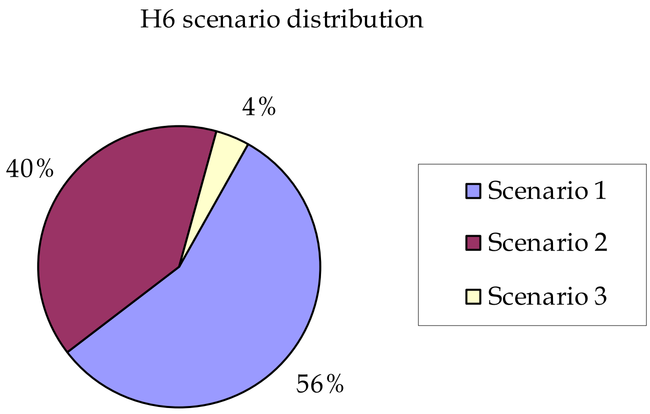


Figure 5.C.26.-H6 Scenario distribution

As can be seen here the majority of accidents occurring with H6 as a causation, follows a similar scenario distribution as all the accidents on the whole. The accidents occurring under this causation factor are due to faults made by the truck driver, mainly because of haste and the pressure to complete a journey by a certain time causing the driver to prioritise the work aspect and making them more likely to disregard road rules and take more risks.

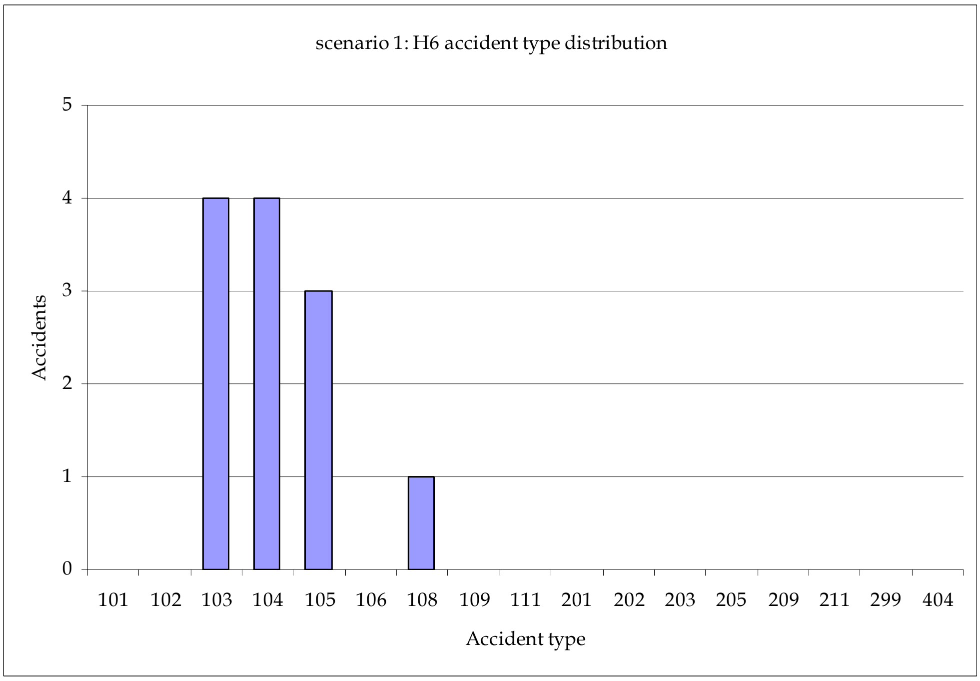


Figure 5.C.27.-H6 Scenario 1 – accident type distribution

Again like in the E3 causation factor 103 and 104 are the most common accident types, the explanation for 103 being predominantly linked to the explanation of too high speeds. Oncoming opposing once again vehicles entering the lane unexpectedly, but unlike in the E3 scenario there was perhaps more chance to react on the truck drivers behalf. This would be linked to the pressure the drivers are under to keep their time restrictions.

104 however, is due more to a disregard of the traffic code, either driving too fast or too close to vehicles and disobeying stop signs in order to try and make better time. This ultimately resulting in a collision with another vehicle because there is then no longer enough time to readjust speed or react when driving with a truck carrying heavy loads.

105 is also a dominant accident type for H6, similar to 104, but more specifically linked to the adjustment of speed and the drivers not slowing down in enough time to allow for this.

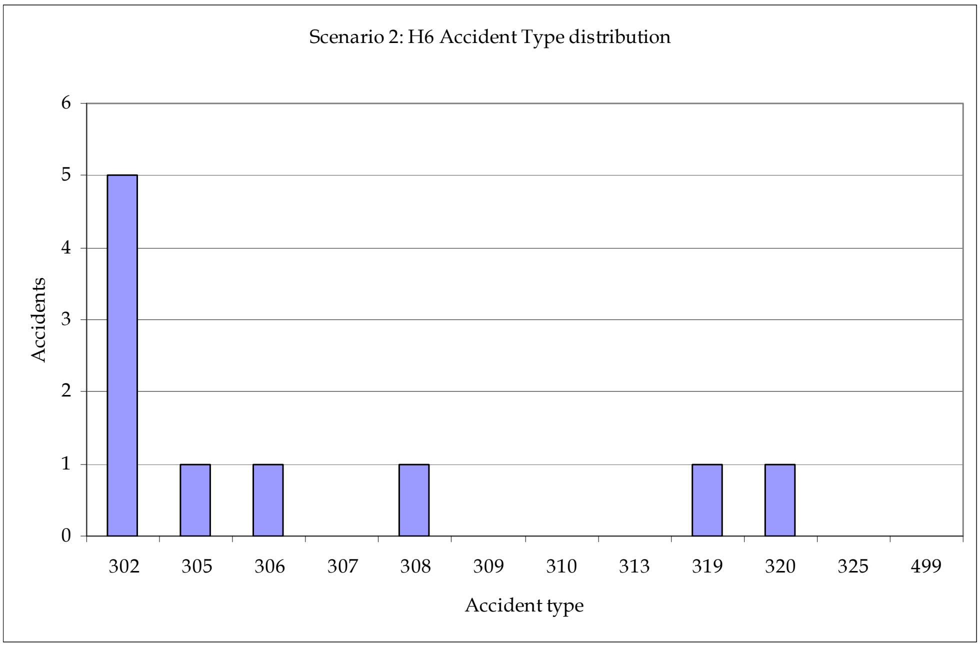


Figure 5.C.28.-H6 Scenario 2 – accident type distribution

Once again 302 is the most common accident type for Scenario 2. This is because when approaching junctions if there is another vehicle, the truck driver may be inclined not to adapt speed and take risks i.e. seeing a vehicle approaching an intersection, and rather than slowing down to be safe, speeding up or maintaining speed so as to cross first and save time or the eventuality of maybe waiting for several cars to pass. This applies to the disregard of stop signs at intersections too, choosing to continue if the road looks clear on approach resulting in collisions.

Again there was only one accident for this causation in scenario 3, it involved running off the road at an entrance road. This was due to unadapted speed of the driver under time restrictions (though not late) who was taking risks and as a result lost control of his truck in the bend.

5.9.3.c H3 Human - Psychological condition (9,3%):

Emotional (upset, angry, anxious, happy…), in a hurry, fatigue, internal conditioning of the driving task (e.g. right of way status)

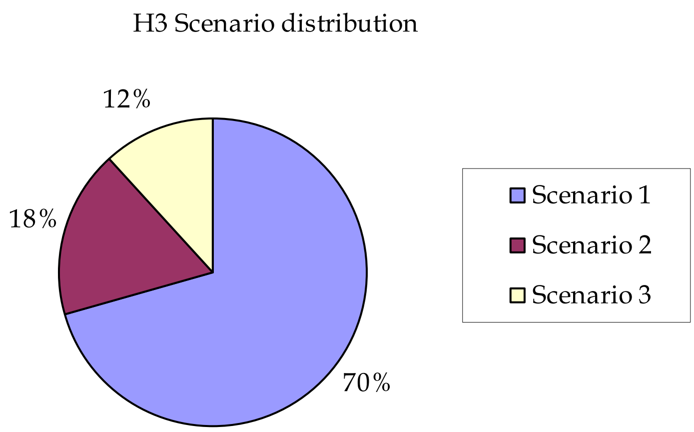


Figure 5.C.29.-H3 Scenario distribution

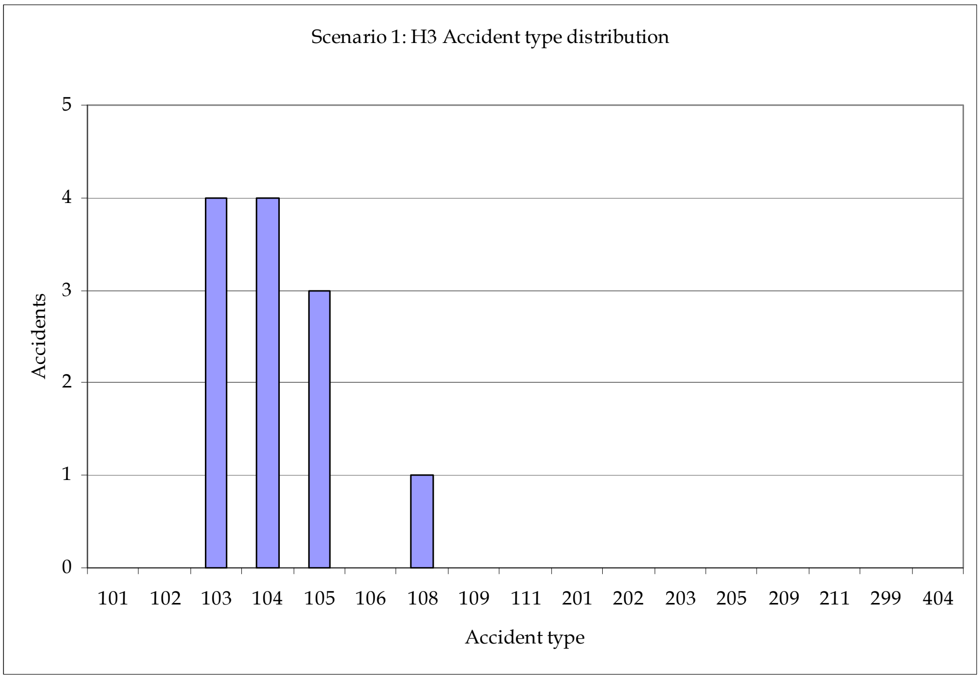


Figure 5.C.30.-H3 Scenario 1 – accident type distribution

Scenarios 2 and 3 have too little data in this causation type to warrant plotting the graphs and conclude any definite results or trends.

5.9.3.d H4 Human - Experience (9,3%):

Little/no/over-experience of driving/route/vehicle/driving environment

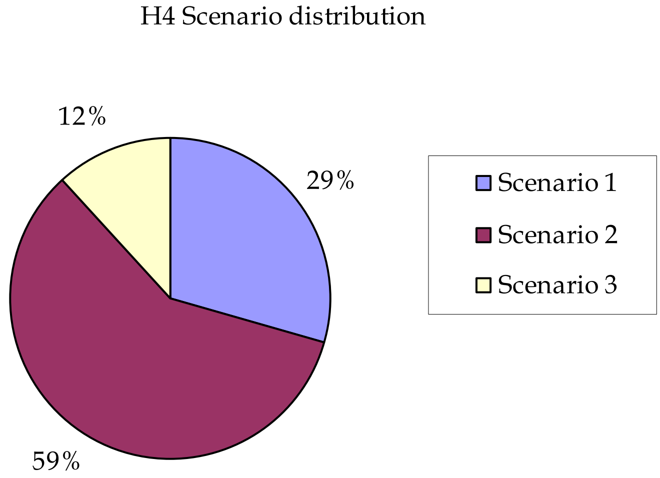


Figure 5.C.31.-H4 Scenario distribution

Most of the accidents involving H4, unlike the general trend, arose in scenario 2. As with truck drivers nearly all the accident cases were linked with over experience of the route (driven either daily or once a week) this is logical that junctions would be the main location for the occurrence of this accident causation. Drivers feeling familiar with the road they are on, assuming similar traffic circumstances to when they usually are on the road may not slow down at corners they know are usually not busy, or they may skip stop signs for the same reason, resulting in a crash should there be a vehicle as they have not sufficiently adapted their speed to account for this.

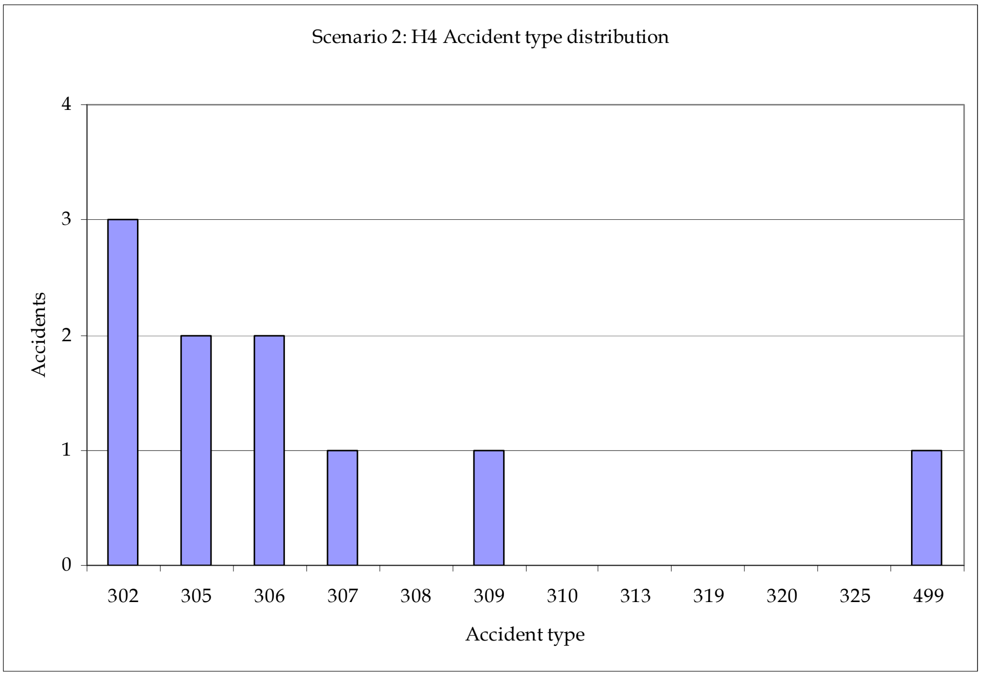


Figure 5.C.32.-H4 Scenario distribution

Scenario 2 once again shows 302 to be the most common scenario, due over experience and familiarity of the route linked with to lack of visibility either due to roadside objects or darkness preventing the driver from seeing other approaching vehicles. The driver's lack of realisation to this limitation in visibility often means that the junctions are still approached at the same speed, but the situation is then more dangerous on arrival when there is less time to react and decreased visibility distance.

Individually assessing the scenarios1 and 3 individually here is not justifiable as there are too few cases to be able to establish a definite trend or pattern in occurring accident types and no clear majority.

5.9.3.e E4 Environment - Visibility impaired (9,3%):

Road lighting, vehicle lighting, day/night conditions, sun glare, weather, smoke, terrain profile (bends etc..), other vehicles, roadside objects

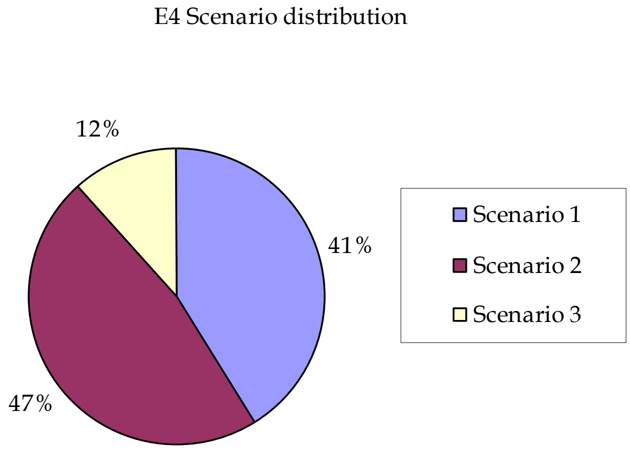


Figure 5.C.33.-E4 Scenario distribution

Again scenario 2 is more popular here than scenario 1, this is mainly due to the majority of these accidents occurring at nigh time i.e. carriageways are much more often equipped with lighting than junctions away from the main road where visibility becomes an issue for the driver.

The accidents in scenario 1 on the carriageways were linked more to roadside objects e.g. broken down vehicles, or long bends without visibility rather than the actual lack of lighting.

Individually assessing the scenarios individually here is not justifiable as there are too few cases to be able to establish a definite trend or pattern in occurring accident types.

5.10 Conclusions

5.10.1 General database statistics

The main causes for accidents at intersections are presented below according to 2 points of view:

- ✓ When the truck is causing the accident (in this case the main accidents causes are "failure to observe intersection rules (20,1%)", "non-adapted speed (13%)" and "improper manoeuvre when turning (7,8%)").
- ✓ When the other vehicle is causing the accident ((in this case the main accidents causes are "failure to observe intersection rules (28,2%)", "non-adapted speed (10,9%)" and "lack of driving experience (9,2%)").

The reasons why the truck impacted a vehicle driving in front going in the same direction and the reasons why the other vehicles impacted a truck driving in front going in the same direction, have been separated. The Main accident causes when the truck impacts a vehicle driving in front going in the same direction are the "non adapted speed (22,1%)", "the insufficient safety distance (16,2%)" and the "inattention (12,8%)". The main accident causes when another vehicle impacts a truck driving in front going in the same direction are the "non adapted speed (28,8%)", "the insufficient safety distance (12%)" and the "inattention (11%)".

The main causes of an accident happening during an overtaking manoeuvre are shown according to the origin of the accident:

- ✓ When the truck is causing the accident
- ✓ When the other vehicle is causing the accident

When the truck is causing the accident, 45% of the main causes are due to:

- ✓ Improper manoeuvre when overtaking/changing lane,
- ✓ Over fatigue/falling asleep,
- ✓ Non-adapted speed,
- ✓ Lack of driving experience,
- ✓ Crossing line

The accident causes are quite different when other vehicles are causing the accidents. In those cases, 50% of the causes are due to:

- ✓ Improper manoeuvre when overtaking/changing lane,
- ✓ Non-adapted speed.

In 64% of all cases, the truck was not driving in a straight line immediately before the precipitating event but was changing direction or negotiating a bend.

The ETAC study identified specific parameters to be analysed: load, fatigue, infrastructure and blind spot accidents. Some interesting conclusions were found.

The load of the truck is the main cause of the accident in only 1,4% (9 accidents) of all accidents in the database. Only in 3 accidents (among the 9 accidents), the truck had tipped over.

Based on the 624 accidents of our database, fatigue was the main cause in 6% of the accidents. 37% of these accidents were fatal. When fatigue plays a role in the accident, 68% of these accidents involved a truck and another vehicle (car, two-wheels, motor two-wheels…) and in 29% of the cases the accident is a single truck accident. Regarding the time of the accident where fatigue was the main cause, two hours have been identified as crucial. Most accidents happen between 02:00 and 02:59, obviously a time when the biorhythm is at a low point, and from 15:00 to 15:59 when it is nearly the end of the working day. Nearly 90% of the accidents in which fatigue is the main cause, happen on highways or on inter-urban roads. However, it must be stated, that to prove that fatigue is the main cause of the accident is very difficult because the expert based their judgement on what they saw and what the drivers told them. Moreover, fatigue is a complex system in which you can find different vigilance states from slightly fatigue to sleeping and fatigue is often linked to other issues as being inattentive.

Considering the blind spot as the area around a commercial vehicle which are not visible for the driver neither through the windshield, side windows nor the mirrors, among the accidents (30) occurring in an intersection and involving at least one vulnerable road user (a pedestrian or a two-wheels), in 47% of them, blind spots from the truck driver's view, was the main cause of the accident. When blind spot is the main cause of the accident in this configuration, 2/3 of the accidents are fatal accidents. That means that the accidents with a vulnerable road user and a truck at an intersection are very severe accidents.

Related with the severity of the injuries, there are more truck road users injured, from minor to moderate injuries, than the other road users. While from critical to dead injuries, there are more other road users injured than truck road users. This is not surprising regarding the difference of size in case of a collision between them.

5.10.2 Main study results

Figures

The main results gathered from the in depth study showed that Environmental influence as a causation group represents 53% of the cases; Human influence represents 44% and Vehicle influence is representative only of 8% of the accident cases reviewed.

The main scenario distribution showed that scenario 1 (Accidents between a truck and a passenger car moving along in carriageway) represented 61% of cases. Scenario 2 (Accidents between a truck and a passenger car and caused while turning into a road or by crossing it) represented 31% and scenario 3 (The single vehicle accident (Driving accident) of truck) represented 8%.

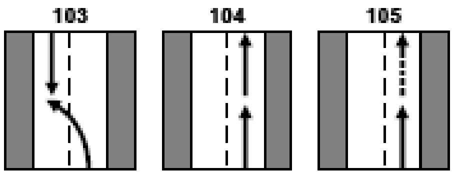
The distribution of accidents studied in this report can be seen in the table below:

	Scenario 1	Scenario 2	Scenario 3
Human	45	26	9
Environment	62	30	5
Vehicle	4	0	1

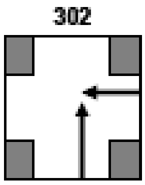
Table 5.C.10.-Overall causation distribution

Looking further at the accident types involved and the causation factors, there are three main recurring accident configurations:

- ✓ Within 'Vehicle/ Vehicle impacts' (which fall into the Scenario 1):



- ✓ Within 'Junctions' (which appears in Scenario 2):



The main causation factors overall were found to be as shown below in the table:

	Causation factor	%
H3	Human - Psychological condition	9,3
H4	Human - Experience	9,3
H6	Human - Behaviour (Risk tasking)	14
E3	Environment - Traffic condition	32
E4	Environment - Visibility impaired	9,3

Table 5.C.11.-Overall causation frequency

Main Human Functional Failures influence

Environmental influences are the main causation grouping that occurs in HGV accidents, of this E3 and E4 are the two most common.

E3 is a recurring factor linked to the impacts predominantly caused by other road users' faults and also the truck drivers' misinterpretations of their actions. This shows that there is insufficient ability for the truck drivers to efficiently anticipate and take into consideration the actions of other road users, as a result of either inexperience or not paying enough attention.

E4 is a recurring factor predominantly in the second scenario, as a result of blind spots when approaching intersections.

Next most common causation factors appear in the Human influence grouping, of these H6 is the highest, showing that truck drivers have a tendency to take risks and a reluctance to adapt their speed. H4's main recurrence is as a result of over experience/ familiarity of the route, in turn resulting in reduced attention to the road and less strict adherence to all road signalling due to 'knowing the route'. H3 is mostly recurrent due to over fatigue. These three factors can be considered together more easily than the environmental effect as their causes and consequences more than often are combined. Unlike predictions, alcohol/ substance intoxication was not a significant issue.

Effect of the failures

It is largely due to the type of job truck drivers have: the combination of long hours, often working nights and also the lack of variation in route (i.e. often taking the same journey several times a week or month) results in a number of recurrent factors such as fatigue, decreased attention when in familiar surroundings or unchanging surroundings (a long and straight carriageway).

Truck drivers also seem to have a reduced ability to be able to correctly interpret the behaviour of other road users whether due to lack of attention or experience. The truck drivers position higher in his vehicle may have influence on this, and once again the over familiarity of a route can lead to concentration lapses and focus being set more in the distance rather than on immediate and potential unexpected circumstance changes at close proximity.

Next steps

Having defined the main problem areas, it is important to find ways of tackling these. The next step is to use these findings and actively do more to prevent and reduce the frequency of HGV accidents.

Tackling E3, the most common causation factor:

- ✓ Installation of Driver Drowsiness Detection in the trucks.
  This will ensure the alertness of drivers and reduce the reaction time increasing the ability of the drivers to anticipate and respond to changes in behaviour of other road users.
- ✓ Enforced driving time.
  Stricter enforcement/ regulation of the hours truck drivers spend driving should be achieved. This is difficult to do, as although it is already required by law ensuring these regulations are respected can be troublesome. Therefore other ways to tackle this problem should be investigated.

Tackling H6, Human behaviour – risk taking:

- ✓ Make the drivers understand the problem and the sensitivity of the issue.
  The point must be put across to all drivers that neglect or disrespect of road rules in what may seem to them a trivial situation could result in fatalities for other road users.

- ✓ Stricter enforcement to ensure the drivers related to traffic rules. i.e. the introduction of more severe punishment and/ or increased controls and surveillance.

Tackling E4, visibility:

- ✓ Introduction of Advanced Driver Assist systems.
  These systems will improve the drivers ability to anticipate and react to situations they may not normally be able to.

All of these propositions are further supporting the tackling of H3 and H4 which tie in with a combination of the same issues. Therefore if all these steps can be followed and achieved in the future all the main issues and causation factors in relation with HGV accidents will be tackled and eventually improved.

Limitations of the study

It would be useful to look at even more accidents to firmly establish perhaps an even clearer relationship and causation with the HGV accidents that have taken place. Also, it would be interesting to go back and include certain extra factors, i.e. to remove all the accidents where the truck driver was not 'fully responsible' and see if this would dramatically change the overall results of the study and its analysis. Another interesting viewpoint could be to include further into the investigation the experience of the driver, comparing statistics between long-term established drivers and new drivers.

The easiest way to generally summarise what should be done to improve these statistics is to look at the main problem areas, as shown in table, consider distribution of the three main scenarios, and their frequency with respect to the three main causation groups. It is evident that the areas in need of most attention and improvement lie in the top left of this table, i.e. scenarios 1 and 2 with regard to both human and environmental issues; scenario 1 being the more dominant issue and in need of slightly more attention.

Challenges

Working with TRACE definitions and ETAC definitions without a uniform structure or classification type was problematic as due to the lack of definite correspondence between the two there was an element of ambiguity. Through studying the information however this possible to overcome as the ETAC accident types were grouped into sub scenario types, each of which corresponded to one of the three main scenarios as defined by TRACE.

6 Task 1.4: Pedestrians and Cyclists

Within WP1 of the TRACE Project the different road users are regarded. First the descriptive analysis and the literature review revealed the most important facts that apply to the different users. Task 1.4 is concerned with Pedestrians and Cyclists. In the Deliverable D1.1 four most common scenarios for these vulnerable road users had been identified (see D1.1).

Why is TRACE studying the accidents of these vulnerable users?

Pedestrians
The proportion of pedestrian fatalities to the total number of road traffic fatalities in each country is shown in the next table. Pedestrian fatalities amounted to approximately 10% of all road accidents in Belgium, Luxemburg, The Netherlands and France. This is comparatively much lower than 21% in the United Kingdom, 19% in Ireland, and 18% in Portugal and Greece. However, Spain, the United Kingdom, France and Italy had the highest number of pedestrian deaths overall, this is why it is important to consider percentages of the accidents as differing population sizes could result in misleading statistics.

	Pedestrian fatalities	Total fatalities	Ratio
BE	101	1,162	8.7%
DK	43	369	11.7%
EL	293	1,67	17.5%
ES	683	4,741	14.4%
FR	581	5,53	10.5%
IE*	64	337	19.0%
IT	710	5,625	12.6%
LU**	6	62	9.7%
NL*	97	1,028	9.4%
AT	132	878	15.0%
PT	233	1,294	18.0%
FI	49	375	13.1%
SE	67	480	14.0%
UK	694	3,368	20.6%
EU-14	3,753	26,919	13.9%

Table 6.A.1.-Pedestrian fatalities as a percentage of total fatalities, 2004.

Cyclists
Cyclist fatalities made up 4.5% of the total number of road accident fatalities in 2004. In 2004, 1,209 people riding bicycles were killed in traffic accidents in 14 European Union countries, which is 5.1% less than the 1,275 bicycle fatalities reported in 2003 in the same countries. There was a reduction of 37.3% during the decade for the same countries, 731 fatalities less in 2004 than the 1,940 in 1995.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
BE	128	121	122	135	122	134	130	105	110	79
DK	77	88	65	58	59	58	56	52	47	53
EL	34	28	32	34	23	22	29	14	21	24

ES	123	101	116	114	119	84	100	96	78	88
FR	368	296	318	296	295	244	235	208	185	177
IE	28	22	24	21	14	10	12	18	10	-
IT	391	413	428	364	402	381	331	314	326	296
LU	3	1	1	1	0	1	1	1	-	-
NL	267	233	242	194	194	198	195	169	188	-
AT	77	73	66	57	68	62	55	80	56	58
PT	96	75	75	74	41	56	50	58	63	47
FI	74	46	61	54	63	53	59	53	39	26
SE	57	49	42	58	45	47	43	42	35	27
UK	217	208	187	165	173	131	140	133	116	136
EU-14	1,940	1,755	1,779	1,626	1,618	1,481	1,436	1,343	1,2752	1,2091
Yearly change		-9.6%	1.4%	-8.6%	-0.4%	-8.5%	-3.0%	-6.4%	-5.1%	-5.1%

Table 6.A.2.-Annual number of cyclist fatalities in EU-14, 1995-2004.

Comparing the cyclist fatalities with the total fatalities in 2004, the countries with the highest percentage of bicycle fatalities are Denmark, the Netherlands and Finland, as is indicated by the following table. In contrast, in Greece, Spain and Luxembourg bicycle constitute only a small part (<2%) of the road accident fatalities. Of these fatalities, the overall average shows the most affected group to be males over the age of 60 who are involved in over a third (36.9%) of these bicycle fatalities.

%	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
BE	8.8	8.9	8.9	9.0	8.7	9.1	8.7	8.0	9.1	6.8
DK	13.2	17.1	13.3	11.6	11.5	11.6	13.0	11.2	10.9	14.4
EL	1.4	1.3	1.5	1.6	1.1	1.1	1.5	0.9	1.3	1.4
ES	2.1	1.8	2.1	1.9	2.1	1.5	1.8	1.8	1.4	1.9
FR	4.1	3.5	3.8	3.3	3.5	3.0	2.9	2.7	3.1	3.2
IE	6.4	4.9	5.1	4.6	3.4	2.4	2.9	4.8	3.0	-
IT	5.6	6.2	6.4	5.8	6.0	5.7	4.9	4.7	5.4	5.3
LU	4.3	1.4	1.7	1.8	0.0	1.3	1.4	1.6	-	-
NL	20.0	19.7	20.8	18.2	17.8	18.3	19.6	17.1	18.3	-
AT	6.4	7.1	6.0	5.9	6.3	6.4	5.7	8.4	6.0	6.6
PT	3.5	2.8	3.0	3.5	2.1	3.0	3.0	3.5	4.1	3.6
FI	16.8	11.4	13.9	13.5	14.6	13.4	13.6	12.8	10.3	6.9
SE	10.0	9.1	7.8	10.9	7.8	8.0	7.4	7.5	6.6	5.6
UK	5.8	5.6	5.0	4.6	4.9	3.7	3.9	3.7	3.2	4.0
EU-14	5.3	5.0	5.1	4.7	4.7	4.4	4.4	4.2	4.42[2]	4.51[1]

Table 6.A.3.-Percentage of cyclist fatalities to total traffic fatalities in EU-14.

6.1 Main results from deliverable D1.1

6.1.1 Main literature review results

6.1.1.a Accident causation

There are few papers found concerning accident causation. In the technical documents reviewed the main relevant parameters discussed are location of accidents (i.e. crossings, signalled intersections), visibility and opponent vehicles. There is no clear definition as to the most concurrent scenarios and conditions relating to pedestrian and cyclist accidents. Data from studies focussed on accidents in UK, Japan and Korea has been collected and it is found that pedestrians differ in sizes and biomechanical response during accidents, even behaving differently while crossing the street (Cheol et altri 2005, Clarke et altri 2005, Depriester et altri 2005). 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 (Leffler et altri 2004).

The visibility and light conditions are two of the main factors related with the accident causation. The distribution of fatalities by light conditions shows that the most dangerous time for pedestrians to be during darkness, representing the average of almost 50% of the total. This is variable between the respective countries, from 58% in Austria to 35% in The Netherlands.

6.1.1.b Other general issues

Accident patterns
Pedestrians
Considering the age of the pedestrians involved in an accident a very high reduction, from 2,623 to 1,667 people (-36.4%), in the number of senior citizen (aged>64) pedestrian fatalities over the last 10 years is shown. Although the total number of pedestrian fatalities was reduced by 38.2% in the same time period, senior citizens remain the largest group in pedestrian fatalities. Young people (aged>18) remain the smallest affected group quantitively, even though they too have had a proportionally high decrease in fatalities over the last decade. While considering gender, of the females the proportion of pedestrian accidents to the total number of fatalities is significantly high. Suggesting that females are more likely to be involved as a pedestrian when in a road traffic accident, even though it is still the male population dominating the quantity of fatal road traffic accidents on the whole.
Cyclists

The number of fatalities has dropped for all ages, but most for people younger than 40 years old. The majority of bicycle fatalities in all countries occur within urban areas. Bicycles have an extremely high share of fatalities at junctions: almost half of the fatalities occurred at a junction. Of all the bicycle fatalities that happened on a junction the majority happened on crossroads.

Industry countermeasures

The industry is developing active and passive safety systems trying to avoid accidents and reduce the severity of their consequences (Berg et altri). New testing and simulation tools have been designed in order to get more information about all aspects concerning accident causation (Wanke et altri 2005, Nagatomi et altri 2005). From this testing and simulation it can be said that technical measures in the structure and frontal vehicle shape can clearly improve the safety performance (Lee et altri 2005, Crandall et altri 2005). However, the effectiveness of these parameters strongly depends on the individual vehicle's front geometry and differs for between adults and children. Impactor and/or component test procedures have been proposed for further evaluating pedestrian safety; some modifications are applicable when using these methods for the evaluation of cyclists (Maki et altri 2003). More testing is necessary to assess the possible effects that differences introduced in pre-test orientation, surrogate stature, and clothing will have on the surrogate response (Kuehn et altri 2005, Lawrence 2005).

Legislative countermeasures

The National Administrations are developing new regulations in Pedestrian Protection as the Directive of the European Parliament and of the council relating to the protection of pedestrians and other vulnerable road-users in the event of a collision with a motor vehicle (Directive 2003/102/EC), so as to try and force to the automotive industry into the application of measures to improve this dramatic situation. These new regulations will take into consideration the presence of active systems such as the Advanced Driver Assist and Pre-Crash Systems (Hardi et altri 2003). Options under discussion for resolving these changes are to increase the number of vehicle types and protected areas, as well as providing protection at higher speeds. Possible improvements to the test methods and tools, refining the impact conditions, and testing with a combination of dummy and subsystem tests, are also being considered.

Global harmonization should not be used an as an excuse for delaying efforts to reduce traffic casualties; the overdue EU Directive on Pedestrian Protection for example. Furthermore, due to the differences in vehicle fleets and other legitimate considerations, harmonization might not be appropriate at all and our scarce resources should not be wasted in futile efforts.

6.1.2 Main descriptive analysis results

Pedestrian

Only the urban areas should be studied distinguishing between when the accident occurs in an intersection and when it happens in a crossing pass. Only cases where the pedestrian is hit by a passenger car will be objective to the study. The analysis will consider two main age groups for the pedestrian: young people (< 20) or elderly people (>60). This differentiation will lead to two groups of studied cases. In all of these scenarios, the visibility and conspicuity associated should be 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.**

Cyclist

All the age groups will be analysed. The visibility of all the participants and the conspicuity of the environment will be central to the effort shown in the following steps. For the bicycles, the zone of the accident, differentiating between conventional roads on countryside and urban scenarios, will be the main point in order to group the studied cases. The most common scenarios regarding cyclist accidents are:

- ✓ Outside urban areas
  - **Straight road, cyclist in the road shoulder and car overtaking the cyclist.**
  - **Curvy road, car driving and cyclist not visible (blind curve).**

- ✓ Urban areas
  - **Cyclists in the bicycle lane and car invading it.**
  - **Bicycle riding between lanes.**
  - **Illicit turning at an intersection**

This chapter will be divided in two subchapters. The first one will be focused on **pedestrians** and the second one on **cyclists** issues. For both of them, methodology used and results from 'In-depth' and 'Risk analyses' will be explained.

A.- Pedestrians

6.2 In depth analysis

6.2.1 *Data used for the in-depth analysis*

6.2.1.a LMU database

In Germany 1112 pedestrians were killed in road traffic accidents in 2004; in Bavaria 159 pedestrian fatalities were documented. On behalf of the public prosecutions of Munich, Augsburg, Passau, Traunstein, Rosenheim, Memmingen, Landshut and Ingolstadt 51 pedestrians being killed in accidents were autopsied at the Institute for Legal Medicine in Munich. For this southern part of Bavaria, which resembles about 50% of the area, no exact numbers for pedestrian fatalities are traceable. Other criteria for estimating the representativeness of this sample like km road, inhabitants, are not useful because of the varying catchment areas and circuits of the cases. A bias towards fatal accidents where death occurs on site must be assumed. Death within 30 days after traffic crash defines a fatal traffic accident. Autopsies might be requested primarily for unclear situations raising legal interest The sample being implemented in the LMU fatality database therefore might be biased towards fatal pedestrian accidents where death happened on site and where information about the accident circumstances are lacking on a first view so that the police orders a legal investigation. The advantage of this selection can be seen in the fact that focus is laid on traffic accidents where tertiary prevention might not influence the outcome. Death might have occurred to the pedestrians independent of time and mode of first aid, transport, intensive medical treatment and factors like age and co-morbidities.

LMU was granted access to the prosecution files for the TRACE research project. For the final analysis 45 fatal accidents out of 51 cases could be used. Three files were not available; another three cases had to be excluded from the survey. Exclusion criteria were suicide of the pedestrian (one case) and accidents involving pedestrians but no driver of a vehicle (like death of a worker of a construction site due to a rolling tag, counting as a work related accidents, and the other case where a pedestrian was killed by a ripping tow rope).

In two of the 45 included cases we could find more than one fatal injured pedestrian. One case with 2 killed persons another one with three. These 48 pedestrians consisted of 26 male persons and 22 females. Their age distribution, see the following table, shows that more than 50% of the pedestrians killed in road traffic accidents belong to the age groups older than 60 years.

Age group	Total n=48
0-9	1
10+	6
20+	3
30+	2
40+	7
50+	4
60+	8
70+	10
80+	7

Table 6.A.4.-Age distribution of pedestrians killed in traffic accidents.

In contrast to the pedestrians killed where the gender distribution seems reasonable balanced the share of males in the related (so-called for further use) "opponent" distribution is higher than expected. Nearly 87% of the drivers involved in fatal pedestrian accidents are male. Only 6 of the 45 drivers are female. The highest share with more than one third is represented by the age group between 30 and 40, being comparable to the normal driver population.

age (opponents)	Total n= 45
16+	3
20+	8
30+	16
40+	9
50+	5
60+	3
70+	1

Table 6.A.5.-Age distribution of opponents (drivers involved in fatal pedestrian accidents).

The accidents happened within the city limits in about 43%. In around 46% there had been daylight conditions, followed by darkness with streetlights in 31%. The majority of accidents took place between 12p.m. and 6.p.m. in about 35%, followed by the first half of the night until 12 a.m. in 26%. A high share of accidents occurred on a Tuesday with around 33%.

6.2.1.b IDIADA database

The accidents analysed by IDIADA correspond to severe pedestrian accident cases documented in Barcelona city (Catalonia, Spain) in 2005, 2006 and 2007. This sample does not include all the pedestrian accident cases in the city during this period: it is big a sample of them but some cases could be missing. It includes only passenger car run over. For this reason, exact numbers for pedestrian fatalities are not traceable.

In Catalonia, there were 177 pedestrian accidents in interurban roads (30 of them fatal) and 3.239 pedestrian accidents in urban zones (46 of them fatal). Barcelona has 1.891 pedestrian accidents. Then, it can be stated that the data contained in this database represents a good sample of the accidents in urban zones. 55 cases have been documented, resulting in 12 fatalities and 54 severely injured.

Cases come from Barcelona City Council and Guàrdia Urbana de Barcelona (local police) accidents database. All urban accidents in Barcelona are documented there, but only a sample of 55 accidents was selected because data was not consistent. The access to the database has been granted for the exploitation of the figures in the TRACE project.

Some general statistics of the accidents analysed are presented here. Over the 55 accidents and the 66 victims, 22 of them were females (5 fatalities) and 33 were males (7 fatalities). Regarding the age of the victims, most of them were concentred in the extremes (35% were ≤ 30 yo and 35% were > 60).

gender	distribution of pedestrians involved
male	33
female	22
Total	55

Table 6.A.6.-Gender distribution of pedestrians killed in traffic accidents.

age	distribution of pedestrian involved
16+	6
20+	13
30+	8
40+	6
50+	3
60+	7
70+	12
Total	55

Table 6.A.7.-Age distribution of pedestrians killed in traffc accidents.

Regarding the opponents involved in the accidents, in most of the accidents were males (85%) and young (56% were ≤ 40 yo, while only 9% were > 60 yo).

gender	distribution of opponents
male	47
female	8
Total	55

Table 6.A.8.-Gender distribution of opponents (drivers involved in fatal pedestrian accidents)

age	distribution of opponents
16+	1
20+	18
30+	12
40+	11
50+	8
60+	3
70+	2
Total	55

Table 6.A.9.-Age distribution of opponents (drivers involved in fatal pedestrian accidents)

The majority of the accidents represent a pedestrian crossing the street through a non-marked zone (no pedestrian crossing) or crossing through a pedestrian crossing with red traffic lights for the pedestrian (in 39 over 55 accidents, the pedestrian action was the main cause of the accident, with marks/signals disobeyed). This configuration leads to the typical approach currently done for pedestrian protection developments with impactors and a vehicle moving in straight line. In most of the cases, the driver was driving at legal speeds, but his action was not enough (in terms of time or effort) to avoid the accident. Weather or light conditions do not seem to be critical points in the accidents as most of them happened with daylight and dry and good road conditions.

site	distribution of pedestrian fatalities
urban	55
rural	0
Total	55

Table 6.A.10.-Distribution of pedestrian fatalities by site.

light/time of day	distribution of pedestrian fatalities
daylight	34
dusk/dawn	14
night with lighting	7
night without lighting	0
Total	55

Table 6.A.11.-Distribution of pedestrian fatalities by light/time of day

6.2.2 Human functional failure (HFF) analysis

6.2.2.a Analysis of the feasibility of the HFF method: 2 LMU cases

According to the method developed and presented in the deliverables D5.1 (van Elslande, 2007) and D5.2 (Naing, 2007) provided by WP5, and which was additionally trained in a workshop for WP1 where LMU and IDIADA took part, first only two fatal pedestrian cases where analysed by this method. This was necessary as the method was developed on the basis of road traffic accidents where psychologists were able to interview the involved parties. Applying the method to fatal accidents therefore has to be tested. In addition the method focuses not primarily on pedestrian accidents, which could lead to missing tasks and conflicts within the grid of factors. This sub-report for 1.4 provided by LMU must therefore also be seen as a feasibility study of the method being applicable to fatal pedestrian accidents.

These two cases were prepared for evaluation which was done by WP5 experts, and in discussion with them the method seemed to be feasible also for the LMU data sample and the correlating information content of the files. The HFF method was performed for the other cases similarly, except for picturing the whole case in that detail for presentation for all cases. Two cases for presentation are attached in the Annex 1.4 as case examples.

6.2.2.b In-depth human functional failure analysis: methodology

For this in-depth human functional failure analysis 45 pedestrians killed in road traffic accidents and 45 opponents in Germany and 55 severe and fatal accidents in urban area (Barcelona) were taken into account. The accidents in which more than one pedestrian was killed were first screened if there had been different accident mechanisms or functional failures for the fatalities. But, as failures, tasks, conflicts, explanatory elements, movement and mechanism of accident were homogenous for the fatalities relating to one case it was decided to select only one pedestrian being representative for all involved pedestrians per case. This, resulting in one opponent driver and vehicle and one pedestrian killed per case, avoids the need for analysis methods for dependent inter-individual data.

Two people evaluated the files independently (the same method was followed in LMU and IDIADA). Then they compared their results. In case of different results of the analysis these two discussed about one possible solution for each case by consulting the original files again. If no agreement could be gained a third person also trained in the method was consulted. Finally always one analysis result was decided upon and implemented in the database. In cases where no analysis was possible for single variables due to missing information giving too much space for individual interpretation it was either decided to take the most probable option, or to leave this variable as n.e. (not evaluable). This (n.e.) might also be coded for seldom situations of the evaluation scheme not being applicable.
The analysis of the results of the human functional failure analysis are then presented for both the pedestrians and the opponents by frequency analysis and cross tabulation of human functional

failures and the corresponding tasks, conflicts and degree of involvement. Only for the most frequently occurring HFF the distribution of explanatory elements is performed.

6.2.2.c In-depth human functional failure analysis: results: pedestrian

Pedestrian Human Functional Failures – an overall view
To get an overview on the most frequently occurring failures applying to pedestrians in traffic accidents first only the HFF groups distribution is presented in table.

LMU results

HFF group	Explanation	Total n= 45
D	Failures at the stage of deciding on the execution of a specific manoeuvre (DECISION)	6
E	Failures at the psychomotor stage of taking action (EFFECT)	1
G	Overall failure (GENERAL)	14
n.e.	Not evaluable	7
P	Failures at the information detection stage (PERCEPTION)	9
T	Failures at the diagnostic stage (information processing stage 1) and on the prognostic stage (information processing stage 2) (TRANSLATION)	8

Table 6.A.12.-Human functional failure groups, distribution for fatalities.

IDIADA results

HFF group	Explanation	Total n= 55
D	Failures at the stage of deciding on the execution of a specific manoeuvre (DECISION)	21
E	Failures at the psychomotor stage of taking action (EFFECT)	3
G	Overall failure (GENERAL)	4
n.e.	Not evaluable	7
P	Failures at the information detection stage (PERCEPTION)	15
T	Failures at the diagnostic stage (information processing stage 1) and on the prognostic stage (information processing stage 2) (TRANSLATION)	5

Table 6.A.13.-Human functional failure groups, distribution for casualties.

In many cases of LMU (14 out of 45) pedestrians performed overall failures (G-failures). However, in the IDIADA cases, only 4 out of 55 were classified in the G-failures group. In 9 out of 45 LMU cases and 15 out of 55 IDIADA cases they committed failures at the information detection stage (P-failures) (comparable figures). In 7 LMU cases and 7 IDIADA cases we could not detect or define any failure. Either this was due to lack of information (no witness of the accident, more than one failure possible) or problems for coding occurred because no rupture phase for the pedestrians was possible to identify. E.g. the pedestrians were drawn into the accident situation even if they did not take part at the usual road traffic and thus caught by surprise (e.g. walking on pavement, standing at road banquet).
The single HFF subgroups distribution for pedestrian fatalities is pictured in the following table

LMU results

	HFF sub groups – HFF groups	D	E	G	P	T	n.e.
G2	*Alteration of sensorimotor and cognitive capacities*			12			
n.e.	*not evaluable*						7
D2	*Deliberate violation of a safety rule*	6					
P5	*Neglecting the need to search for information*				6		
T5	*Expecting another user not to perform a manoeuvre*					6	
P2	*Information acquisition focused on a partial component of the situation*				3		
G1	*Loss of psycho-physiological capacities*			2			
E2	*Guidance problem*		1				
T2	*Erroneous evaluation of the size of a gap*					1	

T6	*Actively expecting another user to take regulating action*					1	
sum	Total n= 45 in HFF groups	6	1	14	9	8	7

Table 6.A.14.-Human functional failure sub-groups, distribution for fatalities.

IDIADA results

	HFF sub groups – HFF groups	D	E	G	P	T	n.e.
G2	*Alteration of sensorimotor and cognitive capacities*			3			
n.e.	*not evaluable*						7
D2	*Deliberate violation of a safety rule*	21					
P5	*Neglecting the need to search for information*				9		
T5	*Expecting another user not to perform a manoeuvre*					0	
P2	*Information acquisition focused on a partial component of the situation*				6		
G1	*Loss of psycho-physiological capacities*			1			
E2	*Guidance problem*		3				
T2	*Erroneous evaluation of the size of a gap*					3	
T6	*Actively expecting another user to take regulating action*					2	
sum	Total n= 55 in HFF groups	21	3	4	15	5	7

Table 6.A.15.-Human functional failure sub-groups, distribution for fatalities.

On closer examination one can see that even if overall failures (G), decision (D) and perception failures (P) hold the majority in HFF groups the distribution for the subgroups differs. Correlative to prevalent G-failure we found that most pedestrians performed a G2 failure meaning an impairment of sensorimotor and cognitive abilities. Within this group the vast majority was detected to have high blood alcohol level while taking part in traffic. Even if detection failures (P-failures) occur at large they often play a subordinate part when it comes to split HFF sub-groups up. The failure D2 - Deliberate violation of a safety rule is especially important in the IDIADA cases (urban area). Other significant number is the related with P5 - Neglecting the need to search for information 6 in the LMU database and 9 in the IDIADA sample).

Pedestrian Human Functional Failures and Tasks

As a next step, we specified Human Functional Failures and linked them to evaluated tasks. Most people tried to cross the street when the accident happened.

LMU results

The evaluation scheme was not designed for pedestrian fatalities so we had to insert a new category "crossing the street" which fits for almost half of the accidents (19 of 45). Included in this new category are all kinds of crossing the street by a pedestrian, including crossing either at a pedestrian crossing (with or without a traffic light) or not. Nevertheless, 15 accidents could not be set into the scheme as they were just single events which could not be put into a new category. "not evaluable" (n.e.) was applied to all pedestrians whose tasks are unknown to the investigators or performed a task not intended by the scheme (e.g. crossing tram tracks, being stationary on a road like kneeling, laying on the ground, waiting in the middle of a road,…).

By cross tabulating HFF to tasks it can be seen that the most frequently occurring combination is the general (G-)failure while crossing the street (n=6). It is followed by diagnostic and prognostic (T-) failures in combination with crossing the street (n=5).

	HFF group						
Task	D	E	G	P	T	n.e.	total
Going ahead on a straight road	1		1			2	4
Going straight at "traffic signal" intersection							
Going ahead on a left bend	1						1
Approaching pedestrian crossing				1			1
Crossing the street	3		6	3	5	2	19
n.e.	1		3	4	2	5	15
total	6	1	14	9	8	7	45

Table 6.A.16.-Human functional failure and tasks, distribution for casualties.

Going into deeper structure of Human Functional Failures we found that most pedestrians who wanted to cross the street were impaired in consideration of sensorimotor and cognitive abilities (n=6), nevertheless some pedestrians (n= 4) did not expect (by default) a manoeuvre by another user (T5-failure). Another 4 pedestrian fatalities took place when sensorimotor and cognitive impaired pedestrians were walking along a straight road. In 5 cases we could neither find out what kind of task had been performed nor which failure had been committed.

IDIADA results

	HFF group						
Task	D	E	G	P	T	n.e.	total
Going ahead on a straight road	1	0	0	0	0	2	3
Going straight at "traffic signal" intersection	1	2	0	4	0	1	8
Going ahead on a left bend	0	0	0	0	0	0	0
Approaching pedestrian crossing	0	0	0	1	0	0	1
Crossing the street	18	1	3	10	5	4	41
n.e.	1	0	1	0	0	0	2
total	21	3	4	15	5	7	55

Table 6.A.17.-Human functional failure and tasks, distribution for casualties.

It can be seen from this table that dominant accident scenario of 'Crossing the street' is predominantly linked to human errors in decision making. As commented in the data description, most of the accidents analyzed represent a pedestrian crossing a street, with or without the right of crossing. It is important to take into account that this data comes from urban traffic accidents database and it is not likely to find other scenarios (going ahead, left bend…) in comparison with the scenario of 'crossing the street'. The detailed table of HFF sub-groups is attached in the Annex1.4.

Pedestrian Human Functional Failures and Conflicts

Conflicts leading to an accident situation are a matter of central concern. We opposed Human Functional Failures of pedestrians to conflicts taken place. For conflict analyses we refer to the direction of crash impulse.

LMU results

	HFF groups						
Conflict	D	E	G	P	T	n.e.	total
Oncoming vehicle			1				1
Vehicle from side	3		10	8	7	4	32
Following vehicle	3	1	3	1	1	2	11
n.e.						1	1
total	6	1	14	9	8	7	45

Table 6.A.18.-Human functional failure and conflict, distribution for fatalities.

An overwhelming majority had a conflict with a vehicle from side. In this group all pedestrians are assigned to who collided with a vehicle approaching from the side from the pedestrian's point of view e.g. pedestrians crossing over a street. Furthermore, 11 out of 45 pedestrian fatalities happened in a conflict with a following vehicle.

For nearly all pedestrians a conflict could be assigned, even in cases when walking on pavement. For one pedestrian no conflict could be found as direction of crash impulse and walking are unknown.

By linking Human Functional Failures to Conflicts one can see that most pedestrians performing an overall failure (G-failure) had a conflict with a vehicle from the side (n= 10). Nevertheless, 8 pedestrian with failures at the information detection stage (P-failures) and 7 cases with failures at the diagnostic and prognostic stage (T-failures) also crashed with vehicles from side.

Analysing Human Functional Failure subgroups to give more specific information about failure-conflict combinations there are found mainly pedestrians performing overall failures, e.g. due to impairment of sensorimotor and cognitive abilities (G2) being confronted with a vehicle from side (n= 9). They are followed by the group who neglected the need to search for information (n= 5, P5-failure) or did not expect by default manoeuvre by another user (n= 6, T5-failure) and are hit by a vehicle from the side.

IDIADA results

	HFF groups						
Conflict	D	E	G	P	T	n.e.	total
Oncoming vehicle	3	1	0	2	3	3	12
Vehicle from side	18	2	3	13	2	4	42
Following vehicle	0	0	0	0	0	0	0
n.e.	0	0	1	0	0	0	1
total	21	3	4	15	5	7	55

Table 6.A.19.-Human functional failure and conflict, distribution for fatalities.

Most of the pedestrians had a conflict with a vehicle coming from the side (n=42 over 55), something which is very representative of urban accidents. In most of the cases, the Human Functional Failure was related to a D-failure (deliberate violation of a safety rule, n=18 over 55) or a P-failure (information detection failure, n=13 over 55). These combinations represent 2 situations:

- A pedestrian crossing the street with no right of crossing (due to traffic lights or no crossing zebra) and overrun by a vehicle coming from the side.
- A pedestrian crossing the street with right of crossing but not taking care of the boundary conditions of the traffic.

Oncoming vehicle conflicts (n=12 over 55) mostly represent a situation of a vehicle interfering with pedestrians in the sidewalk or close to it.

Pedestrian Human Functional Failures and Degree of Involvement

Analysing data we were not only interested in tasks and conflict but also in the degree of involvement as a contribution to accident causation.

LMU results

	HFF groups						
Degree of Invovement	D	E	G	P	T	n.e.	total
Non-active	1					1	2
Passive			2			4	6
Primary active	4	1	12	6	5	2	30
Secondary active	1			3	3		7
total	6	1	14	9	8	7	45

Table 6.A.20.-Human functional failure and degree of involvement, distribution for fatalities.

Our study population of 45 pedestrian cases had been mainly "primary active" (n= 30) according to our results which means that these pedestrians initiated the situation in which the accident took place. As already been seen in other context, mostly G-failures occur and apparently is here the case, too. 12 out of 45 pedestrians committed an overall-failure (G-failure) and were "primary active" according to evaluation scheme.

On closer examination it can be seen that 11 out of 12 persons being primary active and committing G-failures were meant to be impaired in their cognitive and sensorimotor abilities (G2-failure). Furthermore, these persons were "primary active" and therefore, they caused a dangerous situation for other street users in which the accident took place. The detailed HFF sub-groups and degree of involvement distribution can be found in the annex 1.4.

IDIADA results

	HFF groups						
Degree of Involvement	D	E	G	P	T	n.e.	total
Non-active	0	0	0	0	0	1	1
Passive	0	0	1	0	1	5	7
Primary active	21	2	2	11	3	0	39
Secondary active	0	1	1	4	1	1	8
total	21	3	4	15	5	7	55

Table 6.A.21.-Human functional failure and degree of involvement, distribution for fatalities.

In most of the cases, the pedestrian took the responsibility and his own action was the instigator of the accident. As all accidents were urban and the law for vehicles/pedestrians is clearly defined, it is easy to determine which subject caused them. Once again, the neglecting action of the pedestrian, caused primary actively, is the most important degree of involvement (n=21 over 55). Other cases marked as primary active represent accidents where even when the pedestrian had the right of crossing the street, the fault of observing the traffic conditions became into accident (n=11 over 55), generally in zones with no specific marked crossing zebras.

Most frequent HFF group and subgroups in pedestrian fatalities (LMU cases)

As can be seen in this previous evaluation Overall-failures (G-failures) occur most often. A detailed analysis of this relevant group seems to be necessary. It was tried to find out information in detail concerning HFF subgroup and Explanatory Elements for accident causation. First, again the G-failures are opposed to task, conflict and degree of involvement, and then the explanatory elements are presented.

G-Failures of pedestrians, sub-groups and task

Task	G1	G2	total
Going ahead on a straight road		4	4
Going ahead at "traffic signal" intersection"		1	1
Crossing the street		6	6
n.e.	2	1	3
total	2	12	14

Table 6.A.22.-G- failures and tasks, distribution for fatalities.

14 pedestrian fatalities were linked to Overall-failures (G-failures). 12 cases out of 14 were G2 meaning an impairment of sensorimotor and cognitive abilities. Most often, these people tried to cross the street (n= 6) or were just walking along a road (n= 4).

For pedestrians having lost psycho-physiological abilities (G1-failure) evaluation of tasks was not possible in regard to evaluation scheme (n.e.= not evaluable) as one of them slept on the road and the other laid on the ground due to a medical problem.

<u>G-Failures of pedestrians, sub-groups and conflict</u>

Conflict	G1	G2	total
Vehicle from side	1	9	10
Oncoming vehicle	1		1
Following vehicle		3	3
total	2	12	14

Table 6.A.23.-G- failures and conflicts, distribution for fatalities.

The majority of pedestrians with G-failures had a collision with a vehicle from side (n= 10). Moreover 9 of 10 people being confronted witch a vehicle from side committed a G2-failure. In three cases, belonging to G2-group, a following vehicle was involved.

<u>G-Failures of pedestrians, sub-groups and degree of involvement</u>

Degree of Inv	G1	G2	total
Passive	1	1	2
Primary active	1	11	12
total	2	12	14

Table 6.A.24.-G- failures and degree of involvement, distribution for fatalities.

Considering G-failures linked to the degree of involvement pedestrians had in traffic accident situation, most pedestrians were "primary active". Most pedestrians belong to the G2-group.

<u>G-Failures of pedestrians, sub-groups and explanatory elements (EE)</u>

As evaluated before most frequent failure is an impairment of sensorimotor and cognitive abilities (G2-failure). In the following we tried to find out explanatory elements which are linked to Human Functional Failures. Overall 24 explanatory elements were applicable to the 14 pedestrians with G-failures. In eight cases we could assign one EE, in three cases two, in two cases three and in one case four Explanatory Elements.

EE	Absolute frequency
Medical condition	3
Pre-existing impairment	1
Substances taken – alcohol above "legal" limit	9
Substances taken – alcohol below "legal" limit	1
Substances taken – illegal drugs	1
Substances taken – correctly used medication	2
Identification of potential risk about only part of the situation	2
Little/None experience - driving	1
Distraction within user – lost in thought	1
Risk taking – traffic control (signs/signals/markings disobeyed etc.)	1
Risk taking – "eccentric" motives (competing)	1
Visibility impaired – other vehicles	1

Table 6.A.25.-G- failures and explanatory elements, distribution for fatalities.

Oftentimes, explanatory elements can be found within the state of user, and the psycho-physiological condition, respectively. 9 pedestrian fatalities showed that alcohol had been taken "above" legal limit". In these cases we assumed that a "legal" limit does not exist for pedestrians and that these pedestrians were none the less impaired in acting properly. In three cases a "medical condition" of the pedestrian was found. For two cases each displayed in table 3-9 "correctly used medication" or an "internal conditioning of performed task leading to non-identification of potential risk about only part of the situation" follow as third most frequently applied explanatory elements. Other EEs were single events.

Most frequent HFF groups and explanatory elements (IDIADA cases)

G-failure

EE	Absolute frequency
Medical condition	1
Pre-existing impairment	0
Substances taken – alcohol above "legal" limit	0
Substances taken – alcohol below "legal" limit	0
Substances taken – illegal drugs	0
Substances taken – correctly used medication	1
Identification of potential risk about only part of the situation	3
Little/None experience – driving	0
Distraction within user – lost in thought	0
Risk taking – traffic control (signs/signals/markings disobeyed etc.)	0
Risk taking – "eccentric" motives (competing)	0
Visibility impaired – other vehicles	0

Table 6.A.26.-G- failures and explanatory elements, distribution for fatalities.

In contrast to data provided by LMU, overall failures are not the most concurrent Human Functional Failures for IDIADA cases. Cases with G-failures have only been marked where several failures were produced at the same time and the other categories were not the only representative failure type.

This type of failures include a number of Identification of risk about part of the situation (n=3 over 55) as the action of the pedestrian was explained by an incomplete view of the boundary conditions. G-failures have also been associated to medical conditions with and without control, but only in two cases.

D-failure

EE	Absolute frequency
Medical condition	0
Pre-existing impairment	0
Substances taken – alcohol above "legal" limit	2
Substances taken – alcohol below "legal" limit	0
Substances taken – illegal drugs	0
Substances taken – correctly used medication	0
Identification of potential risk about only part of the situation	2
Little/None experience – driving	0
Distraction within user – lost in thought	1
Risk taking – traffic control (signs/signals/markings disobeyed etc.)	15
Risk taking – "eccentric" motives (competing)	2
Visibility impaired – other vehicles	0

Table 6.A.27.-D- failures and explanatory elements, distribution for fatalities.

"Deliberate violation of the safety rule" is generally concurrent with "Risk taking – traffic control" explanatory elements (n=15 over 55). It is representing the scenario where the pedestrian is not respecting the crossing zones or traffic lights. Another EE found in this cases was "Risk taking – eccentric motives", which appeared in 2 cases with young children involved. Alcohol, above legal limit was found as well, both times in risk taking attitudes and not respecting the traffic rules.

P-failure

EE	Absolute frequency
Medical condition	0
Pre-existing impairment	0
Substances taken – alcohol above "legal" limit	1
Substances taken – alcohol below "legal" limit	0
Substances taken – illegal drugs	0
Substances taken – correctly used medication	0
Identification of potential risk about only part of the situation	4
Little/None experience – driving	0
Distraction within user – lost in thought	4
Risk taking – traffic control (signs/signals/markings disobeyed etc.)	5
Risk taking – "eccentric" motives (competing)	2
Visibility impaired – other vehicles	1

Table 6.A.28.-P- failures and explanatory elements, distribution for fatalities.

The most concurrent EE for P-failures are Risk taking (safety rules disobeyed, n=5), Distractions (n=4) and Partial identification of the risk (n=4).

T-failure

EE	Absolute frequency
Medical condition	0
Pre-existing impairment	0
Substances taken – alcohol above "legal" limit	0
Substances taken – alcohol below "legal" limit	0
Substances taken – illegal drugs	0
Substances taken – correctly used medication	0
Identification of potential risk about only part of the situation	5
Little/None experience - driving	0
Distraction within user – lost in thought	0
Risk taking – traffic control (signs/signals/markings disobeyed etc.)	0
Risk taking – "eccentric" motives (competing)	0
Visibility impaired – other vehicles	0

Table 6.A.29.-T- failures and explanatory elements, distribution for fatalities.

All the cases marked with T-failures represent an "Identification of potential risk about only part of the situation". In all these 5 cases, although the pedestrian perceive the risk, the speed and / or the trajectory of the vehicle was not correctly estimated.

E-failure

EE	Absolute frequency
Medical condition	0
Pre-existing impairment	0
Substances taken – alcohol above "legal" limit	0
Substances taken – alcohol below "legal" limit	0
Substances taken – illegal drugs	0
Substances taken – correctly used medication	1
Identification of potential risk about only part of the situation	1
Little/None experience - driving	0
Distraction within user – lost in thought	0
Risk taking – traffic control (signs/signals/markings disobeyed etc.)	3
Risk taking – "eccentric" motives (competing)	0
Visibility impaired – other vehicles	0

Table 6.A.30.-E- failures and explanatory elements, distribution for fatalities.

Most of the cases marked here cannot be used for strong conclusions; they include cases where a fault during the accident of the pedestrian was the cause of the accident. In all these cases, a priori, the accident could have been avoided but, a fault of the pedestrian (falling on the road when the vehicle was seen), made it happen.

6.2.2.d HFF Analysis for drivers being involved in fatal pedestrian traffic accidents (opponents)

Opponents Human Functional Failures – an overall view

To get an overview on the most frequently occurring failures applying to opponents being involved in fatal pedestrian traffic accidents first only the HFF groups distribution is presented in following table.

LMU results

HFF group	Explanation	Total n= 45
D	Failures at the stage of deciding on the execution of a specific manoeuvre (DECISION)	7
E	Failures at the psychomotor stage of taking action (EFFECT)	5
G	Overall failure (GENERAL)	4
P	Failures at the information detection stage (PERCEPTION)	20
T	Failures at the diagnostic stage (information processing stage 1) and on the prognostic stage (information processing stage 2) (TRANSLATION)	8
n.e.	Not evaluable	1

Table 6.A.31.-Human functional failure groups, distribution for opponents.

IDIADA results

HFF group	Explanation	Total n= 55
D	Failures at the stage of deciding on the execution of a specific manoeuvre (DECISION)	3
E	Failures at the psychomotor stage of taking action (EFFECT)	6
G	Overall failure (GENERAL)	1
P	Failures at the information detection stage (PERCEPTION)	15
T	Failures at the diagnostic stage (information processing stage 1) and on the prognostic stage (information processing stage 2) (TRANSLATION)	28
n.e.	Not evaluable	2

Table 6.A.32.-Human functional failure groups, distribution for opponents.

Most frequently P-Failures at the information detection stage and T-Failures at diagnosis and prognosis stage are found (P-Failures "n= 20 for the LMU cases and n=15 for IDIADA cases" and T-Failures "n= 8 for the LMU cases and n=28 for IDIADA cases"). The numbers in the other categories are significantly lower.

LMU results

Six different vehicle types are represented in the driver sample (opponents): cars (n= 29), trucks (n= 10), trams (n= 3), one motorbike, tractor and a van.

	HFF group						
Types of traffic participation	D	E	G	P	T	NE	total
Car	3	4	3	15	4		29
Truck	2	1		5	2		10

Tram	1				1	1	3
Motorbike					1		1
Tractor	1						1
Van			1				1
Total	7	5	4	20	8	1	45

Table 6.A.33.-Human functional failures, distribution for types of drivers.

P-failures occurred in accidents with car drivers (n= 15) and truck drivers (n= 5). In one case of a tram driver no failure could be assigned. Due to accident situation the tram driver could not have guessed at any time a pedestrian would step out directly in front of the tram without watching out for traffic. This case has been discussed and found to be rather n.e. than T7 (no restricted visibility, chain of unlucky circumstances for the driver).
We chose car drivers to analyse more deeply as they represent the great majority of opponents (n= 29).

On closer examination one can see that especially P1 failures (Non-detection in visibility constraints conditions) apply to the car drivers in 8 cases. Second most frequently occurring failure for the car drivers was the P5 failure (Neglecting the need to search for information) in 4 cases.

	HFF sub groups – HFF groups	D	E	G	P	T	total
D1	*Violation directed by the characteristics of the situation*	1					1
D2	*Deliberate violation of a safety rule*	2					2
E1	*Poor control of an external disruption*		3				3
E2	*Guidance problem*		1				1
G1	*Loss of psycho-physiological capacities*			2			2
G2	*Alteration of sensorimotor and cognitive capacities*			1			1
P1	*Non-detection in visibility constraints conditions*				8		8
P2	*Information acquisition focused on a partial component of the situation*				2		2
P4	*Momentary interruption in information acquisition activity*				1		1
P5	*Neglecting the need to search for information*				4		4
T5	*Expecting another user not to perform a manoeuvre*					1	1
T7	*Expecting no perturbation ahead*					3	3
	Total n= 45 in HFF groups	3	4	3	15	4	29

Table 6.A.34.-Human functional failure sub-groups, distribution for car drivers.

IDIADA results
For the IDIADA cases, only passenger cars were considered. On closer examination one can see that most frequently occurring failure for the car drivers was the T7 failure (Expecting no perturbation ahead) in 20 cases. Especially P1 failures (Non-detection in visibility constraints conditions) and T5 failure (Expecting another user not to perform a manoeuvre) apply to 8 cases each other.

	HFF sub groups – HFF groups	D	E	G	P	T	NE	total
D1	*Violation directed by the characteristics of the situation*	1						1
D2	*Deliberate violation of a safety rule*	2						2
E1	*Poor control of an external disruption*		4					4
E2	*Guidance problem*		2					2
G1	*Loss of psycho-physiological capacities*			1				1
G2	*Alteration of sensorimotor and cognitive capacities*			0				0
P1	*Non-detection in visibility constraints conditions*				8			8

P2	*Information acquisition focused on a partial component of the situation*				4			4
P4	*Momentary interruption in information acquisition activity*				1			1
P5	*Neglecting the need to search for information*				2			2
T5	*Expecting another user not to perform a manoeuvre*					8		8
T7	*Expecting no perturbation ahead*					20		20
	Not applicable						2	2
	Total n= 55 in HFF groups	3	6	1	15	28	2	55

Table 6.A.35.-Human functional failure sub-groups, distribution for car drivers.

Opponents Human Functional Failures and Tasks

LMU results

By cross tabulating HFF to tasks it can be seen that the most frequently occurring combination is the P-failure while going ahead on a straight road (n= 10). It is followed by diagnostic and prognostic failures in combination with the same task (n= 5).

	HFF group						
Task	D	E	G	P	T	n.e.	total
Going ahead on a straight road (1)	3	2	2	10	5		22
Going ahead on a left bend (2)			1				1
Going ahead on a right bend 3)		1		1			2
Approaching intersection where road user has right of way (7)					1		1
Going straight at "traffic signal" intersection (14)	1		1	1			3
Turning across traffic at "traffic signal" intersection (20)				1			1
Starting (not at junction) (34)				1	1		2
Turning away from traffic from main road into private drive (37)				1			1
Turning across traffic out of private drive (38)				3			3
Reversing (40)	2			2			4
Driving in wrong direction (42)		1					1
Approaching pedestrian crossing (45)		1					1
Approaching railway crossing (47)					1		1
n.e.	1					1	2
total	7	5	4	20	8	1	45

Table 6.A.36.-Human functional failure and tasks, distribution for opponents.

It can be seen that 50% of P-failures were committed while going ahead on a straight road (n=10 out of 20 P-failures) and mainly drivers with P-failures carried out this task (10 out of 22 times task 1).

The case where no failure could be assessed was the previously mentioned tram driver; but, furthermore also no task could be found applicable to the tram drivers in general. The 3 tram drivers in the opponents sample were going ahead on tracks and this option is not defined in the evaluation schema. One tram driver was nevertheless able to be put into the evaluation scheme as he was approaching a railway crossing. Thus only two tasks remain that are coded n.e.

Splitting up to failure sub-groups and combining them with tasks, P1-failures become dominant to other failures (n= 9). But even if P-failures occur oftentimes drivers in our study did also often commit D2-failures (n= 6), a small subgroup of HFF. Most of the drivers who were going ahead on a straight road underwent a P1-failure (n=6) or a T7-failure (n= 4). The detailed table is found in the Annex1.

For car drivers only the following distribution could be found. Most often the tasks "going ahead on a straight road" (n=15) , " Going straight at "traffic signal" intersection" (n=3) and " Reversing" (n=2) is found.

	HFF group					
Task	D	E	G	P	T	total
Going ahead on a straight road (1)	2	2	1	7	3	15
Going ahead on a left bend (2)			1			1
Going ahead on a right bend 3)		1		1		2
Approaching intersection where road user has right of way (7)					1	1
Going straight at "traffic signal" intersection (14)	1		1	1		3
Turning across traffic at "traffic signal" intersection (20)				1		1
Starting (not at junction) (34)				1		1
Turning away from traffic from main road into private drive (37)				1		1
Turning across traffic out of private drive (38)				1		1
Reversing (40)				2		2
Driving in wrong direction (42)		1				1
total	3	4	3	15	4	29

Table 6.A.37.-Human functional failure and tasks, distribution for car drivers.

Accidents mainly happened when drivers were going ahead on a straight road (n=15) and were often linked to P-failures (n=7), especially P1 failures (n=5). Other tasks were not performed often and therefore single events. The detailed tables in the annex 1.4 shows the distribution of HFF sub-groups by tasks for car drivers only.

IDIADA results

By cross tabulating HFF to tasks it can be seen that the most frequently occurring combination is the T- failure while going ahead on a straight road (n= 14).

	HFF group						
Task	D	E	G	P	T	n.e.	total
Going ahead on a straight road (1)	0	2	1	6	14	1	24
Going ahead on a left bend (2)	0	0	0	0	0	0	0
Going ahead on a right bend 3)	0	0	0	0	0	0	0
Approaching intersection where road user has right of way (7)	0	0	0	0	0	0	0
Going straight at "traffic signal" intersection (14)	2	4		2	7	1	16
Turning across traffic at "traffic signal" intersection (20)	1	0		4			5
Starting (not at junction) (34)	0	0	0	0	0	0	0
Turning away from traffic from main road into private drive (37)	0	0	0	0	0	0	0
Turning across traffic out of private drive (38)	0	0	0	0	0	0	0
Reversing (40)	0	0	0	0	0	0	0
Driving in wrong direction (42)	0	0	0	0	0	0	0
Approaching pedestrian crossing (45)	0	0	0	3	7	0	10
Approaching railway crossing (47)	0	0	0	0	0	0	0
n.e.	0	0	0	0	0	0	0
total	3	6	1	15	28	2	55

Table 6.A.38.-Human functional failure and tasks, distribution for opponents.

It can be seen that 50% of T-failures were committed while going ahead on a straight road (n=14 out of 28 T-failures) and mainly drivers with T-failures carried out this task (14 out of 24).

Opponents Human Functional Failures and Conflict

LMU results

	HFF groups						
Conflict	D	E	G	P	T	n.e.	total
None			2				2
Stationary vehicle ahead		1			1		2
Pedestrian crossing over	7	2		14	6	1	30
Pedestrian walking along road		1	1	4	1		7
n.e.		1	1	2			4
Total	7	5	4	20	8	1	45

Table 6.A.39.-Human functional failure and conflict, distribution for opponents.

As mentioned before, P-failures a dominant among our study population of opponents. Considering conflict drivers had to cope with while going ahead, one can find an overwhelming majority of a conflict dealing with the problem that a pedestrian is crossing over the street (n= 30 out of 45). Further 7 drivers had to face a pedestrian walking along the street.

Among those whose conflict was a pedestrian crossing over P-failures are dominant above D- and T-failures (14 vs. 7 out of 30).

No conflicts could be found for those who encountered a problem not listed in given schema e.g. pedestrian sleeping on road (can't be defined as "stationary obstacle"), fallen asleep while driving, medical problem, diverting from road due to high alcohol intoxication, losing control of the car.

Giving a closer look on HFF-subgroups P1-failures and D2-failures are most frequently among the conflict "pedestrian crossing over" correlative to previous tables. Drivers belonging to these groups most often had a conflict with a crossing pedestrian (D2: n= 6, P1: n= 5). The detailed table is found in the annex as table 6.

Regarding the car drivers only the following distribution can be found.

	HFF groups					
Conflict	D	E	G	P	T	total
None			2			2
Stationary vehicle ahead		1				1
Pedestrian crossing over	3	1		11	3	18
Pedestrian walking along road		1		2	1	4
n.e.		1	1	2		4
Total	3	4	3	15	4	29

Table 6.A.40.-Human functional failure and conflict, distribution for car drivers.

Conflict situations were mainly introduced by a pedestrian crossing over the street (n= 18). Even in this category the P-failure is the most common (n=11), especially the P1-failure (n=5) (see table 4-7 in annex).

IDIADA results

Regarding the car drivers only the following distribution can be found.

	HFF groups						
Conflict	D	E	G	P	T	NE	total
None	0	0	0	0	0	0	0
Stationary vehicle ahead	0	0	0	0	1	0	1
Pedestrian crossing over	3	5	0	14	26	2	50
Pedestrian walking along road	0	1	1	1	1	0	4
n.e.	0	0	0	0	0	0	0
Total	3	6	1	15	28	2	55

Table 6.A.41.-Human functional failure and conflict, distribution for car drivers.

Conflict situations were mainly introduced by a pedestrian crossing over the street (n= 50). Even in this category the T-failure is the most common (n=26). It is important to take into account that IDIADA cases are a sample of urban accidents only.

Opponents Human Functional Failures and Degree of Involvement

The next point of interest was laid on drivers and their degree of involvement. Linking data to Human Functional Failures it seems that most opponents are "secondary active" in contrary to pedestrians who are considered to be mainly "primary active".

LMU results

Connected to failures the impression arises that mainly drivers dealing with P-failures were meant to be "secondary active" (n=10) in taking action.

	HFF groups						
Degree of Inv	D	E	G	P	T	n.e.	total
n.e.			1				1
Non-active	1			6	1	1	9
Primary active	2	3	3	4	1		13
Secondary active	4	2		10	6		22
total	7	5	4	20	8	1	45

Table 6.A.42.-Human functional failure and degree of involvement, distribution for opponents.

P1-failure is more often than other failures (n=9) and it plays are great role for consideration of degree of involvement. Even if most drivers were "secondary active" a few more drivers were "non-active" within P1-group (n=5). Second group also refers to P1-failure but these people were like most drivers "secondary active" (n=4). (see table 8 in annex1.4)

	HFF groups					
Degree of Inv	D	E	G	P	T	total
n.e.			1			1
Non-active				5	1	6
Primary active		2	2	4		8
Secondary active	3	2		6	3	14
total	3	4	3	15	4	29

Table 6.A.43.-Human functional failure and degree of involvement, distribution for car drivers.

Comparable to the population of drivers where cars are dominant to other vehicles car drivers were mainly "secondary active" (n=14). But having a closer look one can see that "primary active" (n= 8) and "non-active" (n= 6) occur relatively often regarding amount of study population. Within P-failures degree of involvement is quite balanced even if "secondary active" holds majority (n= 6), see table 3-18.

In one case we could not define a degree of involvement (n.e.). On the one hand the driver initiated the accident ("primary active"). On the other, this driver had most likely been unconscious while applying the gas petal due to his medical condition (aortic rupture) and for this reason some kind of "non-active". Discussing this case, it was concluded, that this driver cannot be categorised (n.e.).

Considering HFF subtypes linked to degree of involvement most car drivers had a P1-failure while being "non-active". Overall, P1-failure is most common within failure types as seen before. (see table 9 in annex1.4)

IDIADA results

	HFF groups						
Degree of Inv	D	E	G	P	T	n.e.	total
n.e.	0	0	0	1	3	0	4
Non-active	0	0	0	0	1	0	1
Primary active	1	1	0	5	4	0	11
Secondary active	2	5	1	9	20	2	39
total	3	6	1	15	28	2	55

Table 6.A.44.-Human functional failure and degree of involvement, distribution for opponents.

In most of the cases, the driver was considered as secondary active (n=39 over 55). This consideration includes cases where the pedestrian took the primary responsibility of the accident (not respecting the safety rule) but the action of the driver did also lead to the accident (driving over the speed limit or not implementing a successful avoidance action). At this point, faults in the diagnostic or prognostic of the situation (T-failures, n=20) which finally lead to the accident were a very concurrent, but also the faults in the detection (P-failures, n=9).

When the driver was primary active (n=11 over 55), T and P-failures were also the most repeated ones.

Car drivers Human Functional Failures and EE

LMU results

As presented for the LMU cases, P-failures are most common among car drivers. For this category, we tried to find out elements explaining accident situation.

<u>P1-failure</u>

This failure refers to a lack of visibility for the driver and due to restricted view he could not detect the pedestrian. P1-failure was detected eight times within car drivers.
21 EEs were applicable to the 8 car drivers undergoing a P1 failure. In three four EEs, twice one or two EEs each, and once three EEs cases were applicable.

EE	Absolute frequency
Identification of potential risk about only part of the situation	1
Risk taking: Speed	1
Road geometry: Road width	1
Visibility impaired: Road lighting	1
Visibility impaired: Vehicle lighting	3
Visibility impaired: Night	5
Visibility impaired: Weather	3

Visibility impaired: Other vehicle(s)	4
Maintenance: Glass	1
Maintenance: Exterior lights	1

Table 6.A.45.-P1- failures and explanatory elements, distribution for car drivers.

Most often, these drivers had to deal with a situation in which visibility was impaired for them, e.g. due to night/darkness (n=5), other vehicles (n=4), weather (n= 3) and/or vehicle lighting (n=3).

P5-failure

This failure refers to lack of information acquisition meaning the driver neglected the need to search for information. Four cases showed a P5-failure for the driver. Overall 8 explanatory elements could be found for the drivers with P5-failures.
Two times we found two EEs for the accidents, per one case three EEs or one EE.

EE	Absolute frequency
Identification of potential risk about only part of the situation	1
Over-experienced: Route	1
Distraction within vehicle: other occupant	1
Risk taking: Traffic control (signs/signals/markings disobeyed)	2
Road geometry: Road width	1
Visibility impaired: Weather	1
Design: Visibility	1

Table 6.A.46.-P5- failures and explanatory elements, distribution for car drivers.

The 4 drivers undergoing this kind of failure had different problems and due to this low number no clear pattern can be derived.

IDIADA results

As presented for the IDIADA cases, T-failures are most common. For this category, the elements explaining accident situation were analyzed.

T7-failure

This failure refers to the expectation of no perturbation ahead. This failure is applicable to 20 cases. It represents the behaviour of the driver, partially engrossed because of the trust in the traffic safety rules. At this point, it was not possible to provide only one EE, as sometimes, the accident could not be explained with only explanation.

27 EEs were applicable to the 20 car drivers undergoing a T7 failure. In seven cases, two EEs, were applicable, while the other 13 cases given only one EE.

EE	Absolute frequency
Identification of potential risk about only part of the situation	10
Risk taking: Speed	7
Road geometry: Road width	0
Visibility impaired: Road lighting	0
Visibility impaired: Vehicle lighting	1
Visibility impaired: Night	0
Visibility impaired: Weather	0
Visibility impaired: Other vehicle(s)	9
Maintenance: Glass	0
Maintenance: Exterior lights	0

Table 6.A.47.-T5- failures and explanatory elements, distribution for car drivers.

Most of this cases (n=10) were classified with an EE of 'Identification of potential risk about only part of the situation'. In some of these cases, additional risks were taken: visibility impaired by vehicles (n=9) and speed (n=7).

T5-failure

This failure refers to the assumption that another user would not perform an action (but he actually does). Eight cases showed a T5-failure for the driver. Overall, 3 different explanatory elements could be found for the drivers with T5-failures: 'Identification of potential risk about only part of the situation', 'Risk taking: Speed' and 'Visibility impaired: Other vehicle(s)'. Their distribution is quite homogeneous.

Only one time a case was given two EEs.

EE	Absolute frequency
Identification of potential risk about only part of the situation	3
Risk taking: Speed	2
Road geometry: Road width	0
Visibility impaired: Road lighting	0
Visibility impaired: Vehicle lighting	0
Visibility impaired: Night	0
Visibility impaired: Weather	0
Visibility impaired: Other vehicle(s)	4
Maintenance: Glass	0
Maintenance: Exterior lights	0

Table 6.A.48.-T5- failures and explanatory elements, distribution for car drivers.

No big differences are shown with these figures, as the number of cases is low and so is the absolute frequency. The three EEs associated to this failure are the 'Identification of potential risk about only part of the situation' (n=3), Risk 'taking: Speed' (n=2) and 'Visibility impaired by other vehicle' (n=4).

6.3 Discussion

6.3.1 LMU

By applying the method introduced by WP5 for the in-depth analysis in TRACE to the fatalities database for pedestrians at LMU a kind of feasibility study was performed on the one hand. On the other hand some reasonable insights could be gained.

45 fatal pedestrian accidents had been analysed in-depth. These comprise all fatal pedestrians of which the prosecution files were available for evaluation at LMU Institute for Legal Medicine, within the catchment area in 2004. Due to an estimated selection bias towards accidents where death occurs immediately during the crash, the urban accidents which are assumed to happen at lower velocities with a higher chance for surviving at least up to 30 days are under-represented.

The pedestrians killed in road traffic accidents were nearly evenly distributed for sex, and the majority was more than 60 years old. The pedestrians most often underwent G2 failures, meaning they were impaired in their sensorimotor and cognitive abilities. The task they performed was "crossing the street" when the conflict with a vehicle from the side occurred. In most cases the pedestrians had to be regarded as "primary active". The most frequently found explanatory elements for this failure x task x conflict combination was alcohol above the legal limit (as would have been applied to drivers with a value of 0.05% BAC).

For the opponents as being the drivers involved in the fatal pedestrian accident the distribution of sex is shifted towards males, and show an age distribution comparable to the driver population in general. For the drivers most often a P1 failure (Non-detection in visibility constraints conditions) could be detected. The task they were performing was going ahead on a straight road most frequently when conflicting with a pedestrian crossing the street. In most cases the drivers have to be regarded as "secondary active" as the pedestrian initiated the situation. The explanatory elements found for the drivers comprise visibility constraints like night, other vehicles, weather, and vehicle lighting.

The results are comparable to published facts concerning pedestrian accidents. The pedestrians being primarily of older age and by taking the total number of fatalities in traffic for females into account, the higher risk for females is also documented by the CARE- database results (see SafetyNet, 2007). The number for Germany is also given with 47% of pedestrian fatalities being in the age group of 65+. (see WP1, D1.1).

A study conducted in France in the early 90ies (Fontaine, 1997) proposes four different groups of pedestrians being involved in fatal accidents. Due to low case numbers in this analysis this type of analysis could not be performed. Elderly traffic participants crossing the road, and the problem of alcohol nevertheless were found as well. Especially the suggestions of separating pedestrians and other traffic by infrastructural and environmental modifications to prevent pedestrian fatalities like done by Retting (2003) might apply here as well.

Whereas Langham (2003) cannot show clear evidence for improving pedestrian visibility for preventing accidents in a review because of the included studies methodological differences, still conspicuity and visibility are regarded as main factors for pedestrian and bicycle accidents. "Visibility aids have the potential to increase visibility and enable drivers to detect pedestrians and cyclists earlier. Public acceptability of these strategies would merit further development. However, the effect of visibility aids on pedestrian and cyclist safety remains unknown. Studies which collect data on simple, meaningful outcomes are required." is the authors' conclusion of an updated review from 2006 (Kwan, 2006). In our sample it can be found that the drivers were faced with visibility constraints when crashing with the pedestrian. The conspicuity of the pedestrian doesn't show up as an explanatory element.

Still, the primary prevention attempts by active and passive safety measures of cars, might have helped to avoid a majority of the analysed accidents as well. According to WP1 D 1.1 the suggested systems "range from driver visual aids such as night vision, to autonomous emergency braking systems. Further, some of the more traditional vehicle systems such as brake assist and traction control can also work to reduce braking distances or prevent vehicles from leaving road surfaces, both of which could aid the prevention of an impact with pedestrians. "

Limitations:
The method was not developed for fatal accidents, as no interview can be performed with a fatally injured traffic accident victim. Thus, a lack of information in the files used has to be accepted for this study. Especially for the human functional failure and the explanatory elements the lack of information is very striking.

Although information provided by the opponents and eye-witnesses is included in the prosecution files, the definite motives, failures and EEs of the pedestrian can never be evaluated exactly. The most probable choice had been decided upon by taking into account all available information and expert knowledge.

For the HFF of the opponents most often also eye-witness reports had to be taken into account in addition to their own statements towards the police and the prosecution. As from the pedestrian no information can be expected, the opponents might be tempted to lying or refrain from statements at all, in order not to be convicted. Especially confessing to having been in thoughts, being in a hurry, or being sleepy might be easily avoided, as no objective proof afterwards is possible. In contrast the speed driven or alcohol limit can still be assessed afterwards by expertises. In addition it has to be taken into account, that drivers that crashed a pedestrian fatally might be too disturbed for clear statements concerning the accident.

The assessment of the HFF therefore is subject to mistakes due to missing information. The evaluation scheme is primarily focusing on vehicle accidents and their drivers. Tasks and conflicts sometimes lack possibilities for coding apt items. In addition three times tams had been involved, where tasks are also not meant to be applied to. A suggestion for new categories within the tasks would comprise:

- "walking on pavement"
- " standing beside the traffic lane (banquette)"
- "pedestrian crossing at a pedestrian crossing with pedestrian lights"

The conflict "vehicle from side road" was used like "vehicle approaching from side" (from the pedestrian's point of view). It is difficult to assess conflicts in cases where the vehicle was out of control.

The explanatory element "Identification of potential risk of only part of the situation" was often the only chance for expressing the pedestrians' behaviour.

In general the HFF analysis applying to fatal pedestrian traffic accidents turned out to be very dissatisfactory due to missing psychological interviews and therefore information content necessary for the analysis. In addition, roughly 240 hours of work were invested for this analysis, showing the time consuming aspect of this analysis.

Nevertheless, although the sample size is only 45 accidents, the information in combination with expert knowledge seemed to be enough to find some results that are comparable to pre-existing knowledge derived from literature.

6.3.2 IDIADA

The same method was used by IDIADA for the in-depth analysis. 55 sever or fatal pedestrian accidents were studied. They correspond to a sample of urban pedestrian accidents which took place in Barcelona city (Spain) during the period of 2005 and 2007. The data was explicitly accessed for this project thanks to the collaboration of Barcelona City Council and Guàrdia Urbana de Barcelona. Unlike LMU data, these cases include severely injured pedestrian, which were able to provide information about the scene of the accident afterwards. On the other hand, these cases are limited to urban and against passenger pedestrian accidents.

Some kind of pattern could be identified in most of the accidents. Despite the odd samples, most of them presented a similar configuration. In most of the accidents, the pedestrian was crossing the street and the accident took place with a car coming from the side. This situation is quite evident if we focus in urban scenarios: typically, pedestrians and vehicles have a differentiated circulating area (sidewalk and carriageway). The accident only happens when someone intrudes the other's area. In urban routes, it is not likely that a vehicle interferes with the sidewalk, as speed is low enough to avoid any loss of control. Then, the only possibility of interference is a pedestrian invading the carriageway and this happens when the pedestrian is crossing the street, with or without the right of crossing.

There is not an equal distribution of the pedestrian subjects taking part. Two thirds correspond to males, most of them relatively old or relatively young. An important number of D-failures has been identified (nearly 40%). They have been associated to 'Deliberate violation of a safety rule', as most of the accidents took place in a traffic light signalised pedestrian crossing with no right for the pedestrian or a pedestrian crossing the street through an unmarked zone (no pedestrian crossing). In other important number of cases (27%) the pedestrian made a P-failure, as no information about the incoming traffic was observed. The task which was being done by the pedestrian was 'crossing the street' (75%) or 'going straight at a traffic signal intersection' (15%), which is associated when a pedestrian is crossing an intersection with traffic lights and the vehicle is turning in the intersection. In only 5% of the cases, the pedestrian was overrun by car intruding the sidewalk. Due to the strength of the D-failures, the involvement of the pedestrian has often been marked as 'primary active' (71%) and 'risk taking – traffic control' or 'identification of potential risk about only part of the situation' have been found as EE (42 an 29% respectively).

No special attention should be made to alcohol or other substances. Alcohol, over the legal limit for the drivers, was perceived in the pedestrian in only 4 cases (7%) and some others presented correctly used medication (5%). Alcohol was directly attributed to the accident in all cases, but medication only in one out of three.

The gender distribution regarding drivers is clearly shifted to males (85%) and the age keeps relatively young compared with the driver population. The most common failures done by drivers include T and P-failures (51 and 27%). Generally, T-failures refer to expecting there will be no perturbation ahead (in traffic light controlled scenarios, 36%), but also some of them consider a perception of the pedestrian, but also the assumption that he would not cross the street with no right (14.5%). As commented, the conflict was against a pedestrian crossing the street (91%), situations which include pedestrians crossing with no right (no zebra or no green traffic light) and intersections where the vehicle is turning and the pedestrian is crossing. The degree of involvement is generally active, but in a second term (71%), as the main initiator of the accident was the pedestrian. In most of the cases, the driver did some actions, adequate or non adequate, but the accident was not avoided, due to time or effort actions. The associated explanatory elements include impaired visibility by other vehicles (42%) (generally not parked, but driving in parallel with the case vehicle), 'identification of potential risk about only part of the situation' (47%). Speed was also present in some of the cases (20%), but other additional elements were present.

Further analysis

If the previous data is analyzed, it is clear that most of the accidents could have been avoided if the safety rules had been obeyed. The conflict appears when the pedestrian intrudes the route of the vehicles when it is not expected. It is not easy to find a solution against these circumstances, as there is a D-failure from the pedestrian. Any measure (correcting or punishing) able to decrease this number of failures would lead directly into a drop of victims in urban pedestrian accidents. In any case, it is not easy to define these measures and apply them in a fair and effective way.

Then, the second option is to find measures which could make compatible, or less aggressive, this incursion of the pedestrian into the carriageway. In most of the accidents, the driver was not expecting any disturbance ahead or he considered that the safety rules would be obeyed. Somehow, there is a poor attention of the driver because the risk is not perceived, as the situation is supposed to be controlled by these safety rules. This drop of attention causes a delay of the reaction of the driver and then, the accident cannot be avoided. In most of the cases, there is a perception of the driver prior to the impact, but this reaction is not enough.

Some of the cases have been reconstructed with PC-Crash. This analysis has shown that improving the action of the driver (e.g. with a Brake Assist System, information coming from WP6) would represent a small benefit, as the situation changes only with a lower time response of the braking system (-0.15 seconds) and panic braking actions (medium brake power) are converted into full braking actions (maximum brake power). In most of the cases, this leads to a speed reduction (especially significant when there is a panic effect), but only in a few cases there is an avoidance. The main problem is the driver reaction. At least, 1 second is needed to identify a risk situation and start actuating. A system able to decrease this time would be very effective and result in avoidance in half of the accidents. Such system should be a 'pedestrian detection system with autonomous braking'. For this analysis, data coming from DaimlerChrysler and the SAVE-U project has been used (also contained in WP6).

Limitations
The same problem addressed by LMU with fatal victims and the no possibility of performing a further interview has been found in some cases (fatal). To supply this lack, witness and environment information has been used to establish the most representative functional failure.

Possible tasks are also a bit poor for the right definition of the action of the pedestrian. As most of the accidents referred to 'crossing the street', a more explicit set of possibilities should be used:

- Crossing the street through a pedestrian crossing with no traffic lights
- Crossing the street through a pedestrian crossing with traffic lights and no right of crossing
- Crossing the street through a pedestrian crossing with traffic lights and right of crossing
- Crossing the street through no pedestrian crossing and pedestrian crossings available
- Crossing the street through no pedestrian crossing and no pedestrian crossings available

6.4 Conclusions

This chapter includes an outline of the most important comments, results, conclusions and suggestions which have appeared in the previous sections. Two main studies with differentiated accident cases have been done: study by LMU and study by IDIADA. When possible, the outcome of these studies will be merged. If not, the origin of the outcome will be shown.

The information will also be structured. First, an overview of pedestrian accidents, with discussions for pedestrians and drivers will be presented. Recommendations for the improvement of vulnerable road users will also be done. Finally, a review of the methods used, with a detail of the assumptions and the difficulties found, will be presented, as well as some indications to continue the work.

6.4.1 Comments related to the available data

- A total of 100 pedestrian accidents have been in-depth analysed.
- These cases represent only a part of the pedestrian accidents in Bavaria region (Germany) in 2004 and part of the pedestrian accidents in Barcelona city (Spain) between 2005 and 2007.
- They cannot be used to provide global statistics for pedestrian accidents, as they constitute a small sample, but their representativeness of the complete road map has been shown.
- In any case, their detailed descriptions have allowed a deep analysis. Special attributes on the cause of the accident, understood from the human factor point of view, have been given to each case, associated to the task being done, the conflict which followed, the degree of involvement and the explanatory elements.
- Data provided by LMU contains accidents in urban and interurban areas with different types of vehicles, while data coming from IDIADA is only based in urban passenger car vs pedestrian accidents.
- There are some differences regarding the Human Functional Failure categorisation but most of these differences can be justified by the type of cases analysed.
- Most of the IDIADA accidents represent a pedestrian crossing the street through a non-marked zone (no pedestrian crossing) or crossing through a pedestrian crossing with red traffic lights for the pedestrian (generally, the pedestrian action was the main cause of the accident, with marks/signals disobeyed).
- On the other hand, LMU cases show more distributed situations, including pedestrians walking or standing on the road and caught by surprise.

6.4.2 Conclusions for pedestrians involved in pedestrian accidents

- 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.

6.4.3 Conclusions for drivers involved in pedestrian accidents

- 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.

6.4.4 Recommendations for improving safety

- 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.

6.4.5 Difficulties found and lacks to be solved

- A considerably wide number of cases have been in-depth analysed. Most of these cases include fatalities. The methodology requires a complete understanding of the actions done by each of the participants in the accidents, with some of the data obtained by an interview. In fatal accidents, some of the data has been fulfilled taking into account the complete scene of the accident.
- Most of the accidents have been virtually reconstructed to contrast the information obtained from the participants and the physically possible results.
- In some points, the categories available to classify the tasks done, the conflicts and the failures committed seemed incomplete in certain points. Some additional possibilities for 'crossing the street' have been proposed.

6.4.6 Next steps

- Causes of pedestrian accidents 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.

- It is still necessary to check the capabilities of these proposed systems, develop and tune them and define testing methods which are representative of the failures established failures.

6.5 References

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B.- Cyclists

6.6 In depth analysis

6.6.1 Data used for the in-depth analysis

6.6.1.a UK, OTS database

On-The-Spot Accident Research Project (OTS) which is available from VSRC. This provides in-depth data from 2001-2004, with 500 cases per year covering Midlands & South-East regions of England. Investigation roster on 30 day cycle repeated without interruption (inc. holidays). Shifts progress over 6 days: 7am-3pm, 3pm-11pm, 11pm-7am followed by 4 rest days. Accident selection is based on random notification from police control room. It is a representative sample of recent UK accidents including detailed information on causes. Common police accident ref number allows some dataset comparison between OTS and UK statistical database. Key variables also compared with local police accident records. Data covers the road user, the accident situation, participants (inc. cars, motorcycles, pedestrians/cyclists and trucks), accident cause, injury cause, human factors and vehicle technologies.

6.6.1.b Italy, ELASIS database

Sistema Integrato Sicurezza Stradale (SISS) which is available from ELASIS. This provides in-depth, descriptive and exposure data from 2001-2004, with 30,000 cases per year across Milan province, Sorrento city and Salerno city (Italy). Data are collected by police. In depth investigations are carried out at black spots. Data covers the road user, the accident situation, participants (inc. cars, motorcycles, pedestrians/cyclists and trucks), accident cause, injury cause, human factors and vehicle technologies. Provision of this data is subject to authorisation by the local municipality. The SISS Database is connected to GIS providing maps showing road types to various scales.

6.6.2 Data analysis

Due to the lack of HFF data for cyclists, full in-depth analysis for this road user group is not possible, however a basic analysis can be made on the data available concerning the factors why accident occurrence took place.

6.6.2.a VSRC Results

Injury:

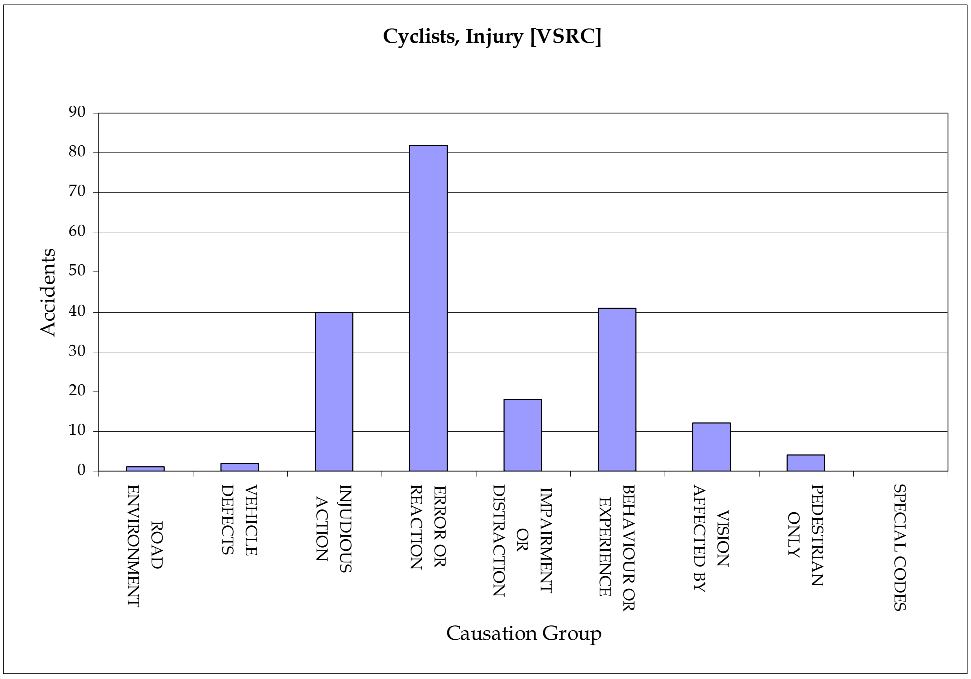

Figure 6.B.1.-VSRC Injuries: Cyclists Causation Groups

As can be seen when looking at the main groups of factors, Error or Reaction is clearly the most common cause for cyclist during accidents. This trend also applies to the opponents.

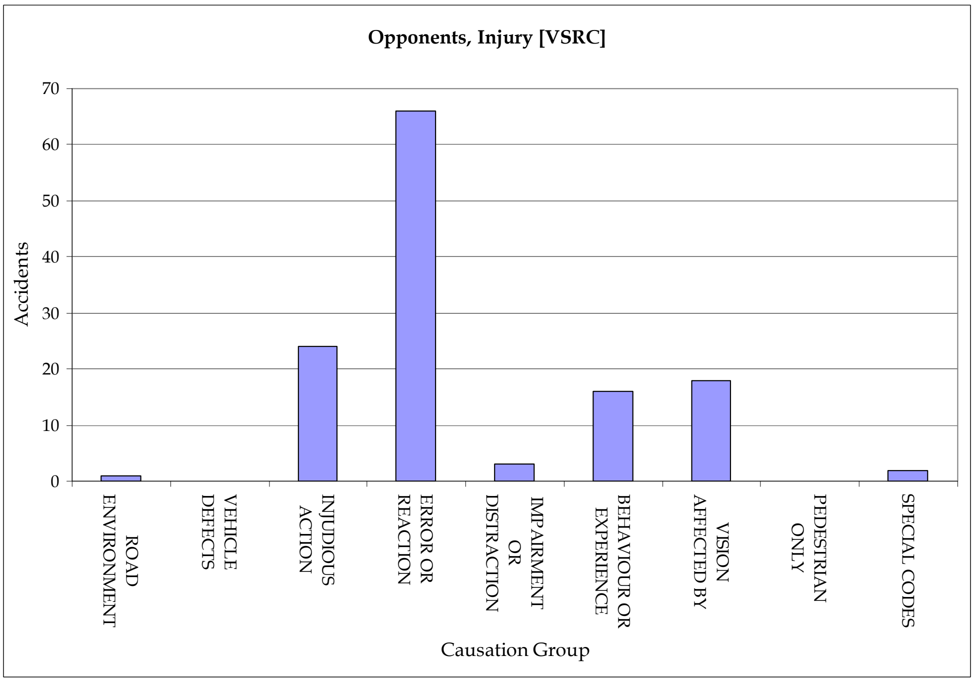

Figure 6.B.2.-VSRC Injuries: Opponents Causation Groups

Now looking at the 'Error or Reaction' group more closely in order to understand the break down of these factors, it can be seen that in Cyclists, the primary cause is failure to look properly. Again the statistics for the opponents also follow the same trend.

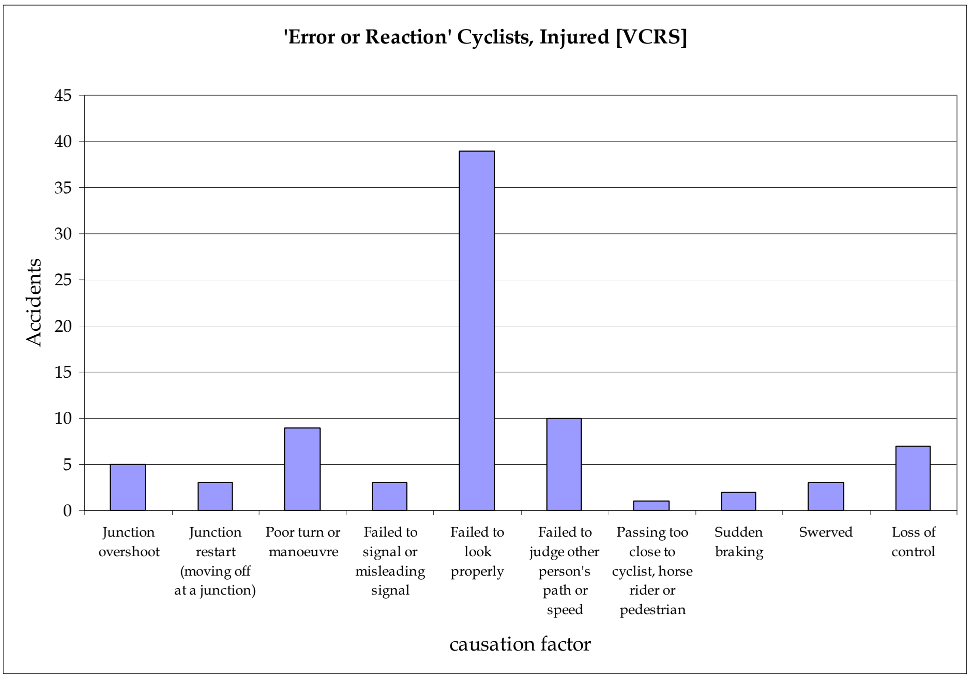

Figure 6.B.3.-VSRC Injuries: Cyclists Causation Factors

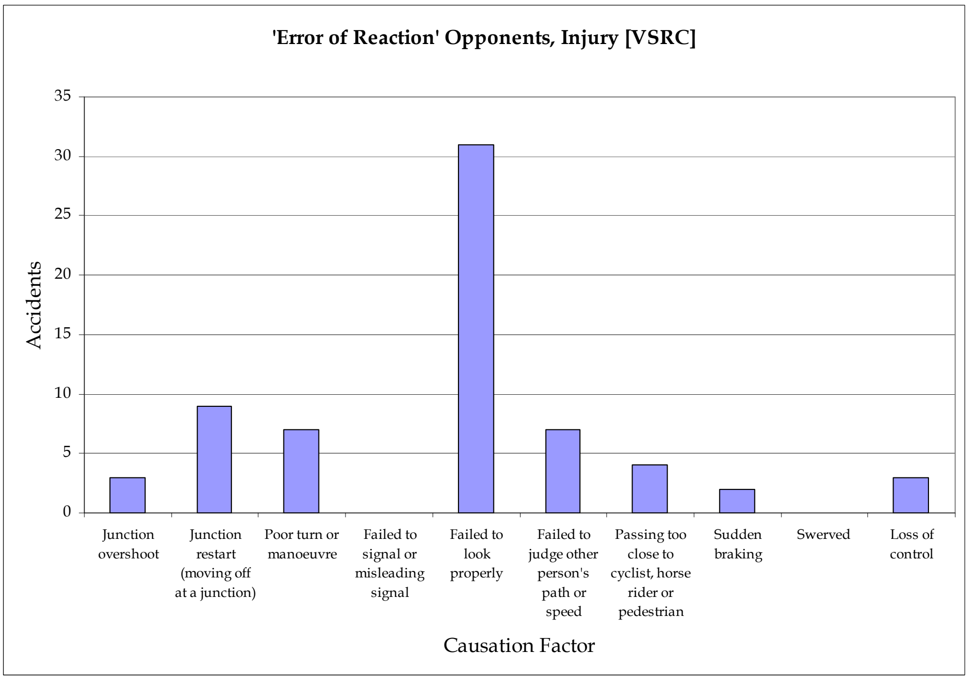

Figure 6.B.4.-VSRC Injuries: Opponents Causation Factors

Fatalities:

Causation Group	Causation Factor	Accidents
Error or Reaction	Failed to look properly	1
	Passing too close to cyclist, horse rider or pedestrian	1
Behaviour or Experience	Careless, reckless or in a hurry	1

Table 6.B.1.-VSRC Cyclist Fatalities distribution.

6.6.2.b ELASIS Results

The data for ELASIS was not grouped into factor groups as was the VSRC data, therefore the collected data was made to fit into similar groups as the VSRC data so they could be analysed. Unfortunately not all of the Factors listed were either compatible with grouping or clear in their meaning and therefore were excluded from the analysis to avoid confusion. Due to several factors arising in some accidents, the decision was made to go through and review the main factor groups, though no comments can be made on the combinations of these factors arising collectively in the same accident as this is unknown.

Injury:

Starting with the injury cases it is useful to look at the Main factors for both the cyclists and the opponents during accidents. Listing the top 15 causation factors as shown in the following two tables, It is very quickly evident that there is a trend concerning Road environment and Injudious Actions as the main causation groups. These therefore should be looked at more closely in order to try and gain more understanding as to their frequency and to be able to resolve why these factors have such a high frequency.

Factor	Accidents	Grouping
System of sign: absent	512	Road Environment
Careless driving	439	Behaviour
Accidental obstacle	188	Road Environment
Side skid for careless driving	173	Behaviour
Driving in the wrong direction	164	Injudious Action
Side skid for avoiding an accident	144	Error
Driving without respecting transit or access signs	90	Injudious Action
Not driving on the right side of the roadway	74	Injudious Action
Driving without respecting the "STOP" sign	73	Injudious Action
Incorrectly turning on the left	60	Error
RL:Large radius bend	58	Road Environment
Driving without respecting the "GIVE WAY" sign	54	Injudious Action
RL:Bend	51	Road Environment
Driving without giving the priority to the vehicle coming from the right	45	Injudious Action
RL:Hairpin bend	44	Road Environment

Table 6.B.2.-ELASIS Cyclist Injuries Main Factors

Aside from these two causation groups, 'Careless Driving' ranks second as the main individual factor in both accident types. Although the rest of its causation group isn't as common, careless driving is clearly a huge factor when assessing cyclist accidents. Unfortunately, from this data it cannot be deduced why the road users were involved in 'careless driving', only to state that careless driving is dangerous, and obviously can frequently result in the injury of another road user.

Factor	Accidents	Group
System of sign: absent	512	Road Environment
Careless driving	446	Behaviour
Driving without respecting the "STOP" sign	204	Injudious Action
Driving without respecting the "GIVE WAY" sign	183	Injudious Action
Driving without giving the priority to the vehicle coming from the right	129	Injudious Action
Driving with exceeding speed	100	Injudious Action
Driving without keeping safety distance	93	Injudious Action
Incorrectly turning on the right	81	Error
Accidental obstacle	60	Road Environment
RL:Large radius bend	58	Road Environment
Incorrectly turning on the left	51	Error
RL:Bend	51	Road Environment
RL:Hairpin bend	44	Road Environment
RL:Slope	40	Road Environment
Incorrectly stopped vehicle	36	Error

Table 6.B.3.-ELASIS Opponent Injuries Main Factors

Having established that Road environment and Injudious Actions are the highest causation groups, it is next it is interesting to look at them more closely. It should however be noted that due to the nature of the factors listed in Road Environment as a causation group, for ELASIS (different to VSRC data) has now been further split into two groups: Road Environment, and Road Layout. This is because Road layout is more specific to the geometry of the road rather than its condition.

Factor	Accidents
Accidental obstacle	188
Flood	1
Fog	13
Frost/Ice	12
Holes	5
Road yard bad marked	5
Ruined paved road	14
Slippery	18
System of sign: absent	512
System of sign: bad condition	27

Table 6.B.4.-ELASIS Cyclist Injuries: Road Environment Factors

From this table it can be clearly be deduced that when the road environment is responsible, more often than not the accident occurs due to a missing road sign. This implies that although the ridermay have been paying attention and keeping vigilant, the lack of road sign to alert attentions to a specific potential danger at this location, then resulted in an impact.

The next most common factor regarding the road environment is an 'Accidental Obstacle' these are not permanent fixtures, and so it is logical that the driver perhaps wasn't prepared for it, or didn't fully appreciate the possible influence it could have on other areas of driving e.g. by limiting manoeuvres or obstructing vision.

Factor	Accidents
RL:Back	9
RL:Back/narrow carriageway	8
RL:Bend	51
RL:Ditch	2
RL:Hairpin bend	44
RL:High slope	7
RL:Large radius bend	58
RL:Multiple curve	3
RL:Narrow carriageway	2
RL:Slope	40

Table 6.B.5.-ELASIS Cyclist Injuries: Road Layout Factors

Looking at the influence of Road layout on Accidents, the Bend, Hairpin Bend, Large Radius Bend and slope are the biggest danger zones. This is logical as these are situations on the road visibility might be blocked. Also bends, for cyclists, may provoke the rider to lean more, or stray out of the bike path/ cut the corner in order to make the turn. This then puts the cyclist into more imminent danger with respect to any approaching cars.

Considering the two previous tables collectively, though there is no confirmation of this, we might suppose that the more popular Road layouts where accidents occur are perhaps also those lacking appropriate signalling.

Factor	Accidents
Driving in the wrong direction	164
Driving with exceeding speed	8
Driving without giving the priority to the vehicle coming from the right	45
Driving without keeping safety distance	16
Driving without respecting the "GIVE WAY" sign	54
Driving without respecting the "STOP" sign	73
Driving without respecting the speed limits	2
Driving without respecting the traffic light or ploce order	30
Driving without respecting the traffic light or police order	1
Driving without respecting transit or access signs	90
Not driving on the right side of the roadway	74
Not giving the priority to pedestrian on the pedestrian crossing	2
Overtaking without respecting the "NO PASSING" sign	1
Side skid for driving with exceeding speed	1

Table 6.B.6.-ELASIS Cyclist Injuries: Injudious Action Factors

Now looking at the second of the two main causation groups, it can be seen that driving in the wrong direction is the most common cause, again it is hard to justify the reason for this, but it can be supposed that the high frequency of these injudious actions is linked with the nature of the road user in general. As we are considering the cyclists here, perhaps the cyclist often feels like as they are not a moajor road user and they are only on a bike, it is not as significant to disregard the road rules, unfortunately however this sort of behaviour will catch other road users ofguard and will most likely result in an accident as can be seen.

Now considering the same main causation groups with regard to the cyclists opponents; once again the 'system of sign: absent' is the main cause. This is logical as if there is insufficient signally for a cyclist then it is more than likely also insufficient for the opponent. Again however it is not possible to suggest why this is the most common factor.

Factors	Accidents
Accidental obstacle	60
Flood	1
Fog	13
Frost/Ice	12
Holes	2
Road yard bad marked	5
Ruined paved road	14
Slippery	18
Snow	20
System of sign: absent	512
System of sign: bad condition	27

Table 6.B.7.-ELASIS Opponent Injuries: Road Environment Factors

The road layout frequencies also show the same trend as before with the cyclists, this is because any situation which would pose as a dangerous location for the cyclist will inevitably also become a danger point for their opposing road users approaching them.

Factors	Accidents
RL:Back	9
RL:Back/narrow carriageway	8
RL:Bend	51
RL:Ditch	2
RL:Hairpin bend	44
RL:High slope	7
RL:Large radius bend	58
RL:Multiple curve	3
RL:Narrow carriageway	2
RL:Slope	40

Table 6.B.8.-ELASIS Opponent Injuries: Road Layout Factors

Now looking at the Second most frequent causation group, Injudious Action, although the main causes are different, generally this causation group is more distributed than that of Road Environment, meaning all the factors are quite common. Excess speed is significantly higher in opponents, which is to be expected as the opponent of a cyclist will usually be a car or another motorized vehicle.

Unfortunately however, once again it is hard to say why these factors took place, as they are decisions made by the driver and there is no more data linking the precise circumstances to specific locations or other parameters that could help clarify.

Factors	Accidents
Driving in the wrong direction	11
Driving with exceeding speed	100
Driving without giving the priority to the vehicle coming from the right	129
Driving without keeping safety distance	93
Driving without respecting the "GIVE WAY" sign	183
Driving without respecting the "STOP" sign	204
Driving without respecting the speed limits	1
Driving without respecting the traffic light or ploce order	22
Driving without respecting the traffic light or police order	1
Driving without respecting transit or access signs	10
Not driving on the right side of the roadway	11
Overtaking without respecting the "NO PASSING" sign	1
Side skid for driving with exceeding speed	1

Table 6.B.9.-ELASIS Opponent Injuries: Road Layout Factors

Fatalities:

There are not as many accidents concerning fatalities during cyclist accidents. Looking at the cyclist and the opponent main factors at the same time we can see that the general trends are similar to those shown by the main factors with the injury cases. The 'Careless Driving' element of behavioural influence still ranks as one of the highest factors overall, showing that the road users should perhaps be more aware and alert.

Factors	Accidents	Group
Driving in the wrong direction	6	Injudious Action
System of sign: absent	6	Road Environment
Careless driving	5	Behaviour
Driving without respecting the "GIVE WAY" sign	4	Injudious Action
Driving without respecting the "STOP" sign	2	Injudious Action
Driving without respecting the traffic light or ploce order	2	Injudious Action
Incorrectly turning on the left	2	Error
Incorrectly turning on the right	2	Error
Not driving on the right side of the roadway	2	Injudious Action

Table 6.B.10.-ELASIS Cyclist Fatalities Main Factors

Factors	Accidents	Groups
Careless driving	11	Behaviour
Driving with exceeding speed	8	Injudious Action
System of sign: absent	6	Road Environment
Driving without respecting the "STOP" sign	2	Injudious Action
Driving without respecting the speed limits	2	Injudious Action

Table 6.B.11.-ELASIS Opponent Fatalities Main Factors

There are not enough accident cases to justify presenting the data of the individual causation groups.

6.7 Discussion

6.7.1 VSRC (OTS)

The main cause for accidents according to the data from VSRC was found to be 'failure to look properly', this factor applies both to the cyclists and the opponents.

6.7.2 ELASIS

ELASIS data showed that careless driving was a primary factor when considering accidents with cyclists. Besides this, the two main causation groupings in which accidents take place are 'Road Environment' and 'Injudious Action'.

From the Road Environment factors, it was found that bends and slopes are the most dangerous types of road layout, and that the most common cause for an accident occurring was absence of road sign.

With respect to the injudious action, there was no clear main factor between opponents and cyclist, for the cyclist 'driving in the wrong direction' was the main factor; for opponents disobeying road signs. The group on the whole however, had a high occurrence frequency distributed across various factors.

6.8 General Conclusions

A lot of the accidents with cyclist 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.

6.8.1 Recommendations for improving Safety

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 the 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 signalling 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.

6.8.2 Difficulties found and lacks to be solved

The lack of data posed great difficulties in being able to make any definitive conclusions. In VSRC, for the fatalities for example there were only 3 cases and they all differed from one another making it impossible to deduce any definitive trends.

The inconsistency of the data also posed problems from one data set to another. The VSRC data had been ordered into factor groups by type, whereas the ELASIS data was a list of factors in alphabetical order. This meant that going through and trying to order/ group the data in the ELASIS statistics was very time consuming and problematic. Not only were there no groupings, but some of the factors were unclear as to their meaning i.e. 'Going out from driveway without careless' and also some of the factors seemed to repeat themselves under different names e.g. other/ unknown; Normal/ Normal driving; Other condition/ Other misuse. Even though basic groupings were made it meant that some data was lost in the analysis.

A major problem with the data however was the lack of statistics in the HFF analysis, there was no data available to analyse in this area and therefore no matter how many ways the listed factors are represented in tables or graphs, true in depth study is not possible to the extent it was represented for the pedestrians. The resolution to this issue is to be discussed in the next section.

6.8.3 Next Steps

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 utilising 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.

6.9 References

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7 Task 1.5: Elderly people and Gender related accidents

This chapter devoted to 'Elderly People and Gender-Related Accidents' addresses the issue of in-depth analyses on the basis of the previous identification of what is characteristic of the accidents for these two demographic parameters that are age and gender, as developed in TRACE report D1.1, chapter 5.

This study will provide an understanding of the mechanisms and specificities of accident patterns for:

- Elderly people (+65) as compared to younger people;
- Women as compared to men.

The method used is the one provided by the TRACE WP5 'Human Factors'. In brief, this methodology tries to go further than the usual trend showing a tendency to confuse human errors and human factors, i.e. the consequences and the causes. Such confusion usually leads to a poor capacity to define operational countermeasures to accidents, apart from blaming the drivers and complaining about human nature. In the purpose of improving the safety of the driving system as a whole, the analysis will be oriented toward: 1) the diagnosis of the difficulties met by road users which lead them to an accident through the definition of so called 'Human Functional Failure' (TRACE D5.1), 2) the identification of the contexts in which they take place (D5.2), and 3) the definition of the origins of these difficulties whether they are related to layout, to vehicles, or to human characteristics (physical, cognitive, motivational, but also sociological and cultural) (D5.2). The aggregation of those diverse parameters will allow the identification of Typical Human Functional Failure-Generating Scenarios (D5.3) useful to characterise generic accident processes.

This methodology will be specifically applied to the in-depth INRETS EDA accident database.

But in order to get a wider view of accident facts given by in-depth accident studies, a preliminary chapter will provide some general figures aggregated from several European in-depth databases. They will be used to define the most frequent accident factors that can be put forward by current in-depth studies, given that they are all different in the scope and detail of analysis, and also in the methodology used.

This chapter will be divided in two sub-chapters. The first will focus on elderly people, while the second will focus on gender issues.

We will proceed to an in-depth investigation of accident scenarios involving in a one hand elderly drivers, and in another hand male and female drivers making use of data from the DAS in-depth accidents study database from the INRETS Department of Accident Mechanisms (Salon de Provence).

A.- Elderly people

7.1 In-depth investigation of accident patterns among elderly drivers using the TRACE WP5 methodology

The selection of accident cases was made regarding the age bracket of the persons involved in the accidents. The age defining an elderly driver was fixed at 65 years old, this decision mainly being related to the age threshold usually considered in previous studies and national statistics (age of retirement).

This group of road users is compared to the rest of the population, i.e. the 10-64 years old group (users under 18 are those riding bicycles or mopeds).

The whole sample includes 1,676 road users involved in 1,067 accident cases.

Among these cases, we have identified:

- 128 drivers aged 65 years and over (n=128). This group is called 'elderly drivers'.
- 1,546 road users under 65 (n=1,546). This group is recorded under the label 'control group'.

For this study, data were weighted in relation to European data, notably for age and gender.

7.1.1 Pre-accident situation

The "pre-accident situation" corresponds to the task that the driver was seeking to perform in his environment at the moment he encountered a disturbance.

This variable can be divided into 3 categories:

- Stabilised traffic situation,
- Intersection situation,
- Performing a special manoeuvre.

The classification of pre-accident situations can be found in Annex1.5 (Table 2).

The tables corresponding to the data quoted below can be found in the Annex1.5 (Table 1)

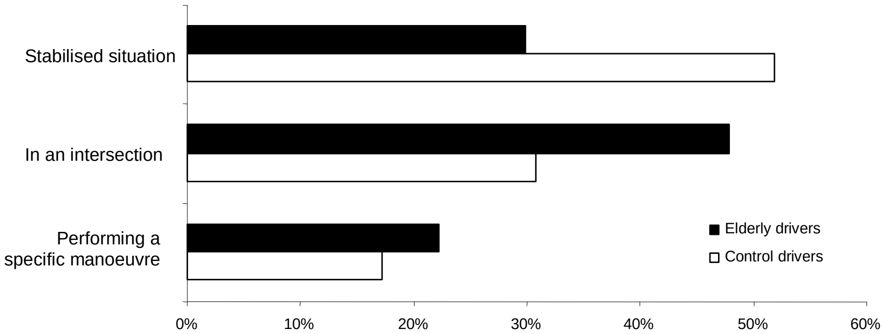

Figure 7.A.1: Percentage of the different categories of pre-accident situations among elderly drivers over 65 and other drivers

The tasks that the elderly people were seeking to perform in the pre-accident situation mainly correspond (Figure 7.A.1) to situations of crossing intersections (47.8% vs. 30.8% for the controls). In intersections, most accidents involving the elderly occur when they do not have the right-of-way and they try to cross when a vehicle is coming on the priority road (25.5% of situations vs. 11.6% for the control group; χ^2=20.25, p<0.01).

The elderly have fewer accidents in stabilised traffic than the controls (29.9% of situations vs. 51.9% for the controls). We observe, however, that most of the problems that the elderly have in this case occur when a vehicle pulls out in front of them on the carriageway (9.2% of situations) or when they are seeking directions (6.6% of situations; χ^2=8.83, p<0.01). In these 2 types of situation, elderly women have more problems than elderly men (18.2% and 4.0%, respectively, when a vehicle pulls out onto the carriageway, and 16.5% vs. 1.0% in a direction-seeking situation), whereas there are fewer gender differences in the control group. There is no obvious explanation for this difference; the study of exposure variables such as mobility and infrastructure characteristics (types of travel, etc.), beyond gender, may help to explain these results.

The "performing a specific manoeuvre" category appears to pose more problems to the elderly (22.3% of situations vs. 17.1% for the controls). We should point out the fact that half of the problem situations for elderly people when performing specific manoeuvres lie in changing directions with the interference of another vehicle on the road (15.9% of situations; $\chi^2=13.4$, $p<0.01$). Even more precisely, 92.0% (vs. 77.3% among the controls) of these direction-changing situations are manoeuvres involving turning across traffic[1] (TAT). The literature tells us that this is a manoeuvre that especially poses problems to elderly drivers (Caird and Hancock, 2002). In our cases, elderly men are represented more than elderly women (they account for 54.3% of the elderly drives with TAT problems).

7.1.2 Level of involvement in the accident

Following the TRACE WP5 methodology, the level of driver involvement in accidents will not be analysed in terms of responsibility, but rather in terms of degree of behavioural contribution to the breakdown of the situations, so as not to confuse an ergonomically-focused accidentology analysis with a penal approach to accidentality (cf. TRACE D5.1 and D5.5).

A distinction is made among 4 degrees of driver involvement:

- Primary actors: designates drivers who "cause the disturbance", who have a decisive functional involvement in producing the accident: they are directly at the origin of the destabilisation of the situation.
- Secondary actors: these drivers are not at the very origin of the disturbance, but they still take part in producing the accident. They contribute to the non-resolution of the problem through their lack of foresight as to how the situation will develop.
- Reactive: these drivers are confronted with another person's atypical manoeuvre that is hard to foresee, no matter whether or not it is in contradiction with the legislation. They are not considered active because they were unable to foresee the other person's failure.
- Passive: These are drivers who were not involved in the destabilisation but who were an integral part of the system. Their only role consisted in being present and they cannot be blamed for the disturbance.

The tables corresponding to the data given below can be found in the Annex1.5 (Table 3).

In most cases, elderly drivers are primary actors in accidents involving them; they are far more so than the control drivers (74.2% vs. 53.9% for control drivers). They therefore often have a decisive functional involvement in the accident's occurrence. Some might conclude that they are more often responsible ("at fault"). Another approach to this over-involvement considers that elderly drivers are weakened by a poorer control of certain types of situation, notably when they lose the right-of-way (which inevitably puts them "at fault" when an accident occurs). But the loss of right-of-way also corresponds to a loss of control of the time course of the situation (Van Elslande, 2003a). The compensation mechanisms (such as taking the time to analyse the situation properly, not making a manoeuvre too hastily) that seniors usually apply to make up for their difficulties can thus no longer be applied in these situations. They find themselves under situational pressure brought about by the behaviour of others, which strongly penalises them and causes them to make mistakes.

The majority of accidents involving male (35.6%) and female (32.3%) primary actors occur in intersections where they do not have the right-of-way. Elderly drivers are therefore, in most of the accidents in intersections where they do not have the right-of-way, the ones who cause the disturbance at the origin of the accident.

[1] Turning left when travelling on the right or turning right when travelling on the left (UK).

7.1.3 Errors and error factors among the elderly: overall analysis

7.1.3.a Functional failures

The list of the different categories of functional failures and the tables corresponding to the data quoted below can be found in the Annex1.5 (Table 4).

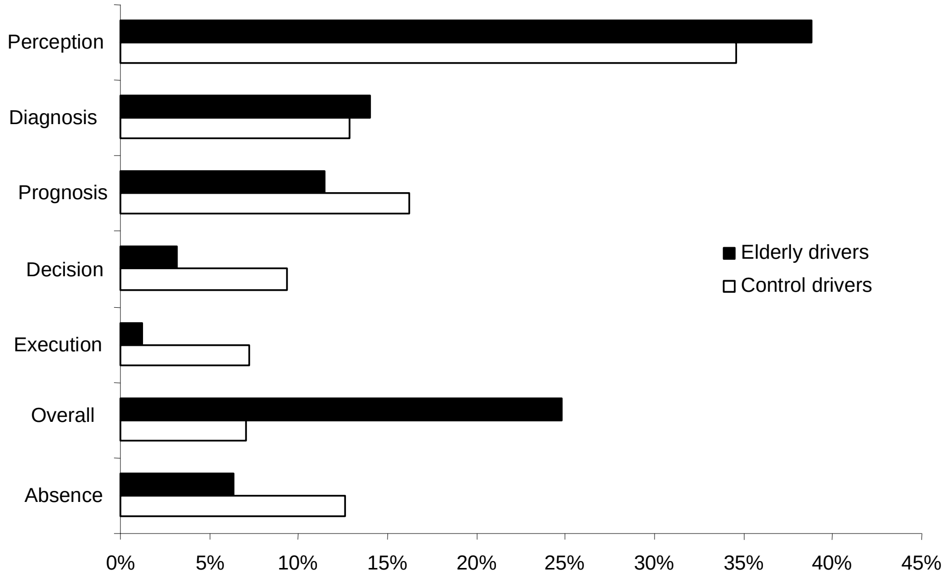

Figure 7.A.2: Percentage of different failure categories among elderly drivers over 65 and other drivers

Most of the failures observed among the elderly are perceptive (Figure 7.A.2), as is the case for the control drivers (38.8% vs. 34.6%).

The rate of overall failures, i.e. when all of the driver's capacities fail, is particularly high among elderly drivers (24.8%). A significant difference concerning these overall errors can be observed between the two groups of users (χ^2=20.2, $p<0.05$): elderly drivers have more than 3 times as many "generalised" errors as other drivers (7.1%). In the following section, the question will be to determine under what conditions these failures occur.

We can also observe slightly more failures in diagnosis among elderly drivers than among other drivers (14.1% vs. 12.9%): the question here is to determine whether it is their understanding of information or their evaluation of the cues transmitted by the environment which poses a problem for elderly drivers.

As a repercussion, elderly drivers appear to be less inclined than other drives to failures in prognosis (11.4% vs. 16.2%), decision-making (3.2% vs. 9.4%) and execution (vehicle control) (1.3% vs. 7.2%). A connection can be made between elderly people's slow driving speeds (Keskinen *et al.*, 1998) and the fact that the make few errors of execution: this method of compensation enables them to react to problems in time and to avoid accidents related to this type of failure[1]. The low rate of decision-making errors among elderly drivers can notably be explained by the decrease in traffic violations with age (Reason, 1990): less risk-taking, playful behaviour, deliberate transgressions, etc.

[1] Notably loss of control (as an isolated vehicle) for which elderly drivers are underrepresented (Girard, 2000).

7.1.3.b Failure and annual mileage

An analysis of the literature shows that the accident rate among the elderly differs with the annual number of kilometres that they drive (cf. TRACE report D1.1). We felt it was important to round out this observation with a qualitative analysis of the types of errors that occur with different annual kilometrages.

The comparative analysis by levels (infrequent driving, average driving and frequent driving[1]) thus shows an interaction between kilometrage and failures among elderly drivers, which is not the case for other drivers. The results show a tendency among elderly drivers who do not drive much to commit a high proportion of generalised failures, whereas those who continue to drive a great deal are closer to the failure profile observed among younger drivers.

- Among infrequent drivers (less than 4,000 km/year), we exclusively observe failures of the perceptive (42.9%) and overall (42.9%) types. This means that the error is situated in the first link of the functional chain or the entire functional chain is defective. Even though elderly drivers make almost twice as many perceptive errors as the controls, it is mainly overall failures that distinguish elderly drivers, with 6 times more overall failures than among the controls. It is therefore mainly overall failures that characterise accidentality among elderly drivers who drive infrequently.
- Among elderly drivers who drive between 4,000 and 14,000 km/year, we observe fewer overall failures than among infrequent drivers (less than 4,000 km) – although this rate is still high (29.2%) – and also fewer perceptive failures (30.2%), but more failures in diagnosis (15.9%) and prognosis (8.7%).
- Elderly people who drive frequently (more than 14,000 km/year) mainly have perceptive (52.0%) followed by prognostic (23.9%) failures. The curve representing these elderly drivers is closer to those of the control drivers (with different annual kilometrages): it consequently appears that the more an elderly person drives, the more the inter-generational functional differences in driving disappear.

The tables corresponding to the data quoted below can be found in the Annex1.5 (Tables 5 and 6).

In keeping with Janke (1991), Hakamies-Blomqvist (2003), Fontaine (2003) and Langford *et al.* (2006), we can therefore look at the question of annual kilometrage in terms of cognitive abilities. Failures among elderly drivers are not the same depending on how much they drive: for elderly drivers, this goes from more perceptive and overall failures among infrequent drivers to perceptive, diagnostic, prognostic and overall failures for medium-frequency drivers, becoming prognostic and mainly perceptive failures among frequent drivers.

7.1.3.c Explanatory elements

Explanatory elements are divided into endogenous and exogenous elements. The source of endogenous elements lies within the user and the activity he is performing; they are therefore related to the driver. The origin of exogenous elements lies in the environment of the driving task; they are therefore related to the situational context. We should point out that they are exclusive in explaining a failure in keeping with the principle of multicausality.

Details of their classification and tables corresponding to the data quoted below can be found in the Annex1.5 (Tables 7, 8 and 9).

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[1] Numerical data for failure percentages as a function of annual kilometrage are described in Annex1.5).

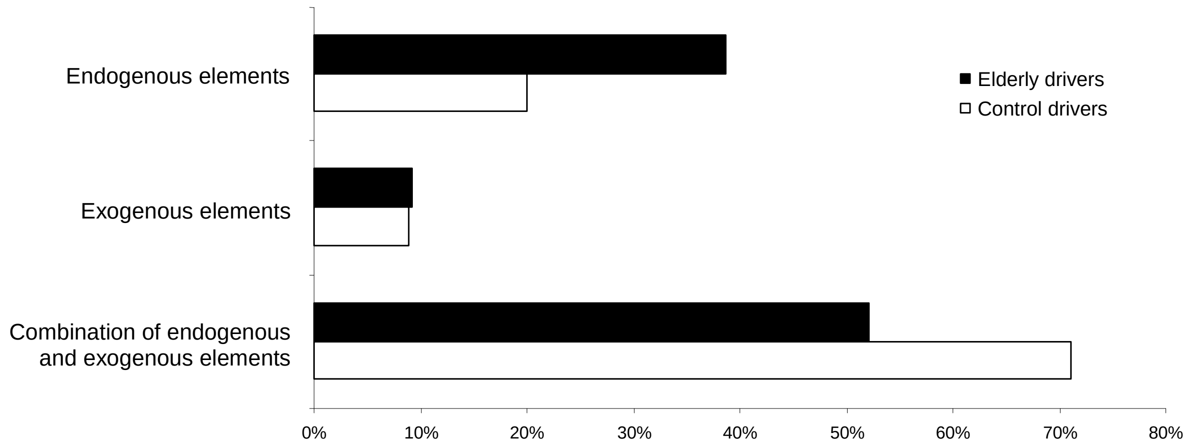

Figure 7.A.3: Percentage of involvement of the different categories of explanatory elements for all failures among elderly drivers over 65 and other drivers

Figure 7.A.3 presents the proportions of explanatory elements contributing to failures among elderly drivers and among other drivers. We can see a clear difference in the proportion of failures that can be explained by exclusively endogenous elements between elderly drivers and other drivers (38.7% vs. 20.1%). This implies that seniors more often commit errors whose origin lies in the individual's own characteristics (experience, vigilance, attention, etc.), whereas for other drivers (control group) the failure is more often accompanied by a combination of endogenous and exogenous elements. Both groups have fairly few failures that come exclusively from exogenous elements.

Accidents are rarely due to a single cause. Certain endogenous and exogenous elements often turn up in accidents involving the elderly, notably hesitant behaviour and infrequent driving, low vigilance and problems in terms of attention, difficulties in finding the right direction and merging into traffic, as well as problems when visibility is reduced (whether by the infrastructure or by temporary interferences).

We shall look at the specific influence of these elements on the different failures affecting elderly drivers so as to define the prototypical accident scenarios that emerge for this group of users.

7.1.4 Errors and error factors among the elderly: fine analysis

Above we saw an overall analysis of the different failure categories. An in-depth analysis of these cases (Figure 7.A.4) gives a refined preliminary analysis, thus providing us with a breakdown of the different categories of the processes involved in accidents among the elderly. By taking a more detailed look we shall gain a better understanding of the different types of failures comprising these categories. The most commonly observed failures in accidents will be stressed, i.e. perceptive failures (P2, P3 and P5), T2 and T6 failures and the G3 overall failure (cf. the figure below). A short summary of these processes and situations will be proposed at the end of each section dealing with a failure category. The tables corresponding to the data quoted below can be found in the Annex1.5 (Table 10).

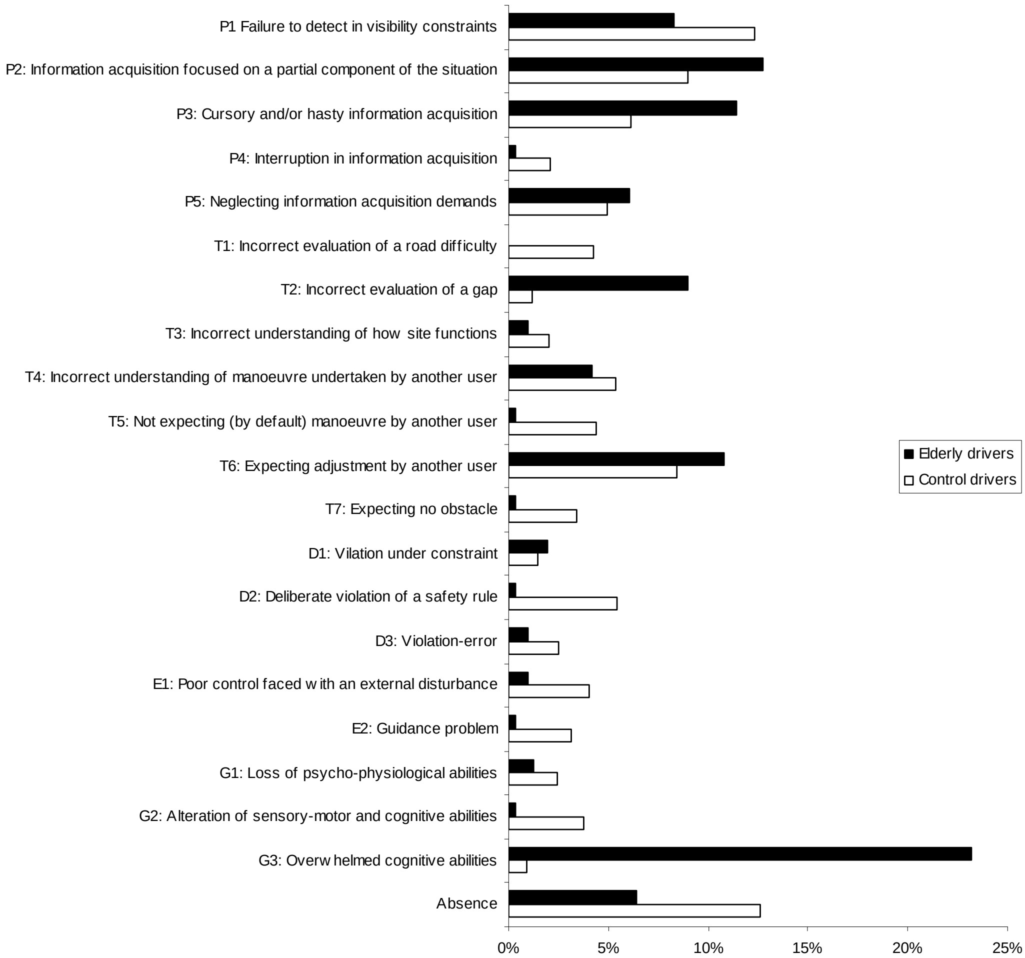

Figure 7.A.4: Percentage of all types of failures among elderly drivers over 65 and other drivers

✓ P2 Failure: Information acquisition focused on a partial component of the situation:

In this perceptive failure, the driver focuses his view and monopolises his attention on one aspect of the driving situation which appears most important to him at the time. But this focus is to the detriment of other aspects of the situation, which are nonetheless visible, leading the driver to miss detecting another user. The element which mainly focuses their attention corresponds to a problem of seeking directions (Figure 7.A.5), notably in places that have been renovated. Low driving frequency and certain slowness in reacting also influence this failure's occurrence. The influence of the infrastructure contributes to this by the complexity of the layout and signalling defects. The tables corresponding to the data quoted below can be found in the Annex1.5 (Table 11).

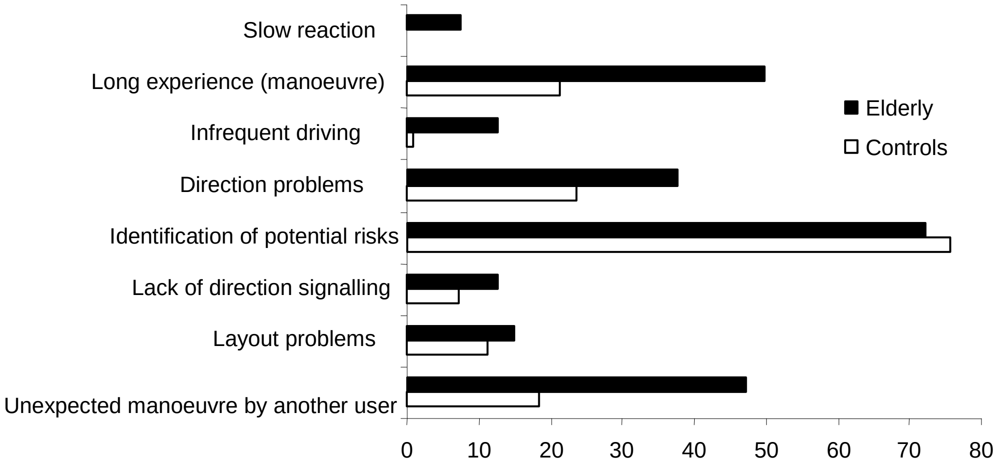

Figure 7.A.5: Percentage of the main explanatory elements for P2 failures among elderly drivers over 65 and other drivers[1]

A prototypical scenario gives a good idea of this focus on the search for directions by elderly drivers:

__Scenario P2a[2]: Focus on direction problems__

The driver is generally in an intersection and in an unknown area (Figure 7.A.6**Erreur ! Source du renvoi introuvable.**). He usually does not have the right-of-way, and is so busy looking for directions that he temporarily forgets the demands of information acquisition on priority roads before pulling out.

In most of the cases observed, elderly driver then cuts off an undetected vehicle driving along the priority road (coming from the left or right), leading to a front-lateral collision. Elements contributing to the accident – in addition to the search for directions – are essentially related to the layout (defective directional signalling, advance signalling, relatively limited visibility or site complexity).

We can also see a variant to this scenario in which the driver is in stabilised traffic and looking for a parking space and hits a crossing pedestrian who is not detected.

We should point out that in cases corresponding to this direction-searching scenario, the elderly drivers are men. They may have more of a tendency to use known elements than women and may be more destabilised on unknown itineraries. Another hypothesis is that, in elderly couples, men drive more often than women on unusual itineraries. These elements once again demonstrate the interest of an in-depth study of risk exposure (driving time variables, vehicle features, driving conditions, etc.).

[1] This is the intervention of each explanatory element on a given failure represented, whence a total which exceeds 100%. The same holds true for the figures below corresponding to the factors related to failures.
[2] The description of this scenario, as for those below, is specified from the point of view of elderly drivers.

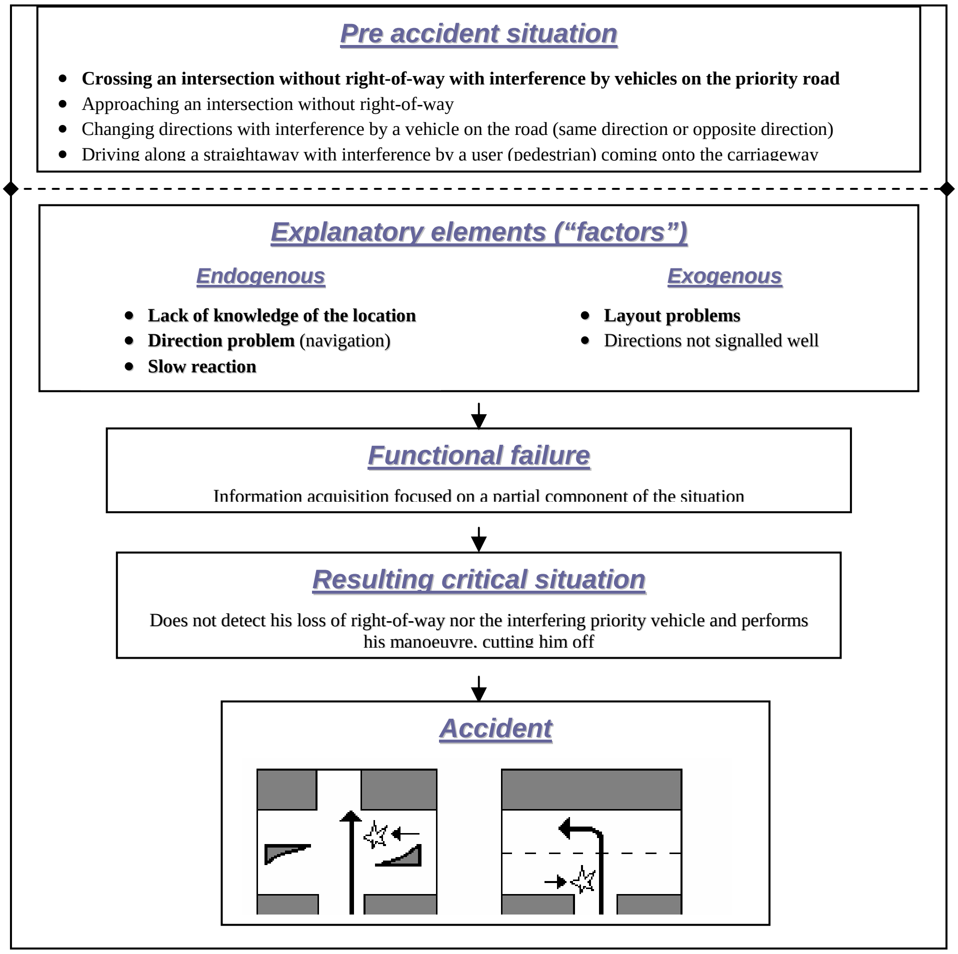

Figure 7.A.6: Characteristics of scenario[1] P2a – Focus on a direction problem

✓ P3 Failure: Cursory and/or hasty information acquisition

This defective information acquisition procedure observed among these drivers can come from a low level of attention given to the manoeuvre or from an overly hasty operating method by users who take a minimum amount of time for information acquisition. All P3 failures in our sample of elderly people occurred in intersections (84.6% where they did not have the right-of-way) or in left-hand turn situations. There are more elderly women than elderly men involved in this failure (18.2% vs. 7.5%).

[1] Legend for the figures characterising the scenarios:

- Elements in bold characters are the most representative elements in the scenario.
- The figurative drawings for the types of collision in the scenarios only represent the most typical types of accidents. The "bold" arrow represents the elderly driver, the other arrows represent the interfering drivers and the "star" represents the point of collision.

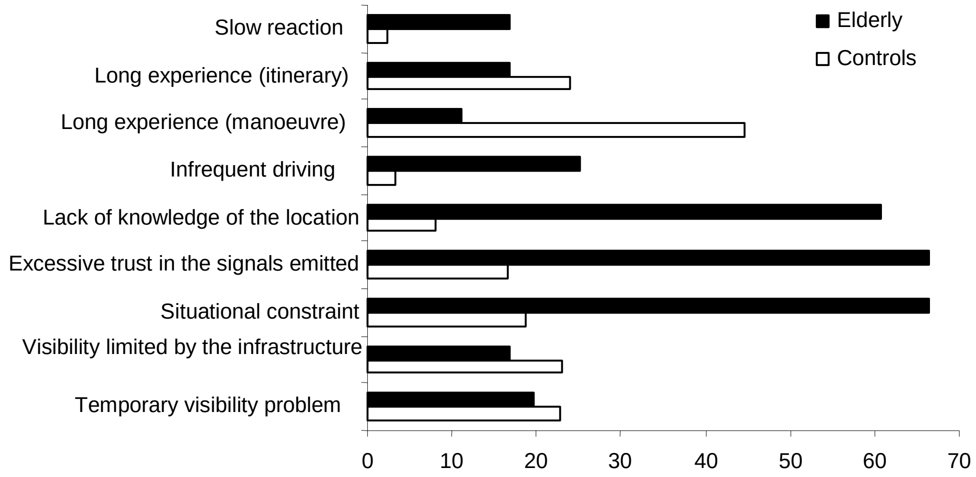

Figure 7.A.7: Percentage of the main explanatory elements for P3 failures among elderly drivers over 65 and other drivers

We can observe here that a lack of knowledge of the location (60.8%) appears to have a strong influence on P3 failures among elderly drivers (Figure 7.A.7), causing a certain degree of fragility which leads them to undertake incomplete information acquisition. To this can be added a strong feeling of priority among elderly drivers (66.4% vs. 16.6%), in that they are sure of their own manoeuvres given that they emitted a signal to other users (turn signal, for example). We can also see factors related to limited visibility, although in a smaller proportion compared with the controls.

The "slow reaction" and "infrequent driving" elements and the lack of knowledge of the location are elements that were already observed in P2 failures and which therefore seem to pose problems for elderly drivers. One possible explanation is that it is actually the combination of these elements that affects the perceptive failure, rather than these elements taken individually.

The most recurrent prototypical scenarios among the elderly are cursory information acquisition when making a left-hand turn and cursory information acquisition when crossing an intersection. In both cases, the elderly driver "cuts off" a priority vehicle. The tables corresponding to the data quoted below can be found in the Annex1.5 (Table 12).

Scenario P3a: Cursory information acquisition when making a left-hand turn

In this scenario (Figure 7.A.8), drivers pay too little attention to the acquisition of information relative to the feasibility of their left-hand turn manoeuvre as this bifurcation manoeuvre is familiar to them. They take a quick, almost automatic glance, which does not enable them to identify the interference of another vehicle; whose trajectory they cut off. A low level of attention linked to long experience with the manoeuvre and a visibility problem (temporary or coming from the infrastructure) work together to cause the accident. The elderly drivers found in this type of scenario are mostly women (8.0% vs. 1.9% for men).

Pre accident situation

- **Crossing an intersection without right-of-way with interference by vehicles on the priority road**
- Crossing a priority intersection with the interference of a vehicle without right-of-way starting to cross
- Changing directions with interference by a vehicle on the road (same direction or opposite direction)

Explanatory elements ("factors")

Endogenous

- **Driving in automatic mode**: low level of attention linked to long experience with the manoeuvre
- Excessive confidence in the signals emitted to others (feeling of priority)
- Lack of knowledge of the location or vehicle

Exogenous

- Visibility problem (temporary or limited by the infrastructure)

Functional failure

Cursory and/or hasty information acquisition

Resulting critical situation

Does not detect the priority vehicle interfering with his manoeuvre, cutting him off

Accident

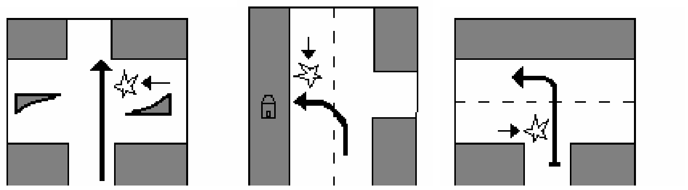

Figure 7.A.8: Characteristics of scenario P3a – Cursory information acquisition when making a left-hand turn

Scenario P3b: Cursory information acquisition when crossing an intersection

In this scenario (Figure 7.A.9**Erreur ! Source du renvoi introuvable.**), the elderly driver does not have the right-of-way and does not detect the priority vehicle approaching. The low level of attention paid to information acquisition and a contextual difficulty in acquiring information (visibility restricted by the infrastructure or by another vehicle, for example) are often related to this type of accident scenario. No gender influence has been observed.

Pre accident situation

- **Crossing an intersection without right-of-way with interference by vehicles on the priority road**
- Approaching an intersection without right-of-way

Explanatory elements ("factors")

Endogenous

- **Driving in automatic mode**: low level of attention linked to long experience with the itinerary and/or its monotony
- **Slow reaction**
- Infrequent driving
- Lack of knowledge of the location

Exogenous

- **Temporary visibility problem**

Functional failure

Cursory and/or hasty information acquisition

Resulting critical situation

Does not detect the interfering priority vehicle and performing a manoeuvre, cutting him off

Accident

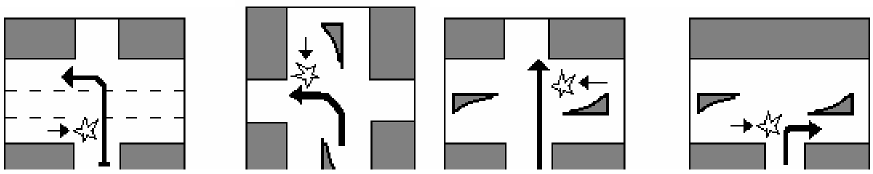

Figure 7.A.9: Characteristics of scenario P3b - Cursory information acquisition when crossing an intersection

✓ P5 Failures: Neglecting information acquisition demands

This failure appears in routine driving situations or situations with weak constraints for which the driver's attention becomes so diffuse that they cannot identify an interfering element when it becomes an obstacle. In accident cases, no proven outside activities are seen, other than being lost in their thoughts. This failure is found among 6.1% of elderly drivers vs. 5.0% of controls. Among the elderly, we can see many more men than women (9.0% vs. 0.9%).

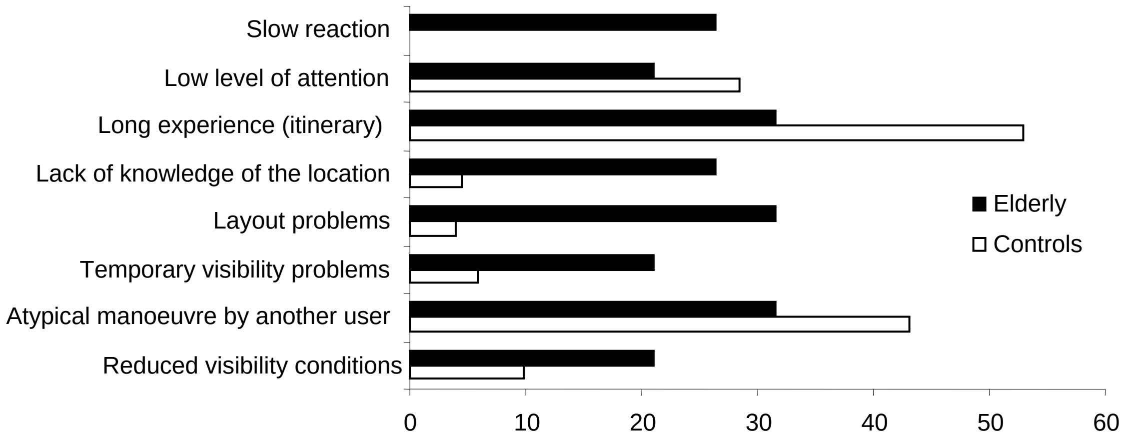

Figure 7.A.10: Percentage of the main explanatory elements for P5 failures among elderly drivers over 65 and other drivers

A low level of attention is one of the main elements involved in P5 failures (Figure 7.A.10). We observe it in 21.1% of elderly drivers and 28.5% of the controls. Slow reaction, layout problems and a lack of knowledge of the location are the main elements differentiating these 2 groups of users: slow reaction is exclusively found among the elderly (26.3%), and can notably cause the driver's failure when discovering an imminent danger. Layout problems play a role by causing specific difficulties for elderly drivers (complicated intersections, poor visibility of traffic lights, etc.) and confront them with the danger that other users may represent in these places, mainly when they are not familiar with the location. It should be pointed out that temporary visibility problems and reduced visibility conditions can accentuate this phenomenon. The tables corresponding to the data quoted below can be found in the Annex1.5 (Table 13).

One scenario that is highly represented among the elderly is the late detection of a vehicle slowing down ahead.

Scenario P5a: Late detection of a vehicle slowing down ahead

In this scenario (Figure 7.A.11), the drivers are driving in stabilised traffic and are surprised by a vehicle slowing down ahead of them (coming to a traffic light, preparing to change directions or simply traffic density). The low level of attention paid to the driving task is often at the origin of the late identification of the slowdown. In some cases we can observe an influence from layout problems as well as poor traffic conditions (rain and/or wet carriageway). The elderly drivers involved in this type of accidents are men. A hypothesis is that men may tend to overestimate their driving skills and let their attention wander more than women when performing the driving task.

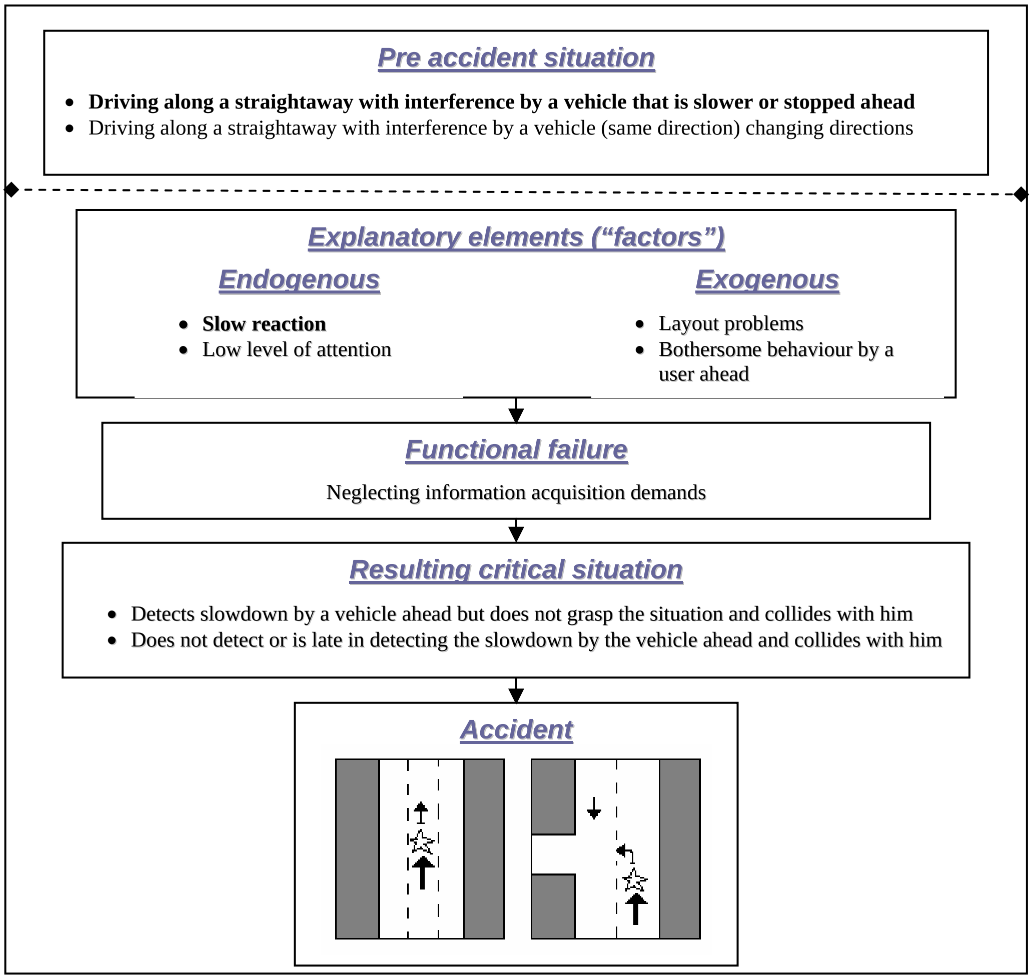

Figure 7.A.11: Characteristics of scenario P5a – Late detection of a vehicle ahead

Summary: perception errors among elderly drivers

- Perceptive failures account for 38.8% of all failures among elderly drivers.
- The especially occur in intersections where the elderly drivers have to yield right-of-way to other users.
- They concern 3 main mechanisms:
  - Information acquisition focused on a direction problem, to the detriment of information on the infrastructure and other users;
  - Cursory information acquisition in crossing an intersection or when making a left-hand turn;
  - Neglect of information acquisition demands leading to late detection of slowdown by a vehicle ahead.
- These mechanisms mostly appear to have underlying problems of shared attention and selective attention, altered visual abilities (acuity and field of vision), a certain degree of slowness in reactions and little driving practice.
- Being in an unknown location appears to pose many difficulties for elderly drivers, notably when layout problems are combined.

✓ T2 Failures: Overestimating a gap

This failure concerns a problem in assessing the distance/time ratio separating drivers from other vehicles while performing a manoeuvre. This crossing, merging or changing direction manoeuvre brings them into interference with a priority flow whose distance they assess poorly, leading them to be hit. This failure is found in 9.0% of elderly drivers (vs. 1.2% of the controls).

Accompanying elements (Figure 7.A.12) include behavioural slowness (32.1% for elderly drivers vs. 0% for the controls, characterised here by slowness in performing the manoeuvre once the decision to move has been made), routine operations based on being used to the manoeuvre (72.4% vs. 33.3%) and infrequent driving (10.7%). This is often combined with a certain trivialisation of the situation among elderly users (28.6%) and low vigilance in both groups. It is probable that, beyond this failure, limited upper body movement (Bayam *et al.*, 2005) lead elderly drivers not to check their blind spots (when merging onto the carriageway, but also when crossing, when the roads leading to the intersection are curved), and thus not to detect a vehicle coming faster than expected. The tables corresponding to the data quoted below can be found in the Annex1.5 (Table 14).

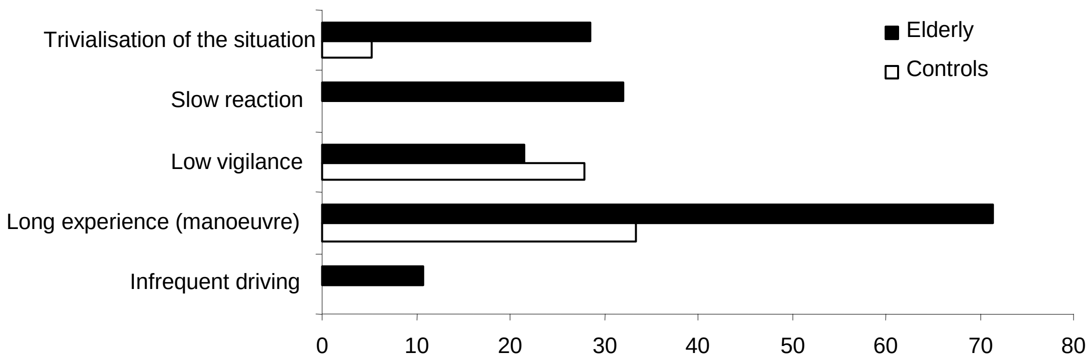

Figure 7.A.12: Percentage of the main explanatory elements for T2 failures among elderly drivers over 65 and other drivers

Once again, it appears probable that it is more the combination of slow reactions an little driving practice, rather than these elements taken individually, that has a strong impact on this poor assessment of the gap, which could explain why it is observed much more often among elderly drivers than among others.

Scenario T2b: Poor assessment related to a low level of attention paid to the manoeuvre

Among the failures observed in elderly drivers, this poor assessment may be related (Figure 7.A.13) to a low level of attention paid to the manoeuvre (driving in "automatic" mode) due to their familiarity with the manoeuvre being carried out. Trivialising the situation, they cut off another vehicle (even though it is detected) without paying much attention to the speed at which it is approaching.

The majority of these accident scenarios occur in intersections (62.5%) when the elderly driver has to cross a priority road. Most of the elderly people involved in these accidents are men.

Pre accident situation

- **Crossing an intersection without right-of-way with interference by vehicles on the priority road**
- Changing directions with interference by a vehicle on the road (same direction or opposite direction)
- Approaching an intersection without right-of-way
- Crossing the carriageway (not at an intersection) with interference by a vehicle on the road being crossed

Explanatory elements ("factors")

Endogenous

- **Driving in automatic mode**: low level of attention related to long experience of the manoeuvre
- **Slow reaction**
- Low vigilance
- Trivialisation of the situation

Exogenous

Functional failure

Poor assessment of a gap for merging into the traffic

Resulting critical situation

Detects the interfering vehicle (behind, in front or on the other road) but assesses its speed poorly, begins to cross and hits the vehicle

Accident

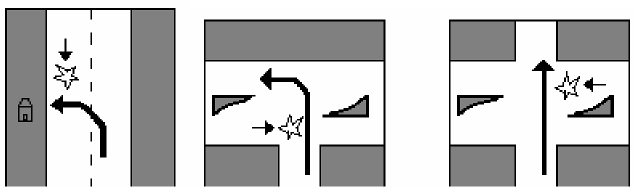

Figure 7.A.13: Characteristics of scenario T2b – Poor assessment of a gap related to a low level of attention paid to the manoeuvre

Summary: diagnostic errors among elderly drivers

- We observe a fairly high rate of diagnostic failures (14.1%) which can be summed up by one principal mechanism:
  - Poor assessment of a gap related to the low level of attention paid to the manoeuvre.
- Elements contributing to this failure include slow reactions and infrequent driving, low vigilance and a low level of attention. Trivialising the situation also appears to have an impact on this failure.
- One might suspect that elderly drivers, especially men, do not take the time to properly assess the speed at which other vehicles are approaching or that they pull out after minimal information acquisition.

✓ T6 Failures: Actively expecting adjustment by another user

In this failure, the driver with right-of-way detects alarming cues of interference by a non-priority user but does not implement a strategy adapted to the foreseeable critical developments.

This failure occurs in 10.8% of elderly drivers (vs. 8.4% of the controls). For both groups, it is accompanied by (Figure 7.A.14) a strong feeling of having the right-of-way (their reasoning being, "I have the right-of-way, the other user has to let me through", especially among the elderly: 97.0% vs. 65.6%), and often an attitude of surprise related to the fact that the other user undertakes an atypical manoeuvre. It is no doubt their lifelong driving experience that pushes seniors to feel sure of their priority and not to attempt to remedy the situation.

This failure can also occur in relation to a "pressure" effect felt by these drivers because of the other users and time constraints related to their manoeuvre, rather than visibility conditions limited by the infrastructure. The tables corresponding to the data quoted below can be found in the Annex1.5 (Table 15).

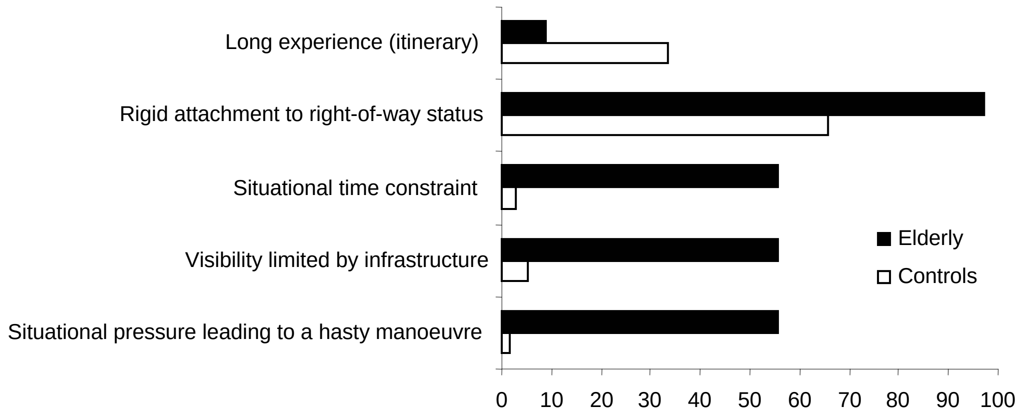

Figure 7.A.14: Percentage of the main explanatory elements for T6 failures among elderly drivers over 65 and other drivers

Scenario T6b: Erroneously expecting a non-priority vehicle to stop when approaching an intersection

The specific scenario corresponding to T6 failures is erroneously expecting a non-priority vehicle to stop when approaching an intersection. In these cases (Figure 7.A.15), the drivers come to an intersection with the right-of-way. They detect another vehicle on the secondary road but, given their feeling of priority, they do not pay particular attention to the situation and do not foresee the possibility that a precaution should be taken. Certain that the moving vehicle is going to stop, they are totally surprised when it crosses in front of them. In this type of scenario we observe a low level of attention by elderly drivers, a strong feeling of having the right-of-way and a trivialisation of the situation, with the other user's manoeuvre being atypical and/or in violation of the traffic laws.

All of the elderly drivers involved in this scenario were men, whereas there was no gender difference among the controls.

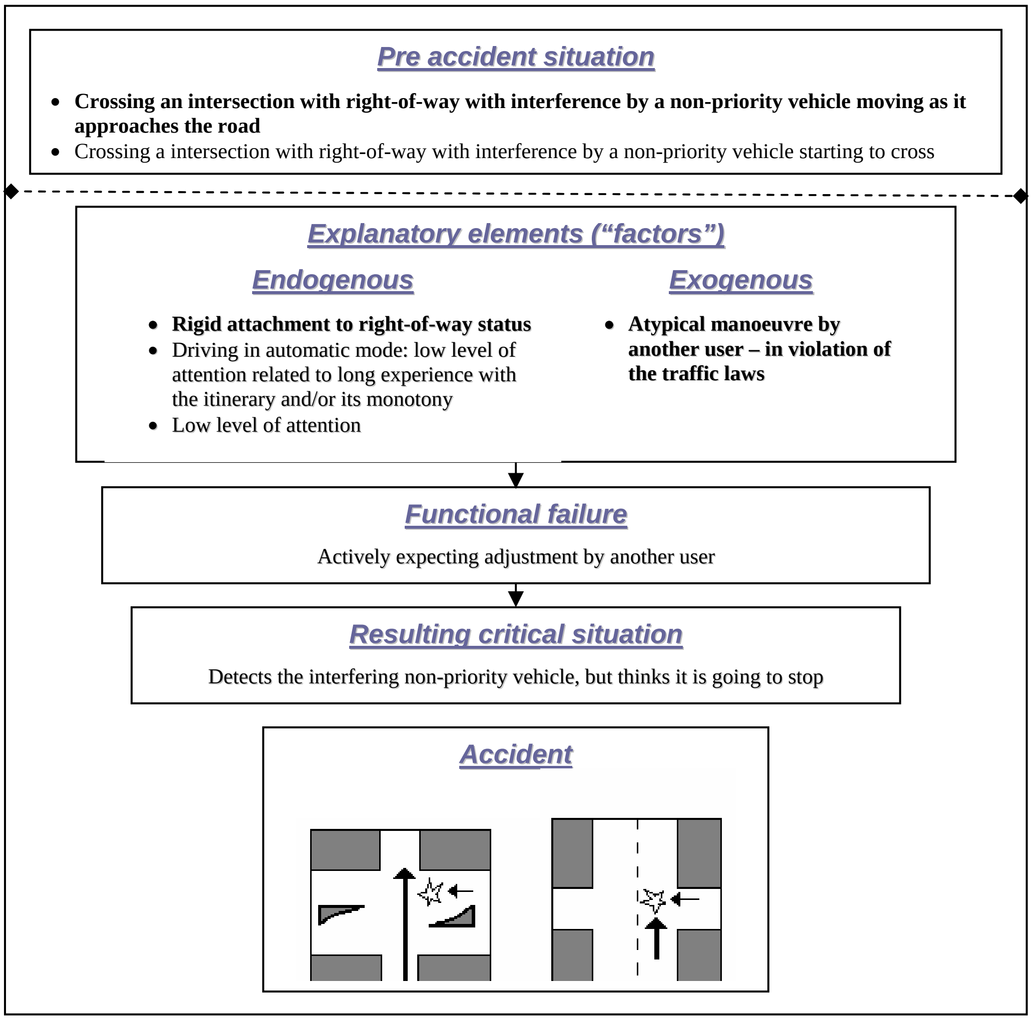

Figure 7.A.15: Characteristics of scenario T6b – Erroneously expecting a non-priority vehicle to stop when approaching an intersection

Summary: prognostic errors among elderly drivers

- A low level of prognostic failures is observed (anticipation, foresight) compared with the controls (11.4% vs. 16.2%), but which translates into a major mechanism:
    - An erroneous expectation that a non-priority vehicle is going to stop when approaching an intersection
- This failure is accompanied by a strong feeling of having the right-of-way related to a trivialisation of the situation among elderly drivers. The fact that the non-priority user's manoeuvre is atypical surprises the senior and leads him to actively expect the author of the manoeuvre to perform an adjustment.
- Driving experience and knowledge of the itinerary can cause elderly drivers to have this feeling of right-of-way and to neglect their level of attention. An overestimation of driving skills among men may also be involved.

✓ G3 Failures: Overwhelmed cognitive abilities

The G3 failure – "overwhelmed cognitive abilities" – is by far the main failure among elderly drivers. It originates in a loss of general driving skills related to the age of the drivers, sometimes combined with fatigue and a lack of knowledge of the location, leading to a directional problem that causes anxiety in this type of user. It is found in 23.2% of the accident cases involving seniors (vs. 0.9% of the controls) and more often among elderly women (35.6%) than elderly men (16.1%). This failure, in terms of abilities, typically calls into question cognitive pathologies related to ageing (Van Elslande, 2003a).

Here again (Figure 7.A.16), slow reactions and infrequent driving participate in the failure, but even more so than in other failures: they appear preponderant (93.1% and 82.1%, respectively) in the driving characteristics of elderly drivers qualified as G3 failures. The difficulties among seniors who do not drive much thus affect a disturbance in the different stages of the functional chain useful to driving. Low vigilance, a complex site and a rigid attachment to right-of-way status appear to accentuate this defective process. We should also point out that the drivers are quite often seeking directions when the accident occurs. The alteration of shared attention can potentially be partially at the origin of the failure, to such a degree as to cause the elderly driver to adopt abnormal behaviour (making a U-turn on the motorway, etc.). The tables corresponding to the data quoted below can be found in the Annex1.5 (Table 16).

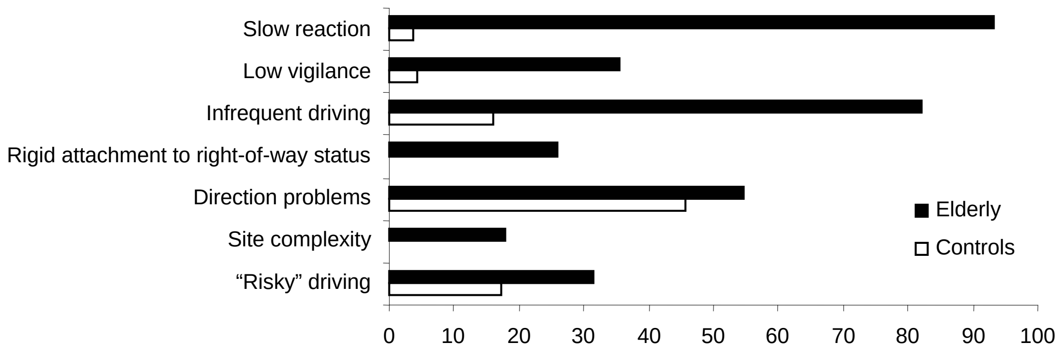

Figure 7.A.16: Percentage of the main explanatory elements for G3 failures among elderly drivers over 65 and other drivers

The scenarios that emerge for elderly drivers are overwhelmed processing abilities in a situation of interaction with traffic and performing abnormal manoeuvres.

Scenario G3a: Overwhelmed processing abilities in a situation of interaction with traffic

In this scenario (Figure 7.A.17), cognitive abilities are overwhelmed during a specific encounter with other vehicles. This difficulty causes the elderly driver's activity to become disorganised, affecting all of the functions involved in driving. When confronted with another vehicle, the elderly driver then finds himself in a situation of generalised incapacity to solve the slightest problem.

Pre accident situation

- **Crossing an intersection without right-of-way with interference by vehicles on the priority road**
- **Changing directions with interference by a vehicle on the road (same direction or opposite direction)**
- Driving along a straightaway with demands for seeking directions
- Driving along a straightaway with no other demand than steering the vehicle
- Approaching an intersection without right-of-way
- Crossing the carriageway (not at an intersection) with interference by a vehicle on the road being crossed
- Crossing an intersection with right-of-way with interference by a non-priority vehicle moving as it approaches the road

Explanatory elements ("factors")

Endogenous

- **Slow reaction**
- **Infrequent driving**
- Low vigilance
- Driving in automatic mode: low level of attention
- Lack of knowledge of the location or vehicle
- Direction problems

Exogenous

- **Temporary interference to visibility**
- Visibility limited by the infrastructure
- Complexity of the site

Functional failure

Overwhelmed cognitive abilities

Resulting critical situation

- Starts to cross without visibility and hits the interfering priority vehicle
- Does not detect or is too late in detecting a signal (toll booth, railroad) and hits an interfering object or vehicle

Accident

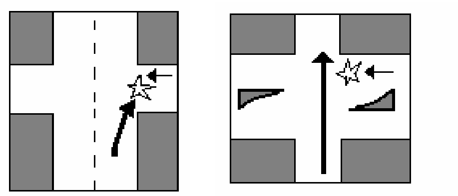

Figure 7.A.17: Characteristics of scenario G3a[1] - Overwhelmed processing abilities in a situation of interaction with traffic

For this scenario, the explanatory elements that contribute to the accident are infrequent driving, little experience with the situation and the complexity of the site. We also observe driver distraction (discussion with a passenger), difficulty in finding a gap for crossing or merging and a situational time constraint for the manoeuvre. Some of these abnormal manoeuvres are thought to occur under the influence of pressure caused by traffic (presence of other vehicles behind the elderly driver causing a feeling of bothering other users). Slightly more elderly men than elderly women are observed in this scenario.

[1] The figures representing the types of accidents in this scenario are simply examples, given the wide variety of the accident situations.

Summary: overall failures among elderly drivers

- A high rate of overall failures (24.8%) has been observed. These failures are particularly characteristic of the elderly driver population (a variation of 17.7% vs. other users was observed). One mechanism is overriding in this failure:
  - Overwhelmed cognitive abilities, leading to 2 prototypical scenarios: overwhelmed processing abilities in a situation of interaction with traffic and performing abnormal manoeuvres.
- Slow reactions and infrequent driving appear to play a preponderant role in this failure. We also observe the search for directions in several cases, the complexity of the site of the accident and low vigilance.
- The generalised disturbance of the information processing stages is what poses a problem for elderly drivers who experience this failure, notably for those who only drive infrequently. It is possible that illnesses such as dementia may have a harmful effect on the overall level of information processing, affecting the driving activity through this failure.

7.1.5 Failures among elderly people in emergency situations

This section is the subject of an additional analysis complementary to the previous section. It was motivated by the frequent involvement of the "slow reaction" variable in the population of elderly people involved in accidents. It was also motivated by the data in the literature suggesting greater difficulty for these drivers in emergency situations.

An emergency situation is an accident phase characterised by a sudden increase in time and dynamic demands. It requires the driver to perform a sudden manoeuvre that he was not prepared for (and is not familiar with). The question thus came up as to whether these characteristics specifically affect the senior sample in our population of drivers involved in accidents.

To answer this question, we undertook an analysis of the emergency manoeuvres undertaken using the following categories:

- Recovered: a suitable avoidance manoeuvre was undertaken (the driver did everything dynamically possible and the accident is explained by a poor manoeuvre by another user);
- Absence of Detection of danger (AD): the user involved detects neither the accident situation nor the emergency situation;
- Poor decision under constraint (D1): the manoeuvre is the result of a decision made under the constraint of the situation (the user involved had no other choice than the manoeuvre);
- Poor choice of manoeuvres (D2): the manoeuvre that the user decides to undertake is ill-suited, although he had another possibility;
- Difficulty of execution (E1): the intention behind the execution was right but it was not performed correctly because of heavy situational constraints (dynamics);
- Poor execution (E2): the intention behind the execution was right but it was not successful (poor dosage of controls);
- Unavoidable: the distance/time ratio was too small to be able to recover the situation successfully.

The tables corresponding to the data quoted above can be found in the Annex1.5 (Table 17).

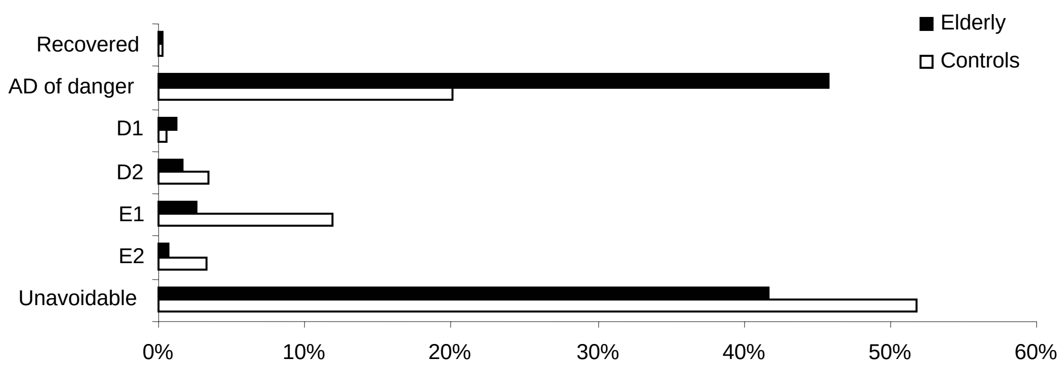

Figure 7.A.18: Percentage of the different categories of emergency situations for elderly drivers over 65 and other drivers

For a large share of accidents (45.8%), elderly people do not detect the accident risk (Figure 7.A.18). They therefore do not try to undertake any emergency manoeuvre. By comparison, for the control drivers, the absence of detection of danger only accounts for 20.1% of the emergency situations.

These elderly drivers who do not detect the danger are massively characterised (37.3%) by overwhelmed driving abilities (G3 failures) vs. only 1.7% of the controls. They are so "overwhelmed" by the situation that they are not even aware of the breakdown in events until the collision takes place. This is notably seen in the perseverance in carrying out an abnormal manoeuvre (such as driving the wrong way on the motorway) until the accident occurs.

The P3 failure – "cursory information acquisition" – accounts for 23.6% of the failures preceding the Absences of Detection of danger in emergency situation (18.7% for the controls). This can be easily explained by the fact that P3 failures cause the user not to detect the interfering vehicle from the outset.

We also observe among elderly drivers who do not detect danger that there is a fairly high rate of T2 failures preceding the emergency situation: overestimating a gap for merging into traffic (11.9% vs. 4.0% for the controls). It thus appears that, when they undertake their crossing or merging manoeuvre, elderly drivers do not detect the risk caused by their manoeuvre and do not seek to verify the prior information acquired. Explanations for this failure to renew their information acquisition lie with their difficulties with upper body movements.

The majority of the other emergency situations that elderly users involved in accidents are faced with (41.7%) are unavoidable accidents.

7.1.6 Discussion

Due to socio-demographic changes, the elderly are driving more and more and longer and longer. But this category of users is not immune to traffic accidents. The literature mainly presents quantitative data on their accidentalness. 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 study presents a detailed qualitative analysis of the origin of the functional failures specific to accidents in a sample of drivers over the age of 65 studied using INRETS EDA data. It 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, while the other refers to failures in terms of functions.

Principal failures among elderly drivers

A first group 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 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. Concerning errors related to interaction with traffic, 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. Concerning abnormal manoeuvres, a situational time constraint related to the context of the moment is combined with these elements. It is possible that elderly drivers 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. If this is the case, it is probable that drivers who are victims of this generalised alteration tend to have overall failures during the driving activity. This brings up the never-ending debate: what is the threshold at which people should stop driving? Should people who start to show signs of dementia simply be informed, discouraged or outright forbidden from all driving activity? This is a current debate and measures (frequent medical visits, etc.) have been taken in various countries.

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 only make overall and perceptive errors (overall errors are what most distinguish the elderly from other drivers). It may be that driving infrequently leads to a loss of expertise. This loss of expertise shows up more or less at every level of information processing, causing a diffuse failure when they have to deal with any problem occurring while driving. These overall errors may therefore be mainly related to limited driving practice. Figure 7.A.19 gives an idea of the type of failure that occurs according to the number of kilometres driven annually: the more elderly drivers drive, the less they make overall errors.

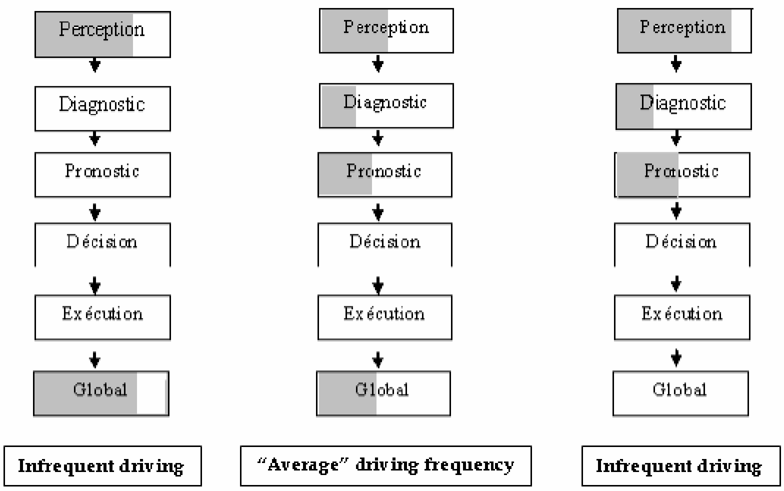

Figure 7.A.19: Proportion (shaded) of failures among elderly drivers as a function of the annual kilometres driven

This failure raises the question of the interaction between driving frequency and the evolution of functional abilities in driving: we tend to think, at first glance, that the alteration of cognitive, sensory and motor abilities (slow reaction, reduced visual capacities, dexterity, etc.) is at the origin of reduced driving frequency among elderly people. But the opposite influence is also possible: the drop in expertise related to less frequent travel, often along the same, more urban itineraries (Binet *et al.*, 2001; Langford *et al.*, 2006), can lead to a decrease in the functional abilities needed for safe driving. It appears probable that there is a reciprocal influence between these 2 phenomena.

A second set of accident-producing mechanisms emerges from the analysis 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 failures. Three main mechanisms underlie the perceptive failures identified: one concerns difficulties in sharing attention resources, another concerns cursory information acquisition and the last concerns 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). It thus appears that, when the elderly drive outside their habitual context and are confronted with a difficulty (a complex intersection, for example), their abilities fail them. Infrequent driving also seems to be a major element in all perception errors among elderly drivers. Furthermore, slow reactions among seniors appear to have an impact on all of these perceptive failures, whether when making the decision to undertake a manoeuvre or when discovering an imminent danger. These elements combined make it hard for them to respond safely to a complex situation. We should point out 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. It is interesting to observe that most elderly drivers who are at the origin of destabilising situations leading to accidents are affected by these diagnostic errors. Consequently, it would seem that the difficulties that seniors have in intersections without right-of-way mainly come from a problem in assessing a gap for crossing (or merging), i.e. the speed at which the priority vehicles are approaching and the distance separating them. It is probable that this poor assessment is caused by the alteration of movement perception (Guerrier *et al.*, 1999) and an attention deficit in peripheral vision (Ball *et al.*, 1993) related to ageing. We should once again point out 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 that 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.

The last type of failure that should be pointed out, although relatively rare among elderly drivers, corresponds to errors in prognosis, insofar as one mechanism appears to be specific to them: actively expecting adjustment by another user, and more specifically erroneously expecting a non-priority vehicle to stop when approaching an intersection. Driving experience acquired throughout their lifetime and their knowledge of the itinerary explains their strong feeling of having priority and their neglect of attention arising from the trivialisation of the situation by certain elderly drivers. It is probable that the deficit in detecting an object and perceiving movement (Guerrier *et al.*, 1999) delays their recognition of a danger and also contributes to the occurrence of this type of accident.

Failure production context and elements favouring their occurrence

Most accidents involving elderly drivers occur in intersections (nearly 50% of cases), and mainly 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.

B.- Gender issues

7.2 In-depth investigation of accident patterns according to gender using TRACE WP5 methodology

The whole sample from which this in-depth investigation using WP5 methodology was performed is the same as above, bringing together 1,676 road users involved in 1,067 accident cases. This will make it possible to compare the results on gender specificities to those revealed by the analysis of elderly drivers.

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.

7.2.1 Error production context: pre-accident situation and level of involvement

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.

Further analysis will be undertaken when reaching the Typical Failure-Generating Scenarios as this level of analysis appears more relevant than an overall analysis to consider differences between men and women's accident characteristics.

7.2.2 Errors and error factors among drivers: overall analysis

7.2.2.a Functional failures

The list of the different failure categories and the tables corresponding to the data quoted below can be found in the Annex.

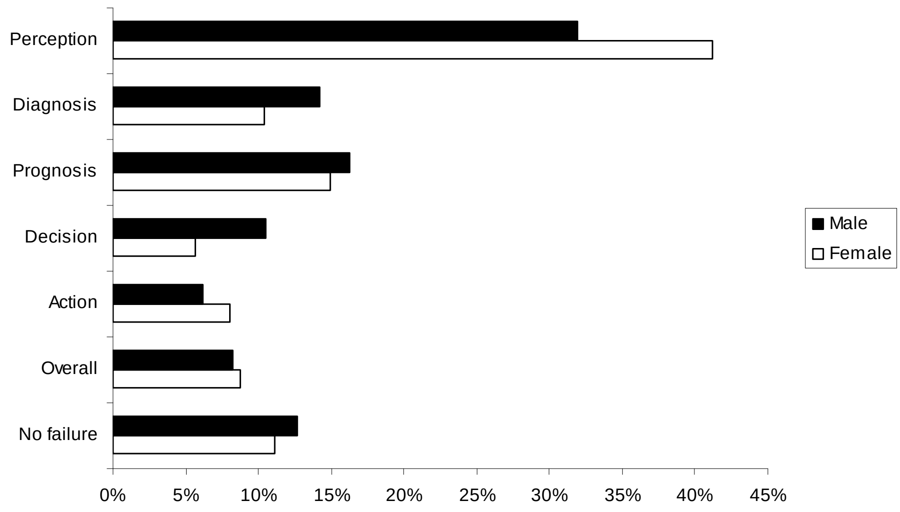

Figure 7.B.1.-Distribution of those involved by failure and gender (n=1,674).

We can observe a significant difference in the distribution of those involved by failure between men and women (χ^2=26.08; p=0.0002). This overall difference mainly comes from gender differences for three failure categories: perceptive, diagnostic and decision-making failures (Figure 7.B.1).

Most of the failures observed among drivers overall are on the perceptive level, and this tendency is even more marked among women than among men (41.2% vs. 31.9%; χ^2=13.97; p=0.002). These observations are in line with Storie (1977), who claimed that women are more subject to perceptive errors than their male colleagues.

On the other hand, men have more decision-making failures (10.5% vs. 5.6%; χ^2=10.86; p=0.001) and diagnostic failures (14.2% vs. 10.4%; χ^2=4.7; p=0.03) than women. It would be interesting to look into these data further to find out how much these decision-making and diagnostic errors are related to prior risk-taking (Finn & Bragg, 1986; Matthews & Moran, 1986; Dejoy, 1992).

We also observe more errors in execution among women than among men (8.0% vs. 6.2%), which is also in line with some of the data in the literature.

Very little gender difference is observed in prognostic failures (15.0% for women vs. 16.3% for men) and overall failures (8.8% for women vs. 8.3% for men).

These different characteristics are analysed in greater detail below.

7.2.2.b Explanatory elements

As in the previous section on age, explanatory elements are divided into "endogenous" and "exogenous" elements. The source of endogenous elements lies within the user and the activity he is performing; they are therefore related to the driver. The origin of exogenous elements lies in the environment of the driving task; they are therefore related to the situational context. These 2 groups of elements are not exclusive in explaining a failure, in keeping with the principle of multicausality. The following data indicate the percentage of explanatory elements contributing to all failures[1].

Details of their classification and the tables corresponding to the data quoted below can be found in the Annex1.5.

The analysis of explanatory element categories does not show any particular differences between men and women (see Annex1.5). Distinctions only appear when these elements are observed in greater detail (see Annex1.5). Using these data, we have selected the most characteristic explanatory elements for drivers of each sex so as to shed light on the most marked differences.

- **Explanatory elements mainly identified among male users:**
  - Driving too fast for the situation and "risky" driving (playful driving, testing a vehicle) are mainly male elements in accidents (23.1% for men vs. 14.2% for women and 16.7% vs. 4.9%, respectively). These two elements are mainly male, but also related to youth: 70.0% of the men involved in accidents had demonstrated risky behaviour (vs. 21.5% for women) and 48.4% of the men in the accident sample who drove too fast for the situation (and 45.9% of women) were under the age of 25.
  - Rigid attachment to right-of-way status (19.8%).
  - Men also have slightly more explanatory elements related to the driver's condition than do women (48.6% vs. 45.0%). Among these elements, alcohol[2] is the most significant: this element is involved in 7.4% of failures among male drivers vs. only 1.9% among women drivers, or 3.9

[1] The percentage is therefore calculated using a number of failures and not the total number of explanatory elements. This explains why the sum of the percentages of the explanatory elements contributing to a failure may be greater than 100%.

[2] High blood alcohol level: >0.5g/l

times more often. 63.2% of these accidents occur at night and, for nearly half of the cases (46.5% of the accidents occurring at night), concern young people under the age of 25.

- The difficulties that men have with the road infrastructure are characterised by sensitivity to layouts encouraging greater speed (6.4% vs. 4.0% for women) and by a difficult road design (tight bends, etc..) (5.2% vs. 3.6%). This last variable is often combined with playful driving among men (in 31% of cases vs. 11% for women). We can see that it is when they encounter a difficulty in the road layout that men suffer the consequences of their risk-taking which had been "under control" up to that point (excessive feeling of control according to Dejoy, 1992).

- Explanatory elements mainly identified among female users:

- Women have more of a tendency than men to focus on a certain component of the situation where they have identified a potential risk, to the detriment of other sources of information (11.3% vs. 8.7% for men).
- Rigid attachment to their right-of-way status (20.3%) is an element that contributes a bit more often to failures among women drivers.
- More elements related to distraction are found among women than among men (9.1% vs. 6.6%). This confirms the hypothesis presented by Storie (1977) on the higher probability of women's being distracted while driving than men. We can also see slightly more elements related to impatience, irritation and stress among women (5.8% vs. 3.6% among men). According to Dobson *et al.* (1999), this is the driving behaviour with the most risk for young women in combination with stress and habitual alcohol consumption.
- The set of variables related to driving experience affects failures among women more than among men (77.3% vs. 60.1%). This is particularly the case of driving in automatic mode, with women paying a low level of attention to the driving activity due to their long experience with the itinerary and/or manoeuvre (41.3% vs. 31.3% for men). Female drivers also have greater difficulties than men related to their low experience of the situation (4.1% vs. 1.7%). Consequently, women not only tend to be distracted when driving, but they are also less attentive than men in known situations (itineraries and manoeuvres). But, as seen in TRACE report D1.1, women tend to drive the same itineraries regularly. It can be seen that, in more than half the cases, women with a low level of attention related to long experience with the itinerary drive an itinerary related to household tasks (school, shopping, etc., in 58.1% of cases) and in 38.1% of cases, a home/work itinerary. Do women underestimate the risks related to these itineraries under the pretext that they don't usually have any problems? It is interesting to observe that, among women between 35 and 39 years of age, home/work itineraries are the most frequent (35.2%). The statements by Chiron *et al.* (2005) on the high accidentality among women of this age group during home/work itineraries should therefore be taken in relation with their exposure to this type of itinerary.
- Concerning the layout, women encounter more problem of visibility limited by the infrastructure (18.7% vs. 16.1% for men).
- Slightly more elements related to traffic conditions are observed among women than among men (84.2% vs. 80.6%). They mainly encounter difficulties when another party performs an atypical manoeuvre (and/or in violation of the law) (32.9% vs. 26.6% for men) and when another vehicle momentarily interferes with their visibility (18.4% vs. 13.9%). This once again appears to be in line with the hypothesis of greater difficulties for female drivers in dealing with unexpected situations.

7.2.3 Errors and error factors among drivers: detailed analysis

We have given an overview of the different failure categories for the gender of those involved. The in-depth case study (Figure 7.B.2) can be used to refine this preliminary analysis by looking at the different types of failures comprising these categories (the table corresponding to the figure below is presented in the Annex1.5). Reading this figure suggests that certain specific failures occur more for one category of users than for the other and vice-versa. Thus, special attention will be paid to the failures shown to affect each type of user as well as the most characteristic scenarios that correspond to them.

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)..

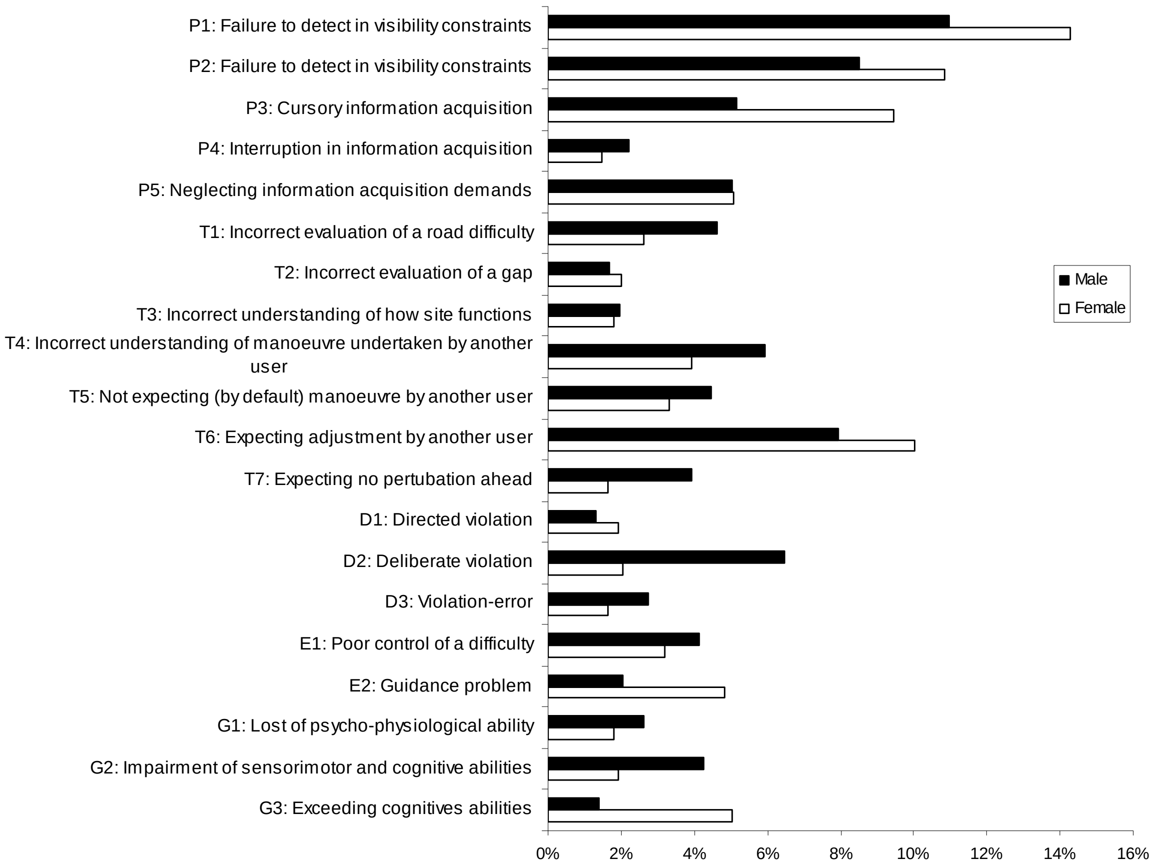

Figure 7.B.2.-Percentage of all types of failures among male and female drivers.

7.2.3.a Specific errors among male users

The tables corresponding to the percentages given in this section are presented in the Annex1.5.

- Diagnostic errors among men:

Men tend to make more diagnostic errors than women (14.2% vs. 10.4%) (Figure 7.B.1). The processing phase of the information perceived is supposed to allow the driver to understand the situation and to assess the physical parameters. Men mainly stand out by a poor assessment of a temporary difficulty related to the infrastructure (4.6% vs. 2.6% for women; χ^2=3.87; p=0.049) and a poor understanding of another user's manoeuvre (6.0% vs. 3.9% for women ; χ^2=3.21; p=0.073) (Figure 7.B.2).

✓ T1 Failures: Underestimating a temporary difficulty related to the infrastructure

The difficulties that drivers encounter with the infrastructure mainly concern difficult bends with narrow radii that change from the preceding approach and for which the pre-signalling does not always clearly indicate the dangerousness.

Men, who are mainly concerned by this failure, are rather young: 56.0% are under the age of 25, more than half of whom are under 20. According to Arnett (2002) and other authors[1], youth, but also driving inexperience, are markers for risky behaviour among men. Our data leans in this direction (Figure 7.B.3): these young drivers, characterised by a low level of attention, drive at high speeds (82.0%) in a playful context (41.8%) and are surprised by a difficulty with the infrastructure in locations that that they tend not to know.

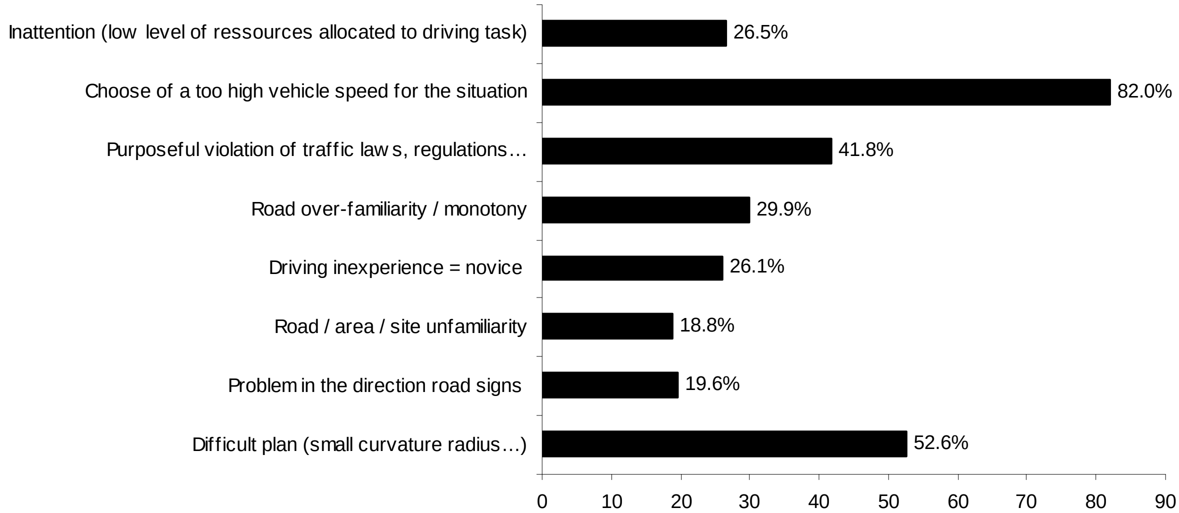

Figure 7.B.3.-Main explanatory elements for T1 failures among male drivers

Nearly half of the trips made by male drivers involving this failure are leisure trips. It thus appears that there is a certain form of risk-taking related to male youth behind the wheel, which in this failure translates into a heavy allocation of attention resources to guiding the vehicle, here for performance, to the detriment of relevant information related to the infrastructure.

For men, this underassessment of a temporary difficulty related to the infrastructure comes mainly in a context of a strong underassessment of the difficulty of a bend in a playful context. The following scenario is highly typical of this form of accidentality.

Scenario T1c: Underassessment of the difficulty of a bend in a playful context

This scenario (see Annex1.5 for details on the component parameters) mainly concerns male drivers under the age of 25 (69.6%), especially 18-19 year-olds, with little driving experience (30.4% of drivers concerned by this scenario). Accidents representing this scenario mainly occur during leisure travel (65.2%) in the daytime. The drivers are generally moving at a high speed in a long straightaway or a series of bends without difficulties and are surprised by coming upon a pronounced bend. They then lose control of their vehicle, which usually veers off the road. Certain cases concern drivers who consider that they know the itinerary well but who do not take into account the limiting variables affecting their trip (wet carriageway, fatigue, alcohol). The bend that they go around, even if slight, becomes a difficulty that these drivers cannot manage.

[1] Ballesteros & Dischinger, 2002; Williams, 2003.

✓ T4 Failures: Poor understanding of a manoeuvre by another user

Poor understanding of a manoeuvre undertaken by another user can come from a lack of cues announcing the manoeuvre, the multiple meanings of cues emitted or a cursory analysis of the interaction by the driver, who goes no further than identifying interference to his progression. Consequently, the driver implements a driving strategy that is ill-suited to the real nature of the interaction.

More errors of this type are found among men than among women (6.0% vs. 3.9%) (Figure 7.B.2). Among men, this failure is correlated with many factors, especially exogenous factors (Figure 7.B.4): cues emitted by others (whether lacking - 30.2% - or hard to interpret - 45.5%) or interfering behaviour by a user ahead of them (34.8%). In this case, the speed differential between the 2 vehicles (speed too high for the situation detected in 21.2% of cases) leaves the "failing" driver little time to understand the manoeuvre - sometimes atypical (and not pre-signalled) – by the other user.

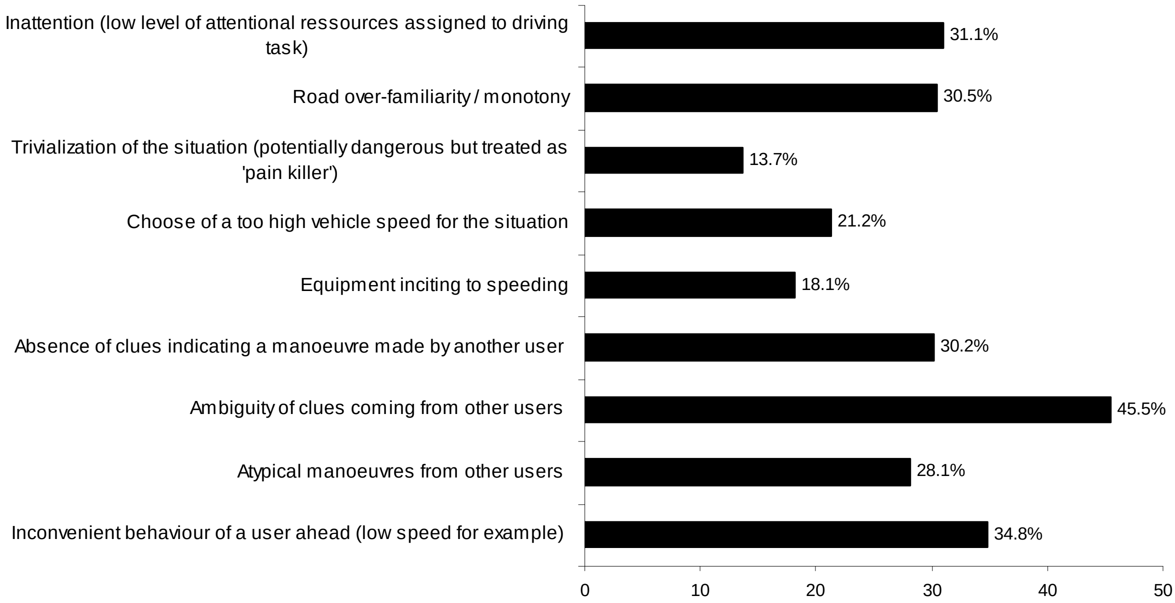

Figure 7.B.4.-Main explanatory elements for T4 failures among male drivers.

If specificities appear in the frequency of this failure, the analysis of prototypical accident scenarios does not show any marked differences between men and women. No scenarios in which T4 failures are central can be considered as typically male.

✓ Errors in expecting no obstacles among men (T7 failures)

The mechanism involved in this forecasting failure lies in adopting a mode of driving that does not integrate the possibility of encountering a disturbance going forward despite a lack of visibility (due to a bend, a vehicle, etc.). This restricted visibility, rather than leading them to take special precautions, appears to confirm the driver in thinking that there is no danger (Van Elslande and Alberton, 1997).

This is mainly a male failure, with 3.9% of expecting no obstacle among men and 1.6% among women (Figure 7.B.2). It is characterised (Figure 7.B.5) by an excessive speed for the situation (55.5%). This excessive speed is often combined with risky driving on a narrow carriageway. Among men, the expecting no obstacle failure tends to occur during leisure travel (28.8%).

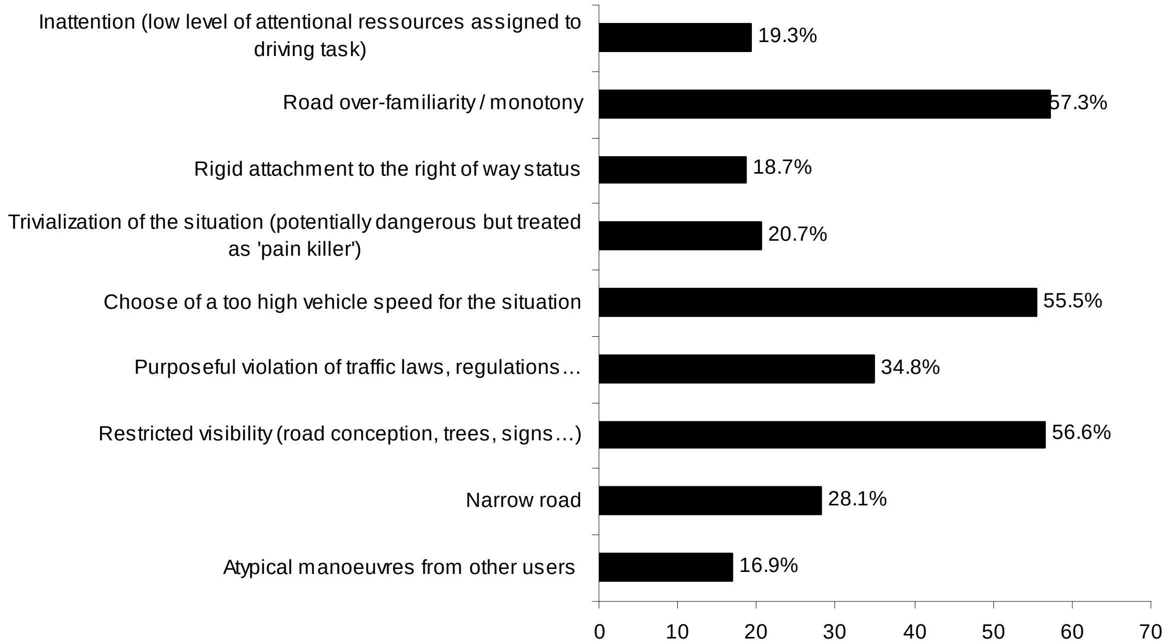

Figure 7.B.5.-Main explanatory elements for T7 failures among male drivers.

Foreseeing no vehicle in a bend without visibility is the scenario most specific to men.

Scenario T7a: Foreseeing no vehicle in a bend without visibility

Half of the male users concerned by this scenario are young (under 30) and the other half are middle-aged men (31-50 years old). This scenario is quite typical of the description given for the expecting no obstacle failure, in that excessive speed on a narrow carriageway is a recurring element in this scenario (see Annex1.5). In some cases, the drivers know the itinerary well and are tripped up in a location where visibility is restricted by the infrastructure. We should also point out that in some cases there was "risky" driving. Furthermore, it is interesting to observe that 16% of these drivers were on a powered two-wheeler.

✓ Deliberate violation of a safety rule among men (D2 failures)

Drivers who experience this failure take a risk when undertaking a manoeuvre by neglecting the applicable safety rules because they are in a hurry or because they confuse driving and fun.

This is the failure that particularly distinguishes men from women among the decision-making errors: men make this type of error 3 times more often than women (6.5% vs. 2.1%) (Figure 7.B.2). Speed and playful driving (Figure 7.B.6) are the main explanatory elements behind this failure among men (35.8% and 68.3%, respectively), notably seen in overtaking in a conflict situation or in an area with limited axial visibility, or even crossing an intersection "going with the flow" during leisure travel. Men tend to trivialise the risk related to the situation. This failure is characteristic of young men (64.9%are under 25) during leisure travel (52.6% of cases). According to our data, their low amount of driving experience affects the occurrence of deliberate traffic violations in 35.7% of cases. All of these results corroborate the data from the literature concerning the overestimation of one's own skills and risk-taking among young men behind the wheel (Finn & Bragg, 1986; Matthews & Moran, 1986; Arnett, 2002; Ballesteros & Dischinger, 2002; Williams, 2003; Laapotti *et al.*, 2006).

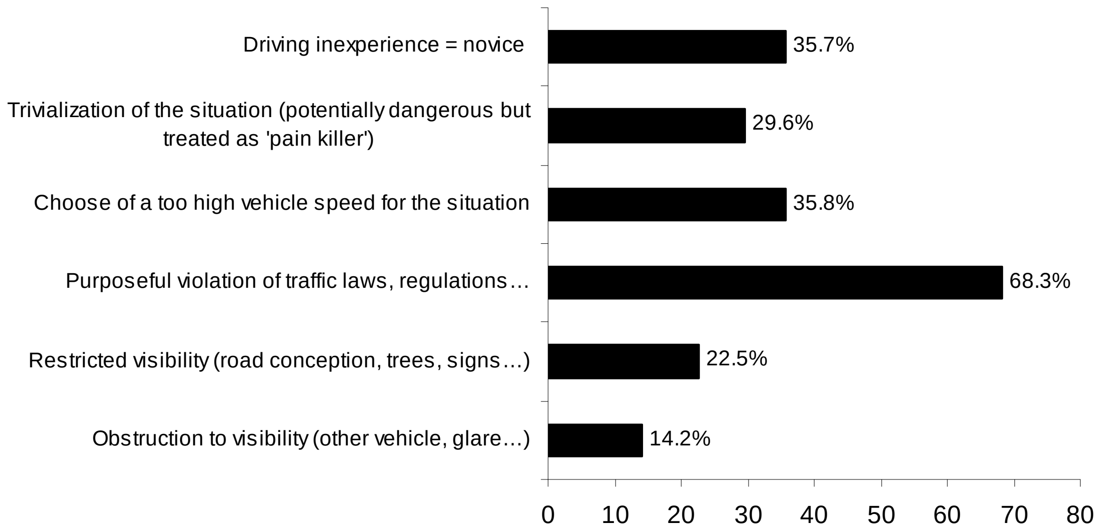

Figure 7.B.6.-Main explanatory elements for D2 failures among male drivers.

<u>Scenario D2c: Crossing an intersection "going with the flow"</u>

This scenario (see details in the Annex1.5) is the most representative of men for whom D2 failures could be identified. In almost half of the cases (46.1%), it concerns very young users (15 ½ years on average) riding a moped or bicycle. All neglect the basic safety rules and right-of-way when crossing the intersection where the accident occurs and it is possible that their young age contributes to this negligence process – were they even aware of the danger?

✓ Alteration of sensory-motor and cognitive abilities among men (G2 failures)

This alteration of driving abilities is related to taking psychotropic substances (alcohol, drugs and medicines). The consecutive breakdown of driving abilities, on both the behavioural and cognitive levels, often appears when the slightest difficulty is encountered on the itinerary, which the user appears to be incapable of managing on all functional levels.

Like the previous failure, this mainly concerns men (4.3% vs. 1.9% for women, see Figure 7.B.2). It is mainly explained by a high level of alcohol consumption (90.2%, Figure 7.B.7) during leisure driving (64.4%).

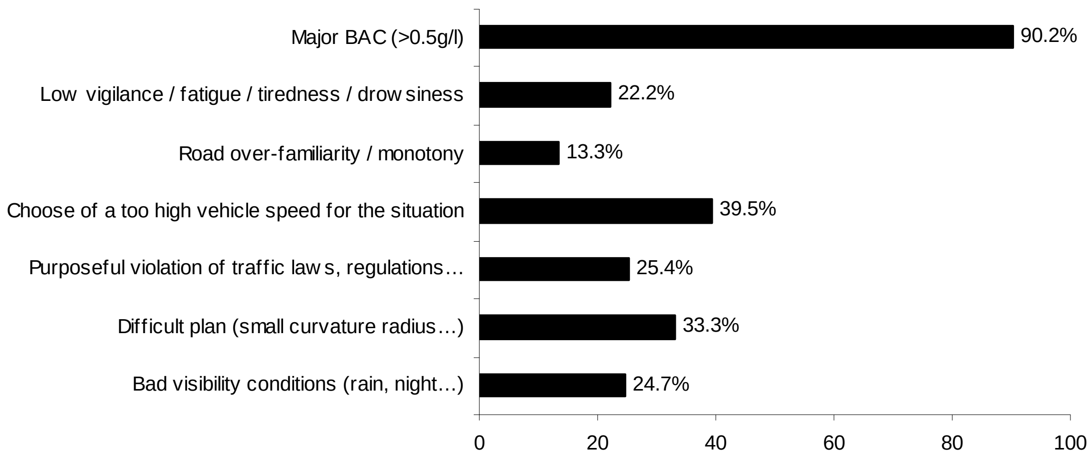

Figure 7.B.7.-Main explanatory elements for D2 failures among male drivers

For male drivers, we see risky behaviour (25.4% vs. none among women), with high speeds despite reduced visibility conditions. The men who have this failure during leisure driving are mostly young (58.7% are under the age of 30).

Scenario G2b, alteration of sensory-motor and cognitive guiding abilities, is typical of this failure among men.

Scenario G2b: Alteration of guiding abilities

Men in this scenario are 19 to 57 years old, with fairly homogenous distribution. All have a relatively high level of blood alcohol (>0.05g/l), playing an undeniable role in altering vehicle guiding abilities. The itinerary driven is, in most cases, for leisure (51.7%), at an excessive speed for the situation, with risky behaviour under reduced visibility conditions. In several cases, these elements were combined with low vigilance due to a state of high fatigue and difficulties in maintaining control of the vehicle along the road. And yet, in most cases, the accidents in this type of scenario occur in straightaways or easy bends.

- Summary of failure processes specific to male users

To summarise, the detailed accident data analysis only used those failures which characterise the accidents identified among men compared with those observed among their female counterparts.

We will therefore take the following as discriminants for male users:

- **Diagnostic errors**, with two major mechanisms:
  - ✓ An underassessment of a temporary difficulty related to the infrastructure (notably a bend in a playful context);
    - Backed up by risky driving, low driving experience, a lack of knowledge of the location or a low level of attention;
    - 69.6% are under 25 years old;
    - Greater attention paid to the vehicle's performance than to information from the environment.
  - ✓ A poor understanding of a manoeuvre by another user:
    - Backed up by cursory processing of slow behaviour by the user ahead and his atypical manoeuvre.
- **Foreseeing no obstacle** in areas without visibility:
    - Backed up by high speed, sometimes related to playful driving, on a narrow carriageway, in places where visibility is limited by the infrastructure, and on an known itinerary (low level of attention);
    - Failures mainly occurring during leisure driving.
- **Deliberate violation** of a safety rule:
    - Backed up by high speed and risky driving during a leisure trip, with trivialisation of the situation;
    - Young age and low driving experience;
    - In accordance with the literature on the question of overestimating one's personal skills and serious risk-taking by young male drivers.
- **Altered sensory-motor and cognitive abilities**, notably in guiding the vehicle:
    - Backed up by heavy alcohol consumption and low vigilance, leading to risky driving at high speed under conditions of reduced visibility
    - Fairly young.

7.2.3.b Specific errors among female users

The tables corresponding to the percentages quoted in this section are given in detail in the Annex1.5.

- **Perception errors among women**

Suitably performing a driving task firstly depends on early detection of all of the relevant data for the task to be performed. Otherwise, the entire chain of functional sequences risks being interrupted and the task could end up in an accident. Dysfunctions on the "perceptive" level may, however, concern different information processing mechanisms (Van Elslande and Alberton, 1997).

As we said above, it appears that women have significantly more perceptive failures than men. They are principally concerned (Figure 7.B.2) with a lack of detection related to difficulties in access to information (14.3% vs. 11.0% for men ; χ^2=3.76; p=0.052), but the gender difference is mainly found, for female drivers, in cursory and/or hasty information acquisition (9.5% vs. 5.2%, χ^2=11.1; p=0.001) and information acquisition focused on a partial component of the situation (10.8% vs. 8.5%).

✓ P1 Failures: Lack of detection due to difficult information access

This first set of dysfunctional situations lies in a problem of detectability of the information provided by the environment: the drivers were unable to detect an interfering object or individual (animal, user, etc.) soon enough to adopt suitable strategies for these situations.

The rates corresponding to a lack of detection due to difficult information access are higher among women than among men (14.3% vs. 11.0%) (Figure 7.B.2) and the explanatory elements contributing to this failure show a certain disparity (cf. Figure 7.B.8): women tend to drive in "automatic" attention mode due to their long experience or the monotony of the itinerary, and not to detect (or to detect too late) the interfering object due to an interference to visibility (temporary or related to the infrastructure). According to our data, this failure mainly occurs among women in itineraries related to household tasks (school, shopping, etc.: 47.4%). Female drivers who have experienced this perceptive failure do not foresee the presence of obstacles because of their knowledge of the location (and certainly the usually effective absence of obstacles).

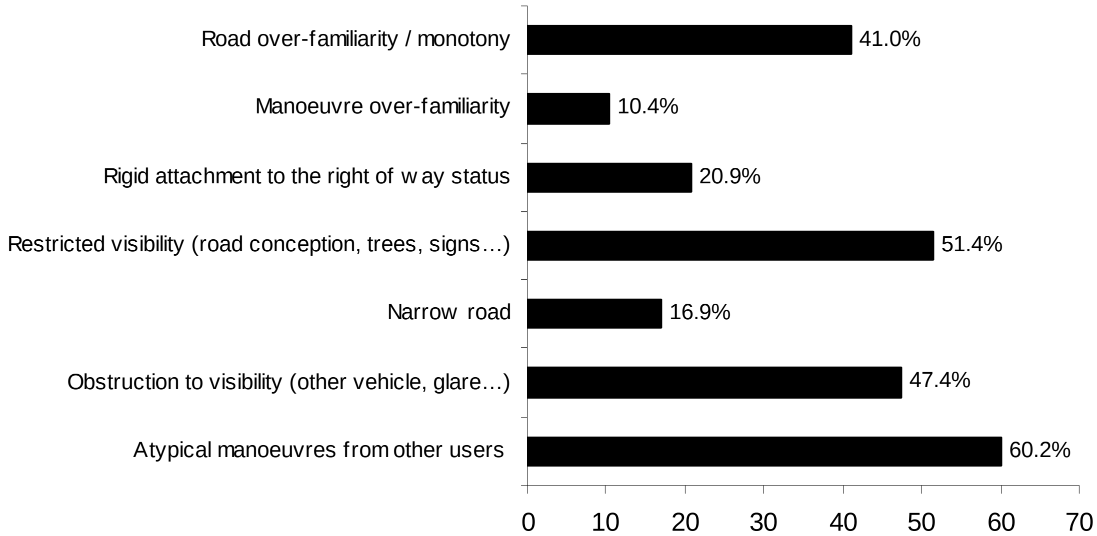

Figure 7.B.8.- Percentage of the main explanatory elements for P1 failures among female users.

Scenario P1d : Female drivers surprised by the manoeuvre of a non-visible approaching vehicle

Whether in an intersection or a flowing section, the female drivers grouped together in this scenario were all confronted with an atypical, or even illegal, manoeuvre by another user that they were unable to detect beforehand (see the details of the scenario in the Annex1.5). In fact, the presence of interference to visibility (infrastructure, buildings, another vehicle, etc.) is central in this scenario and keeps the user from foreseeing the other user's manoeuvre. Nonetheless, we can, in certain cases, wonder about the contribution of an endogenous element to the functional failure insofar as a feeling of having the right-of-way or long experience could have contributed to the female drivers' not taking any particular precautions in this reduced visibility situation.

✓ P2 Failures: Information acquisition focused on a partial component of the situation

This perceptive failure is characterised by a focus of their view and a monopolisation of their attention on an aspect of the driving situation which appears important at the time. Yet this focus comes to the detriment of other aspects of the situation which are nonetheless visible, leading the driver not to detect another user.

This information acquisition focused on a partial component of the situation is more common among female drivers than among their male counterparts (10.8% vs. 8.5%) (see Figure 7.B.2). Women's strong focus on an aspect of the situation considered as dangerous appears to be related to the complexity of the site and the atypical manoeuvre performed by another user (Figure 7.B.9), but also the long experience they have with the manoeuvre being performed (they have strong expectations as to the danger coming from one side rather than another).

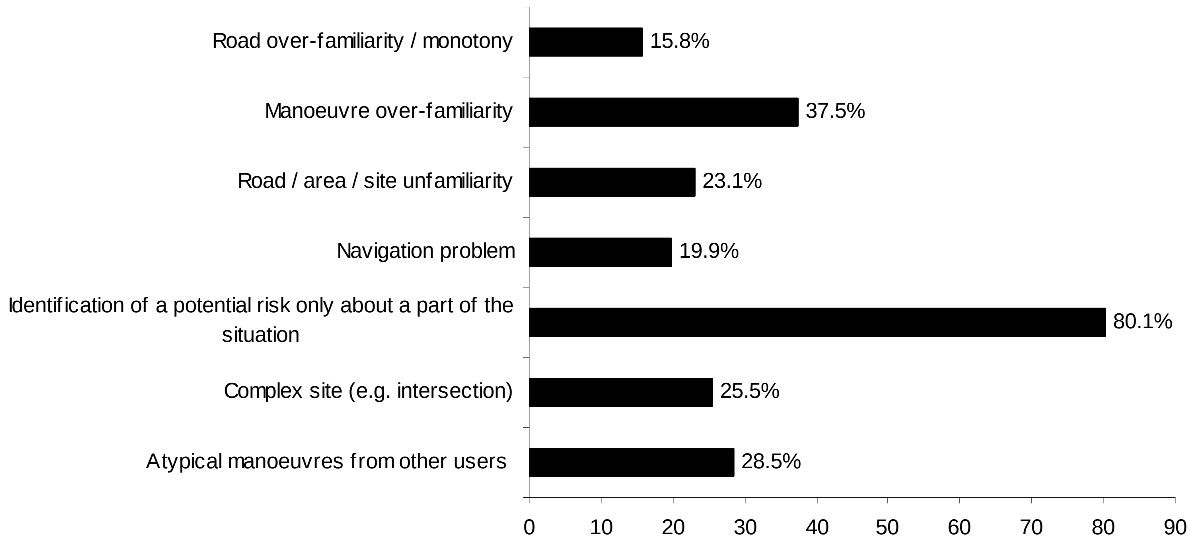

Figure 7.B.9.-Percentage of the main explanatory elements for P2 failures among female users.

One scenario explains this focus by women on a source of potential danger.

Scenario P2c: Focus on a source of information depending on the amount of traffic flow

In this scenario (see Annex1.5), the female drivers' focus appears to be related to a representation of the difficulties of the task, mainly in crossing an intersection, notably depending on the amount of traffic on the road and their expectations concerning the potential occurrence of a danger due to their experience of the task at hand.

In most of the cases corresponding to this scenario, the drivers seek to perform a left-hand turn manoeuvre. For this, they first give a quick glance to the left, and then focus on the vehicles coming from their right. They then undertake their manoeuvre without seeking new information from their left and are hit by a priority vehicle coming from this perceptively neglected side. The complexity of the site and the difficulty of finding a gap for crossing contribute to this failure. We should point out that, in some cases, a traffic pressure effect contributes to not seeking more information from the left.

- ✓ P3 Failures: Cursory and/or hasty information acquisition

The defective information acquisition procedure seen in this perceptive failure may come from a low level of attention to the manoeuvre, or from an overly hasty mode of operating by users who take a minimum amount of time in seeking information.

As for the P2 failures discussed previously, women are more inclined than men toward this type of perceptive error. As for P2 failures, women and men have similar accident rates in intersections (46.1% and 45.6%, respectively) but women have more accidents in the specific situation of crossing an intersection without right-of-way with interference by vehicles on the priority road (in 44.6% of the dysfunctional tasks with this failure, vs. 40.0% for men). Female drivers therefore make more cursory and/or hasty information acquisition errors than men in intersections, but only in situations where they have to yield the right-of-way. The vast majority of their cursory and/or hasty information acquisition errors occur in leisure driving (70.4%) in which they appear only to pay a low level of attention to their driving activity (Figure 7.B.10).

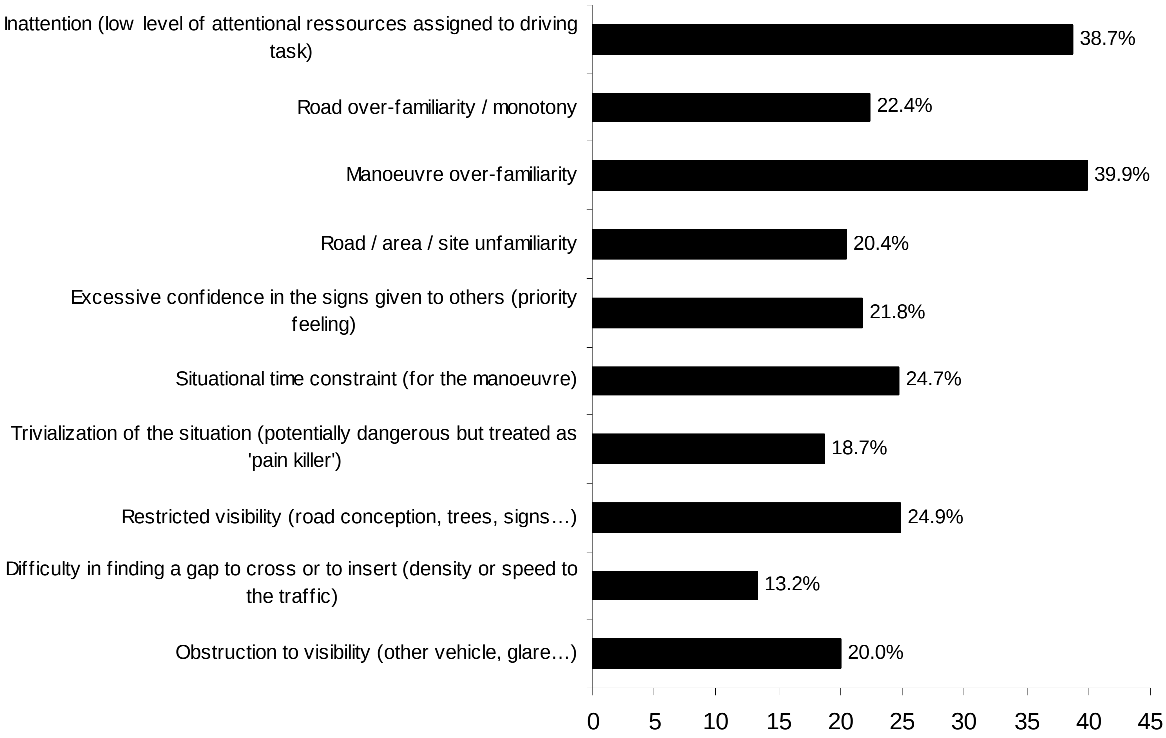

Figure 7.B.10.-Percentage of the main explanatory elements for P3 failures among female users.

These drivers thus appear to undertake their manoeuvre in unknown locations with reduced visibility (due the infrastructure) without checking feasibility on the side with low visibility. It appears possible that their reasoning in this case is of the type, "I can't see anything, so there isn't anything" and their information acquisition is therefore cursory.

Accidents among these drivers are typical of a precise information acquisition scenario:

Scenario P3a: Cursory search for information when making a left-hand turn

The cursory information acquisition failure mainly appears among female drivers in situations where they are seeking to undertake a left-hand turn manoeuvre that is usually very familiar to them, so much so that they pay little attention to seeking information on the feasibility of their manoeuvre. They are satisfied with a quick, almost automatic glance that does not enable them to identify the interference of another vehicle which they cut off. The main elements contributing to this perceptive failure scenario are endogenous. In most cases, the interfering vehicle is driving behind the driver's vehicle, coming up quickly in her lane or is trying to overtake her when she undertakes her left-hand turn manoeuvre. It appears that, in many of these cases, the lack of sustained information acquisition comes from excessive confidence in the signals emitted to other vehicles, here the left-hand turn signal, which leads them to trivialise the interaction situation.

✓ Errors of actively expecting adjustment by another user among women (T6 failures)

In this situation, the priority driver detects alarming cues concerning interference by another, non-priority user, but does not adopt a strategy suited to the foreseeable critical development of the situation.

This failure concerns 10.0% of women and 7.9% of men (Figure 7.B.2), and the elements that explain it differ relatively little by gender. The users here are, in 68.8% of cases, surprised by the atypical manoeuvre of another user (Figure 7.B.11). They usually have a strong feeling of having the priority (65.4%) and, in nearly one-third of cases, are driving too fast for the situation (32.5%). The level of attention paid to the driving task is usually too low given the difficulties related to the pre-accident situation (automatic driving identified in 31.6% of the female drivers involve in this failure). The type of itinerary among these drivers is most commonly when accompanying children (38.4%).

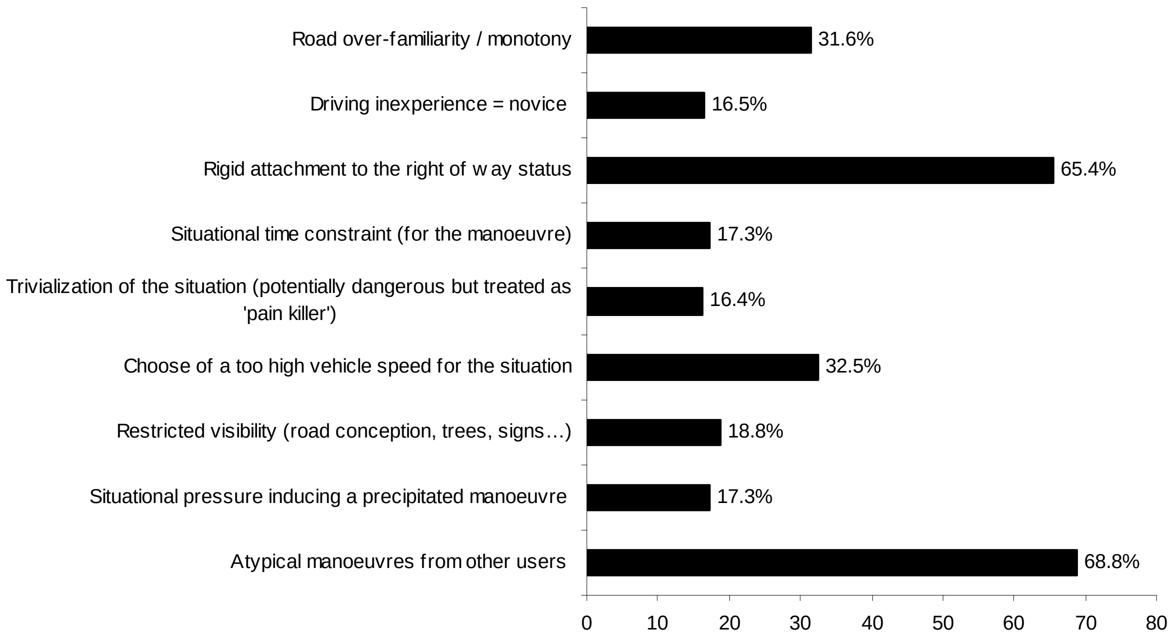

Figure 7.B.11.-Percentage of the main explanatory elements for T6 failures among female users.

Women are distinguished in this failure by 2 particular scenarios, one concerning erroneously expecting a trajectory correction by a vehicle driving along the road and the other related to erroneously expecting an interfering vehicle not to stop.

Scenario T6a: Erroneously expecting a trajectory correction by a vehicle driving along the road

The women concerned with this scenario are mainly middle-aged (66.7% between the ages of 30 and 45) driving a leisure itinerary (55.6%). In most cases, it involves a car coming from the opposite direction swerving over into the "failing" user's lane. The user generally realises the criticality of the situation but, certain that the interfering user is going to adjust, she reacts too late. In most cases (see Annex1.5) there is a certain trivialisation of the situation – potentially dangerous but treated as insignificant – by the driver, combined in some cases with a strong feeling of priority. This trivialisation causes an erroneous forecast of how the situation will develop, with the driver believing to the last moment that the user swerving offs the normal trajectory is going to adjust the situation himself.

Scenario T6d: Erroneously expecting an interfering vehicle not to stop

Most of the women concerned by this scenario are young (under 25). In these cases (see Annex1.5), the drivers are confronted with another vehicle suddenly stopping, whereas they had erroneously expected it to continue with its manoeuvre. This happens when a non-priority vehicle pulls out into the driver's priority lane, or simply when they are driving behind a vehicle that was not expected to stop. Experience on the itinerary, high speed and the unforeseeable manoeuvre by the interfering user are all elements that can explain the accident scenarios among these women.

✓ Guiding fault among women (E2 failures)

This execution failure comes from the attention conditions given to the task of adjusting one's trajectory. Female drivers are more concerned with this failure than males (4.8% vs. 2.1%) (Figure 7.B.2). For these women, this type of error is often linked (approximately 38% of cases) to performing a secondary task with no direct link to the driving activity, and low vigilance (21%) (Figure 7.B.12).

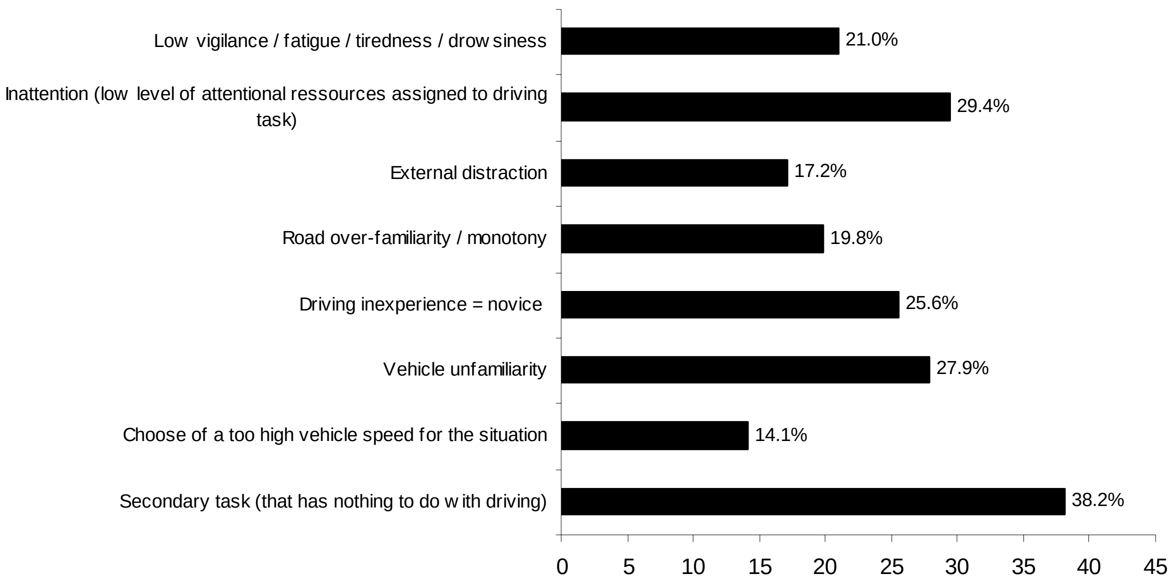

Figure 7.B.12.-Percentage of the main explanatory elements for E2 failures among female users.

Their low experience of driving and of the vehicle appear to play a major role in their guiding errors: weak driving experience influences this failure in 25.6% of cases (keeping in mind that 29.8% of the women who experience this failure are under 20 years old), and weak experience or lack of knowledge of the vehicle has an impact in 27.9% of cases.

The scenario of interrupted guiding after shifting attention toward a secondary task is particularly characteristic of guiding problems among women.

Scenario E2a: Interrupted guiding after shifting attention toward a secondary task

The women concerned with this scenario tend to be young (36.8% are under 25) and in most cases were involved in leisure driving (36.8%). The drivers momentarily interrupted guiding their vehicle to perform an activity unrelated to driving (getting something out of the glove compartment, picking something up off the floor, swatting at a wasp, etc.). In several of these accidents we can observe a problem of poor understanding of vehicle controls by the driver, and sometimes she is driving too fast for the situation (see Annex1.5). In other cases, the driver's attention, and momentarily her vision, was directed toward a passenger. It appears that fatigue has a significant influence on these drivers.

Most of these guiding interruptions caused the vehicle to swerve progressively toward the right of the carriageway, leading to a loss of control (the emergency manoeuvres performed often came from good intentions but were not suitable due to heavy dynamic constraints).

- ✓ Overwhelmed cognitive abilities among women (G3 failures)

This failure originates in a loss of overall skills or a major lack of driving experience related to the driver's age, sometimes combined with fatigue and a lack of knowledge of the location, leading to a direction problem causing anguish.

This failure concerns more women than men (5.0% vs. 1.4%) (Figure 7.B.2), mainly elderly (59.3% of them are over the age of 65, and more than half of these are over 75). They are overwhelmed by events when seeking directions in an unknown location (Figure 7.B.13), while acting on the basis of a feeling of having the priority. Infrequent driving has an impact on this failure, making these drivers less apt to handle several driving tasks simultaneously. Slow reactions and, more generally, cognitive slowdown appear to have a major impact on this failure (61.2%). It is probable that this slowdown has a reciprocal causal relationship with the decrease in kilometres driven by these elderly drivers[1]. These overwhelmed abilities may be at the origin of abnormal manoeuvres (such as stopping in the middle of the road or driving the wrong way down a road), so that their driving is considered "risky" for 32.2%. We also observe that the level of fatigue contributes to this failure in some cases (27.5%).

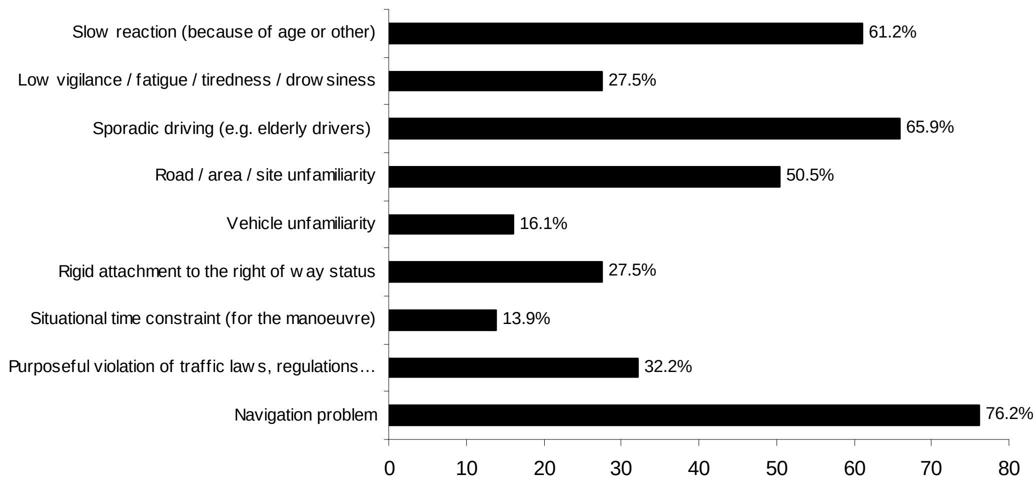

Figure 7.B.13.-Percentage of the main explanatory elements for G3 failures among female users.

The following scenario gives greater details of the contexts in which drivers undertake manoeuvres considered as abnormal, particularly typical of the overwhelmed cognitive abilities failure among women.

[1] Cf. TRACE report D1.1 for further details on this subject

Scenario G3b: Performing abnormal manoeuvres

Women concerned with the performing abnormal manoeuvres scenario are spread out fairly evenly among age groups, from 20 to 74. In some cases, the female driver is confronted with an unexpected manoeuvre by another user and panics, performing a manoeuvre that is inappropriate and overly abrupt for the situation. A lack of knowledge of the vehicle's control organs appears to have a slight impact on performing this manoeuvre. In other cases, the driver loses control of her vehicle in a situation that, *a priori*, is not complex but which she no longer controls, for example in a roundabout or on a motorway by trying to take an exit closed to traffic. Loss of control here can be explained by excessive speed for the situation and a search for directions by the driver who does not know the location well. In other cases, the manoeuvres are totally atypical, such as stopping when pulling out of a toll booth in an acceleration lane (the vehicle is then hit from behind), or backing up in an access lane (the driver hits a lamppost), or driving very close to the vehicle ahead in a work zone. Here again, the lack of knowledge of the location has a negative influence on these users' driving.

- Summary of processes specific to women users

We will take the following as discriminants for female users:

- **Perceptive errors**, with 3 major mechanisms:
  - ✓ Non-detection due to difficult information access:
    - Backed up by long experience with the itinerary or the manoeuvre being performed, correlated with interferences to visibility, whether linked to features of the infrastructure or to traffic conditions (another vehicle), and lastly in relation to manoeuvres undertaken by others (atypical or even violations);
    - When driving to perform household tasks (shopping, school, etc.).
  - ✓ Information acquisition focused on a partial component of the situation (notably on a source of information related to the level of traffic flow):
    - Backed up by long experience with the manoeuvre, identifying a potential risk in a certain component of the situation, but also the complexity of the site and the difficulty of finding a gap for crossing.
  - ✓ Cursory information acquisition when making a left-hand turn:
    - Backed up by long experience with the itinerary, combined with a low level of attention or reduced visibility (infrastructure);
    - Mainly occurring in intersections without right-of-way.
- **Erroneously expecting** an interfering vehicle not to stop:
    - Backed up by excessive speed for the situation;
    - Strong influence of exposure of women to habitual itineraries leading to a low level of attention and a feeling of surprise at an unusual manoeuvre (atypical or against the law) by someone else.
- **Interrupted guiding** when attention is turned to a secondary task:
    - Backed up by performing a secondary task unrelated to driving, combined with low experience with driving and with the vehicle.
- **Overwhelmed cognitive abilities** leading to performing abnormal manoeuvres:
    - Backed up by a direction problem in unknown locations, infrequent driving and sometimes a lack of knowledge of the vehicle;
    - Fairly old.

7.2.3.c Actions in emergency situations

The emergency situation is the phase in which there is a sudden increase in time and dynamic demands. Distinctions are made among various failure possibilities:

- Absence of Detection (AD) of danger: the user involved detects neither the accident situation nor the emergency situation;
- D1: the manoeuvre is the result of a decision made under the constraint of the situation (the user involved had no other choice than the manoeuvre);
- D2: the manoeuvre that the user decides to undertake is ill-suited;
- E1: the intention behind the manoeuvre was right but it was not performed correctly because of heavy situational constraints (dynamics);
- E2:the intention behind the manoeuvre was right but it was not performed correctly because of a lack of mastery of the controls;
- Unavoidable: the distance/time ratio was too small to be able to recover the situation successfully;
- Recovered: suitable avoidance manoeuvre (the driver did his/her best, but external conditions caused the accident anyway).

The tables corresponding to the data quoted below can be found in the Annex1.5.

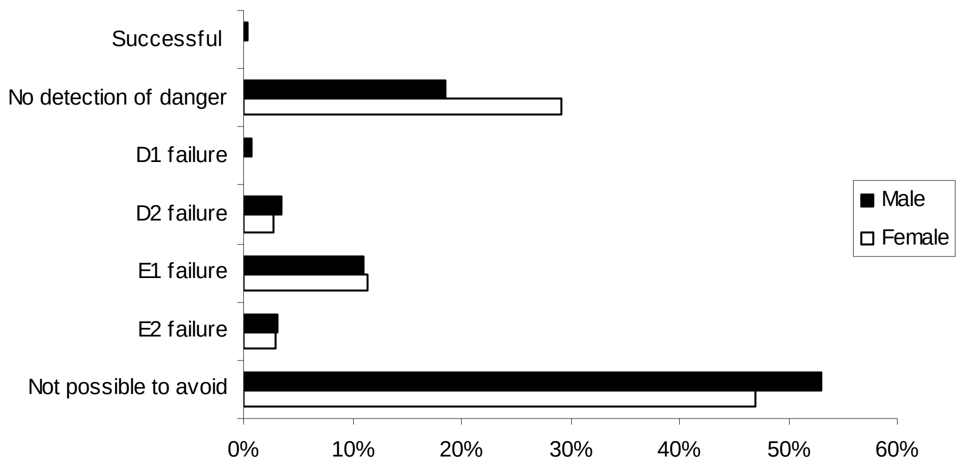

Figure 7.B.14.- Percentage of actions performed in emergency situations by men and women.

We mainly observe emergency actions for which the accident is unavoidable and lacks of action due to an absence of detection of the danger until it is too late (Figure 7.B.14).

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). Given the information in the literature on risk-taking among young people behind the wheel and, in this case, their tendency toward excessive speed, we might think that their lack of foresight as to potential dangers arising in these conditions makes the accident unavoidable when the danger appears.

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%).

No gender differences in the actions performed were observed in the other emergency situations.

7.2.3.d Specific pedestrian population

Concerning the pedestrians in the INRETS database, we observed that all of their accidents occurred in urban areas, mostly when crossing the carriageway (outside intersections) with interference by a vehicle on the road being crossed, principally for women (71.1% vs. 57.7% for men). The tables corresponding to the results presented below can be found in the Annex1.5.

Female pedestrians (Figure 7.B.15) mainly have perceptive failures (65.6% vs. 33.3% for men), in this case information acquisition focused on a partial component in the situation (25.0%) or cursory and/or hasty information acquisition (21.9%). The explanatory elements involved in their failures are mainly a low level of attention due to experience in crossing at these locations, identifying a potential risk in a certain component of the situation and difficulties in finding a gap for crossing.

Male pedestrians, on the other hand, tend more to make errors in prognosis (16.7% vs. 6.3% for women) and overall errors (16.7% vs. no errors of this type among women). They were actively expecting adjustment by another user (11.1%) and their overall failures came from an alteration in sensory-motor and cognitive abilities (11.1%) or overwhelmed cognitive abilities (5.6%). The explanatory elements involved in their failures are mainly trivialisation of the situation, high alcohol consumption and risky behaviour, and they are surprised when confronted with an atypical manoeuvre by another user.

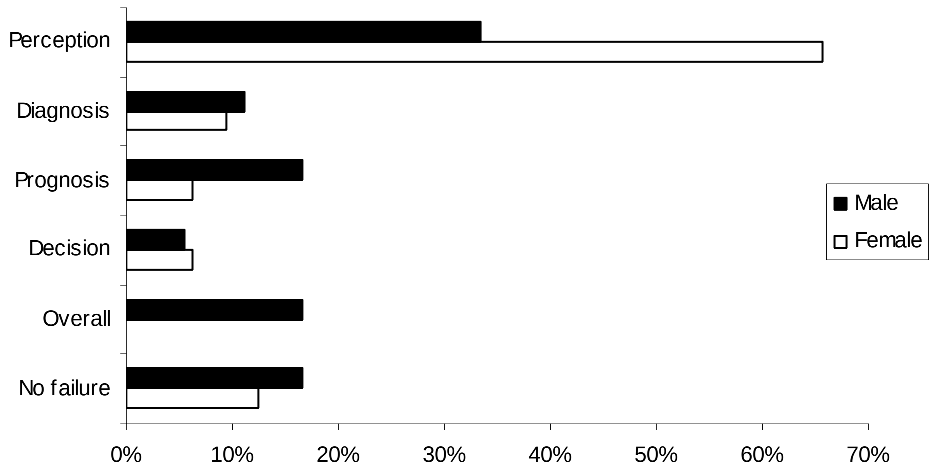

Figure 7.B.15.-Distribution of pedestrians involved in accidents by failure and gender

7.2.4 Discussion

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 observables 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. Below we present a summary, failure by failure, of the characteristics observed in traffic accidents for men and women.

Errors in perception

Perceptive errors mainly occur among women (41.2% vs. 31.9% for men; χ^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 (depending on the amount of traffic flow) and cursory information acquisition when making a left-hand turn. These 2 failures are related to the common involvement of women in habitual itineraries, causing them to assign less of their attention resources to their manoeuvres. These results may in part explain the excess number of perceptive errors among women compared with men, which had already been observed by Storie (1977). 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; χ^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). Waylen and McKenna (2002) pointed out the tendency among men to have accidents in bends. In our cases, men involved in accidents in bends had demonstrated risky behaviour combined with a low level of attention. 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; χ^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, as various authors have noted (Jonah, 1990; Anderson & Ingram, 2001; Laapotti & Keskinen, 2004; SIRC, 2004).

7.2.5 Conclusions

Our analysis shows observable tendencies in terms of accidentality among men and women, but we should not extract excessive inferences as to the origin of gender-related differences. Indeed, many questions remain in terms of risk exposure data which may be linked to genders differently. Certain exposure characteristics can lead to specific interaction situations. We can only mention certain parameters which appear to be characteristic of these two distinct populations.

What stands out for us is that women rather tend to make perceptive errors in the context of a repetitive itinerary. This element often appears to influence the occurrence of failures among women, especially prognostic errors toward erroneously expecting an adjustment of trajectory by an interfering user. On the other hand, a lack of knowledge of the location also seems to pose problems for them: this is the case in their diagnostic, decision-making and overall failures.

Men stand out more by their decision-making errors, especially in deliberate violations of safety rules on leisure itineraries. It appears that this is the type of itinerary that sometimes leads them to risky driving and high speeds. Speed also (partially) characterises diagnostic errors among men, especially young men, and often leads to accidents in bends. Moreover, men sometimes tend to trivialise the situation, for example undertaking a manoeuvre when visibility does not provide certainty that it can be carried out successfully.

Lastly, we should point out that there is a set of traits common to both populations. Thus, low experience and youth, described in the literature as being markers for adopting risky behaviour among men (Arnett, 2002; Ballesteros & Dischinger, 2002; Williams, 2003), concern both women and men in our data, but differently depending on the type of failure.

8 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 m ain 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 to decide 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 axles 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 evaluation of the effectiveness of existing safety devices.
  - The determination of the most promising safety systems.
  - 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 is 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 objetive.

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.

9 References

In this chapter references used in this deliverable are shown, except references from chapters '3. Task 1.1: Passenger Car Drivers', '4. Task 1.2: Powered Two Wheeler Riders', '5. Task 1.3: Van, Bus and Truck Drivers', '6. Task 1.4: Pedestrian and Cyclists' and '7. Task 1.5: Elderly People and Gender related accidents' which have been detailed in the respective chapters:

ANFAC (2004). *European Motor Vehicle Park (2006).*

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

Newstead S.V. and Corben B.F. (2001). *Evaluation of the 1992-1996 transport accident commision funded accident blackspot treatment program in Vitoria.* Monash University (Australia).

SafetyNet Project (2005). *Annual Statistical Report 2005.* Brussels.

Statistics of Road Traffic Accidents in Europe and North America. United Nations (2007). United Nations. New York and Genova.

World Health Organisation. *European Detailed Mortality Database (2007).* http://www.euro.who.int/

10 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 Motocyles'), 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.

11 Annex 1: Tables and figures

In this Annex, some tables and figures are shown, which have been used to analyse the different situation for each road user.

11.1 Annex 1.1: Passenger car drivers

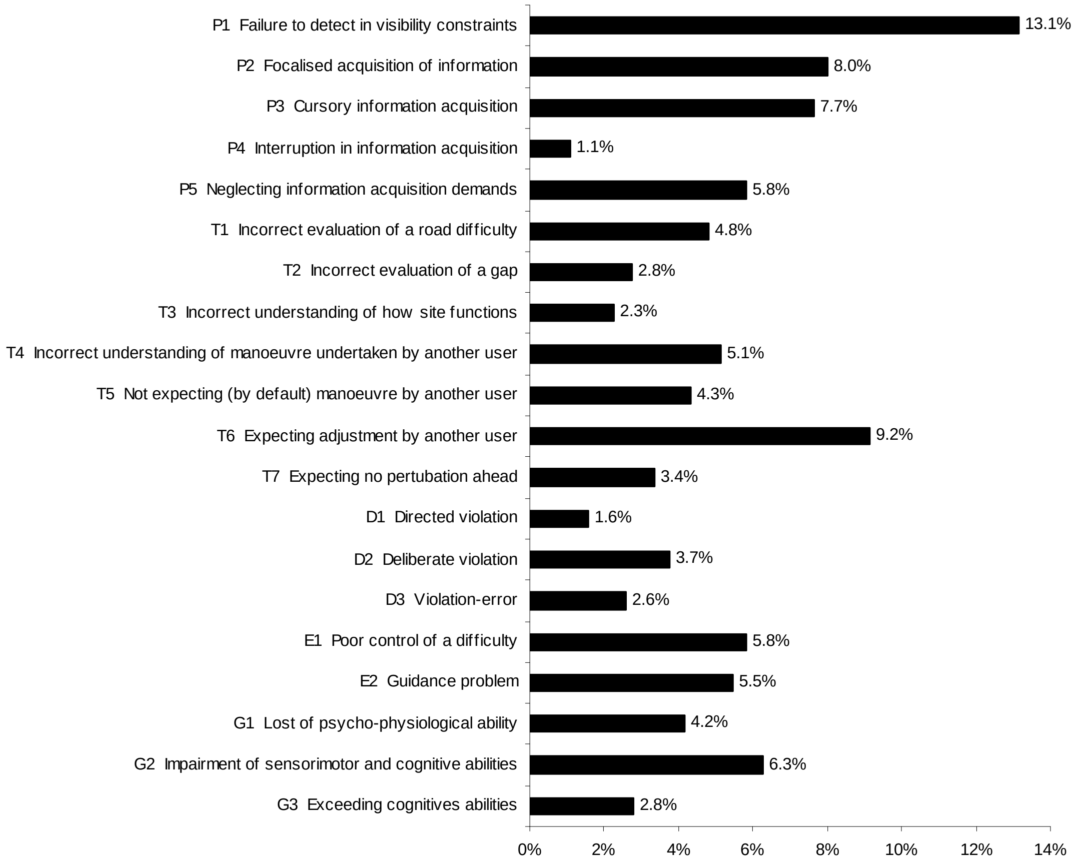

Figure 1_Annex1.4.-Distribution of passenger cars human functional failures.

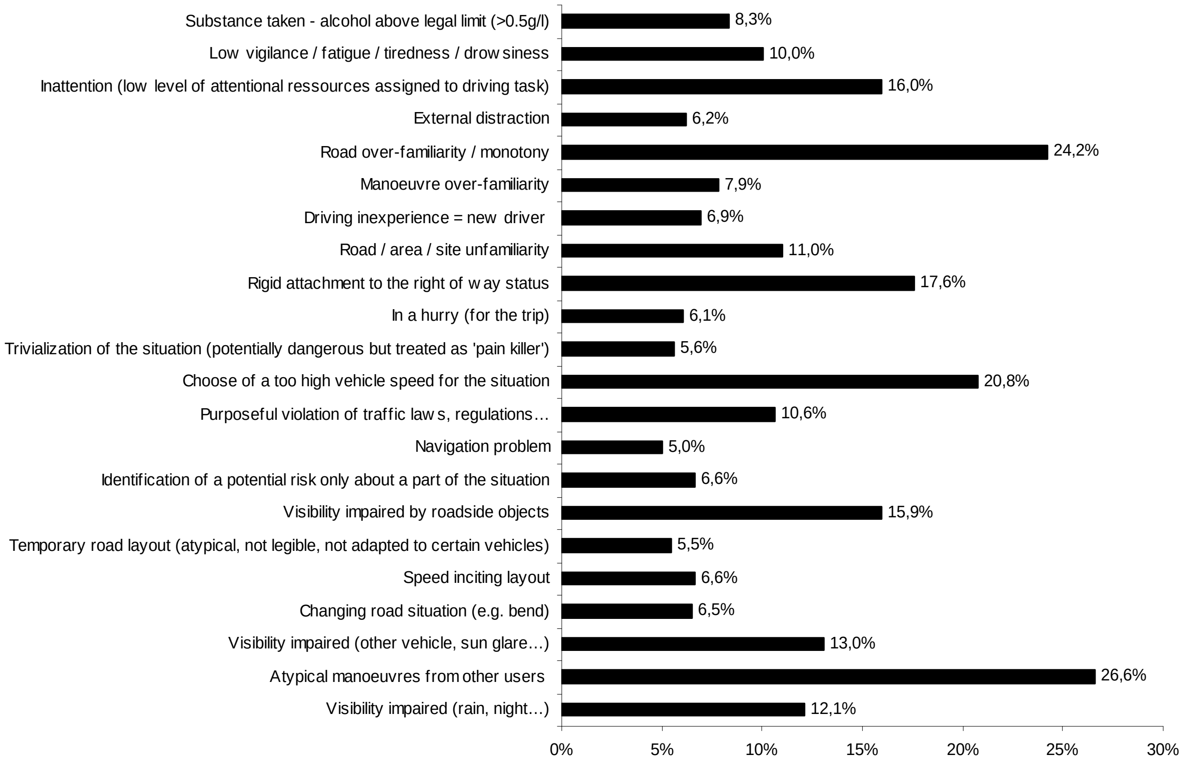

Figure 2_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for human functional failures of passenger car drivers.

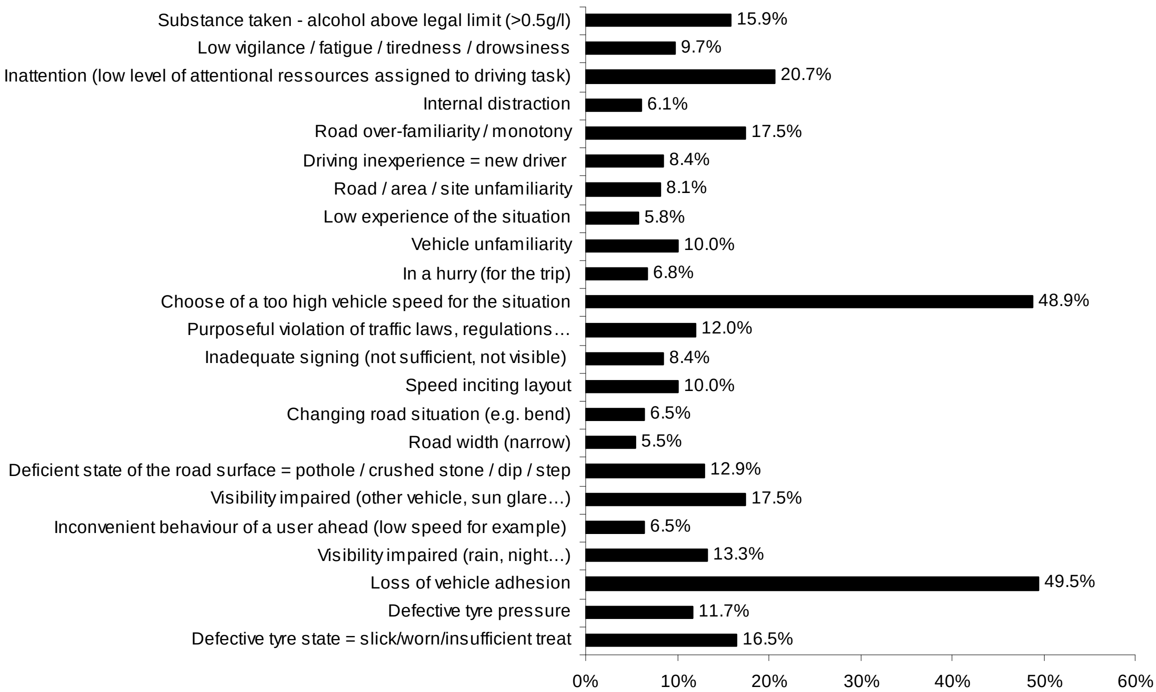

Figure 3_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to E1b scenario.

Sudden encounter of an external disruption, more or less expectable

Driving situation

Going ahead on a straight road
Going ahead on a left or a right bend

Explanatory elements

Endogenous

- Fatigue
- Little/None experience (driving)
- In a hurry
- Risk taking (speed, vehicle positioning, traffic control, 'eccentric motives')

Exogenous

- Road condition (wet, flood, snow…)
- Maintenance (tyre)

Functional failure

Poor control of the vehicle related to driving mode. Sensori-motor procedures are inadequate

Resulting critical situation

Uncontrollability of the vehicle

Crash

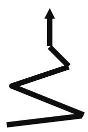

Figure 4_Annex1.4.-Typical scenario E1b.

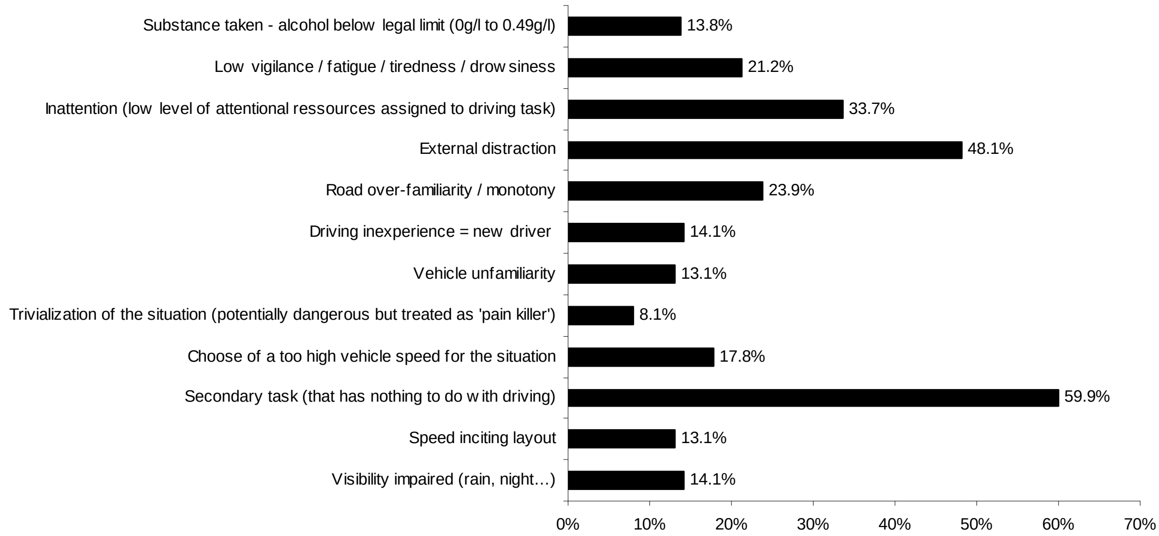

Figure 5_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to E2a scenario.

Guidance interruption consequently to attention orientation towards a secondary task

Driving situation

Going ahead on a straight road
Going ahead on a right or a left bend

Explanatory elements

Endogenous

- Fatigue
- Distraction
- Little/None experience (driving, vehicle)
- In a hurry
- Risk taking (speed, 'eccentric motives')

Exogenous

Functional failure
Interruption of the road environment supervision task

Resulting critical situation
Late detection of the vehicle drifting out of the carriageway

Crash

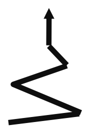

Figure 6_Annex1.4.-Typical scenario E2a.

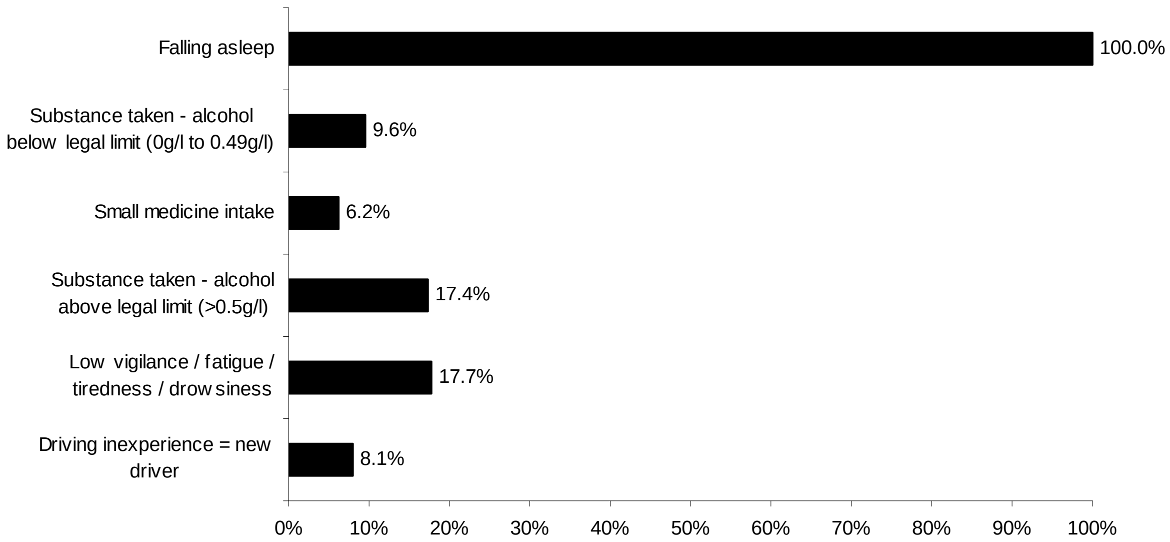

Figure 7_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to G1a scenario.

Loss of psycho-physiological capacities consequently to a falling asleep or ill-health

Driving situation

Going ahead on a straight road

Explanatory elements

Endogenous

- Substances taken (alcohol, drugs)
- Fatigue
- Medical condition

Exogenous

Functional failure

Interruption of the driving task

Resulting critical situation

Non detection (or too late) of the vehicle drifting

Crash

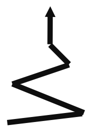

Figure 8_Annex1.4.-Typical scenario G1a.

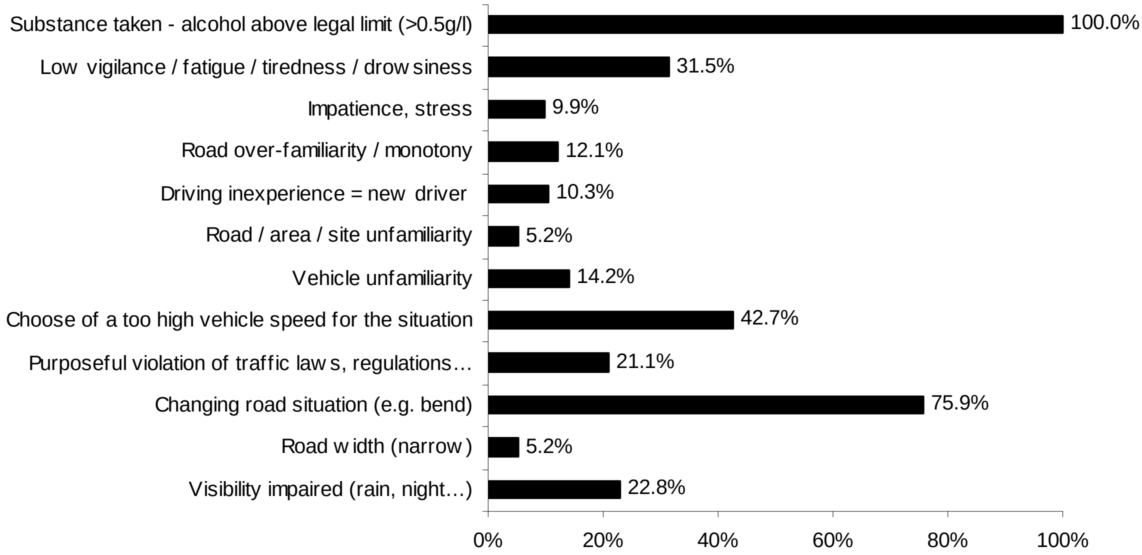

Figure 9_Annex1.4.- Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to G2a scenario.

Alteration of trajectory negotiation capacities

Driving situation

Going ahead on a right or a left bend

Explanatory elements

Endogenous

- Substances taken (alcohol, drugs)
- Fatigue
- Little/None experience (driving)
- Risk taking (speed)

Exogenous

- Speed-inciting road layout
- Road geometry (bend, slope, road width…)

↓

Functional failure

Global incapacity to manage the negotiation of the trajectory

↓

Resulting critical situation

Negotiation of the bend without adjusting speed and trajectory

↓

Accident

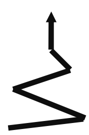

Figure 10_Annex1.4.- Typical scenario G2a.

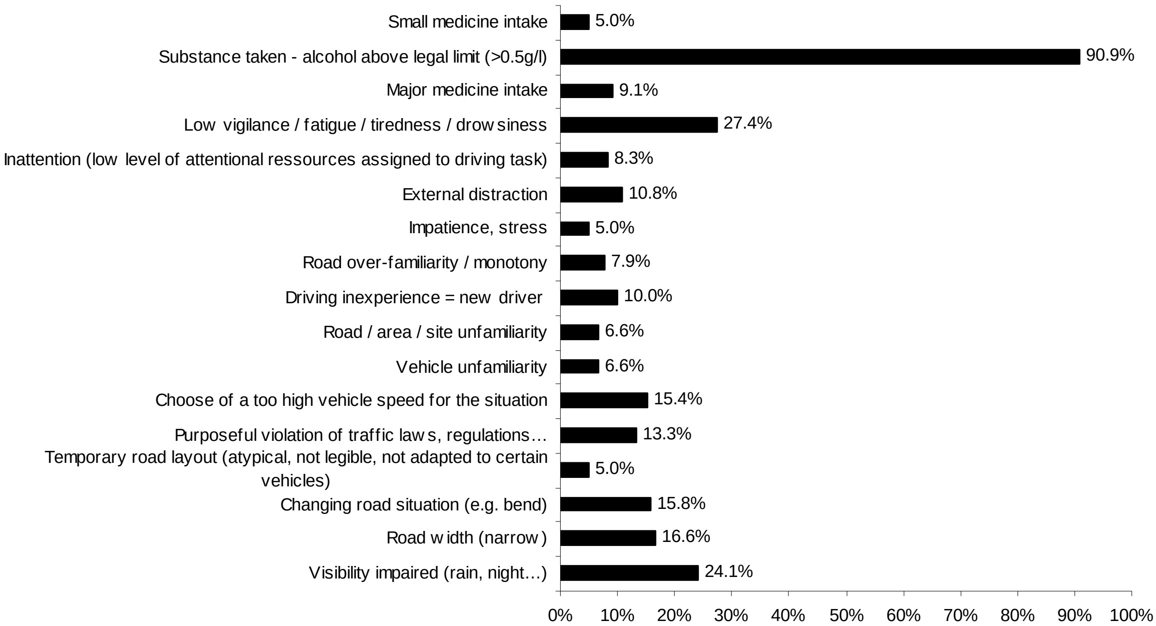

Figure 11_Annex1.4.- Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to G2b scenario.

Alteration of guidance capacities

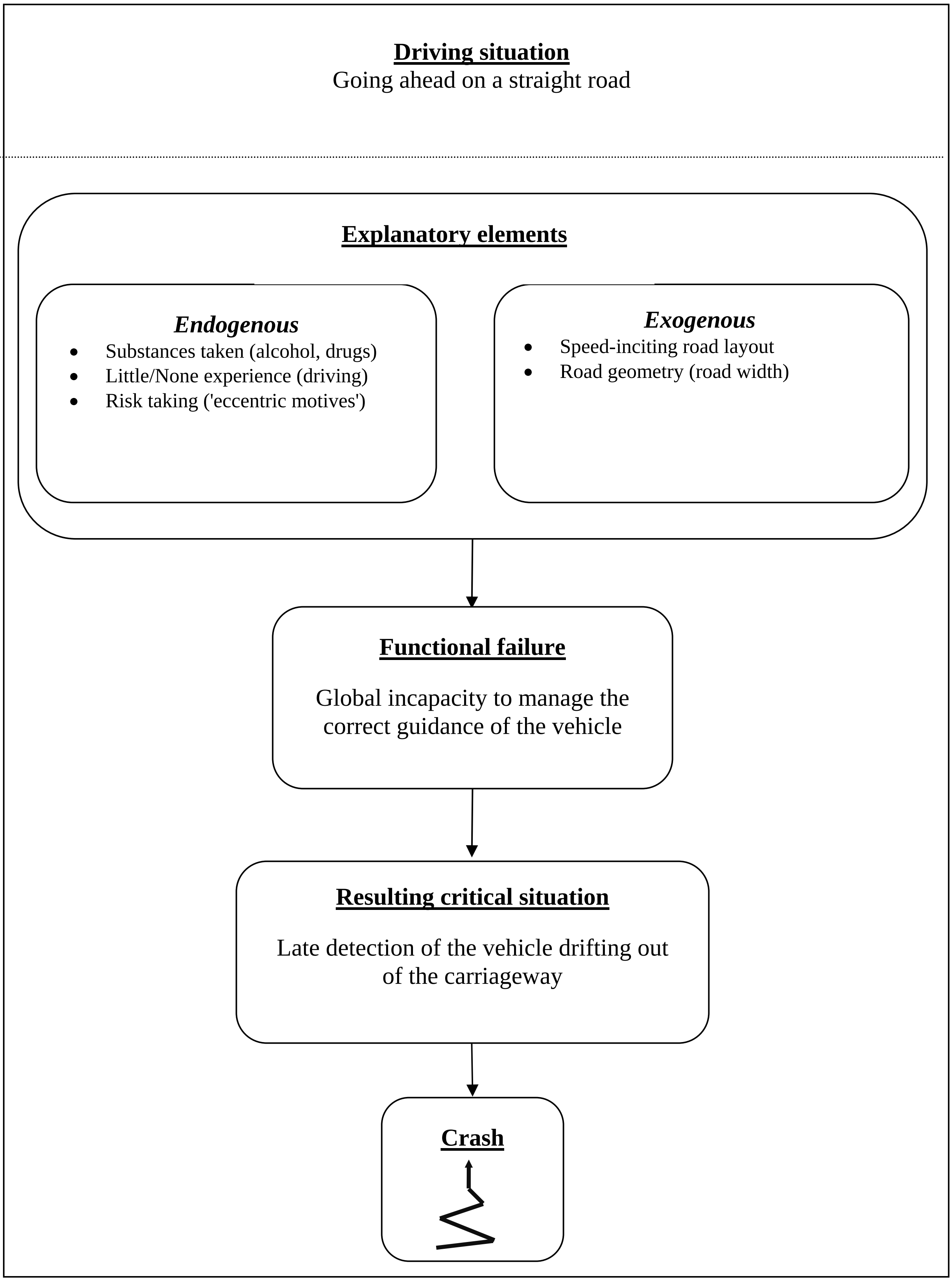

Figure 12_Annex1.4.-Typical scenario G2b.

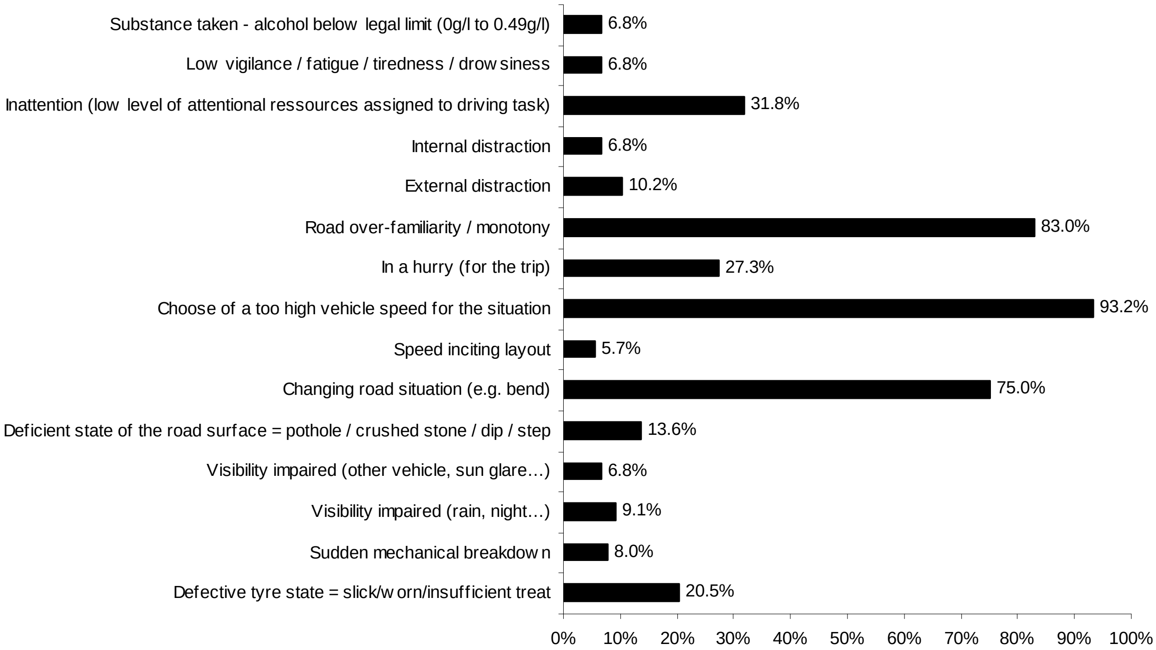

Figure 13_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to T1b scenario

Under evaluation of the difficulty of a know bend

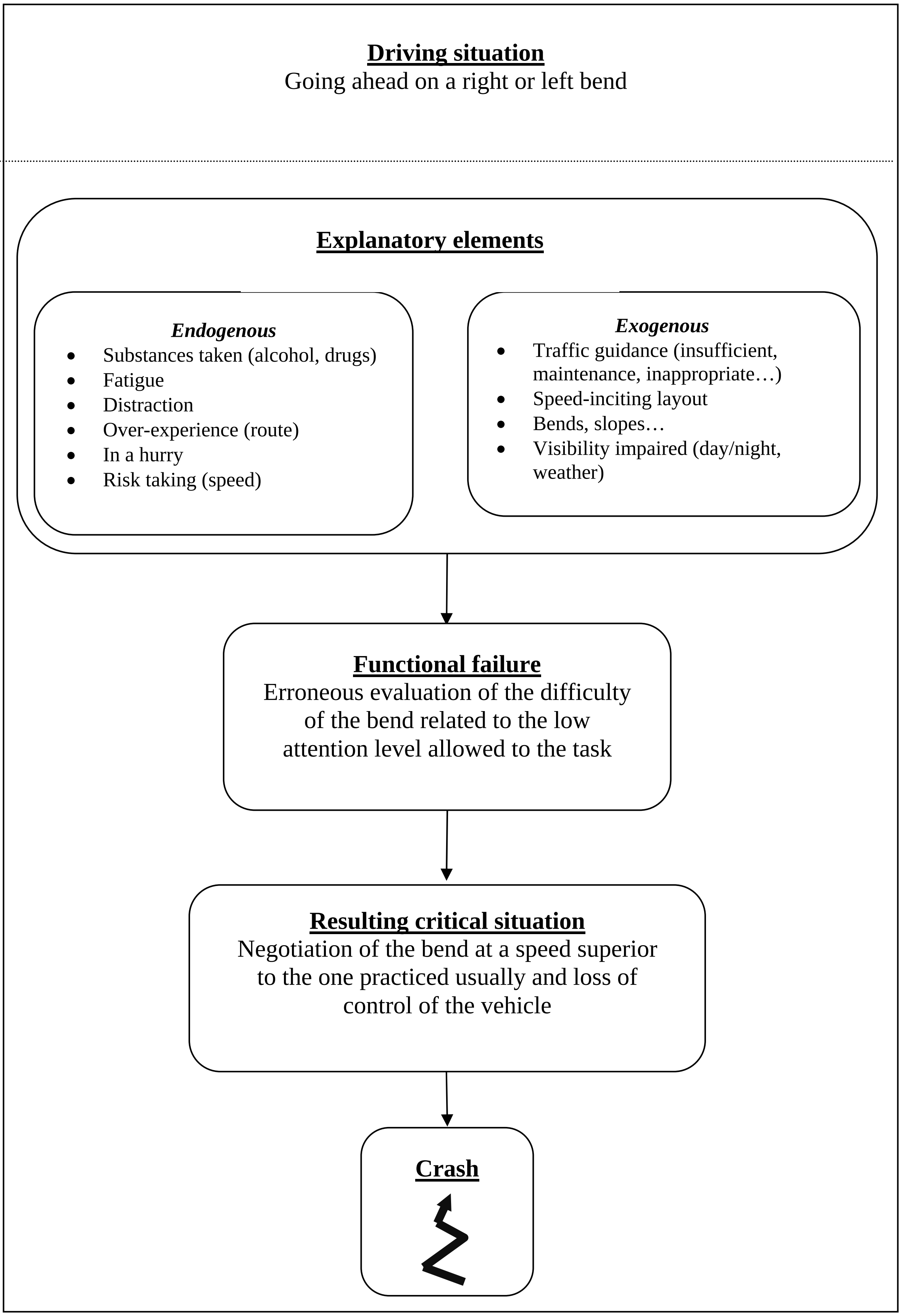

Figure 14_Annex1.4.-Typical Scenario 'T1b'.

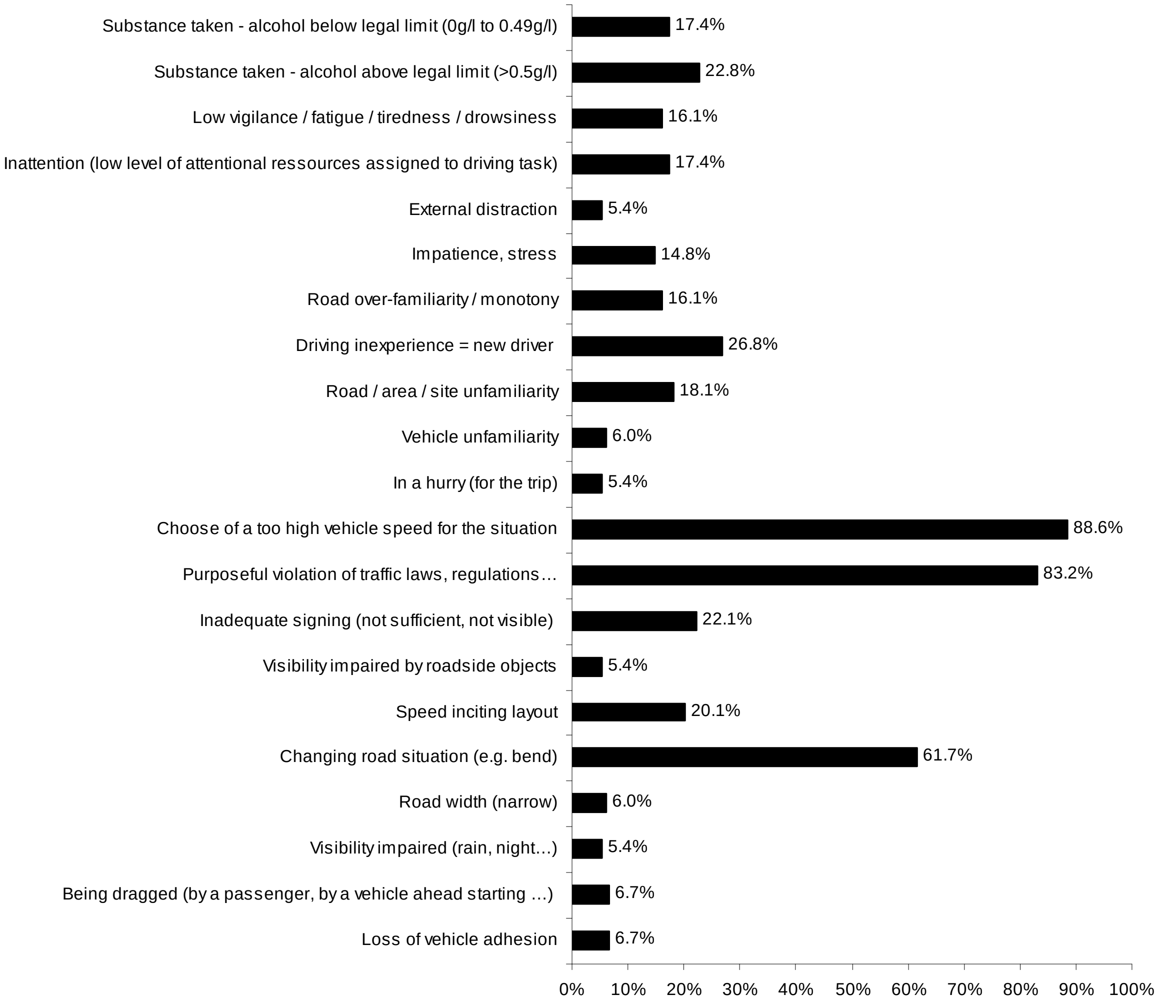

Figure 15_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to T1c scenario.

Erroneous evaluation of a bend difficulty in a context of playful-driving

Driving situation

Going ahead on a right or a left bend

Explanatory elements

Endogenous

- Substances taken
- Fatigue
- Little/None experience (driving, route)
- Risk taking (speed, vehicle positioning, traffic control…)

Exogenous

- Traffic guidance (insufficient, inappropriate, unexpected…)
- Road geometry: bend, slopes…
- Maintenance: tyres
- Speed-inciting layout

↓

Functional failure

Erroneous evaluation of the difficulty of the bend connected to a low attention paid to the task and to the context of playful driving = > carelessness of the accident-generating parameters of the site

↓

Resulting critical situation

Negotiation of the bend at a speed superior to the one allowed on the site and loss of control of the vehicle

↓

Crash

Figure 16_Annex1.4.-Typical scenario T1c.

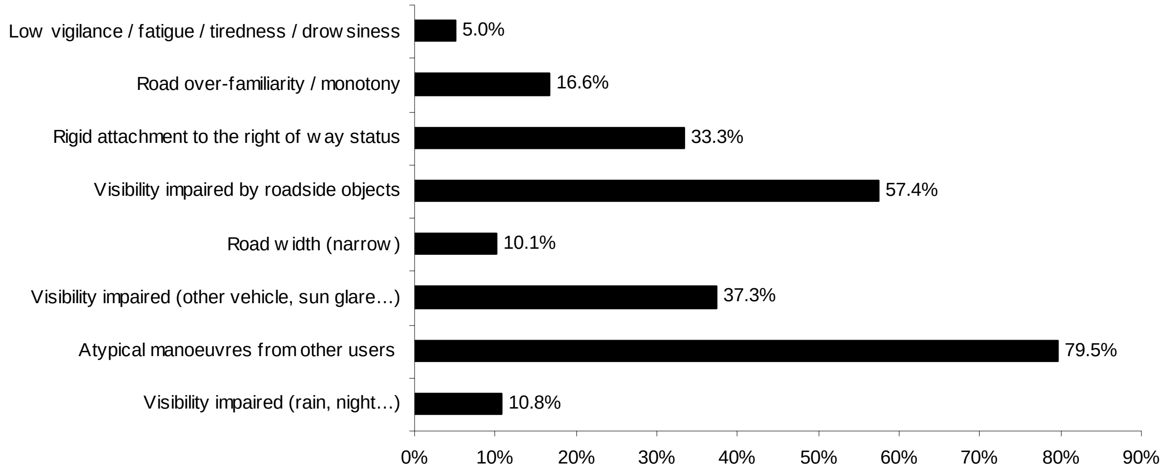

Figure 17_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to P1d scenario.

Driver surprised by the manoeuvre of a non-visible approaching vehicle

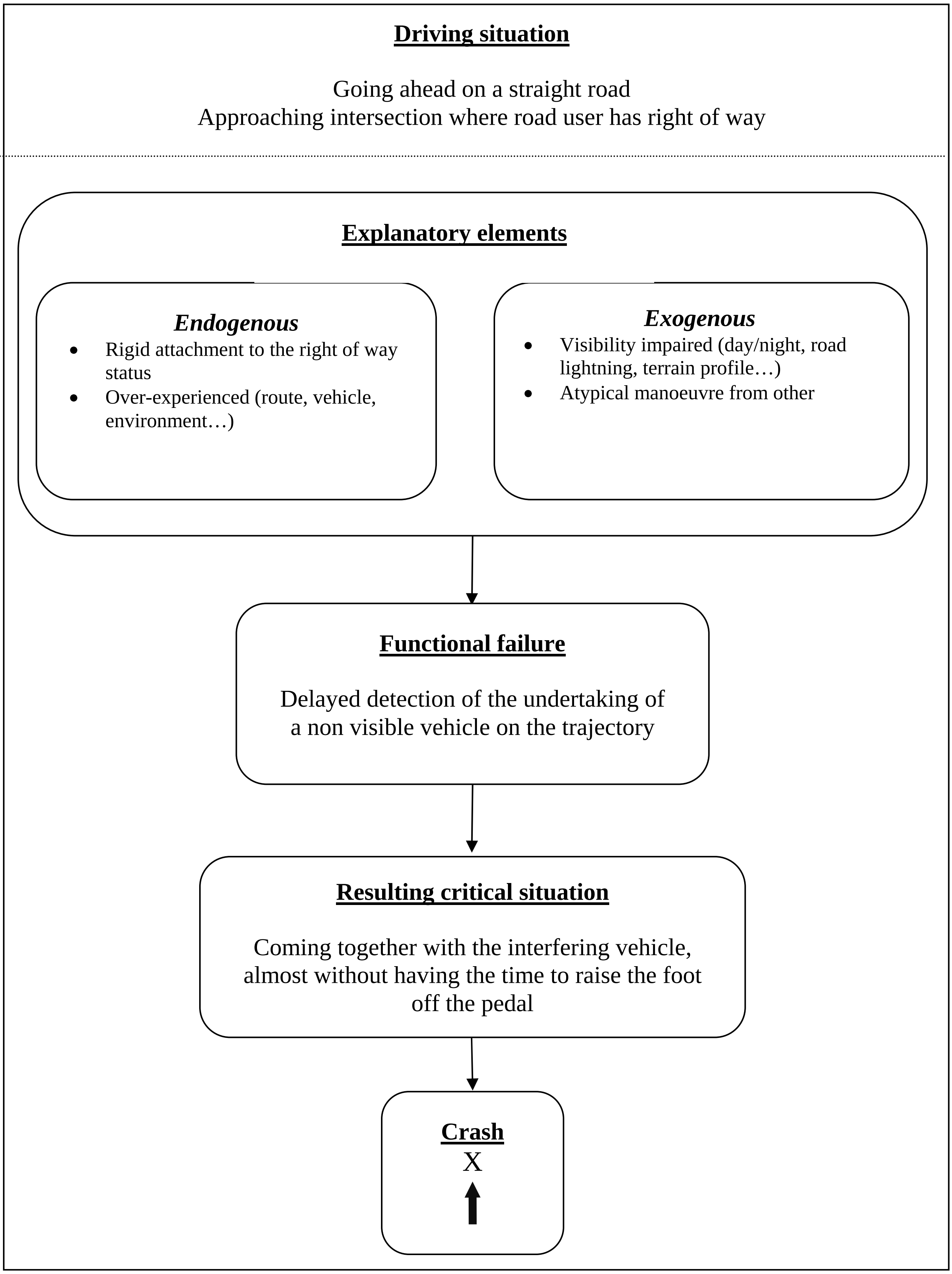

Figure 18_Annex1.4.-Typical scenario P1d.

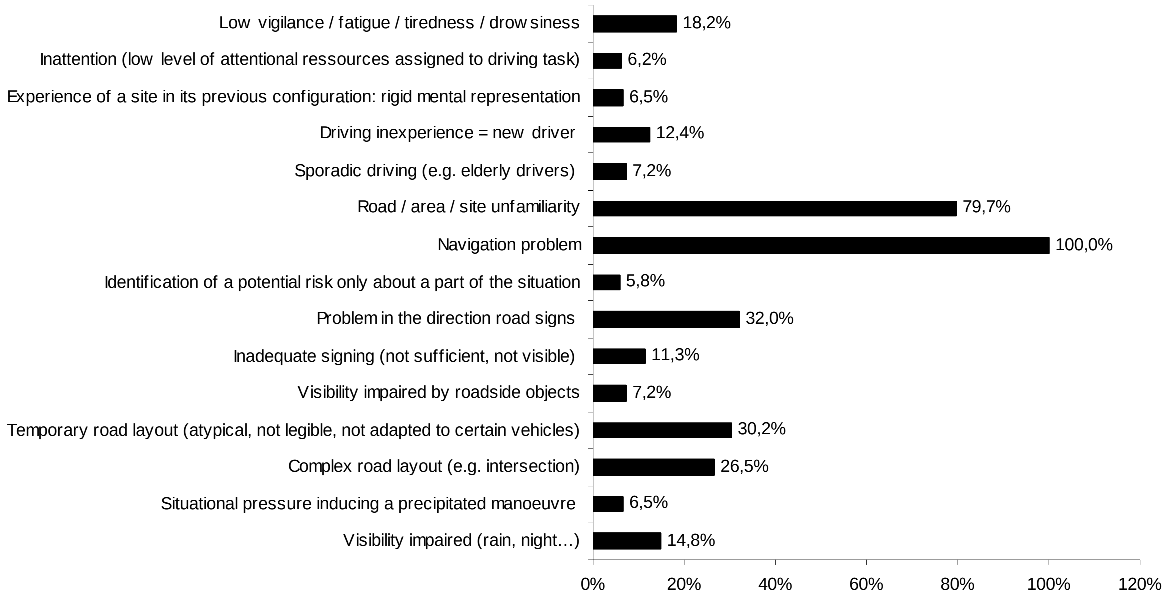

Figure 19_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to P2a scenario.

Focalisation on a directional problem

Driving situation

Turning or going straight across traffic
Going ahead on a straight road
U-turn

Explanatory elements

Endogenous

- Navigation problem
- Little/None experience (route, environment)
- Little/None experience (driving)
- Substance taken: alcohol, drugs

Exogenous

- Traffic guidance (insufficient, inappropriate…)
- Visibility impaired (day/night, terrain profile…)
- Misleading road layout
- Traffic condition (flow, density…)

↓

Functional failure

Focused search of information: non - detection of an interfering vehicle or of the manoeuvre undertaken by this vehicle

↓

Resulting critical situation

Undertaking of the manoeuvre on the trajectory of the interfering priority vehicle

↓

Accident

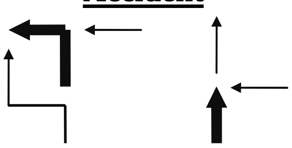

Figure 20_Annex1.4.-Typical scenario P2a.

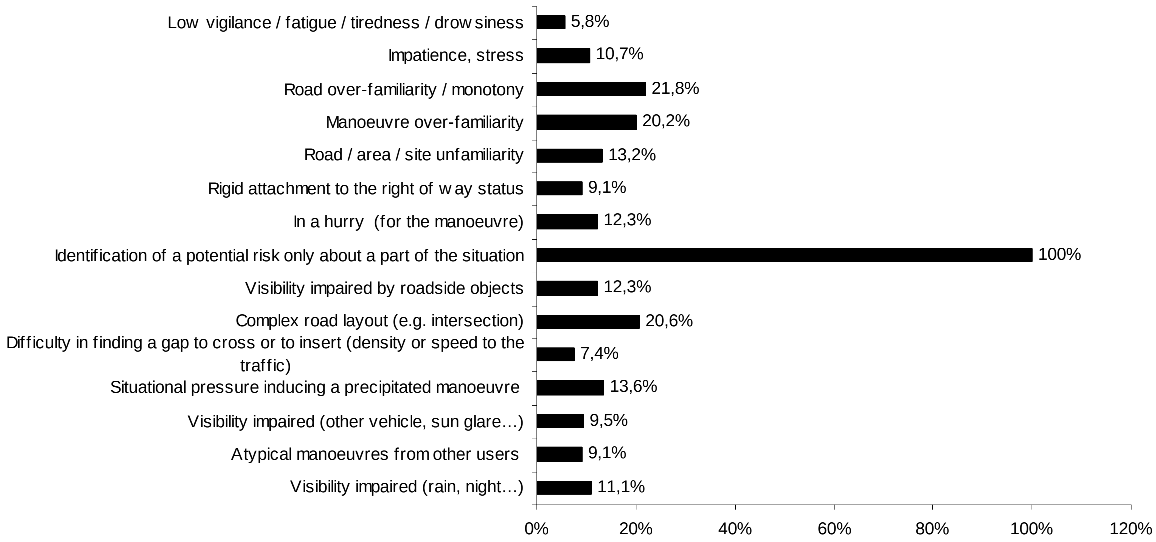

Figure 21_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to P2d scenario.

Focalisation towards an identified source of danger

Driving situation

Going ahead on a straight road
Turning or going ahead across traffic
Starting (not at junction)

Explanatory elements

Endogenous

- Over-experience (route, environment…)
- Little/None experience (driving)
- Rigid attachment to the right of way status
- Identification of potential risk

Exogenous

- Atypical manoeuvres of the other road user
- Complex road layout (eg. intersection)
- Traffic condition (density or speed)

Functional failure

Focalisation towards an interfering vehicle identified as a potential danger

Resulting critical situation

Road users start their manoeuvre being preoccupied only by this source of danger and are hit by another vehicle they did not detect

Accident

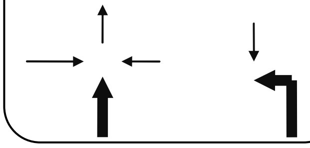

Figure 22_Annex1.4.-Typical scenario P2d.

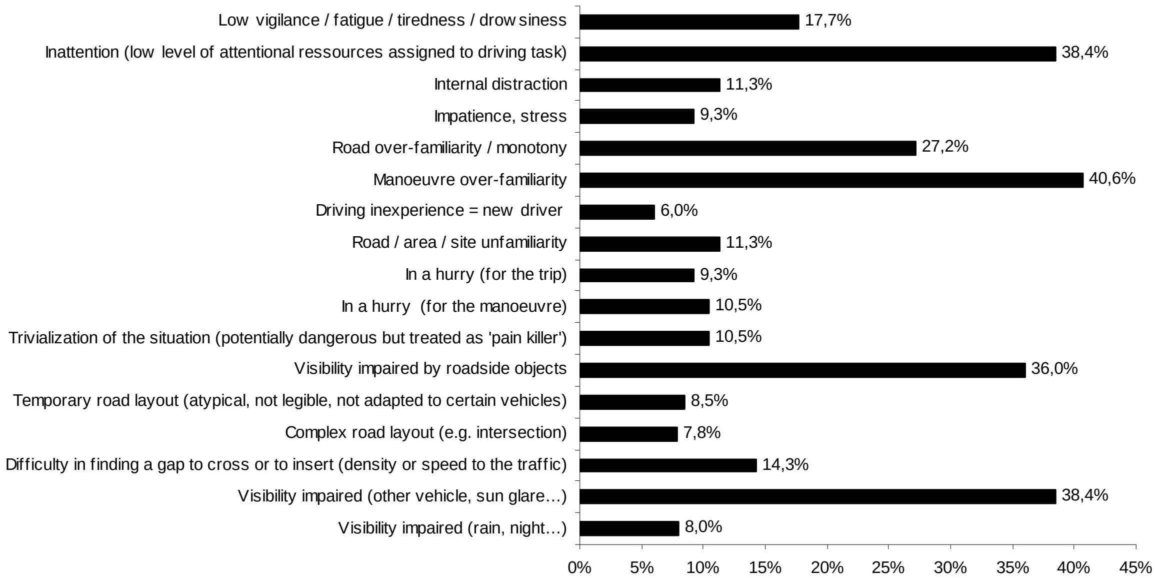

Figure 23_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to P3b scenario.

Cursory search for information while crossing intersection

Driving situation

Going straight on at 'give-way', 'stop' or 'traffic signal' intersection
Starting (not at junction)

Explanatory elements

Endogenous

- Pre-existing impairment
- Fatigue
- Distraction (outside and within the vehicle, within user)
- Over-experience (route, environment…)
- Little/None experience (driving, route)
- In a hurry

Exogenous

- Visibility impaired (terrain profile, other vehicles, road side objects)
- Traffic condition (flow, speed, density)

Functional failure

Cursory attention allocated to search for information, such as glance type

Resulting critical situation

Do not detect the interfering vehicle, undertake their manoeuvre and cross the trajectory of this vehicle

Crash

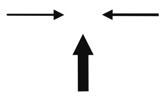

Figure 24_Annex1.4.-Typical scenario P3b.

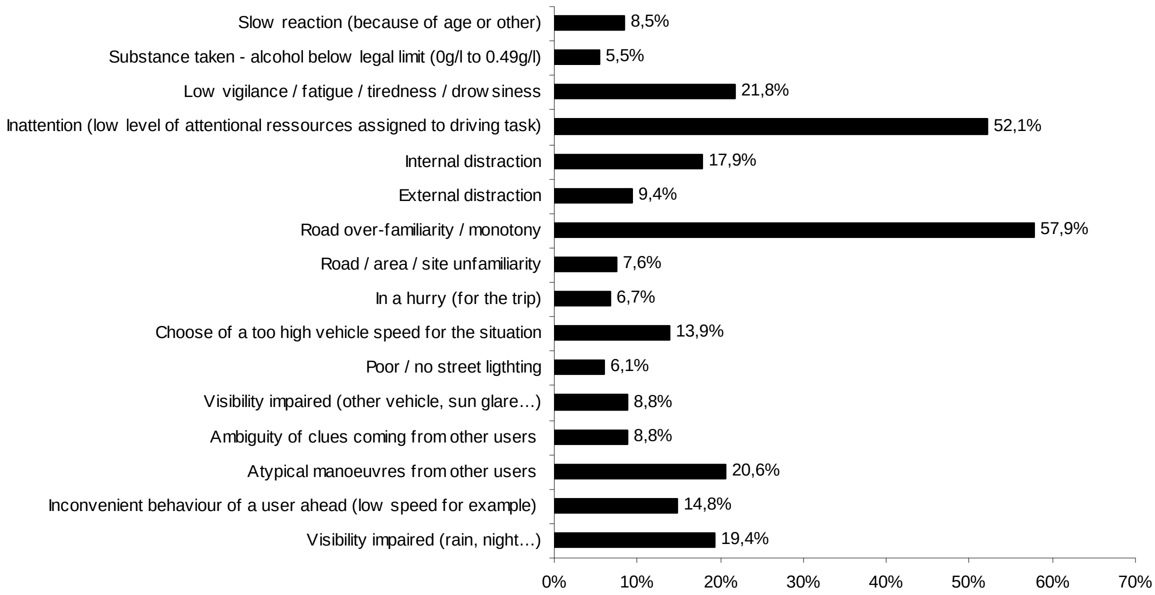

Figure 25_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to P5a scenario.

Late detection of the slowing down of the vehicle ahead

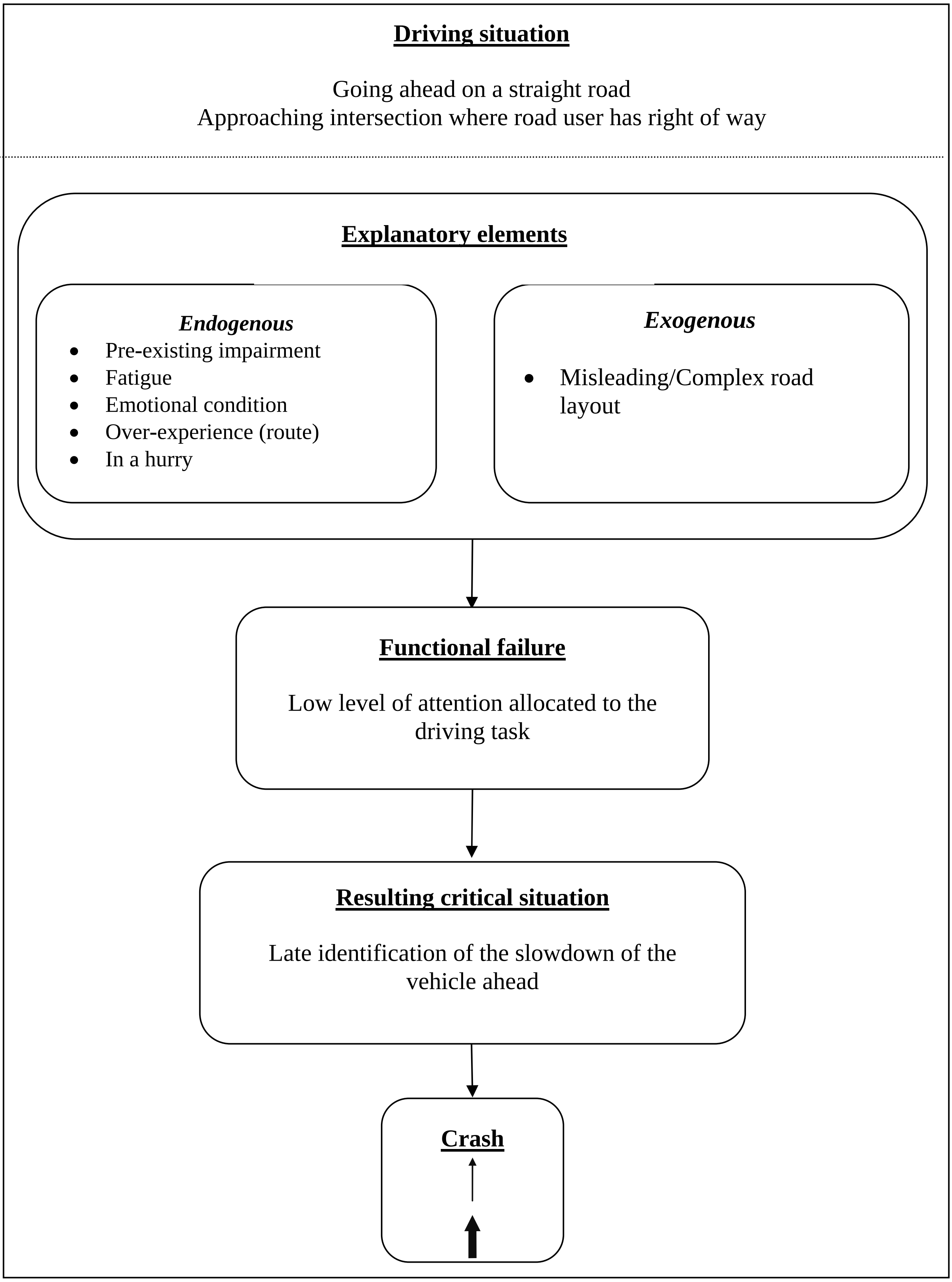

Figure 26_Annex1.4.-Typical scenario P5a.

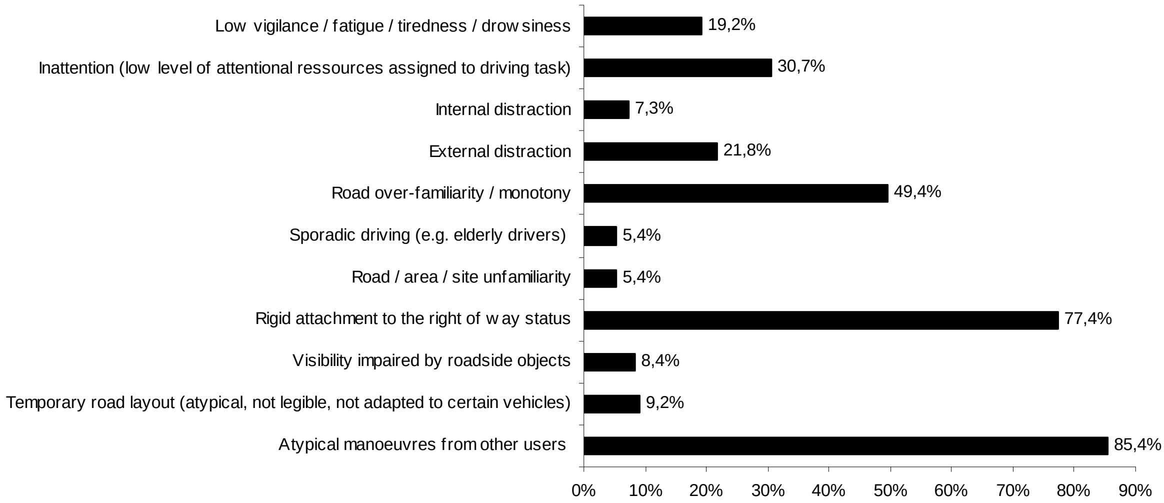

Figure 27_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to P5b scenario.

Late detection of a non-priority road user starting manoeuvre in intersection

Driving situation

Approaching intersection where road user has right of way
Crossing intersection where road user has right of way

Explanatory elements

Endogenous

- Pre-existing impairment
- Substances taken (alcohol, drugs)
- Fatigue
- Distraction
- Over-experience (route, environment)
- Little/None experience (driving)
- Rigid attachment to the right of way status
- In a hurry

Exogenous

- Atypical manoeuvres from other users

Functional failure

Late detection of the non-priority and interfering road user because of not fulfilling the demands of perception acquisition while having the right of way

Resulting critical situation

Keeps progressing with constant speed almost until the shock. Collision with the non-priority vehicle in the beginning of its crossing

Crash

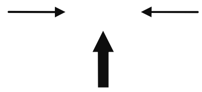

Figure 28_Annex1.4.-Typical scenario P5b.

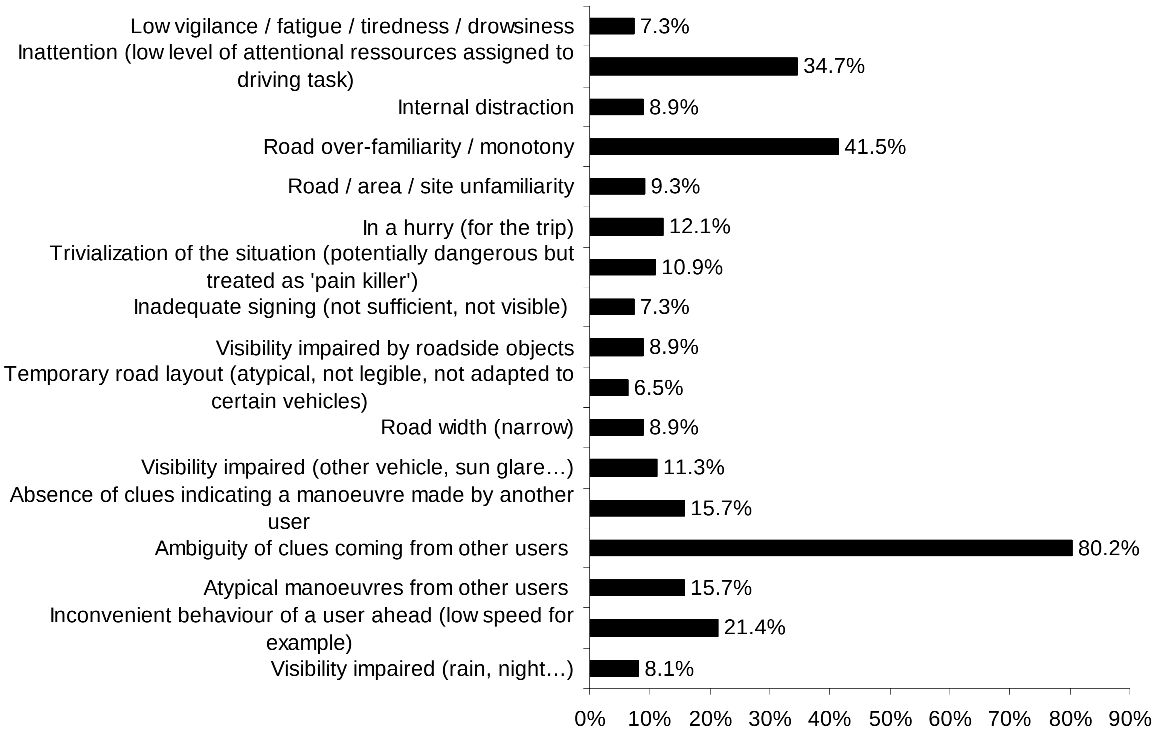

Figure 29_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to T4b scenario.

Mistaken understanding of the other's manoeuvre related to the polysemy of their signals

Driving situation

Going ahead on a straight road
Crossing intersection where road user has right of way
Overtaking moving vehicle

Explanatory elements

Endogenous

- Substances taken (alcohol, drugs)
- Fatigue
- Distraction
- Over-experience (route)
- In a hurry
- Identification of potential risk about only part of the situation

Exogenous

- Traffic guidance (insufficient…)
- Visibility impaired
- Misleading/complex road layout
- Ambiguity of clues to manoeuvre
- Atypical manoeuvre from other

↓

Functional failure

No comprehension of other's intentions
=> trap situation related to ambiguity of
the signals given by the other

↓

Resulting critical situation

Starts to overtake the interfering vehicle while it is
changing of direction, or drives too fast to cope with
the critical bringing closer of the interfering vehicle

↓

Crash

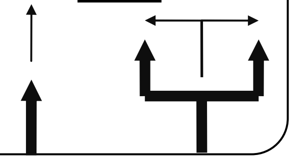

Figure 30_Annex1.4.-Typical scenario T4b.

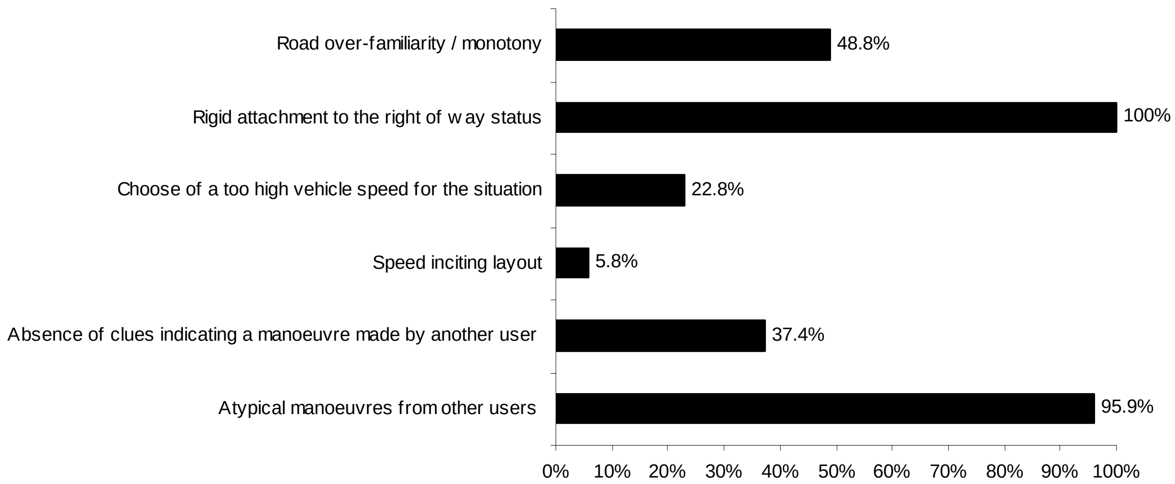

Figure 31_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to T5a scenario.

Expecting a non priority vehicle not to undertake a manoeuvre in intersection

Driving situation

Approaching or crossing intersection where road user has right of way

Explanatory elements

Endogenous

- Distraction
- Over-experience (route)
- In a hurry
- Risk taking (speed)

Exogenous

- Absence of clues to manoeuvre
- Atypical manoeuvre

Functional failure

Does not expect that the vehicle stopped by the axis of the junction starts a manoeuvre

Resulting critical situation

Keeps driving at a too high speed to cope with the interfering non priority vehicle that crosses trajectory

Crash

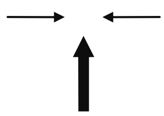

Figure 32_Annex1.4.-Typical scenario T5b.

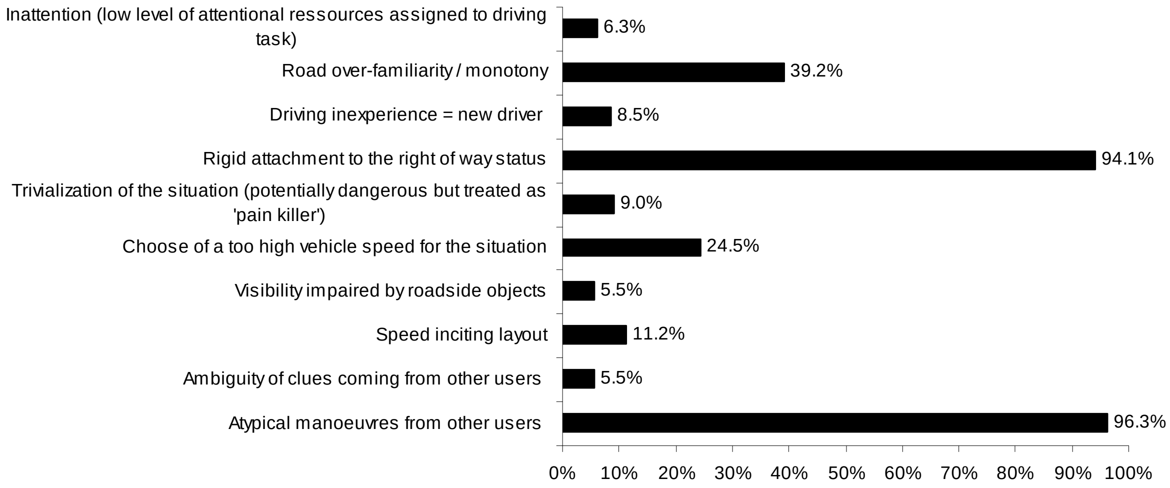

Figure 33_Annex1.4.-Distribution of the main (>= 5%) explanatory elements for passenger car drivers related to T6b scenario.

Erroneous expectation of the stopping of a non priority vehicle approaching intersection

Driving situation

Approaching or crossing intersection where road user has right of way

Explanatory elements

Endogenous

- Little/None experience (driving)
- Over-experience (route)
- Rigid attachment to the right of way status
- Risk taking (speed)

Exogenous

- Speed-inciting road layout
- Atypical manoeuvre from other user
- Visibility impaired (terrain profile)

Functional failure

The user expects actively that the interfering vehicle conforms to the priority rule and stops by the axis of the junction

Resulting critical situation

Progresses at a too high speed to cope with the non-stopping of the interfering vehicle

Crash

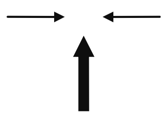

Figure 34_Annex1.4.-Typical scenario T6b.

11.2 Annex 1.2: Powered Two Wheelers

No information related to chapter 4 'Task 1.2: Powered Two Wheelers' is included in this annex.

11.3 Annex 1.3: Vans, Bus and Truck Drivers

No information related to chapter 5 'Task 1.3: Vans, Bus and Truck Drivers' is included in this annex.

11.4 Annex 1.4: Pedestrian and Cyclists

Information related to chapter 6 'Task 1.4: Pedestrian and Cyclists' is included in this annex.

11.4.1 Pedestrians

HFF-subgroups analysis: LMU cases

Pedestrian: HFF subgroup x task

	HFF- subgroups										
Task	D2	E2	G1	G2	P2	P5	T2	T5	T6	n.e.	total
Going ahead on a straight road	1	1		4		1		1			8
Going straight at "traffic signal" intersection				1							1
Going ahead on a left bend	1										1
Approaching pedestrian crossing						1					1
Crossing the street	3			6	2	1	1	4		2	19
n.e.	1		2	1	1	3		1	1	5	15
Total	6	1	2	12	3	6	1	6	1	7	45

Table 1_Annex1.4.- Human functional failure sub groups and tasks, distribution for fatalities

Pedestrian: HFF subgroup x conflict

	HFF- subgroups										
Conflict	D2	E2	G1	G2	P2	P5	T2	T5	T6	n.e.	total
Oncoming vehicle			1								1
Vehicle from side	3		1	9	3	5	1	6		4	32
Following vehicle	3	1		3		1			1	2	11
n.e.										1	1
Total	6	1	2	12	3	6	1	6	1	7	45

Table 2_Annex1.4.- Human functional failure sub groups and conflicts, distribution for fatalities

Pedestrian: HFF subgroup x degree of involvement

	HFF- subgroups										
Degree of Involvement	D2	E2	G1	G2	P2	P5	T2	T5	T6	n.e.	total
Non-active	1									1	2
Passive			1	1						4	6
Primary active	4	1	1	11	2	4	1	4		2	30
Secondary active	1				1	2		2	1		7
Total	6	1	2	12	3	6	1	6	1	7	45

Table3_Annex1.4.-HFF sub groups and degree of involvement, distribution for fatalities

opponent: HFF subgroup x task

	HFF sub groups														
Task	D1	D2	E1	E2	G1	G2	P1	P2	P3	P4	P5	T5	T6	T7	n.e.	total
1		3	2		1	1	6	1	1	1	1	1		4		22
2						1										1
3			1				1									2
7														1		1
14	1				1		1									3
20											1					1
34							1					1				2
37											1					1
38								3								3
40		2									2					4

42				1												1
45			1													1
47													1			1
n.e.		1													1	2
total	1	6	4	1	2	2	9	4	1	1	5	2	1	5	1	45

Table 4_Annex1.4.- Human functional failure sub groups and tasks, distribution for opponents

Legend for tasks:
1 Going ahead on a straight road (1)
2 Going ahead on a left bend (2)
3 Going ahead on a right bend 3)
7 Approaching intersection where road user has right of way (7)
14 Going straight at "traffic signal" intersection (14)
20 Turning across traffic at "traffic signal" intersection (20)
34 Starting (not at junction) (34)
37 Turning away from traffic from main road into private drive (37)
38 Turning across traffic out of private drive (38)
40 Reversing (40)
42 Driving in wrong direction (42)
45 Approaching pedestrian crossing (45)
47 Approaching railway crossing (47)

Opponent car drivers: HFF subgroup x task

	HFF sub groups												
Task	D1	D2	E1	E2	G1	G2	P1	P2	P4	P5	T5	T7	total
1		2	2		1		5	1	1		1	2	15
2						1							1
3			1				1						2
7												1	1
14	1				1		1						3
20										1			1
34							1						1
37										1			1
38								1					1
40										2			2
42				1									1
total	1	2	3	1	2	1	8	2	1	4	1	3	29

Table 5_Annex1.4.- Human functional failure sub groups and tasks, distribution for car drivers

opponent: HFF subgroup x conflict

	HFF sub groups															
Conflict	D1	D2	E1	E2	G1	G2	P1	P2	P3	P4	P5	T5	T6	T7	n.e.	total
None					1	1										2
Stationary vehicle ahead			1											1		2
Pedestrian crossing over	1	6	2				5	4		1	4	2	1	3	1	30
Pedestrian walking along road				1		1	2		1		1			1		7
n.e.			1		1		2									4
total	1	6	4	1	2	2	9	4	1	1	5	2	1	5	1	45

Table 6_Annex1.4.- Human functional failure sub groups and conflicts, distribution for opponents

Opponent car drivers: HFF subgroup x conflict

	HFF sub groups												
Conflict	D1	D2	E1	E2	G1	G2	P1	P2	P4	P5	T5	T7	total
None					1	1							2
Stationary vehicle ahead			1										1
Pedestrian crossing over	1	2	1				5	2	1	3	1	2	18
Pedestrian walking along road				1			1			1		1	4
n.e.			1		1		2						4
total	1	2	3	1	2	1	8	2	1	4	1	3	29

Table 7_Annex1.4.- Human functional failure sub groups and conflicts, distribution for car drivers

opponent: HFF subgroup x degree of involvement

	HFF sub groups														
Degree of Involvement	D1	D2	E1	E2	G1	G2	P1	P2	P3	P4	P5	T5	T6	T7	n.e.	total
n.e.					1											1
Non-active		1					5				1			1	1	9
Primary active		2	2	1	1	2		1			3			1		13
Secondary active	1	3	2				4	3	1	1	1	2	1	3		22
total	1	6	4	1	2	2	9	4	1	1	5	2	1	5	1	45

Table 8_Annex1.4.- HFF sub groups and degree of involvement, distribution for opponents

Opponent car drivers: HFF subgroup x degree of involvement

	HFF sub groups												
Degree of Involvement	D1	D2	E1	E2	G1	G2	P1	P2	P4	P5	T5	T7	total
n.e.					1								1
Non-active							5					1	6
Primary active			1	1	1	1		1		3			8
Secondary active	1	2	2				3	1	1	1	1	2	14
total	1	2	3	1	2	1	8	2	1	4	1	3	29

Table 9_Annex1.4.- HFF sub groups and degree of involvement, distribution for car drivers

HFF-subgroups analysis: IDIADA cases

Internal code of the accident	PEDESTRIAN BASICS				OPPONENT BASICS				
	Gender	Age	Site	Time distribution	Gender	Age	Site	Time distribution	Opponent vehicle
2007S005771	Female	70+	urban	daylight	Male	20+	urban	daylight	car
2007S005699	Male	40+	urban	dusk/dawn	Male	30+	urban	dusk/dawn	car
2007S005346	Male	70+	urban	daylight	Male	70+	urban	daylight	car
2007S005124	Female	70+	urban	daylight	Female	60+	urban	daylight	car
2007S003523	Female	20+	urban	daylight	Female	40+	urban	daylight	car
2007S000790	Male	30+	urban	dusk/dawn	Male	16+	urban	dusk/dawn	car
2006S010699	Male	40+	urban	daylight	Male	20+	urban	daylight	car
2006S010028	Male	60+	urban	daylight	Male	20+	urban	daylight	car
2006S009826	Female	30+	urban	dusk/dawn	Male	30+	urban	dusk/dawn	car
2006S009465	Male	40+	urban	daylight	Male	40+	urban	daylight	car
2006S009303	Male	70+	urban	daylight	Male	30+	urban	daylight	car
2006S008542	Female	60+	urban	night with	Male	20+	urban	night with lighting	car
2006S008301	Male	40+	urban	daylight	Male	30+	urban	daylight	car
2006S007925	Male	70+	urban	dusk/dawn	Male	40+	urban	dusk/dawn	car
2006S007774	Female	60+	urban	dusk/dawn	Male	30+	urban	dusk/dawn	car
2006S007136	Male	20+	urban	daylight	Male	30+	urban	daylight	car
2006S006037	Male	60+	urban	daylight	Male	30+	urban	daylight	car
2006S004603	Male	30+	urban	dusk/dawn	Male	20+	urban	dusk/dawn	car
2006S004578	Female	16+	urban	daylight	Female	50+	urban	daylight	car
2006S003585	Male	20+	urban	daylight	Male	20+	urban	daylight	car
2006S002581	Male	20+	urban	daylight	Male	30+	urban	daylight	car
2006S001220	Female	50+	urban	daylight	Female	40+	urban	daylight	car
2006S001181	Female	70+	urban	daylight	Male	20+	urban	daylight	car
2006S000993	Male	40+	urban	dusk/dawn	Male	40+	urban	dusk/dawn	car
2006S000867	Male	16+	urban	daylight	Male	70+	urban	daylight	car
2006S000568	Female	50+	urban	dusk/dawn	Male	50+	urban	dusk/dawn	car
2006S000457	Male	20+	urban	night with	Male	20+	urban	night with lighting	car
2006S000374	Female	70+	urban	daylight	Male	20+	urban	daylight	car
2006S000306	Male	30+	urban	night with	Male	50+	urban	night without	car
2006S000042	Female	30+	urban	daylight	Male	30+	urban	daylight	car
2005S008592	Female	20+	urban	night with	Male	20+	urban	night with lighting	car
2005S008532	Female	20+	urban	daylight	Male	30+	urban	daylight	car
2005S007807	Male	16+	urban	daylight	Male	20+	urban	daylight	car
2005S007368	Female	70+	urban	daylight	Male	50+	urban	daylight	car
2005S005928	Male	20+	urban	night with	Male	50+	urban	night with lighting	car
2005S005794	Male	50+	urban	daylight	Male	20+	urban	daylight	car
2005S005289	Female	30+	urban	night with	Male	20+	urban	night with lighting	car
2005S004580	Male	30+	urban	daylight	Male	50+	urban	daylight	car
2005S004442	Male	16+	urban	dusk/dawn	Male	40+	urban	dusk/dawn	car
2005S004380	Female	70+	urban	daylight	Male	60+	urban	daylight	car
2005S003956	Female	16+	urban	dusk/dawn	Female	30+	urban	dusk/dawn	car
2005S003572	Male	40+	urban	daylight	Male	40+	urban	daylight	car
2005S003475	Female	70+	urban	daylight	Male	20+	urban	daylight	car
2005S003330	Male	16+	urban	dusk/dawn	Female	50+	urban	dusk/dawn	car
2005S002465	Male	20+	urban	dusk/dawn	Male	40+	urban	dusk/dawn	car
2005S002412	Male	70+	urban	daylight	Male	20+	urban	daylight	car
2005S002370	Male	20+	urban	dusk/dawn	Male	20+	urban	dusk/dawn	car
2005S001892	Male	20+	urban	dusk/dawn	Male	60+	urban	dusk/dawn	car
2005S001872	Female	60+	urban	daylight	Male	40+	urban	daylight	car
2005S001720	Female	60+	urban	daylight	Female	30+	urban	daylight	car
2005S001591	Male	30+	urban	night with	Male	40+	urban	night with lighting	car
2005S001243	Male	20+	urban	daylight	Male	20+	urban	daylight	car
2005S001241	Female	20+	urban	daylight	Female	50+	urban	daylight	car
2005S000775	Male	70+	urban	daylight	Male	40+	urban	daylight	car
2005S000703	Male	60+	urban	daylight	Male	20+	urban	daylight	car

Table 10_Annex1.4.- HFF-subgroup analysis.

Internal code of the accident	PEDESTRIANS																																		
	HFF subgroups										Conflict						Conflict				Degree of involvement				Explanatory elements										
	Alteration of sensorimotor and cognitive capacities	Loss of psycho-physiological capacities	not evaluable	Deliberate violation of a safety rule	Neglecting the need to search for information	Information acquisition focused on a partial component of	Expecting another user not to perform a manoeuvre	Erroneous evaluation of the size of a gap	Actively expecting another user to take regulating action	Guidance problem	Going ahead on a straight road	Going straight at "traffic signal" intersection	Going ahead on a left bend	Approaching pedestrian crossing	Crossing the street	NE	Oncoming vehicle	Vehicle from side	Following vehicle	NE	Non-active	Passive	Primary active	Secondary active	Medical condition	Substances taken - alcohol above "legal" limit	Substances taken - alcohol below "legal" limit	Substances taken - illegal drugs	Substances taken - correctly used medication	Identification of potential risk about only part of the	Little/None experience - driving	Distraction within user - lost in thought	Risk taking - traffic control (signs/signals/markings	Risk taking - "eccentric" motives (competing)	Visibility impaired - other vehicles
2007S005771		1													1			1						1					1	1					
2007S005699			1								1								1				1													
2007S005346			1												1		1							1						1					
2007S005124	1														1			1					1							1					
2007S003523				1								1		1				1					1										1		
2007S000790				1								1		1				1					1											1	
2006S010699				1								1		1				1					1										1		
2006S010028	1										1					1							1			1									
2006S009826				1											1			1					1										1		
2006S009465					1							1		1				1					1									1			
2006S009303									1						1			1						1						1					
2006S008542			1												1			1				1										1			
2006S008301				1											1		1						1			1									
2006S007925									1						1			1				1								1					
2006S007774				1								1		1				1					1									1			
2006S007136					1										1			1					1											1	
2006S006037				1								1		1				1					1										1		
2006S004603				1								1		1				1					1			1							1		
2006S004578				1								1		1				1					1										1		
2006S003585						1									1			1					1										1		
2006S002581						1									1			1					1										1		
2006S001220			1								1						1					1													
2006S001181				1								1		1				1					1										1		
2006S000993				1								1		1				1					1										1		
2006S000867				1								1		1				1					1										1		
2006S000568				1							1							1					1							1					
2006S000457				1								1		1				1					1										1		
2006S000374			1												1			1			1											1			
2006S000306						1						1		1				1						1						1					
2006S000042			1									1		1			1					1													
2005S008592					1									1				1						1						1					
2005S008532										1		1						1					1										1		
2005S007807				1											1			1					1							1					
2005S007368										1		1						1					1						1				1		
2005S005928					1										1			1					1			1							1		
2005S005794					1										1		1						1										1		
2005S005289								1							1		1						1							1					
2005S004580						1									1			1					1									1			
2005S004442						1									1		1						1									1			
2005S004380	1														1			1				1								1					
2005S003956				1											1		1						1										1		
2005S003572					1							1						1						1										1	1
2005S003475			1									1						1				1							1						
2005S003330					1										1			1					1										1		
2005S002465						1						1						1						1								1			
2005S002412								1							1		1						1							1					
2005S002370								1							1		1						1							1					
2005S001892										1					1		1							1						1			1		
2005S001872					1							1						1					1							1					
2005S001720				1											1			1					1										1		
2005S001591					1							1						1					1							1					
2005S001243				1												1	1						1											1	
2005S001241				1											1			1					1										1		
2005S000775				1								1						1					1										1		
2005S000703				1											1			1					1										1		

Table 11_Annex1.4.-Internal code.

OPPONENTS

Internal code of the accident	Opponents												
	Violation directed by the characteristics of the situation	Deliberate violation of a safety rule	Poor control of an external disruption	Guidance problem	Loss of psycho-physiological capacities	Alteration of sensorimotor and cognitive capacities	Non-detection in visibility constraints conditions	Information acquisition focused on a partial component of	Momentary interruption in information acquisition activity	Neglecting the need to search for information	Expecting another user not to perform a manoeuvre	Expecting no perturbation ahead	Not applicable
2007S005771											1		
2007S005699					1								
2007S005346							1						
2007S005124												1	
2007S003523								1					
2007S000790													1
2006S010699		1											
2006S010028							1						
2006S009826													1
2006S009465												1	
2006S009303											1		
2006S008542		1											
2006S008301											1		
2006S007925										1			
2006S007774											1		
2006S007136							1						
2006S006037												1	
2006S004603											1		
2006S004578								1					
2006S003585												1	
2006S002581												1	
2006S001220				1									
2006S001181												1	
2006S000993												1	
2006S000867												1	
2006S000568												1	
2006S000457												1	
2006S000374									1				
2006S000306	1						1						
2006S000042										1			
2005S008592												1	
2005S008532			1										
2005S007807												1	
2005S007368			1										
2005S005928							1						
2005S005794							1						
2005S005289											1		
2005S004580											1		
2005S004442				1									
2005S004380								1					
2005S003956												1	
2005S003572							1						
2005S003475								1					
2005S003330												1	
2005S002465												1	
2005S002412												1	
2005S002370												1	
2005S001892							1						
2005S001872			1									1	
2005S001720			1										
2005S001591											1		
2005S001243												1	
2005S001241												1	
2005S000775												1	
2005S000703							1						

Internal code of the accident	Task													
	Going ahead on a straight road (1)	Going ahead on a left bend (2)	Going ahead on a right bend 3)	Approaching intersection where road user has right of way	Going straight at "traffic signal" intersection (14)	Turning across traffic at "traffic signal" intersection (20)	Starting (not at junction) (34)	Turning away from traffic from main road into private drive	Turning across traffic out of private drive (38)	Reversing (40)	Driving in wrong direction (42)	Approaching pedestrian crossing (45)	Approaching railway crossing (47)	NE
2007S005771												1		
2007S005699	1													
2007S005346												1		
2007S005124												1		
2007S003523					1							1		
2007S000790					1							1		
2006S010699					1							1		
2006S010028	1													
2006S009826	1													
2006S009465					1									
2006S009303												1		
2006S008542						1								
2006S008301	1													
2006S007925														
2006S007774					1							1		
2006S007136	1													
2006S006037	1													
2006S004603					1							1		
2006S004578					1							1		
2006S003585	1													
2006S002581	1													
2006S001220	1													
2006S001181					1							1		
2006S000993					1							1		
2006S000867					1							1		
2006S000568	1													
2006S000457					1							1		
2006S000374												1		
2006S000306					1							1		
2006S000042						1								
2005S008592												1		
2005S008532					1									
2005S007807	1													
2005S007368					1									
2005S005928	1													
2005S005794	1													
2005S005289	1													
2005S004580	1													
2005S004442	1													
2005S004380	1													
2005S003956	1													
2005S003572														
2005S003475					1									
2005S003330	1													
2005S002465					1									
2005S002412	1													
2005S002370	1													
2005S001892						1								
2005S001872					1									
2005S001720					1									
2005S001591					1									
2005S001243	1													
2005S001241	1													
2005S000775					1									
2005S000703	1													

Internal code of the accident	Conflict					Degree of involvement				Explanatory elements									
	None	Stationary vehicle ahead	Pedestrian crossing over	Pedestrian walking along road	NE	Non-active	Passive	Primary active	Secondary active	Identification of potential risk about only part of the	Risk taking: Speed	Road geometry: Road width	Visibility impaired: Road lighting	Visibility impaired: Vehicle lighting	Visibility impaired: Night	Visibility impaired: Weather	Visibility impaired: Other vehicle(s)	Maintenance: Glass	Maintenance: Exterior lights
2007S005771		1	1					1		1									
2007S005699				1				1		1									
2007S005346			1					1									1		
2007S005124			1						1	1									
2007S003523			1						1	1									
2007S000790			1						1								1		
2006S010699			1						1		1								
2006S010028				1					1	1									
2006S009826			1						1	1									
2006S009465			1						1								1		
2006S009303			1					1									1		
2006S008542			1					1							1				
2006S008301			1				1										1		
2006S007925			1					1									1		
2006S007774			1					1			1								
2006S007136			1						1								1		
2006S006037			1			1				1									
2006S004603			1						1		1								
2006S004578			1						1	1									
2006S003585			1						1								1		
2006S002581			1						1				1						
2006S001220				1				1											
2006S001181			1			1											1		
2006S000993			1						1	1									
2006S000867			1						1	1									
2006S000568			1						1								1		
2006S000457			1						1	1									
2006S000374			1					1							1				
2006S000306			1						1		1						1		
2006S000042			1					1					1						
2005S008592			1					1		1	1								
2005S008532			1						1	1									
2005S007807			1						1		1						1		
2005S007368			1						1	1									
2005S005928			1						1								1		
2005S005794			1			1											1		
2005S005289			1						1	1									
2005S004580			1						1	1							1		
2005S004442			1				1			1									
2005S004380			1					1		1									
2005S003956			1			1					1						1		
2005S003572			1					1									1		
2005S003475			1					1		1									
2005S003330			1						1								1		
2005S002465			1						1	1									
2005S002412			1						1	1	1								
2005S002370			1						1	1	1								
2005S001892			1					1		1							1		
2005S001872			1						1	1									
2005S001720			1						1	1									
2005S001591			1						1								1		
2005S001243				1						1	1								
2005S001241			1						1								1		
2005S000775			1						1		1						1		
2005S000703			1						1								1		

Table12_Annex1.4.-Internal code.

Case Examples

Example 1

Accident characteristics:
- A day in February, around 17h30
- Accident involving a truck and a pedestrian
- Urban road with 2 lanes per direction
- Daylight, cold
- Slippery, snow-covered road
- Pedestrian crossing/pedestrian light in operation

The truck driver:
- A 29 year old man
- Greek citizen
- Married, lives in the city where the accident happened
- Truck driver
- Got his driving licence for this kind of truck three month before the accident happened

The pedestrian:
- A 69 year old woman
- Pensioner

Accident map

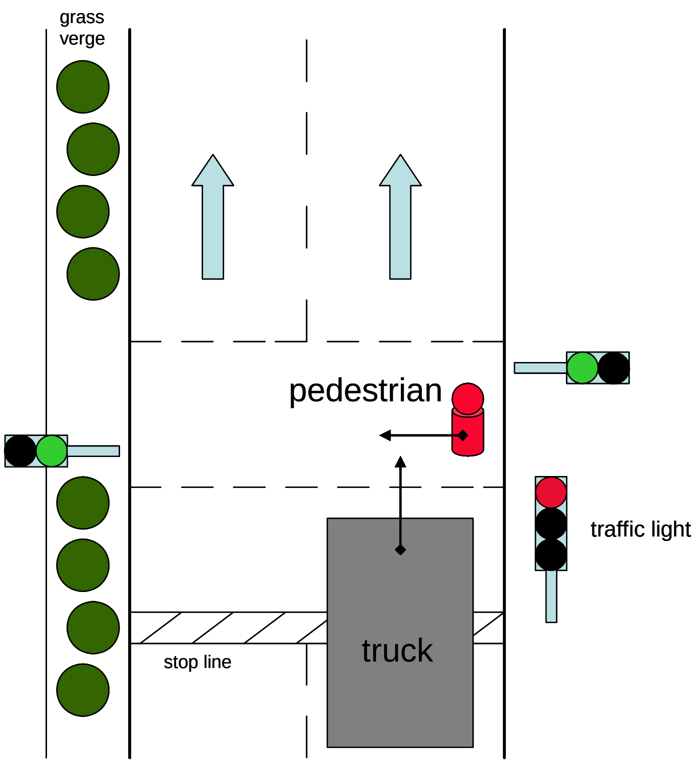

Figure 1_Annex 1.4.- Accident Map.

Traffic condition:
- Light traffic
- Need to drive slowly due to weather conditions

Truck driver:
- Approaching pedestrian crossing
- Speed: 36-42 km/h (not adapted for weather conditions)

Pedestrian:
- Stopped at pedestrian crossing, waiting for the lights to become green

Accident phases for the driver:
Driving phase:
- The truck driver was going ahead on a straight road using the right lane
- Speed: 47 km/h (not adapted for weather conditions)

Rupture phase:
- He saw the traffic light in front of him turn yellow and applied the brakes (normal)
- Suddenly he realized that he would not be able to stop before the pedestrian crossing
- To his right he saw the pedestrian walking on the pedestrian crossing (at green light)

Emergency phase:
- He tried to emerge to the left but his truck continued to slip straight forwards on the snow-covered surface

Crash phase:
- He hit the pedestrian with the right front corner of the truck
- Collision speed: 14-27 km/h

Accident phases for the pedestrian
"Driving phase":
- The pedestrian was waiting for the pedestrian light to turn green
- When the pedestrian light turned green she stepped out on the pedestrian crossing

Rupture phase:
- It's unknown whether the pedestrian realized the oncoming vehicle

Emergency phase:
- It's unknown whether the pedestrian tried to emerge

Crash phase:
- The pedestrian was hit on her left side (while walking on the pedestrian crossing) and was blown away due to collision
- Exact collision position is unknown but limits can be set within the pedestrian crossing

Elements to consider:

Truck driver:
Task to perform:
- Approaching pedestrian crossing

Conflict:
- Pedestrian crossing over

HFF:
- E1 failure: poor control of an external disruption

EE:
- EE1: Identification of potential risk about only part of the situation
- EE2: Driving: New driver
- EE3: Risk taking: Speed: Legal but inappropriate
- EE4: Road condition: Snow-covered

Pedestrian:
Task to perform:
- Wants to use the pedestrian crossing at green light (Crossing the street)

Conflict:
- Oncoming vehicle in correct lane

HHF:
- Information acquisition focused on a partial component of the situation

EE:
- EE1: Excessive confidence in signs given to others

Example No	User No	Vehicle	HHF	Task	Con-flict	EE1	EE2	EE3	EE4	Degree of Inv	Comments
Case 3	river	truck	E1	45	13	13	14	48	52	Pri-mary active	Could have prevented the accident by driving slowly (33 km/h)
Case 3	Pedes-trian	Pedes-trian	P2	Cros-sing the street	9	12				Secon-dary active	Died 3 weeks later (pulmo-nary embo-lism)

Table 13_Annex1.4.- HFF analysis, case example 1

Example 2

Accident characteristics:

- A day of December, around 01h00
- Accident involving a truck and a pedestrian
  - In addition to the main collision between truck and pedestrian, the dead body was ran over by two cars and a second truck
  - in the following we solely consider the main collision (caused death)
- Motorway with 3 lanes in both directions and a breakdown lane
  - before the scene of accident the motorway narrowed from four to three lanes (indicated by a blinking yellow arrow)
- Darkness
- Dense fog; visibility was down to 50-200 m
- Speed limit: 120 km/h
- Wet road

The truck driver:

- A 49 year old man
- Hungarian citizen
- Married, lives in Austria
- On the way back to Austria in order to deliver the truckload
- Blood alcohol concentration (BAC): 0,00%

The pedestrian:

- A 44 year old man
- Bulgarian citizen
- Partial disability (80%) due to schizophrenic psychosis with paranoid syndrome
- It's not yet resolved definitively how/why he came to Germany
- A missing persons report had already been filed by his sister in Bulgaria
- Dark clothing
- *FST* (muscle): GC 0,18% (1) 0,19% (2), ADH 0,36% (1) 0,32% (2)
  FST (urine): GC 0,00%, ADH 0,49%
- *Toxicological Report*: the pedestrian ingested Clozapine - an atypical antipsychotic drug (not overdosed)
- He was not allowed to walk on a motorway, could have prevented the accident

Accident map

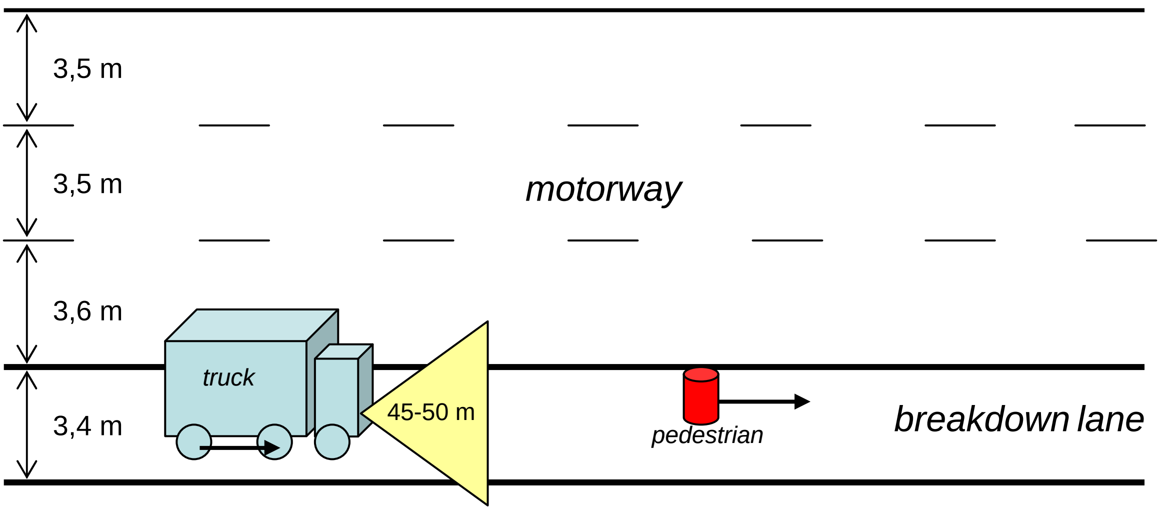

Figure 2_Annex1.4.- Accident map.

Traffic condition:

- Light traffic

Truck driver:

- Going ahead on a straight road
- He's moving on the breakdown lane instead of using the motorway lanes (but he thinks so)

Pedestrian:

- going ahead on a straight road, using the breakdown lane

Accident phases for the driver:

Driving phase:

- The truck driver declared that he had a little rest at a motorway service area before continuing his way, driving on the lane which was the most right one of four
- He used speed control (88 km/h)
- Yet being on the four lane part of the motorway he made a lane change to the third lane
- After the four lane part the motorway continued with three lanes (722 m later the accident happened)
- He witnessed that he decided to take the most right one (not the breakdown lane) and bore left on his lane and even a bit on the middle lane because it was cold outside (-1,5°C) and the right lane could have been icy
  he also said that at light traffic he always decides to take the more frequented lane
- The technical consultant proofed these information to be untrue: it's more likely that the truck was located mid of the breakdown lane or at least with a great part of the vehicle on it
- In spite of dense fog visibility was about 200 m (hearing truck driver)

Rupture phase:

- He saw about 50 m in front of him a pedestrian walking along the motorway between right and middle lane (the consultant arrived at a decision that it must have been breakdown and right lane)

Emergency phase:

- He used the headlight flasher several times, braked sharply and tried to emerge to the left; he was afraid to break through the central barrier, his trailer was slightly swaying

Crash phase:

- He saw the pedestrian at once turn left and crashing into the truck

Accident phases for the pedestrian

"Driving phase":

- According to witness report (truck driver) the pedestrian walked straight forwards with his head ducked, maybe he was cold
- It's not clear why he was located on the motorway and how he got there

Rupture phase:

- The truck driver said that the pedestrian did not notice his headlight flasher at all

Emergency phase:

- It is unsure whether his going to the left/turning left was kind of an escape
  (movement performance can't be reconstructed but autopsy result says that the pedestrian was hit on the left front side)

Crash phase:

- Immediate death
- After hitting the truck several cars ran over the corpse

Elements to consider:

Truck driver:
Task to perform:
- Going ahead on a straight road

Conflict:
- Pedestrian walking along road

HFF:
- P3-failure: cursory or hurried information acquisition

EE1: over-experienced – route - road type (motorway)
EE2: risk taking - traffic control – markings/signs disobeyed (driving on breakdown lane which was not open for traffic)
EE3: low density of traffic
EE4: visibility impaired: night - darkness
EE5: visibility impaired: weather – fog
EE6: road geometry: road width: multiple lanes

The technical consultant found out that the cracked front (windscreen, by tension) had no effect on visibility…so we do not list it for explanatory elements

Pedestrian:
Task to perform:
- Going ahead on a straight road

Conflict:
- Following vehicles

HHF:
- Impairment of sensorimotor and cognitive abilities due to his medical condition

EE1: pre-existing impairment (schizophrenic psychosis)
EE2 substances taken – alcohol below "legal" limit
EE3 substances taken – drugs: correctly used medication

Example No	User No	Vehicle	HHF	Task	Con-flict	EE1	EE2	EE3	EE4	EE5	EE6	Degree of Inv
Case 19	driver	truck	P3	1	14	23	50	68	75	77	60	Secondary active
Case 19	Pedes-trian	Pedes-trian	G2	1	8	1	4	6				Primary active

Table 14_Annex 1.4.- HFF analysis, case example 2

11.4.2 Cyclists

No information related to chapter 6 'Task 1.4: Cyclists' is included in this annex.

11.5 Annex 2.5: Elderly people and Gender related accidents

Information related to chapter 7 'Task 1.5: Elderly people and Gender related accidents' is included in this annex.

11.5.1 Elderly people

Pre-accident situations

Table 1_Annex1.5.-Categories Pre-accident situations for Elderly drivers and Controls

	Controls		Elderly drivers	
	n	%	n	%
Stabilized situation	803.8	51.9%	37.4	29.9%
Intersection	477.2	30.8%	59.8	47.8%
Specific manoeuvre	265.5	17.1%	27.9	22.3%
Total	1548.8		125.1	

Table 2_Annex1.5.-Pre-accident situations for Elderly drivers and Controls

	Controls	Elderly drivers
Stopped	2.0%	0.6%
Going ahead on a straight road	13.4%	4.2%
Going ahead and searching for directional information	0.5%	6.6%
Going on a straight road with a slower vehicle ahead	6.6%	4.8%
Going ahead with a merging vehicle	6.0%	9.2%
Going ahead with a vehicle coming on the carriageway	6.3%	1.9%
Going ahead with unlit obstacle on the carriageway	1.3%	0.6%
Going ahead with a vehicle changing direction	4.3%	0.3%
Negotiate a curve	7.8%	1.6%
Negotiate a curve on a narrow road with interfering vehicle	2.3%	0.0%
Passing another vehicle on a narrow road	1.4%	0.0%
Approaching intersection having priority	3.1%	5.1%
Crossing intersection with a priority vehicle coming	11.6%	25.5%

Crossing intersection with a give-way vehicle approaching	7.0%	12.4%
Crossing intersection with a give-way vehicle stopped	2.8%	1.9%
Crossing intersection with a give-way vehicle starting	6.2%	2.9%
U-turn	1.3%	0.6%
Changing direction	6.9%	15.9%
Reversing	0.6%	0.3%
Merging in the traffic flow	1.9%	1.9%
Stopping / Parking	0.0%	0.0%
Crossing the carriageway (not in intersection)	0.6%	1.6%
Overtaking a vehicle with an other one ahead starting overtaking also	0.4%	0.0%
Critical overtaking	5.5%	1.9%

Degree of involvement

Table 3_Annex1.5.-Degree of involvement of Elderly drivers and Controls

	Controls	Elderly drivers
Primary Actor	53.9%	74.2%
Secondary Actor	22.8%	14.9%
Passive	12.7%	6.4%
Reactive	10.5%	4.5%

Functional Failures (overall analysis)

Table 4_Annex1.5.-Categories of Functional Failure for Elderly drivers and Controls

	Controls	Elderly drivers
Perception	34.6%	38.8%
Diagnostic	12.9%	14.1%
Prognosis	16.2%	11.4%
Decision	9.4%	3.2%
Execution	7.2%	1.3%
Overall	7.1%	24.8%
Absence	12.6%	6.4%

Table 5_Annex1.5.-Categories of Functional Failure for Elderly drivers depending on the mileage

Drivers Controls	Less than 4000 km	from 4000 to 14000 km	More than 14000 km
Perception	42.9%	30.2%	52.0%
Diagnosis	0.0%	15.9%	13.1%
Prognosis	0.0%	8.7%	23.9%
Decision	0.0%	3.2%	6.0%
Action	0.0%	2.4%	1.0%
Overall	42.9%	29.2%	2.0%
Absence	14.3%	10.3%	2.0%

Table 6_Annex1.5.-Categories of Functional Failure for Controls depending on the mileage

Drivers Controls	Less than 4000 km	from 4000 to 14000 km	More than 14000 km
Perception	22.0%	38.0%	38.8%
Diagnosis	17.6%	11.1%	12.2%
Prognosis	23.5%	18.8%	17.6%
Decision	5.7%	9.1%	6.8%
Action	6.7%	6.0%	6.0%
Overall	7.4%	7.9%	5.2%
Absence	17.0%	9.1%	13.5%

Explicative elements

Table 7_Annex1.5.- Distribution and combination of explicative elements categories related to Human Functional Failures detected for Elderly drivers over 65 and Controls

	Controls	Elderly drivers
Endogenous elements	20.1%	38.7%
Exogenous elements	8.9%	9.2%
Combination of endogenous and exogenous elements	71.1%	52.1%

Table 8_Annex1.5.- Distribution and detail of explicative elements categories related to Human Functional Failures detected for Elderly drivers over 65 and Controls

		Controls	Elderly drivers
Endogenous explicative elements	Drivers' state-related factors	40.2	59.6
	Experience-related factors	56.0	79.1
	Factors related to the internal condition of driving task	85.3	88.2
Exogenous explicative elements	Layout-related factors	42.5	33.2
	Traffic-related factors	72.8	59.3
	Vehicle-related factors	3.4	1.6

Table 9_Annex1.5.- Numbers and percentages of all explicative elements having influence on occurrence of Elderly drivers and Controls' Human Functional Failures

				Controls		Elderly drivers	
				n	%	n	%
Endogenous elements	Drivers' state-related factors	1	Falling asleep	27.7	1.8	0	0.0
		1bis	Faintness	7.4	0.5	1.2	1.0
		2	Visual handicap	2	0.1	1.2	1.0
		2bis	Auditory handicap	0	0.0	0	0.0
		2ter	Disability	0	0.0	0	0.0
		3	Slow reaction (because of age or other)	5.8	0.4	40.2	32.1
		4	Small BAC (0g/l to 0.49g/l)	15.9	1.0	0	0.0
		4bis	Small THC intake	3.4	0.2	0	0.0
		4ter	Small medicine intake	8.1	0.5	0	0.0
		5	Major BAC (>0.5g/l)	79.7	5.1	2.4	1.9
		5bis	Major THC intake	4.8	0.3	0	0.0
		5ter	Major medicine intake	7.5	0.5	0	0.0
		6	Low vigilance / fatigue / tiredness / drowsiness	101.7	6.6	15.5	12.4
		7	Inattention (low level of attention resources assigned to driving task)	190.8	12.3	10	8.0
		8int	Internal distraction	45.1	2.9	2	1.6
		8ext	External distraction	60.2	3.9	1.2	1.0
		9	Impatience, stress	62.5	4.0	0.8	0.6
	Experience-related factors	10	Road over-familiarity / monotony	336.9	21.8	9.6	7.7
		11	Manoeuvre over-familiarity	141.8	9.2	20.3	16.2
		12	Experience of a site in its previous configuration: rigid mental representation	8.1	0.5	1.2	1.0
		13	Driving inexperience = new driver	144.2	9.3	1.6	1.3
		13bis	Driving inexperience = presence of a passenger (PTW)	0	0.0	0	0.0
		14	Sporadic driving (e.g. elderly drivers)	11.5	0.7	32.2	25.7
		16	Road / area / site unfamiliarity	141.1	9.1	23.8	19.0
		17	Low experience of the situation	35.6	2.3	0.8	0.6
		18	Vehicle unfamiliarity	48.9	3.2	9.5	7.6
	Factors related to the internal condition of driving task	19	Rigid attachment to the right of way status	269.6	17.4	23.4	18.7
		20	Excessive confidence in the signs given to others (priority feeling)	45	2.9	13.5	10.8
		20bis	Headlight unlit	0	0.0	0	0.0
		21	In a hurry (for the trip)	97.2	6.3	2	1.6

		22	In a hurry (for the manoeuvre)	63.2	4.1	19	15.2
		23	Trivialization of the situation (potentially dangerous but treated as 'pain killer')	124	8.0	4.4	3.5
		24	Choose of a too high vehicle speed for the situation	292.8	18.9	4	3.2
		24bis	Excessive speed (above limitation)	0	0.0	0	0.0
		25	Purposeful violation of traffic laws, regulations…	179.4	11.6	9.1	7.3
		25bis	Deliberate accident-generating behaviour	5.7	0.4	0	0.0
		25ter	Following too close	2.2	0.1	0	0.0
		26	Navigation problem	64.1	4.1	22.2	17.7
		27	Secondary task (that has nothing to do with driving)	49.7	3.2	0.4	0.3
		28	Identification of a potential risk only about a part of the situation	128.2	8.3	12.3	9.8
Exogenous elements	Layout-related factors	29	Problem in the direction road signs	12.8	0.8	2.4	1.9
		30	Inadequate signing (not sufficient, not visible)	43.5	2.8	0.8	0.6
		31	Visibility impaired by roadside objects	228.8	14.8	19.9	15.9
		32	Problems in equipment (atypical, not legible, not adapted to certain vehicles)	79.3	5.1	9.2	7.4
		33	Complex road layout (e.g. intersection)	67.8	4.4	8.4	6.7
		35	Speed inciting layout	82.6	5.3	0	0.0
		36	Poor / no street lighting	7	0.5	0	0.0
		37	Traffic calming (chicane)	68.2	4.4	0.4	0.3
		38	Road width (narrow)	53.8	3.5	0.4	0.3
		39	Deficient state of the road surface = pothole / crushed stone / dip / step	13.9	0.9	0	0.0
	Traffic-related factors	40	Difficulty in finding a gap to cross or to insert (density or speed to the traffic)	51.5	3.3	10	8.0
		41	Situational pressure inducing a precipitated manoeuvre	38.6	2.5	8.3	6.6
		42	Visibility impaired (other vehicle, sun glare…)	207.8	13.4	18	14.4
		44	Unlit obstacle on carriageway / vehicle stopped	20	1.3	0.8	0.6
		44bis	Unlit PTW on carriageway	0	0.0	0	0.0
		45	Absence of clues indicating a manoeuvre made by another user	104.4	6.7	2.8	2.2
		46	Ambiguity of clues coming	68.9	4.4	2.4	1.9

		from other users				
	47	Atypical manoeuvres from other users	401.1	25.9	20.3	16.2
	48	Inconvenient behaviour of a user ahead (low speed for example)	46.8	3.0	3.2	2.6
	49	Visibility impaired (rain, night…)	113.8	7.3	4.4	3.5
	50	Being dragged (by a passenger, by a vehicle ahead starting …)	45.8	3.0	2.8	2.2
	51	Loss of vehicle adhesion	25.1	1.6	0.8	0.6
	52	High winds at site	1.7	0.1	0	0.0
	53	Environmental perturbation (e.g. brushwood fire on the roadside …)	2.8	0.2	0.4	0.3
Vehicle-related factors	54	Vehicle size	21.1	1.4	1.6	1.3
	55	Defective tyre pressure	8.1	0.5	0	0.0
	56	Type blow-out	3.5	0.2	0.4	0.3
	57	Sudden mechanical breakdown	11.9	0.8	0	0.0
	58	Defective tyre state = slick/worn/insufficient treat	7	0.5	0	0.0
	59	Cold tyre	0.5	0.0	0	0.0
	60	Alarm transmitted by a driving aid	0.5	0.0	0	0.0
	61	Defective light	0	0.0	0	0.0
	62	Excessive vehicle load	0	0.0	0	0.0
	63	Defective suspension system	0	0.0	0	0.0
Total of factors (weighted)			4650.4		401.5	
Total of failures (weighted)			1548.8		125.1	

Functional failure: detailed analysis

Table 10_Annex1.5.- Distribution of Human Functional Failure identified for Elderly drivers over 65 Controls

		Controls	Elderly drivers
Perception	P1: Failure to detect in visibility constraints	12.3%	8.3%
	P2: Focalised acquisition of information	9.0%	12.7%
	P3: Cursory information acquisition	6.2%	11.4%
	P4: Interruption in information acquisition	2.1%	0.3%
	P5: Neglecting information acquisition demands	5.0%	6.1%
Diagnosis	T1: Incorrect evaluation of a road difficulty	4.3%	0.0%
	T2: Incorrect evaluation of a gap	1.2%	9.0%
	T3: Incorrect understanding of how site functions	2.0%	1.0%
	T4: Incorrect understanding of manoeuvre undertaken by another user	5.4%	4.2%
Prognosis	T5: Not expecting (by default) manoeuvre by another user	4.4%	0.3%
	T6: Expecting adjustment by another user	8.4%	10.8%
	T7: Expecting no perturbation ahead	3.4%	0.3%
Decision	D1: Directed violation	1.5%	1.9%

	D2: Deliberate violation	5.4%	0.3%
	D3: Violation-error	2.5%	1.0%
Execution	E1: Poor control of a difficulty	4.0%	1.0%
	E2: Guidance problem	3.2%	0.3%
Overall	G1: Lost of psycho-physiological ability	2.4%	1.3%
	G2: Impairment of sensorimotor and cognitive abilities	3.8%	0.3%
	G3: Exceeding cognitive abilities	0.9%	23.2%
Absence		12.6%	6.4%

Specificity of detection failures

Table 11_Annex1.5.- Explicative elements of P2 Failure identified for Elderly drivers and Controls

	Controls	Elderly drivers
Slow reaction (because of age or other)	0.0	7.5
Manoeuvre over-familiarity	21.2	49.7
Sporadic driving (e.g. elderly drivers)	0.9	12.6
Navigation problem	23.6	37.7
Identification of a potential risk only about a part of the situation	75.6	72.3
Problem in the direction road signs	7.1	12.6
Problems in equipment (atypical, not legible, not adapted to certain vehicles)	11.1	15.1
Atypical manoeuvres from other users	18.4	47.2

Table 12_Annex1.5.- Explicative elements of P3 Failure identified for Elderly drivers and Controls

	Controls	Elderly drivers
Slow reaction (because of age or other)	2.3	16.8
Road over-familiarity / monotony	24.0	16.8
Manoeuvre over-familiarity	44.5	11.2
Sporadic driving (e.g. elderly drivers)	3.4	25.2
Road / area / site unfamiliarity	8.1	60.8
Excessive confidence in the signs given to others (priority feeling)	16.6	66.4
In a hurry (for the manoeuvre)	18.8	66.4
Visibility impaired by roadside objects	23.0	16.8
Visibility impaired (other vehicle, sun glare…)	22.9	19.6

Table 13_Annex1.5.- Explicative elements of P5 Failure identified for Elderly drivers and Controls

	Controls	Elderly drivers
Slow reaction (because of age or other)	0.0	26.3
Inattention (low level of attention resources assigned to driving task)	28.5	21.1
Road over-familiarity / monotony	52.9	31.6
Road / area / site unfamiliarity	4.4	26.3
Problems in equipment (atypical, not legible, not adapted to certain vehicles)	4.0	31.6
Visibility impaired (other vehicle, sun glare…)	5.8	21.1
Atypical manoeuvres from other users	43.1	31.6
Visibility impaired (rain, night…)	9.9	21.1

Specificities of diagnosis failures

Table 14_Annex1.5.- Explicative elements for T2 Failure identified of Elderly drivers and controls

	Controls	Elderly drivers
Trivialization of the situation (potentially dangerous but treated as 'pain killer')	5.4	28.6
Slow reaction (because of age or other)	0.0	32.1
Low vigilance / fatigue / tiredness / drowsiness	28.0	21.4
Manoeuvre over-familiarity	33.3	71.4
Sporadic driving (e.g. elderly drivers)	0.0	10.7

Specificities of prognosis failures

Table 15_Annex1.5.- Explicative elements of T6 Failure identified for Elderly drivers and Controls

	Controls	Elderly drivers
Road over-familiarity / monotony	33.5	8.9
Rigid attachment to the right of way status	65.6	97.0
In a hurry (for the manoeuvre)	2.8	55.6
Visibility impaired by roadside objects	5.2	55.6
Situational pressure inducing a precipitated manoeuvre	1.5	55.6

Specificities of Overall Failures

Table 16_Annex1.5.- Explicative elements of G3 Failure identified for Elderly drivers and Controls

	Controls	Elderly drivers
Slow reaction (because of age or other)	3.6	93.1
Low vigilance / fatigue / tiredness / drowsiness	4.3	35.5
Sporadic driving (e.g. elderly drivers)	15.9	82.1
Rigid attachment to the right of way status	0.0	25.9
Navigation problem	45.7	54.5
Complex road layout (e.g. intersection)	0.0	17.9
Purposeful violation of traffic laws, regulations…	17.4	31.4

Human Functional Failures in emergency situation

Table 17_ Annex1.5.- Distribution of emergency situations identified for Elderly and Controls

	Controls	Elderly drivers
Successful	0.2%	0.3%
No detection of danger	20.1%	45.8%
D1 failure	0.5%	1.3%
D2 failure	3.4%	1.6%
E1 failure	11.8%	2.6%
E2 failure	3.2%	0.6%
Not possible to avoid	51.8%	41.7%

11.5.2 Gender issues

Functional Failures (overall analysis)

Table18_ Annex1.5.-Categories of Functional Failure for Male and Female drivers.

	Hommes		Femmes		Total	
	n	%	n	%	n	%
Perception	361	31.9%	224	41.2%	584	34.9%
Diagnostic	161	14.2%	56	10.4%	217	13.0%
Pronostic	184	16.3%	81	15.0%	266	15.9%
Décision	119	10.5%	31	5.6%	150	8.9%
Exécution	70	6.2%	44	8.0%	113	6.8%
Globale	93	8.3%	48	8.8%	141	8.4%
Absence de défaillance	143	12.7%	60	11.1%	204	12.2%
Total	1131		543		1674	

Explicative elements

Table19_ Annex1.5.-Distribution and combination of explicative elements categories related to Human Functional Failures detected for Male and Female road users.

	Male	Female	Total
Combination of endogenous and exogenous elements	71.3%	65.9%	69.6%
Endogenous elements	20.0%	24.6%	21.5%
Exogenous elements	8.6%	9.4%	8.9%

Table20_ Annex1.5.-Distribution and detail of explicative elements categories related to Human Functional Failures detected for Male and Female road users.

		Male	Female
Endogenous elements	Drivers' state-related factors	48.6	45.0
	Experience-related factors	60.1	77.3
	Factors related to the internal condition of driving task	100.6	90.8
Exogenous elements	Layout-related factors	48.6	45.3
	Traffic-related factors	80.6	84.2
	Vehicle-related factors	4.6	2.0

Table21_ Annex1.5.-Numbers and percentages of all explicative elements having influence on occurrence of Male and Female road users' Human Functional Failures.

Explicative elements			Male n	%	Female n	%
Endogenous elements	Drivers' state-related factors	Falling asleep	23.3	2.4	4.4	0.9
		Faintness	5.5	0.6	3.1	0.6
		Visual handicap	1.9	0.2	1.3	0.3
		Auditory handicap	0	0.0	0	0.0
		Disability	0	0.0	0	0.0
		Slow reaction (because of age or other)	24.5	2.5	21.5	4.5
		Small BAC (0g/l to 0.49g/l)	13.6	1.4	2.3	0.5
		Small THC intake	3.4	0.3	0	0.0
		Small medicine intake	5.1	0.5	3	0.6
		Major BAC (>0.5g/l)	72.8	7.4	9.3	1.9
		Major THC intake	4.8	0.5	0	0.0
		Major medicine intake	4.1	0.4	3.4	0.7
		Low vigilance / fatigue / tiredness / drowsiness	76.7	7.8	40.5	8.4
		Inattention (low level of attention resources assigned to driving task)	144.1	14.6	56.7	11.7
		Internal distraction	24.4	2.5	22.7	4.7
		External distraction	40.3	4.1	21.1	4.4
		Impatience, stress	35.5	3.6	27.8	5.8
	Experience-related factors	Road over-familiarity / monotony	216.4	21.9	130.1	26.9
		Manoeuvre over-familiarity	92.6	9.4	69.5	14.4
		Experience of a site in its previous configuration: rigid mental representation	6.2	0.6	3.1	0.6
		Driving inexperience = novice	110.5	11.2	35.3	7.3
		Driving inexperience = presence of a passenger (PTW)	0	0.0	0	0.0
		Sporadic driving (e.g. elderly drivers)	18.6	1.9	25.1	5.2
		Road / area / site unfamiliarity	107.3	10.9	57.6	11.9
		Low experience of the situation	16.7	1.7	19.7	4.1
		Vehicle unfamiliarity	25.6	2.6	32.8	6.8
	Factors related to the internal condition of driving task	Rigid attachment to the right of way status	195.1	19.8	97.9	20.3
		Excessive confidence in the signs given to others (priority feeling)	41.3	4.2	17.2	3.6
		Headlight unlit	0	0.0	0	0.0
		Global time constraint (for the trip)	66.9	6.8	32.3	6.7
		Situational time constraint (for the manoeuvre)	42.6	4.3	39.6	8.2
		Trivialization of the situation (potentially dangerous but treated as 'pain killer')	88.3	8.9	40.1	8.3
		Choose of a too high vehicle speed for the situation	228.1	23.1	68.7	14.2
		Excessive speed (above limitation)	0	0.0	0	0.0

		Purposeful violation of traffic laws, regulations…	164.8	16.7	23.7	4.9
		Deliberate accident-generating behaviour	0	0.0	5.7	1.2
		Following too close	2.2	0.2	0	0.0
		Navigation problem	46.4	4.7	39.9	8.3
		Secondary task (that has nothing to do with driving)	31.2	3.2	18.9	3.9
		Identification of a potential risk only about a part of the situation	86	8.7	54.5	11.3
Exogenous elements	Layout-related factors	Problem in the direction road signs	11.2	1.1	4	0.8
		Inadequate signing (not sufficient, not visible)	36.8	3.7	7.5	1.6
		Restricted visibility (road conception, trees, signs…)	158.6	16.1	90.1	18.7
		Problems in equipment (atypical, not legible, not adapted to certain vehicles)	65.4	6.6	23.1	4.8
		Complex site (e.g. intersection)	47.6	4.8	28.6	5.9
		Equipment inciting to speeding	63.1	6.4	19.5	4.0
		Poor / no street lighting	4.5	0.5	2.5	0.5
		Difficult plan (small curvature radius…)	51	5.2	17.6	3.6
		Narrow road	34.6	3.5	19.6	4.1
		Deficient state of the road surface = pothole / crushed stone / dip / step	7.5	0.8	6.4	1.3
	Traffic-related factors	Difficulty in finding a gap to cross or to insert (density or speed to the traffic)	43.3	4.4	18.2	3.8
		Situational pressure inducing a precipitated manoeuvre	28.3	2.9	18.6	3.9
		Obstruction to visibility (other vehicle, glare…)	137.1	13.9	88.7	18.4
		Unlit obstacle on carriageway / vehicle stopped	18.4	1.9	2.4	0.5
		Unlit PTW on carriageway	0	0.0	0	0.0
		Absence of clues indicating a manoeuvre made by another user	75	7.6	32.2	6.7
		Ambiguity of clues coming from other users	43.7	4.4	27.6	5.7
		Atypical manoeuvres from other users	262.6	26.6	158.8	32.9
		Inconvenient behaviour of a user ahead (low speed for example)	42	4.3	8	1.7
		Bad visibility conditions (rain, night…)	89.4	9.1	28.8	6.0
		Being dragged (by a passenger, by a vehicle ahead starting …)	33.1	3.4	15.5	3.2
		Loss of vehicle adhesion	18	1.8	7.9	1.6
		High winds at site	1.7	0.2	0	0.0
		Environmental perturbation (e.g. brushwood fire on the roadside …)	3.2	0.3	0	0.0

Vehicle-related factors	Vehicle size	20.2	2.0	2.5	0.5
	Defective tyre pressure	6.8	0.7	1.3	0.3
	Type blow-out	2.4	0.2	1.5	0.3
	Sudden mechanical breakdown	11.1	1.1	0.8	0.2
	Defective tyre state = slick/worn/insufficient treat	4	0.4	3	0.6
	Cold tyre	0.5	0.1	0	0.0
	Alarm transmitted by a driving aid	0	0.0	0.5	0.1
	Defective light	0	0.0	0	0.0
	Excessive vehicle load	0	0.0	0	0.0
	Defective suspension system	0	0.0	0	0.0
Total of elements (weighted)		3388		1664	5052
Total de failures (weighted)		987.4		482.9	1470.3

Functional failure: detailed analysis

Table22_ Annex1.5.-Distribution of Human Functional Failure identified for Male and Female road users.

		Male	Female
Perception	P1 Failure to detect in visibility constraints	11.0%	14.3%
	P2 Focalised acquisition of information	8.5%	10.8%
	P3 Cursory information acquisition	5.2%	9.5%
	P4 Interruption in information acquisition	2.2%	1.5%
	P5 Neglecting information acquisition demands	5.1%	5.1%
Diagnosis	T1 Incorrect evaluation of a road difficulty	4.6%	2.6%
	T2 Incorrect evaluation of a gap	1.7%	2.0%
	T3 Incorrect understanding of how site functions	2.0%	1.8%
	T4 Incorrect understanding of manoeuvre undertaken by another user	6.0%	3.9%
Prognosis	T5 Not expecting (by default) manoeuvre by another user	4.4%	3.3%
	T6 Expecting adjustment by another user	7.9%	10.0%
	T7 Expecting no perturbation ahead	3.9%	1.6%
Decision	D1 Directed violation	1.3%	1.9%
	D2 Deliberate violation	6.5%	2.1%
	D3 Violation-error	2.7%	1.7%
Action	E1 Poor control of a difficulty	4.1%	3.2%
	E2 Guidance problem	2.1%	4.8%
Overall	G1 Lost of psycho-physiological ability	2.6%	1.8%
	G2 Impairment of sensorimotor and cognitive abilities	4.3%	1.9%
	G3 Exceeding cognitive abilities	1.4%	5.0%
	Absence	12.7%	11.1%

Prototypical Accident Scenarios

Dysfunctional task

- **Driving along a straightaway (or in a easy bend) with no other demand than guiding the vehicle**

Explanatory elements

Endogenous

- **High speed**
- **Risky driving**
- **Low driving experience**
- Driving in automatic mode: low level of attention related to long experience with the itinerary
- Low level of attention
- Heavy alcohol consumption (>0.5g/l)

Exogenous

- Difficult layout (tight bend, sudden change)

Functional failure

Underassessment of the difficulty of a bend (left or right) in a playful context

Resulting critical situation

Loss of control at the beginning, middle or end of a bend, veering off the road (or in some cases collision with a vehicle coming from the opposite direction)

Accidents

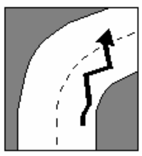

Figure 1_ Annex1.5.-Characteristics of scenario T1c[44] among men: Underassessment of the difficulty of a bend in a playful context

[44] Legend for the figures characterising the scenarios:

- Elements in bold characters are the most representative elements in the scenario.
- The figurative drawings for the types of collision in the scenarios only represent the most typical types of accidents. The "bold" arrow represents the driver with the failure in question, the other arrows represent the interfering drivers and the "star" represents the point of collision.

Dysfunctional task

- **Going around a bend on a narrow carriageway with interference by a non-visible vehicle or pedestrian (generally in the opposite direction)**
- Crossing another vehicle on a narrow carriageway

Explanatory elements

Endogenous

- **High speed**
- **Driving in automatic mode**: low level of attention related to long experience with the itinerary or the manoeuvre
- Playful driving

Exogenous

- **Limited visibility (infra)**
- **Narrow carriageway**

Functional failure

Foreseeing no vehicle in a bend without visibility

Resulting critical situation

Oblique head-on collision with the vehicle coming in the other direction

Accidents

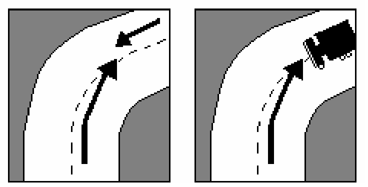

Figure 2_Annex1.5.- Characteristics of scenario T7a among men: Foreseeing no vehicle in a bend without visibility

Dysfunctional task

- Crossing a priority intersection with interference by vehicles on the priority road

Explanatory elements

Endogenous

- Low driving experience
- "Risky" driving behaviour

Exogenous

Functional failure

Decision not to stop at the intersection taken while neglecting the rules and the danger

Resulting critical situation

Begins crossing into the trajectory of the interfering priority user

Accidents

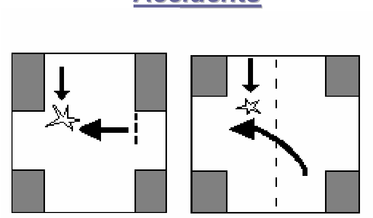

Figure 3_ Annex1.5.-Characteristics of scenario D2c among men: Crossing an intersection "going with the flow"

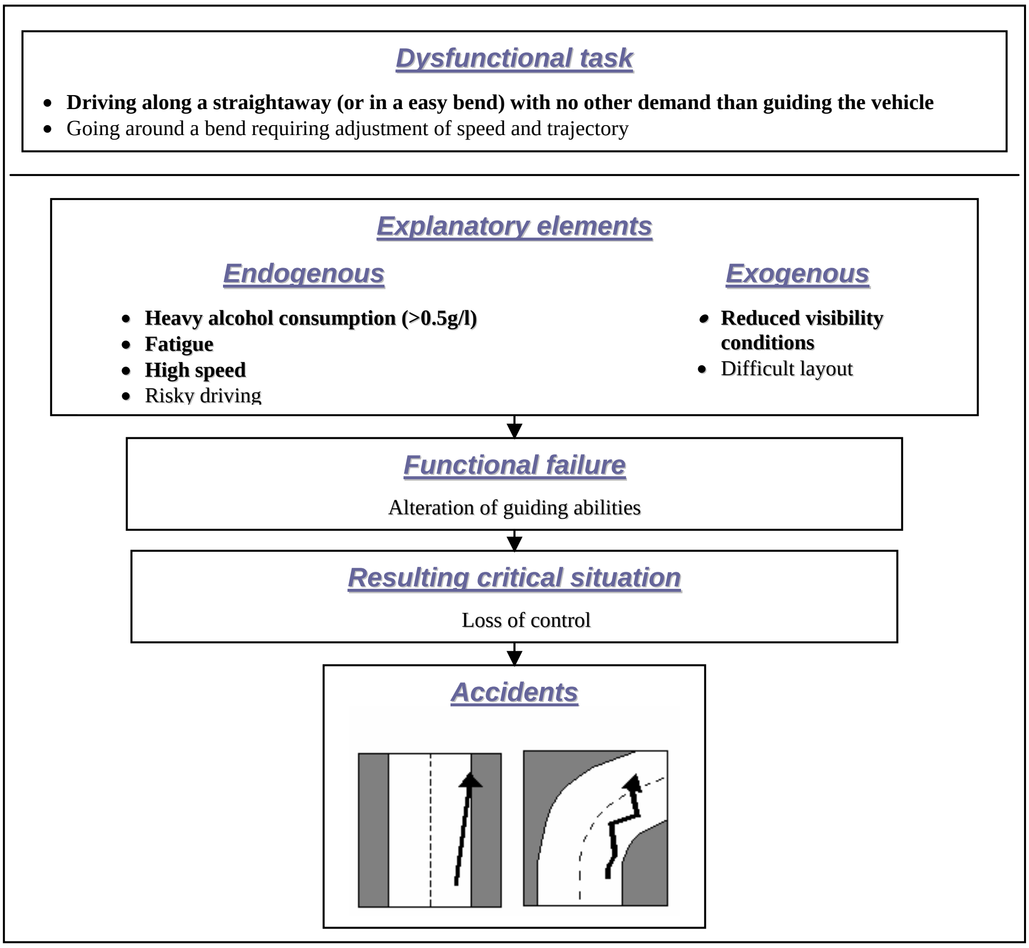

Figure 4_ Annex1.5.-Characteristics of scenario G2b among men: Alteration of guiding abilities

Dysfunctional task

- **Crossing a priority intersection with interference by a vehicle starting to cross**
- Driving along a straightaway with interference by a vehicle merging onto the carriageway

Explanatory elements

Endogenous

- **Feeling of priority**
- Long experience with the itinerary - driving in automatic mode - low level of attention

Exogenous

- **Atypical manoeuvre by another user – in violation of the law**
- Interference to visibility
- Darkness
- Lack of lighting on the other vehicle

Functional failure

Late detection of another, non-visible vehicle pulling out into the driver's trajectory

Resulting critical situation

Interfering vehicle approaching, almost with no time to slow down

Accidents

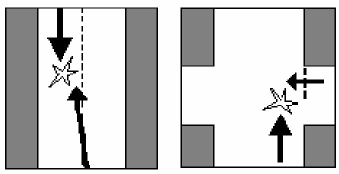

Figure 5_ Annex1.5.-Characteristics of scenario P1d among women: Female drivers surprised by the manoeuvre of a non-visible approaching vehicle

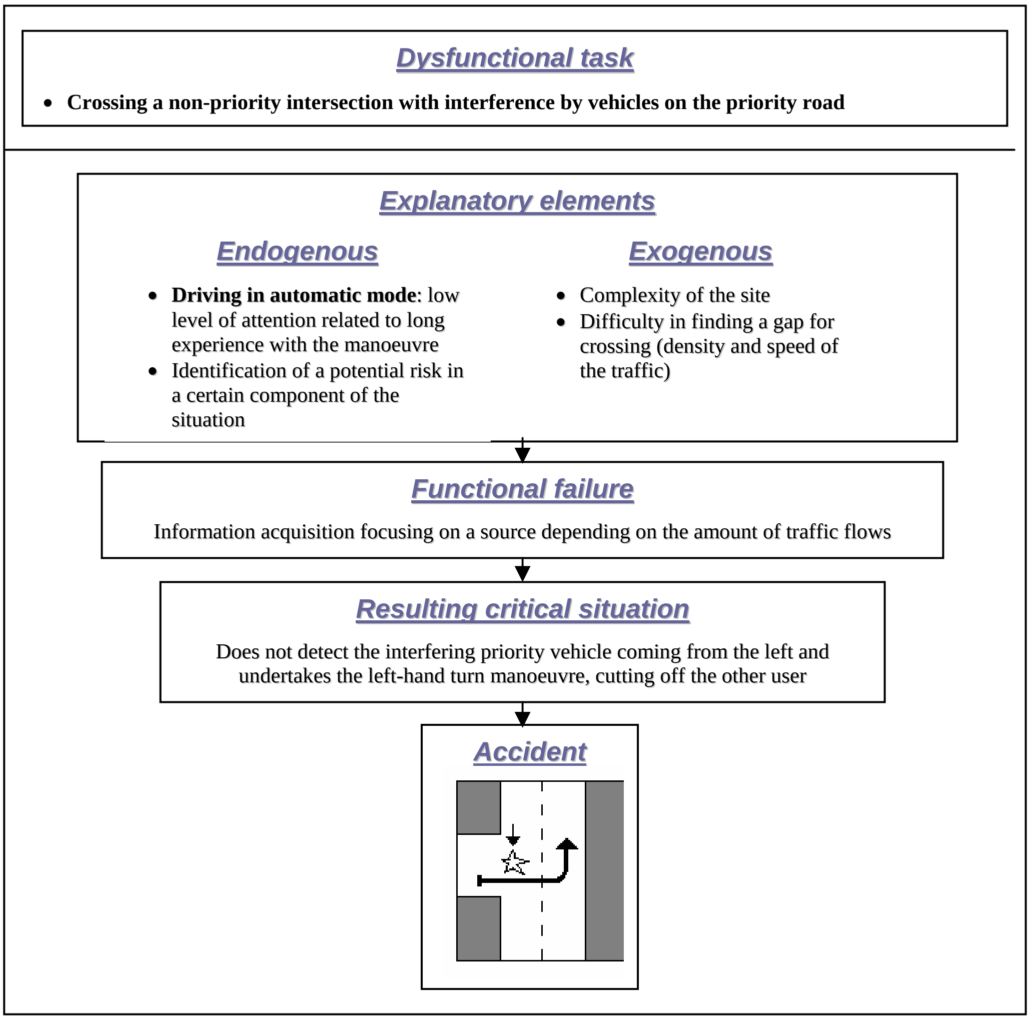

Figure 6_ Annex1.5.-Characteristics of scenario P2c among women: Focusing on a source depending on traffic flows

Dysfunctional task

- **Changing directions (left-hand turn) with interference by vehicles on the road driving in the same direction**
- Changing directions (left-hand turn) with interference by vehicles on the road driving in the opposite direction

Explanatory elements

Endogenous

- **Driving in automatic mode**: low level of attention related to long experience with the itinerary and/or manoeuvre
- **Low level of attention**
- Excess trust in the signals emitted to other users (feeling of priority)
- Trivialisation of the situation

Exogenous

Functional failure

Cursory information acquisition when changing directions (left-hand turn)

Resulting critical situation

Does not detect the interfering vehicle (following or coming in the opposite direction) and undertakes a left-hand turn manoeuvre, cutting the other user off

Accidents

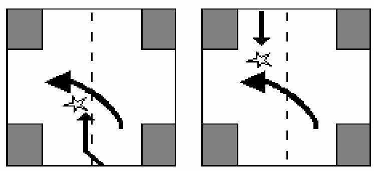

Figure 7_ Annex1.5.-Characteristics of scenario P3a among women: Cursory information acquisition when making a left-hand turn

Dysfunctional task

- **Driving along a straightaway with interference by a vehicle swerving off its trajectory**
- Crossing another vehicle on a narrow carriageway (straightaway or bend)

Explanatory elements

Endogenous

- **Trivialisation of the situation**
- Driving in automatic mode: low level of attention related to experience with the itinerary
- Rigid attachment to right-of-way status
- Low driving experience (beginner)

Exogenous

- **Atypical manoeuvre by another user – in violation of the law**

Functional failure

Erroneously expecting a trajectory adjustment by a vehicle driving in the opposite direction

Resulting critical situation

Late emergency manoeuvre (sudden swerve), hitting the interfering user

Accidents

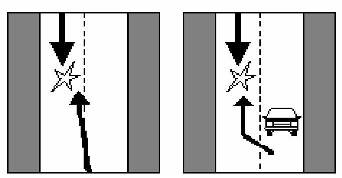

Figure 8_ Annex1.5.-Characteristics of scenario T6a among women: Erroneously expecting a trajectory correction by a vehicle driving on the road

Dysfunctional task

- Driving along a straightaway with interference by a vehicle changing directions
- Approaching a non-priority intersection
- Crossing a priority intersection with interference by a non-priority vehicle starting to cross
- Crossing a carriageway (outside an intersection) with interference by a vehicle on the road being crossed

Explanatory elements

Endogenous

- High speed
- Driving in automatic mode: low level of attention related to long experience with the itinerary or manoeuvre

Exogenous

- Atypical manoeuvre by another user – in violation of the law
- Absence of cues announcing a manoeuvre by another user

Functional failure

Erroneously expecting the interfering vehicle not to stop

Resulting critical situation

- Rear-end or lateral collision with the interfering vehicle
- Loss of control after an attempt to avoid the interfering vehicle

Accidents

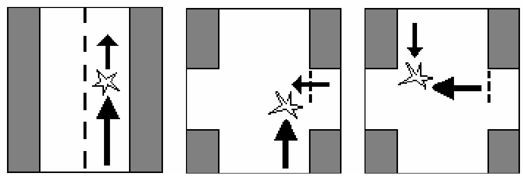

Figure 9_ Annex1.5.-Characteristics of scenario T6d among women: Erroneously expecting the interfering vehicle not to stop

Dysfunctional task

- Driving along a straightaway (or in an easy bend) with no other demand than guiding the vehicle

Explanatory elements

Endogenous | **Exogenous**

- **Performing a secondary task with no direct relation to driving**
- **Distraction**
- Fatigue
- Low driving experience
- Lack of knowledge of vehicle controls

Functional failure

Interrupted guiding after shifting attention toward a secondary task

Resulting critical situation

Loss of control (frequently veering off onto the right-hand shoulder)

Accidents

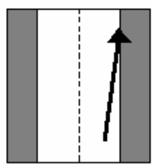

Figure 10_ Annex1.5.-Characteristics of scenario E2a among women: Interrupted guiding after shifting attention toward a secondary task

Dysfunctional task

- **Driving along a straightaway (or in an easy bend) with no other demand than guiding the vehicle**
- Driving along a straightaway with demands for seeking directions

Explanatory elements

Endogenous

- **Lack of knowledge of the location**
- Lack of knowledge of the vehicle (controls)
- High speed
- Direction problem

Exogenous

Functional failure

Overwhelmed cognitive abilities: performing abnormal manoeuvres

Resulting critical situation

Loss of control or collision with a vehicle or obstacle

Accidents

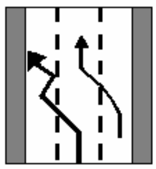

Figure 11_ Annex1.5.-Characteristics of scenario G3b among women: Performing abnormal manoeuvres

Human Functional Failures in emergency situation

Table23_ Annex1.5.-Distribution of emergency situations identified for Male and Female road users.

	Male	Female
Successful	0.4%	0.0%
No detection of danger	18.6%	29.1%
D1 failure	0.8%	0.0%
D2 failure	3.5%	2.8%
E1 failure	11.0%	11.3%
E2 failure	3.1%	2.9%
Not possible to avoid	53.1%	46.9%

Pedestrians Human Functional Failures

Table24_ Annex1.5.-Distribution of Human Functional Failures categories for Male and Female pedestrians.

	Male	Female
Perception	33.3%	65.6%
Diagnosis	11.1%	9.4%
Prognosis	16.7%	6.3%
Decision	5.6%	6.3%
Overall	16.7%	0.0%
No failure	16.7%	12.5%

Table25_ Annex1.5.-Distribution of Human Functional Failures for Male and Female pedestrians.

	Male	Female
P1 Failure to detect in visibility constraints	5.6%	0.0%
P2 Focalised acquisition of information	5.6%	25.0%
P3 Cursory information acquisition	5.6%	21.9%
P4 Interruption in information acquisition	0.0%	3.1%
P5 Neglecting information acquisition demands	16.7%	15.6%
T2 Incorrect evaluation of a gap	11.1%	9.4%
D3 Violation-error	5.6%	6.3%
T5 Not expecting (by default) manoeuvre by another user	5.6%	0.0%
T6 Expecting adjustment by another user	11.1%	3.1%
T7 Expecting no perturbation ahead	0.0%	3.1%
G2 Impairment of sensorimotor and cognitive abilities	11.1%	0.0%
G3 Exceeding cognitive abilities	5.6%	0.0%
No failure	16.7%	12.5%