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ASSESS
Assessment of Integrated Vehicle Safety Systems for improved vehicle safety

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Executive summary

The overall purpose of the ASSESS project is to develop a relevant and standardised set of test and assessment methods and associated tools for integrated vehicle safety systems with the focus on currently “on the market” pre-crash sensing systems. The information and methodology developed hereby can then be used for a wider range of integrated vehicle safety systems, encompassing assessment of driver behaviour, pre-crash performance and crash performance.

The first step in the project was to define casualty relevant accident scenarios so that the test scenarios will be developed based on accident types which currently result in the greatest injury outcome, measured by a combination of casualty severity and casualty frequency. Therefore, the first task in Work Package 1 was to examine how relevant scenarios had been developed by previous projects and to obtain and analyse European accident data to define preliminary accident scenarios which could then be taken by Work Packages 3 (Driver behavioural evaluation) and 4 (Pre-crash evaluation) as the initial accident types on which to base further analysis.

The review of previous projects provided a large overview of activities concerning the research in terms of integrated safety. The most promising assessment method for ASSESS is probably close to the approaches defined by APROSYS and PReVAL. Unfortunately only some of the previous projects performed relevant accident analysis. ASSESS could only benefit from the work that was done within eIMPACT, TRACE, and eVALUE and could use aspects of this data for an overview on the event of the accident on EU level.

In general pre crash sensing systems may combine a wide range of functionalities (e.g. brake assist included or not / driver warning included or not / restraint activation included or not). Activities in ASSESS will be based on two currently “on the market” systems that include various functionalities. In order not to be too restricted to the systems considered and their specific functionalities the principle of accident analysis was that it considered the accidents and casualties independent of the detailed specifications of safety systems considered in ASSESS. The analysis therefore aimed to define the preliminary accident scenarios based on frontal real world accident problems, not the accidents which could be addressed by a particular safety system.

Analysis was completed for a range of accident databases, including those which were nationally representative (STATS19 and STRADA) and in-depth sources which provided more detailed parameters to characterise the accident type (GIDAS and OTS). A common analysis method was developed in order to compare the data from these different sources. While this was not totally successful, the majority of the data was aligned in such a way as to allow a comparison between these databases.

The results from the analyses were also ranked by valuations reflecting the cost assigned to fatal, serious and slight accidents/casualties. This enabled the “total casualty outcome” of the accidents to be assessed, thereby adjusting for accident types which occur less frequently but result in greater number of more severely injured casualties (and vice versa).

After a comparison between the data sources, the ranking of the preliminary accident scenarios from the analysis were:

Rank	Accident type
1	Type 1a: Driving accident - single vehicle
2	Type 6: Accidents in longitudinal traffic (6a and 6b included)
3	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction

4 Type 4: Accidents involving pedestrians

The analysis has confirmed that the systems selected within ASSESS are relevant with respect to the current casualty problems, with Type 6 and Type 2&3 accidents being relevant to the ASSESS pre-crash systems. Further analysis in Task 1.2 will define the accident parameters at a more detailed level.

Contents

1 Objectives

The overall purpose of the ASSESS project is to develop a relevant and standardised set of test and assessment methods and associated tools for integrated vehicle safety systems with the focus on currently “on the market” pre-crash sensing systems. The information and methodology developed hereby can then be used for a wider range of integrated vehicle safety systems, encompassing assessment of driver behaviour, pre-crash performance and crash performance.

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The study on preliminary accident scenarios will be followed by a more detailed analysis to provide relevant information on scenario parameters such as the pre crash vehicle kinematics in terms of speed and approach angle (ASSESS Task 1.2).

The principle of this accident analysis was that it considered the accidents and casualties independent of the safety system - so the real world accident problem. This is to ensure that the procedures developed for ASSESS are focussed on the priority casualty problems (system validation), not simply to develop assessment methodologies to demonstrate the system effectiveness in design conditions (system verification).

2 Previous research

2.1 Introduction

A review of previous research was performed by the members of Work Package 1. The purpose of this review was to determine how these other research projects proceeded in terms of data acquisition as this is essential for the structure of the project, and how they had defined accident scenarios. It may be of benefit to transfer this knowledge to the ASSESS project as a basis for the activities in Work Package 1. The following sections describe the review of the projects considered, highlighting those issues which were considered important for the ASSESS project.

2.2 APROSYS

As part of a large European 6th Framework project, APROSYS (Integrated Project on Advanced Safety Systems), developed a generic methodology for advanced safety systems. APROSYS started in 2004 with 5 years duration.

Existing test methods evaluate the crash performance of a vehicle, but are unsuitable for the assessment of advanced safety systems because additional evaluations of the sensing performance and the effect of autonomous actions on the driver response are required. To meet this need, the APROSYS generic methodology was intended to be applicable to a wide range of advanced safety systems and describes the different steps that should be taken in the development of a performance evaluation protocol for a specific advanced safety system (APROSYS deliverable 1.3.4, 2008). The flowchart providing an overview of the methodology is shown below. The generic methodology was also designed to be flexible such that it can be used by a wide variety of stakeholders, from consumer organisations such as Euro NCAP, legal authorities and industry, all of whom have a need to evaluate the technical performance of pre-crash safety systems. The main conclusions can be summarised as follows:

The APROSYS methodology is highly relevant to the ASSESS project in general; the application of tests focussed on the assessment to driver in the loop, pre-crash and crash assessment being directly transferred from APROSYS. However, the APROSYS methodology describes process of deriving test scenarios, but does not define test scenarios for any system in general other than the pre-crash pedestrian system and side impact protection system used as “pilot” cases.
As can be seen with reference to the draft generic methodology, steps 1 to 3 describe the system, its technology and objective, and its field of application. This is to define the scope of the assessment tests. In Box 4, the accident and/or traffic scenarios from Box 3 are used to develop system specific test conditions, resulting in a test plan for the assessment of the pre-crash, the crash and, if necessary, the driver-in-the-loop behaviour. Additional information, relating to the real world performance of the system is provided via box 6.

The APROSYS project demonstrated that relevant accident scenarios could be identified and transferred to appropriate test conditions. The test procedures developed from the methodology allowed the systems to be evaluated in terms of the pre-crash, crash and driver-in-the-loop performance. These assessments were shown to be successful in evaluating system performance and could be applied in addition to existing regulatory and assessment procedures.

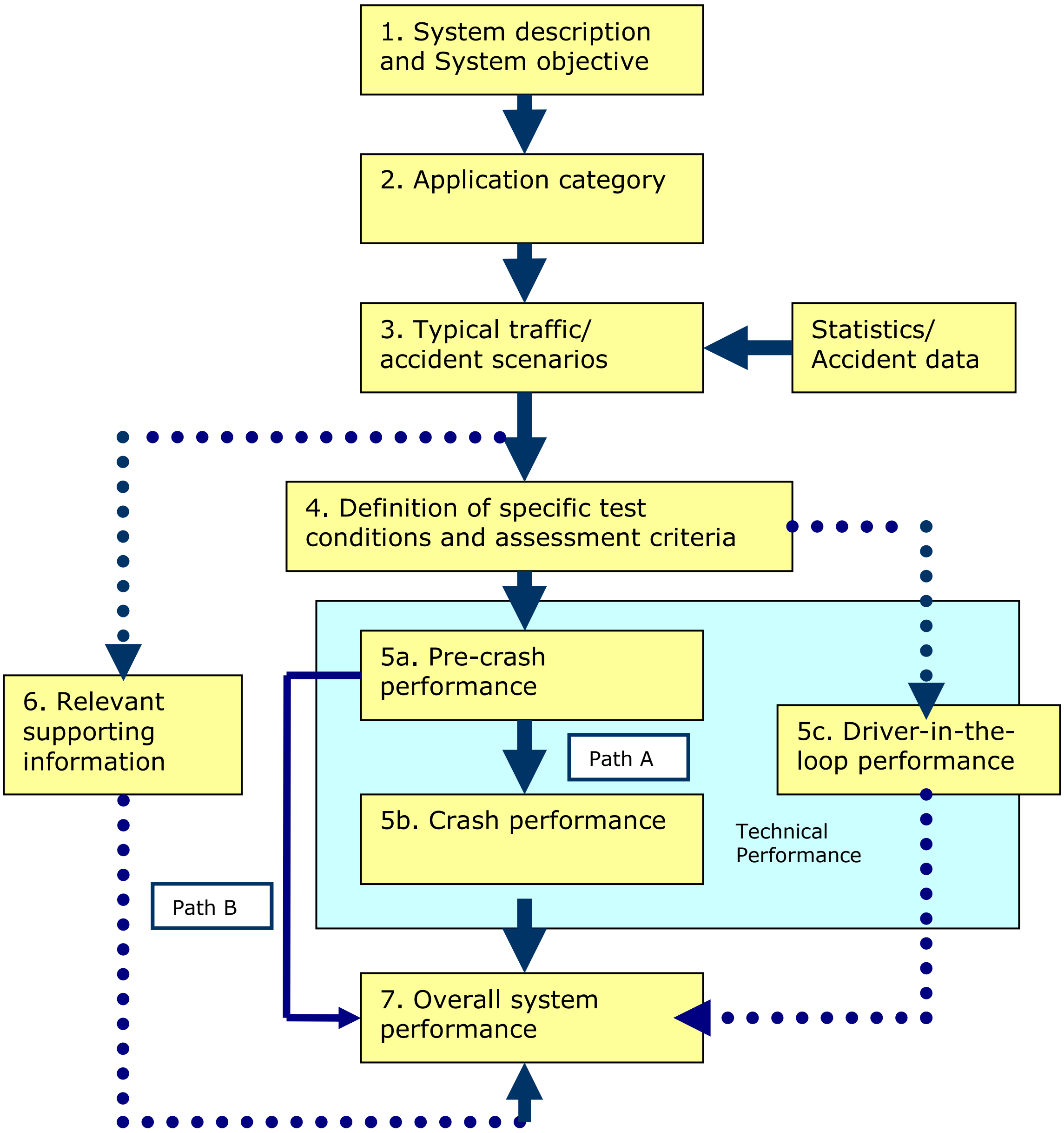


Figure 2-1. APROSYS Generic Methodology

APROSYS recommended that stakeholders should ensure that the tests represent, as accurately as possible, the target population (the group of accidents influenced by the system) and that a sufficient number of repeat tests are performed to characterise system performance; what constitutes this threshold depends on the application of the methodology. A specific test programme should define requirements for valid tests and suitable means of monitoring the key parameters (such as vehicle speed) to ensure that any testing is repeatable. The test conditions developed during the APROSYS testing were highly simplified with relation to the road environment as seen by the sensing system. This indicated that, depending on the specific system under assessment and the purpose of the assessment, relevant supporting information on the “real world” performance of the sensing system may be important. This would assess the pre-crash performance in a wider range of situations than defined in any assessment tests. Finally, the project also concluded that expert knowledge should be permitted by the methodology to supplement situations derived from accident data, in order to represent typical environmental conditions which cannot be defined using currently existing data (e.g. other but uninvolved cars or objects on accident scene).

[www.aprosys.com]

2.3 AEBS project

For a European study on Automated Emergency Braking Systems (AEBS) on a range of vehicle types, accident scenarios were developed for the purpose of providing a cost benefit analysis. This project used a comprehensive Industry and literature survey to gather system specifications for current and near-future AEBS. These specifications were then used to define the accident groups which comprise the target population: the accidents influenced by the system. Therefore, the approach of this project was to assess the accident and casualty benefits of existing (and near-future) systems based on their specific design performance. In ASSESS, this first task is providing initial information to define accident conditions in which the system should be assessed, rather than to examine the system's design conditions.

[ec.europa.eu/enterprise/automotive/projects/report_aebs.pdf]

2.4 PReVENT

PReVENT work is a part of a comprehensive approach to safe traffic pursued by the automotive and supplier industries in Europe. The project was carried out in the framework of eSafety programme by EC and under the Integrated Safety Programme by Members of European Association for Collaborative Automotive Research (EUCAR) supported by CLEPA R&D and ERTICO and coordinated by Daimler AG.

The vision of the PReVENT integrated project is to create an electronic safety zone around vehicles by developing, integrating and demonstrating a set of complementary safety functions. These functions surround the vehicle, assist and protect drivers and unprotected road users. First, they detect and classify the type and significance of the danger. Depending on the nature of the threat, active and preventive safety systems inform, warn and assist the driver in order to escape the accident. In the event of an unavoidable collision, the PReVENT safety systems are even able to mitigate accident consequences.
In accordance with these programme objectives, the PReVENT overall goal was to develop, test and evaluate safety applications, advancing current sensor and communication technologies and finally, integrating them in dedicated demonstrator platforms to show the project integration. Furthermore, an essential target was also to speed up the market introduction and penetration of advanced safety systems and overcoming the major barriers for wide take-up of intelligent vehicle technologies. Reaching the ambitious goal of PReVENT required that the work needed to be split and grouped into separate but interacting fields.

Consequently, the technical objectives were stated in the manner that allowed on one hand, the independent development of single safety functions through vertical activities, and on the other hand, allowing the different vertical function fields to interact with supporting horizontal activities producing an integrated safety system.

These different single activity areas were grouped into separate vertical function fields. The activities aiming at supporting the convergence of different vertical activities into a safety zone around a vehicle were grouped into cross-functional or horizontal activities. The technical objectives of PReVENT follow this logic to be introduced below.

1. Vertical function fields
Vertical activities dealt with the development of single applications and functions needed to make an electronic safety zone around the vehicle. The applications developed in the project

all target to better understanding of the driving environment in order to inform, warn, support and ultimately protect vehicle occupants in accident situations.

(i) Safe Speed and Safe Following: These functions help drivers keep or choose a speed or inter-vehicle distance, allowing them to safely cope with the road situation they will meet in the following seconds. The approach is mostly autonomous.
(ii) Lateral Support: This field deals with autonomous applications focusing on the lateral areas of a vehicle to help drivers keep their vehicle at the safest position in the lane, as well as warn them if the vehicle is about to run off the road.
(iii) Intersection Safety: This function field covers the investigation of autonomous and cooperative approaches to safety applications dedicated at approaching or passing intersections.
(iv) Vulnerable Road Users and collision Mitigation: Collision mitigation and pre-crash protection systems focus on reduction of injuries and fatalities in case of unavoidable crashes (in particular during the last 2-3 seconds before the impact). Collision mitigation by braking significantly reduces kinetic energy of impact, thereby greatly reducing crash severity.

2. Horizontal activities
Horizontal activities were divided into different categories:

(i) addressing legal aspects eventually needed to be considered in the market introduction phase and also uniform methods for developing and testing such systems
(ii) developing technologies and methods to facilitate the integration work of future vehicles
(iii) creating integrated platforms to pave way to future intelligent safety systems
(iv) investigating the potential impacts of PReVENT functions and finally
(iv) increasing users' and stakeholders' awareness of intelligent vehicle technologies

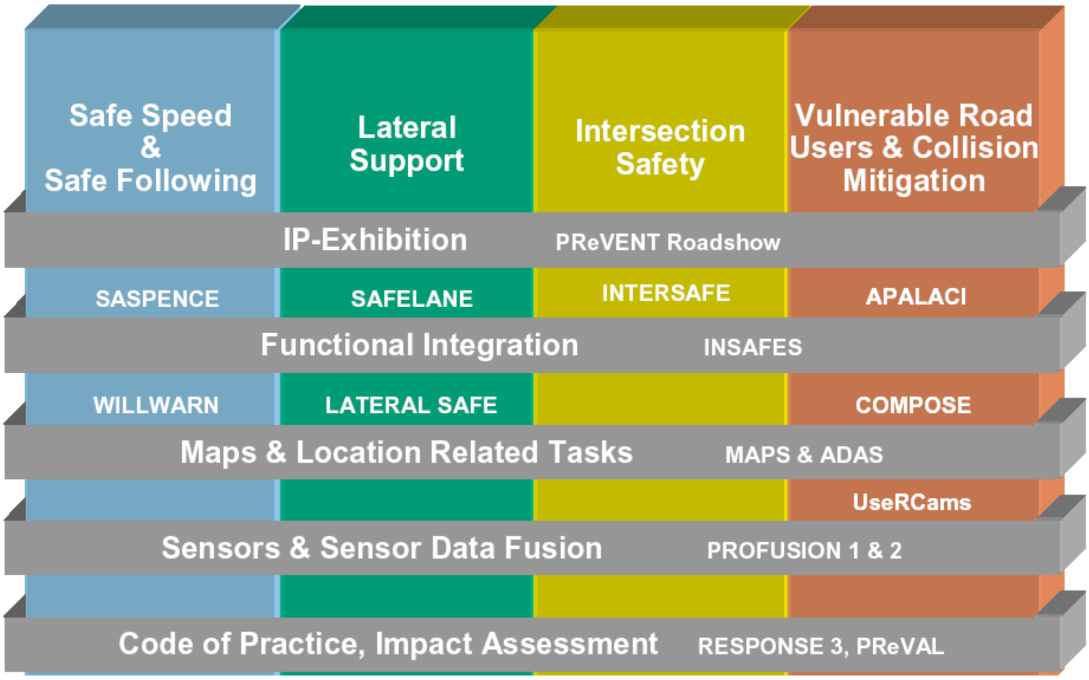


Figure 2-2 Structure of the PReVENT project

[www.prevent-ip.org]

2.5 PreVAL

PReVAL is a subproject of PReVENT which provides with a harmonised evaluation framework, define a methodology to be used in the impact assessment of various applications and apply the methodology to a set of given use cases.

In the PReVAL method, assessment is organised according to the following three aspects: technical and human factors evaluation, followed by safety potential assessment. The *technical evaluation* focuses on the technical performance and reliability of the system. Technical evaluation is performed in two phases: “Verification” to test the individual components and subsystems towards the technical specifications and “Validation” to test whether the goals and specifications of the complete system are met. The main goal of the *human factors evaluation* is to assess the extent to which the system succeeds in generating the intended behavioural responses from the driver in target situations, i.e. once the risk for loss of control is detected, hence to assess the ability of the function to affect situational control *through the driver* by providing information and/or warnings. The goal of the *safety potential assessment* is to make an aggregate-level assessment of the preventive system’s effects on relevant harm metrics (usually number of fatalities) in target situations. The impact assessment is based on the assessments of technical performance and behavioural effects making use of accident statistics, estimations of fleet penetration rates, and other relevant tools. For safety assessment, PReVAL uses the procedure developed and used by the eIMPACT project.

The first purpose of assessment is to evaluate whether the system works as required, i.e. if it achieves the desired improvement of situational control. Therefore, the entire design cycle (including system specifications) is considered rather than merely the evaluation process. The “V” design cycle, which is commonly used in the automotive industry, is extended by including the different steps of the evaluation process (Figure 2-3). The workflow is based on CONVERGE, the evaluation methodology used in the PReVENT subprojects, and the experiences of APROSYS and AIDE. The different evaluations go through similar steps:

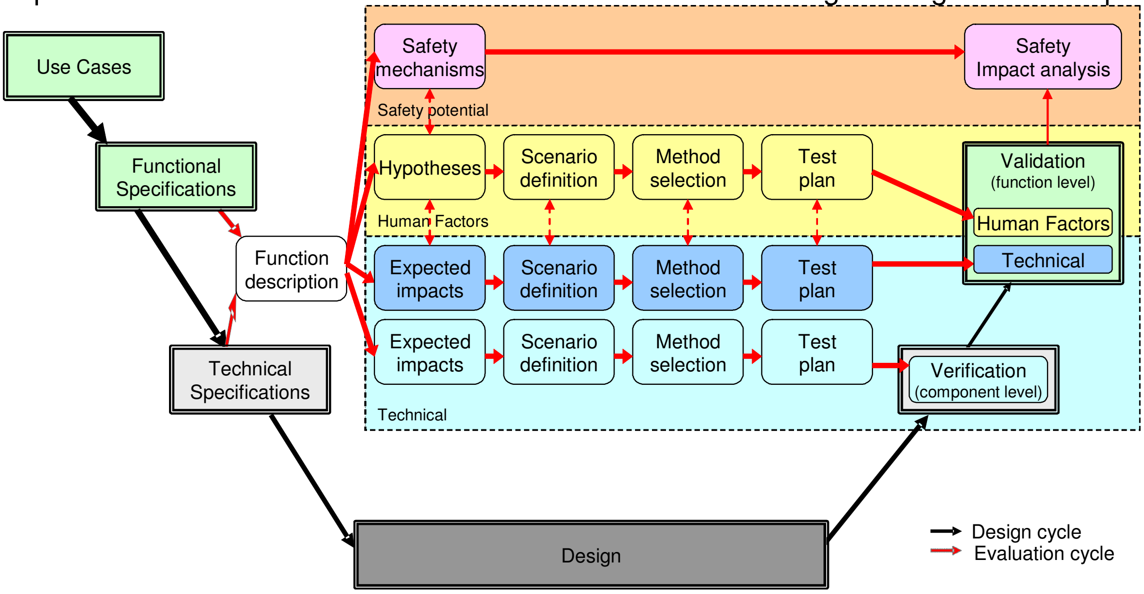


Figure 2-3 Adapted V-shape design and evaluation cycle, showing the relation between technical, human factors and safety potential evaluation and the different steps in the evaluation processes

1) *System and functions description*: a function description is normally the first document produced before the functional specifications, but may not be available to the evaluators and not include all needed information or updates made during development. At the start of the

validation, a sufficiently detailed function description needs to be available, which is common for all assessments and done in a consistent way to assure that all information needed for developing the evaluation plan is available and that similar systems can be compared.
2) *Expected impacts*. For technical evaluation, this step involves describing the technical objectives of the system in such a way that it is possible to evaluate the performance of the system. For human factors evaluation, this step involves generating hypotheses on how the system can be expected to change the driving behaviour in the target situations. This step includes definition of indicators for measuring relevant aspects of system performance in the target situations.
3) *Test Scenario definition*. In order to verify the expected impacts and hypotheses, test scenarios are defined for the different evaluations. The scenarios are specified through a description of the manoeuvres, operational conditions for the tests and the parameters of the target objects for detection.
4) *Evaluation method selection*. The selection of the evaluation method depends on desired level of result quality as well as availability of resources. The range of methods available include inspection methods (e.g. expert panels), inquiry methods (HMI concept simulators, simulator studies, Computer Aided Engineering methods including hardware-in-the-loop simulations), and trial methods (professional or test drivers on test track, roads or in driving simulator).
5) *Measurement plan*. The test plan specifies the number of tests and the definition of independent and dependent variables. The goal should be to get statistically significant answers for all hypotheses under evaluation.
6) *Execution and reporting*. The verification and validation tests are executed, data are analysed and conclusions are drawn.

[http://www.prevent-ip.org/en/prevent_subprojects/horizontal_activities/preval/]

2.6 TRACE

TRACE is a STREP of FP6 funded by the European Commission (DG Infso). It brings together 21 institutes, full partners or sub contractors coming from 8 countries. The project started in January 2006 and was completed in June 2008. The project coordinator is Yves Pages, Deputy Director of the LAB (LAB, GIE RE PSA RENAULT (LAB)).

TRACE has two major objectives. The first one addresses the determination and the continuous up-dating of the aetiology (i.e. analysis of the causes) of road accidents and injuries, and the definition of the real needs of the road users as they are deducted from accident and driver behaviour analyses. The second aim investigates the impact of advanced safety functions on reducing several types of accidents involving passenger cars or mitigating accident consequences:

1. Assessment of safety systems, on passenger cars, before the systems are on the market (a priori effectiveness). This objective has been broken down into three main challenges:
    a. predict the benefits of the safety systems,
    b. give reliable results for future (not yet introduced in the market) safety functions,
    c. define the constraints the safety systems will have to cope with in order to fulfil not only the drivers' needs but also to compensate the characteristics of the situations in which these needs are met.
2. Assessment of the benefits of safety functions once the cars are equipped with existing functions (this is the so-called posterior effectiveness).

TRACE proposes three kinds of models for assessing the safety benefits of technology:

Evaluation of the safety benefits of non existing safety functions: The Drivers' needs approach

A first step of analysis qualitatively defines and quantitatively assesses the **Drivers' Needs** as they are expressed in accident situations. The analysis of these needs is based on the characterization of human functional failures (perceptive, cognitive or active) found in accidents. Most of accidents reveal a difficulty that the driver was not able to compensate for. These human difficulties reversely show the needs of the drivers to be helped. Though, these needs are to be defined from a diagnosis of the real problems that drivers met in accidents.
A second step of analysis defines the characteristics of the safety functions examined in TRACE project and gives an assessment of the **Adaption of the safety functions to drivers' needs**, i.e. their potential capacity to address the needs of the drivers stated in the previous step. It is aimed at estimating the potential efficiency of safety functions under the hypothesis they were equipping the vehicles.
A third step stresses the potential **Contextual Limitations** which could lessen the optimal functioning of the safety systems. These potential limitations are defined from the parameters characterizing the context in which real accidents occurred, showing some essential constraints to take into account in order to optimize the adaption of the systems to effective accident situations. These potential limitations encompass the whole characteristics of both the drivers (internal context) and his driving environment (external context).
A forth step looks at the **Response Efficiency** of the safety functions, i.e. their capacity to compensate for Contextual Limitations diagnosed in the previous stage and by so to tackle the potential limitative impact of these contextual parameters. Such an analysis allows defining lacks and weaknesses in each function and consequently put forward the specifications on which to progress for optimal safety efficiency.
A fifth step of analysis gives a comprehensive result of all previous ones. It stresses the **Safety Effectiveness** of the safety functions. This safety effectiveness is defined as the combination of the adaption of the safety functions to the needs and their response efficiency in compensating for the contextual limitations found in accident situations. The results allow defining which functions are the most promising in a safety purpose but also which drivers' needs are more or less compensated.

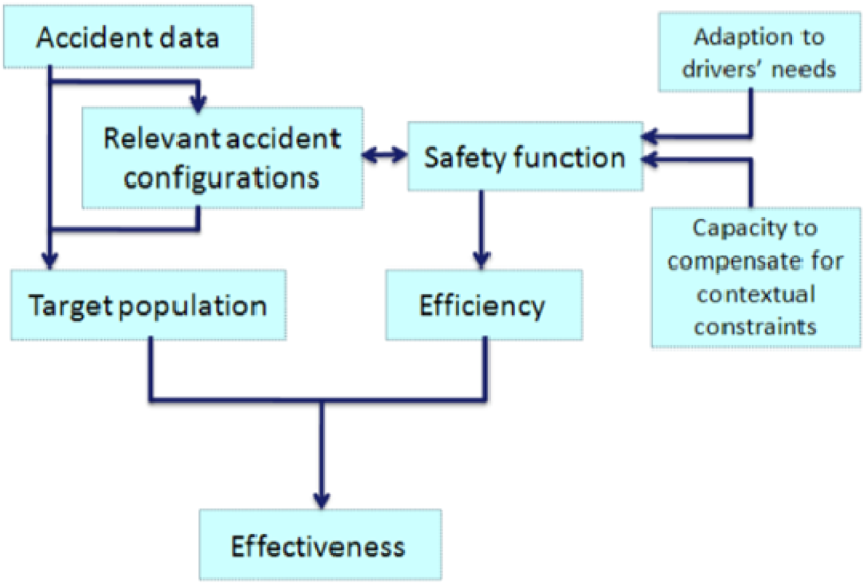


Figure 2-3 Assessing the safety benefits of technology

Evaluation of the safety benefits of non existing safety functions: The life saving approach

Different methods have been applied and different data have been used. The target population method (calculating only the proportion of crashes addressed by the function) is used only for cases where this population is low and does not imply full calculation effectiveness. Neural Networks are used to investigate the impact of primary safety functions on restriction of accident consequences. The proposed approach investigated the effectiveness of several safety functions on different accident configurations by estimating the influence of each safety function on different accident parameters. The evaluation is performed in terms of assessment of the potential proportion of accidents whose severity could be reduced for each safety function. Other methods are chosen according to the function under study, availability of data and relevance of the method.

Evaluation of safety benefits for existing safety functions: Statistical Methodologies
It was intended to evaluate each possible safety function. Nevertheless, as several systems are on board at the same time on the same vehicle, it is of major interest to assess the overall benefit of adding one or two safety functions. For example, it might be interesting to calculate the safety benefit of having an ESC (Electronic Stability Control) and an EBA (Emergency Brake Assistant) compared to having none of these systems. Doing so, it is then possible to estimate the benefit of the combination of active safety function and passive safety function altogether. The benefit of a safety function can be expressed as a percentage of avoided injury accidents due to the presence of the safety function. As the safety function may not be able to avoid the crash but to mitigate the injury severity sustained by the passengers or the colliding road user, the benefit of the safety function also needs to be expressed as a percentage of reduction or injured car occupants at a certain level of injury severity.

The methodology for evaluating the safety benefits of a package of safety functions is an extension of the methodology applicable for the evaluation of a single safety function. It relies on the comparison of two groups of vehicles: one group of vehicles equipped with the safety functions of interest and one group not equipped with these safety functions. The proportions of these two sets of vehicles in neutral accidental situations (situations for which the systems have no effect) and in the sensitive accidental situations (situations for the system is supposed to produce effects) are observed in the accident database.
[www.trace-project.org]

2.7 eIMPACT

eIMPACT is part of the EU's FP6 for Information Society Technologies and Media and will run for two and a half years until July 2008. The consortium is led by TNO and comprises 13 partners that represent OEMs, research institutes and universities, encompassing many EU states.

The eIMPACT project assessed the socio-economic effects of Intelligent Vehicle Safety Systems (IVSS) and their impact on traffic, safety and efficiency. Twelve Intelligent Vehicle Safety Systems (IVSS) have been evaluated and results have been provided in quantitative impact on safety, traffic and cost-benefit effects. eIMPACT also provided perspectives on the market introduction of IVSS in forms of realistic penetration rates in 2010 and 2020.

Many of the IVSS considered were future systems. Therefore there is not much empirical evidence on the effectiveness and efficiency of these systems. An impact assessment approach was developed and implemented within the project covering:

- The estimation of penetration rates (passenger cars, goods vehicles) using information on current fleet composition and mileage as well as information on the (expected) market acceptance of systems.
- The assessment of traffic impacts (direct traffic impacts on the traffic flow e.g. changes in speeds and indirect traffic effects in terms of reduced congestions).

- The assessment of safety impacts. The approach covered intended and unintended effects of IVSS and looked at components of traffic safety analysis (exposure, risk of collision, risk of collision to result in injuries or killed).

The results from the impact assessment were used as input in the cost-benefit-analysis.

Figure 2-4 summarizes the approach within eIMPACT.

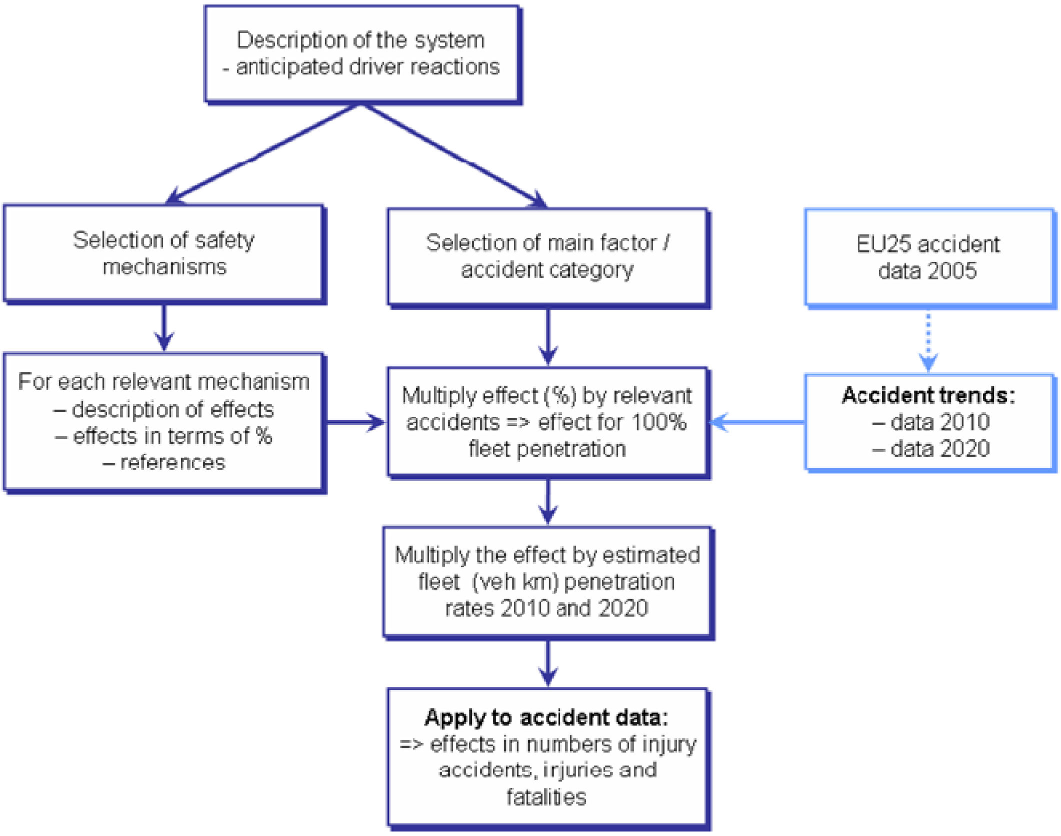


Figure 2-4 Safety impact analysis in eIMPACT

Coming from the description of systems nine safety mechanisms covering the dimensions of safety (exposure, crash risk and consequences) as well as the intended and unintended impacts have been created where the operating mode of a safety system can be related to.

These mechanisms are:

1. Direct in-car modification of the driving task
2. Direct influence by roadside systems
3. Indirect modification of user behaviour
4. Indirect modification of non-user behaviour
5. Modification of interaction between users and non-users
6. Modification of road user exposure
7. Modification of modal choice
8. Modification of route choice
9. Modification of accident consequences

Which safety mechanism or which combination of mechanisms is operative in every particular safety system was determined by expert judgment. Also what kind of effect the mechanism or the combination of mechanisms has got on the event of the accident. The effect (decrease or increase) was indicated in percentage. Afterwards these effects were transfused to a coefficient of efficiency. The multiplication of all coefficients relevant for a certain system then results in the total average effect.

Simultaneously the main accident categories (vehicle type, collision type, road type, weather condition, light condition, junction) have been selected and the frequency of target conditions has been identified in the accident data. For the lack of needed accident data this data was collected directly from individual EU member states in close co-operation with the TRACE project. The safety impact of every system for 100% fleet penetration was calculated by multiplying the coefficient of efficiency by the number of relevant accidents identified in the accident data. Furthermore an estimation of penetration rates 2010 and 2020 has been calculated to determine the effect for the future years. Applied to accident data the effect was determined in terms of numbers of injury accidents, injuries and fatalities.

[www.eimpact.info]

2.8 CHAMELEON

CHAMELEON is an EC promoted project considering the link between preventive (or active) and passive safety. The main objective of the project is the development of an innovative pre-crash system that is able to identify an imminent collision. This information is disposable to different passenger protection systems to improve their safety. An essential part of the project is the development of suitable test methods for assessment and further development of the system.

The aim of the CHAMELEON project is to support, direct and validate the development of a pre-crash sensorial system to detect imminent impact in all types of scenarios (urban, rural and motorway).

- „Support“ means defining common criteria for system requirements
- „Direct“ means producing common guidelines on the European level for the evaluation and approval of systems
- “Validate” means verifying a prototype of the complete system in real-life situation, even if in a controlled environment

The structure of the project is as follows:

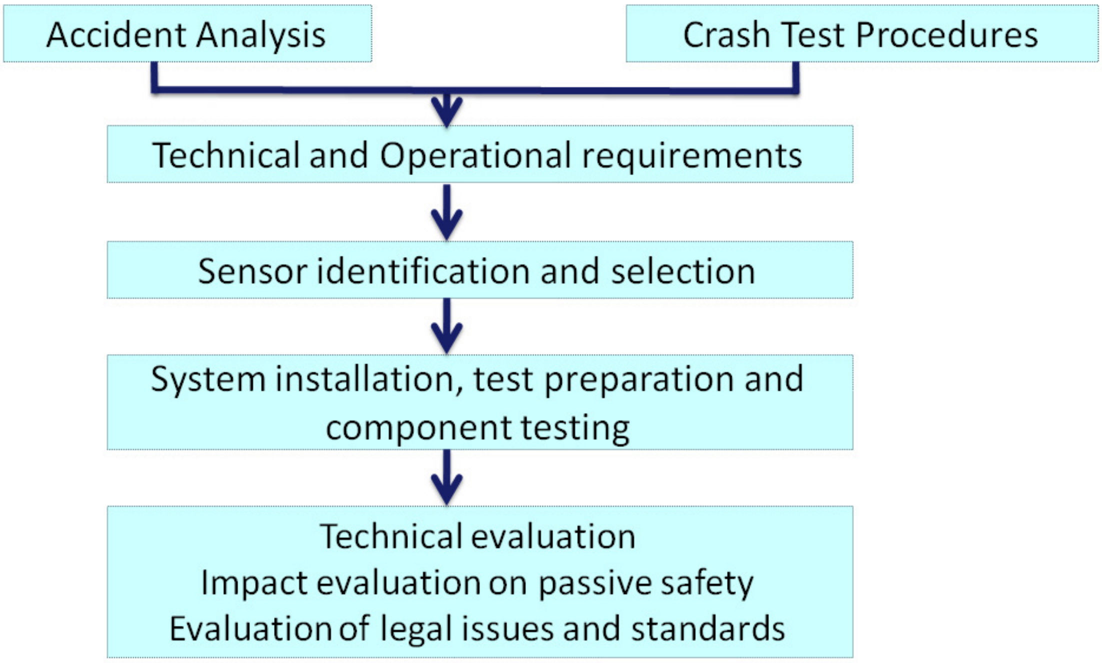


Figure 2-4 Structure of the CHAMELEON project

The accident/crash test procedure investigation and the definition of scenarios are of special interest for ASSESS.
Some accident scenario had to be defined in order to study the dynamic behaviour of the vehicle and define the sensorial system specification.

The scenario shall consider the following parameters:
- Relative direction of the collided object (angle with the trajectory of the equipped car)
- Size and type of the colliding vehicle
- Environment
- Speed of the equipped car
- Speed of the colliding vehicles
- Overlapping or area of impact

Basic CHAMELEON scenarios
Looking at the system the most important thing of the test program is to show that the system works error free under all boundary conditions. In the first phase of investigation it was not possible to check the system in every imaginable traffic situation and boundary condition. The boundary conditions for the CHAMELEON-system operation were fixed to dry weather conditions. Of course in particular bad weather conditions as rain, fog, etc. can influence the sensors of the CHAMELEON-system in their detection behaviour. Taking into consideration that a high number of accidents are happening under good weather conditions this restriction was considered acceptable in CHAMELEON.

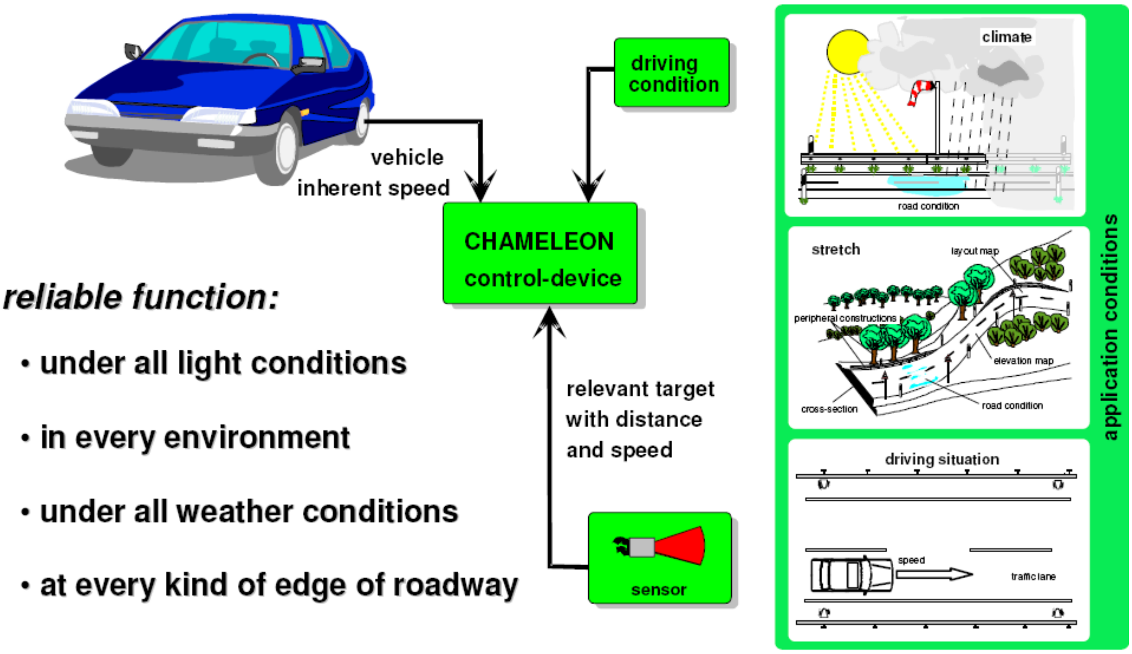


Figure 2-5 Boundary conditions for sensor operation

A very important topic was the definition of the accident scenarios between two vehicles or a vehicle and other obstacles. From the accident analysis it was investigated the most frequent accident scenarios for the simulation of the CHAMELEON system. These seven different categories of accident scenarios can be used as well as a basis for the testing of the CHAMELEON system. The following pictures, sketch these so-called basic scenarios.

- Scenario A: Frontal collision (straight), varying overlapping and speed
- Scenario B: Frontal collision (inclined), varying overlapping and speed
- Scenario C: Frontal side collision, varying speed

- Scenario D: Lateral collision, varying speed
- Scenario E: Lateral collision with pole, varying speed
- Scenario F: Frontal collision with a fixed obstacle (pole), varying speed
- Scenario G: Frontal collision with a fixed obstacle (wall), varying speed

In all these scenarios the pre-crash system has to discriminate between a potential crash event and a harmless traffic situation.

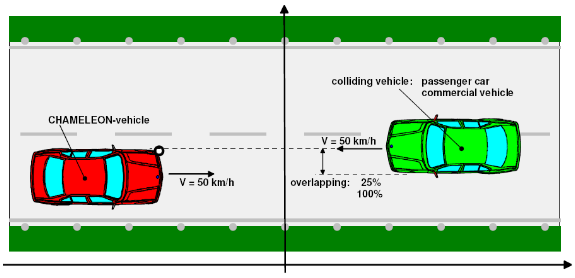


Figure 2-6 Frontal collision (straight)

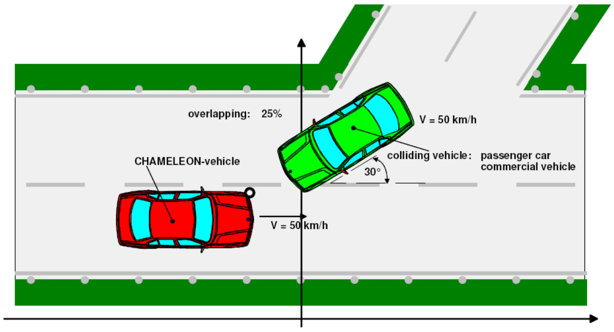


Figure 2-7 Frontal collision (inclined)

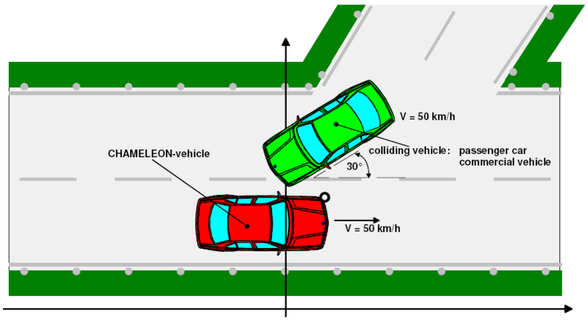


Figure 2-8 Frontal side collision

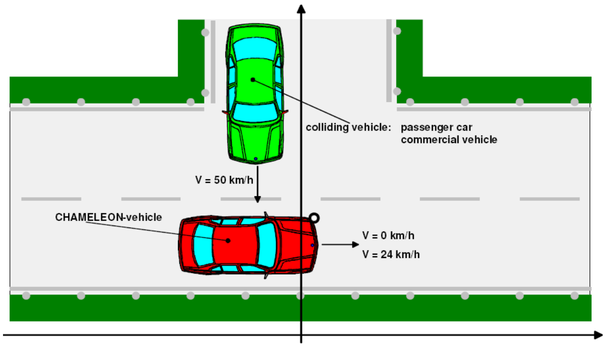


Figure 2-9 Lateral collision

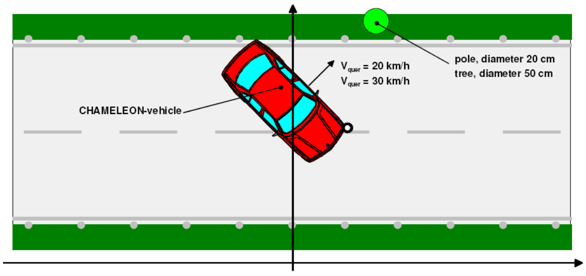


Figure 2-10 Lateral collision with pole

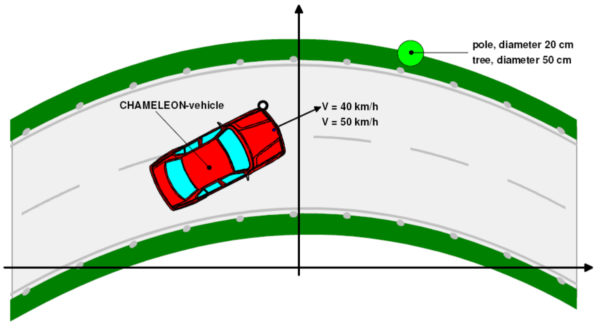


Figure 2-11 Frontal collision with a fixed obstacle (pole)

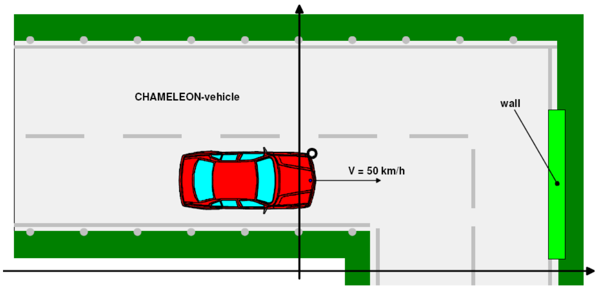


Figure 2-12 Frontal collision with a fixed obstacle (wall)

The CHAMELEON project - answered to the necessity of improving safety within the European roads through the development and adaptation of new components for the intelligent vehicles concept.
The problem covered by CHAMELEON concerns a very high share of accident, practically the totality of the accidents which cause damages to the drivers and passengers.

One of the most important aims of CHAMELEON was the establishment of a common approach and the pooling of resources through the collaboration between European car manufacturers, sensors suppliers and research institutes. Under this point of view, an added benefit raised from the outputs of the project, such as specifications and guidelines, which are transferable outside the project.

[www.chameleon-eu.org]

2.9 SAFETY TECHNOPRO

SAFETY-TECHNOPRO is a Specific Support Action (September 2006 – October 2008), funded by the European Commission Information Society and Media and coordinated by Centro Zaragoza.

SAFETY-TECHNOPRO aims to accelerate the development and use of intelligent vehicle safety systems (IVSS) / advanced driver assistance systems (ADAS). Therefore the mechanism of information transfer had to be identified and this knowledge was used to build up a training system. The needed information was gained by survey. Surveys were made on the user side and on the side of so called professional bodies. Professional bodies are groups working in car industry as: Sales persons working in car distributors, repair staff working in garages, vehicle inspectors working in technical vehicle inspection workshops. One survey was made gathering information directly from the end users, through an internet tool. The other survey was made gathering information directly from the professional bodies involved, through specific questionnaires, in order to know the opinions, if they are interested in receiving a specific training for selling or assessing to customers on safety.
In the project it was identified that a training system addressed to professional bodies of the automotive sector is the most efficient way to achieve maximum acceptance and awareness on new safety technologies for road transport by the end users. The need of improving the information level of end-users on these technologies is perceived as a key factor for a quicker and wider market deployment of them. The end-user opinion and acceptance on safety technologies is strongly influenced by the professionals so it is necessary to train these professionals to transmit to end user high quality information.
The result of the project was a training system prototype.

The structure of the project is illustrated in the following picture.

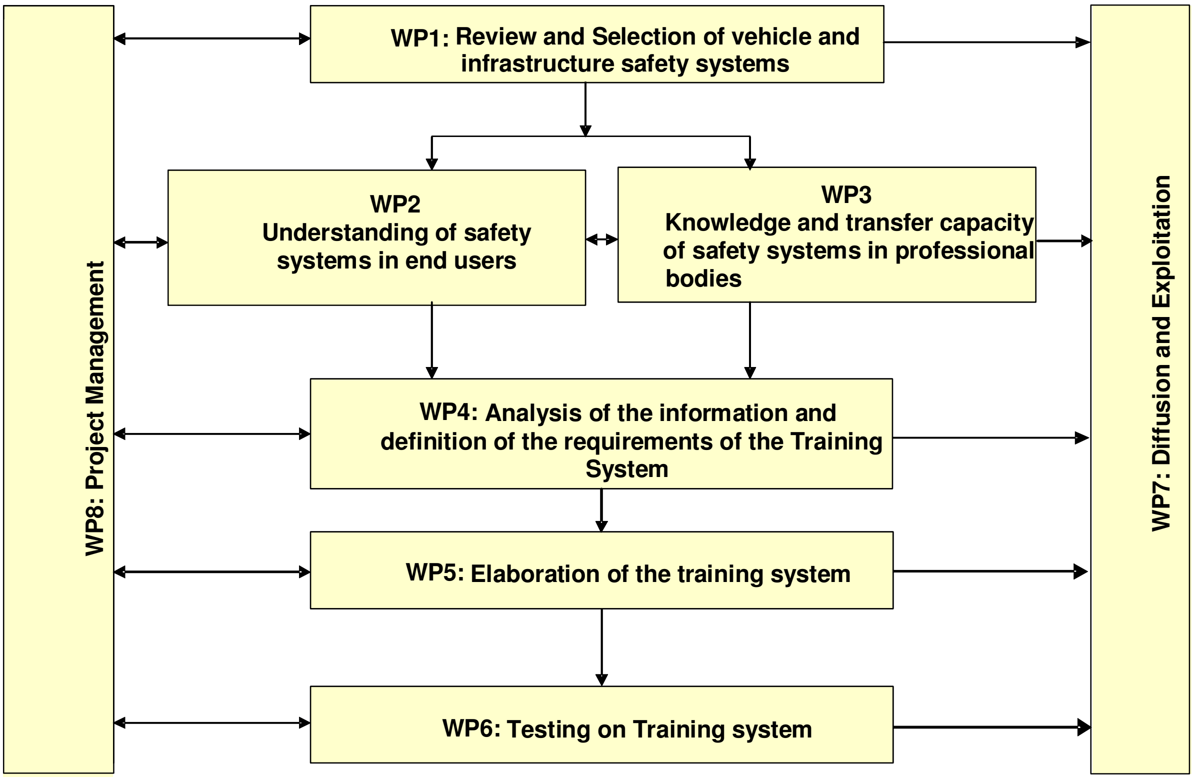


Figure 2-13 Structure of the SAFETY TECHNOPRO project

[www.safety-technopro.info]

2.10 eVALUE

eVALUE is a three years European research project "Testing and Evaluation Methods for ICT-based Safety Systems (eVALUE)" within FP7 which started in January 2008 (ICT Information and Communication Technologies). The main focus is to define objective methods for assessment of active safety systems like ASSESS. The project will address the real function of ICT-based safety systems and their capability to perform the function through two courses of action: defining and quantifying the function output to be achieved by the safety system and developing the testing and evaluation methods for the ICT-based safety systems.

The eVALUE methodology consists of three types of tests: design review, laboratory testing (components / human factors) and physical vehicle testing (full vehicle). For each of the tests the following two different approaches were discussed:

1. System approach. This approach targets on specific systems, i.e., the objective is to test the ICT-based system. Under eVALUE scope this approach is focused on the eight ICT-based safety systems, hence, eight design review tests will be defined (one design review per system considered).

2. Scenario approach. This approach targets not a specific safety system, but the complete vehicle driving in specific traffic scenarios, derived from an analysis of accident data statistics together with the relevance of the considered ICT-based safety systems. The main difference with the system approach is that within this approach several systems, and combination of systems are considered when working together in a certain situation.

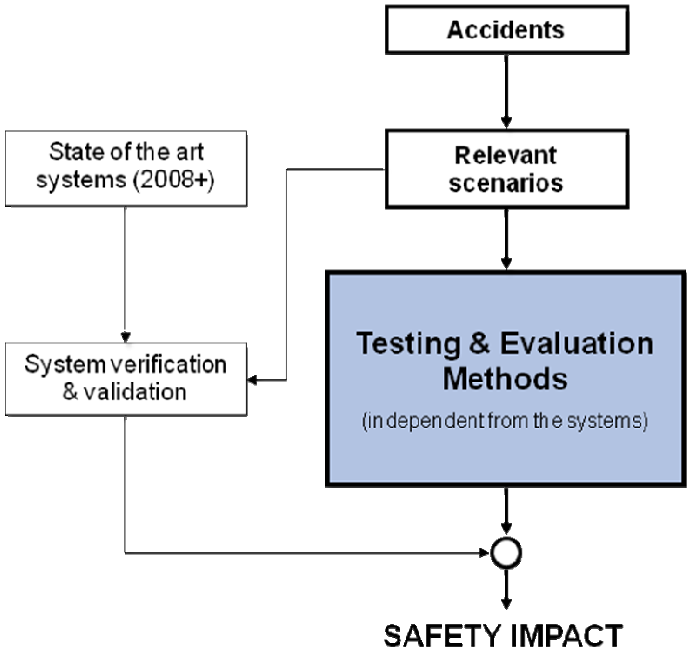


Figure 2-14 eVALUE approach

For the laboratory and physical tests the scenario approach was chosen. Laboratory tests are divided into system performance and human factors testing in a driving simulator, and are carried out on a static environment. It is meant to identify and determine the concepts, requirements, specifications and limitations of the safety systems and components in the subject vehicle, in order to create a set of valid test procedures for the physical vehicle tests.

Physical tests are based on real accident scenarios and validate the complete vehicle's performance. 14 scenarios were selected for physical tests based on existing accidents statistics (National Statistics and European projects, such as TRACE and PReVENT), the state of the art (knowledge on current ICT-based safety systems), international standards (NHTSA and EURONCAP) and the experience of the consortium. Scenarios are grouped into the following three clusters:

1. Functional safety of the subject vehicle on a longitudinal control basis
2. Functional safety of the subject vehicle on a lateral control basis
3. Functional safety of the subject vehicle on a stability control basis

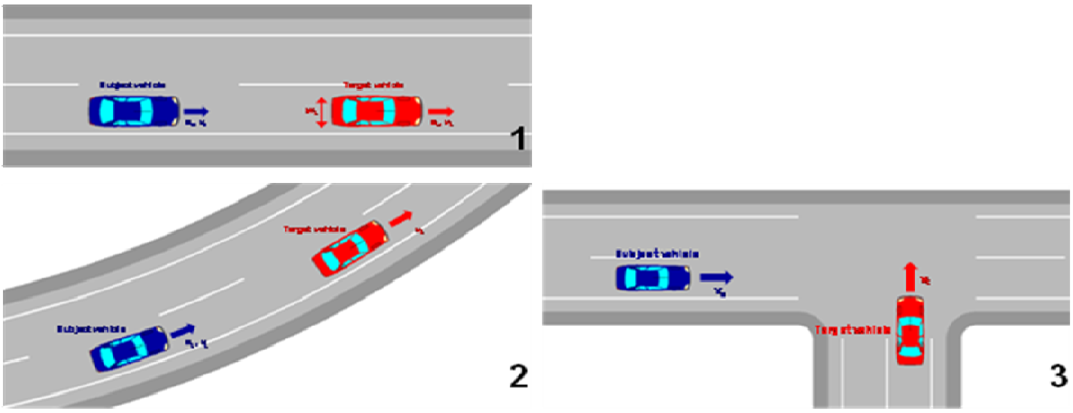


Figure 2-15 Longitudinal scenarios (1 straight road, 2 curved road, 3 transversally moving target)

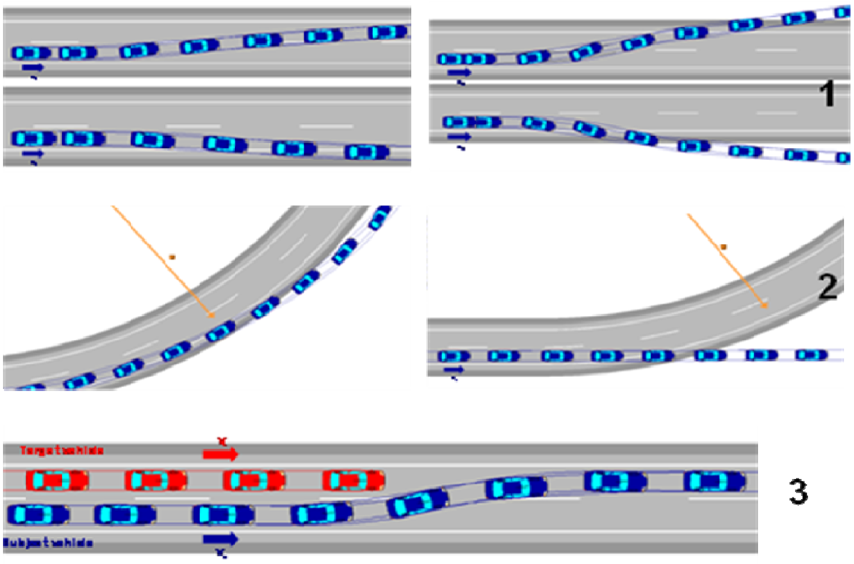


Figure 2-16 Lateral scenarios (1 lane and road departure on a straight road, 2 lane and road departure on curve/on a straight road just before a curve, 3 lane change collision)

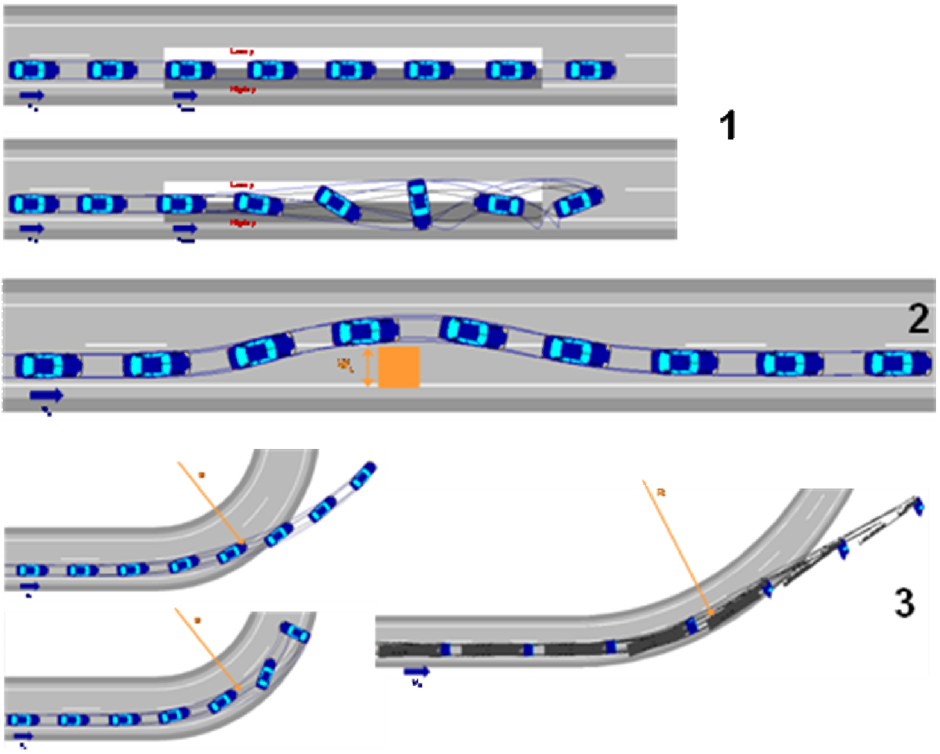


Figure 2-17 Stability scenarios (1 emergency breaking on μ-split, 2 driver collision avoidance, 3 fast driving into a curve / roll stability)

[http://www.evalue-project.eu]

2.11 Conclusions from previous projects

The review of previous projects provided a large overview of activities concerning the research in terms of integrated safety. The most promising assessment method for ASSESS is probably close to the approach defined by APROSYS. Unfortunately only some of the previous projects did perform relevant accident analysis, in particular TRACE and eIMPACT. A complex accident data collection and compilation was conducted in close co-operation with both projects. The analysis of accident data on EU level in most cases represents an enormous challenge due to data availability and compatibility. The CARE database unfortunately does not provide sufficient details on the required variables so a reasonable use of this database within ASSESS is not possible. Therefore ASSESS could benefit from the work that was done within eIMPACT and TRACE and could use their data for an overview on the event of the accident on EU level.

Furthermore the projects, including accident analysis, generally did not define detailed scenarios. One good example for a detailed scenario definition is the CHAMELEON project, but in this case the assessment was done on a prototype car equipped with available sensors on the market. The project SAFETY TECHNOPRO did not assess the systems' technical performance but the systems' acceptance by the user and the possibilities of an easier market introducing. The approach of ASSESS to provide test procedures on certain accident scenarios including concrete tests on already on the market available cars is completely new. As input to ASSESS from the previous projects, the accident analysis from eIMPACT, the scenarios from CHAMELEON, and the assessment method flow chart from APROSYS seem to be the most useful information. This input and the results from the WP 1 accident analysis can be combined to a solid basis for the later ASSESS WPs.

2.12 Naturalistic Driving Studies (NDS) and Field Operational Tests (FOT)

Pre-crash accident configurations are the least documented in available accident databases. However, one way to assess information on driver behaviour and vehicle conditions prior to crashes, near-crashes and critical incidents is to examine Naturalistic Driving Studies (NDS) and Field Operational Tests (FOT). The main aim of NDS is to gather data from drivers during real driving conditions over a period of time by recording data from vehicle sensors and video cameras. The main aim of FOT studies is to validate intelligent vehicle systems by using the naturalistic methodology.

The difference between FOT design and designed experiments lies in its naturalism, or lack of control over the majority of test conditions. Participants will drive the equipped vehicles in place of their personal cars or work vehicles, going wherever, whenever, and however they choose. The driving is thereby largely unmanaged by the research team. Thus, experimental control lies only in the commonality of the test vehicles that are driven, the sampling plan through which drivers are selected, and the types of data obtained for documenting the experience.

Below follow an overview of the 100-car naturalistic driving study, the Integrated Vehicle-Based Safety Systems (IVBSS) Field Operational Test, the Sweden Michigan Field Operational test (SeMiFOT), the large-scale European Field Operational Test (euroFOT) and a discussion on how to use the results for ASSESS purposes.

2.12.1 100-car naturalistic driving study

The 100-car study (Dingus et al., 2006) is an influential large-scale naturalistic driving study that was conducted by Virginia Tech Transportation Institute (VTTI). The study was carried out with the goal of acquire details concerning driver performance, behaviour, environment, driving context and other factors that are associated with crashes, near-crashes and critical incidents.

Data from 100 cars were collected across a period of 12-13 months. The study included, in total, 241 drivers and the drivers' age ranged from 18 to 73 years. Five channels of video were recorded in the study: forward, face/left, right, coupé and rear. Vehicle state and kinematic data were recorded from a network of sensors distributed around the vehicle: front and rear radar sensors, accelerometers, lane tracker, GPS and vehicle speed sensor. Data was collected continuously and it was therefore possible to fine-tune the trigger criteria (e.g. fine tune the thresholds for lateral and longitudinal acceleration and time to collision) to be able to filter out the most relevant events from the data. For each trigger criteria that was fulfilled a 90-second video clip was extracted – one minute prior and 30 seconds after the trigger. The events were viewed and manually coded by analysts. The analysts used a coding scheme, which included variables regarding driver performance, behaviour, environment, driving context and other factors that are associated with critical events. The most important variable to code was the severity of the event. Hence, each safety-related conflict was classified as one of the following:

- Crash: Any contact with an object, either moving or fixed, at any speed, in which kinetic energy is measurably transferred or dissipated. Includes other vehicles, roadside barriers, and objects on or off the roadway, pedestrians, cyclists or animals.
- Near-crash: Any circumstance that requires a rapid, evasive manoeuvre by the subject vehicle, or any other vehicle, pedestrian, cyclist, or animal to avoid a crash. A rapid, evasive manoeuvre is defined as a steering, braking, accelerating, or any combination of control inputs that approaches the limits of the vehicle capabilities.
- Incident: Any circumstance that requires a crash avoidance response on the part of the subject vehicle. Or any circumstance resulting in extraordinarily close proximity of the subject vehicle to any other vehicle, pedestrian, cyclist, animal, or fixed object where, due to apparent unawareness on the part of the driver(s), pedestrians, cyclists or animals, there is no avoidance manoeuvre or response.

All data on crashes, near-crashes and incidents were gathered in an event database. According to Dingus et al. (2006) this database contains many extreme driving cases on drowsiness, impairment, judgement error, risk taking behaviour, secondary task engagement, aggressive driving, and traffic violations.

Approximately 2000000 vehicle miles (≈3200000 km) of driving were collected. The following safety-relevant conflicts were found in the data:

- 15 police-reported and 67 non-police-reported crashes
- 761 near crashes
- 8295 incidents

Nearly 80 percent of all crashes and 65 percent of all near-crashes involved driver inattention (i.e. drowsiness, driving-related inattention to the forward roadway, secondary task engagement, or nonspecific eye glance away from the forward roadway) just prior to the onset of the conflict. In addition it was found that inattention was a contributing factor to 93 percent of the rear-end crashes. Most of the near-crashes involving conflict with a lead vehicle occurred while the lead vehicle was moving, whether all crashes occurred when the lead vehicle was stopped. In 86 percent of the rear-end-striking crashes, the headway at the onset of the event was larger than 2 seconds. The rate of inattention-related crashes and near-crashes decreased dramatically with age – it was four times higher for the youngest age group (18-20 years) than the older age groups. In addition, judgement error, secondary task engagement in high risk situations, aggressive driving and driving while impaired was much more common in the youngest age group than the older age groups. The use of hand-held wireless devices was associated with the highest frequency of secondary-task distractionrelated events. Drowsiness was a contributing factor in 12 percent of all crashes and 10 percent of the near-crashes.

2.12.2 Integrated Vehicle-Based Safety Systems (IVBSS) Field Operational Test

The Integrated Vehicle-Based Safety Systems (IVBSS) FOT is a four-year, two-phase cooperative research program being conducted by an industry team led by the University of Michigan Transportation Research Institute which started in November 2005. The main goal is the assessment of safety benefits and driver acceptance associated with a prototype integrated crash warning system designed to address rear-end, road departure, and lane change/merge crashes.

The report “Development of Crash Imminent Test Scenarios for Integrated Vehicle-Based Safety Systems (IVBSS)” recommends a basic set of crash imminent test scenarios for integrated vehicle-based safety systems designed to warn the driver of an impending rear-end, lane change, or runoff- road crash [DOT HS 810 757]. The scenarios are selected based on the U.S. 2000-2003 General Estimates System (GES) crash databases.

The scenarios are divided into the following categories:
- Rear-end crash threat scenarios
- Lane change threat scenarios
- Road departure crash threat scenarios
- Multiple-threat scenarios
- No-warn threat scenarios

However, these detailed test scenarios and specifications, together with performance metrics, and pass/fail criteria for determining system repeatability and robustness, are part of verification tests which served to demonstrate the effectiveness, repeatability, and general readiness of the developed IVBSS prototypes for field operational testing. That means that these scenarios are developed to verify that the combined prototype system satisfies key performance specifications and not to validate and assess safety benefits. System validation will be done in the following FOT phase.

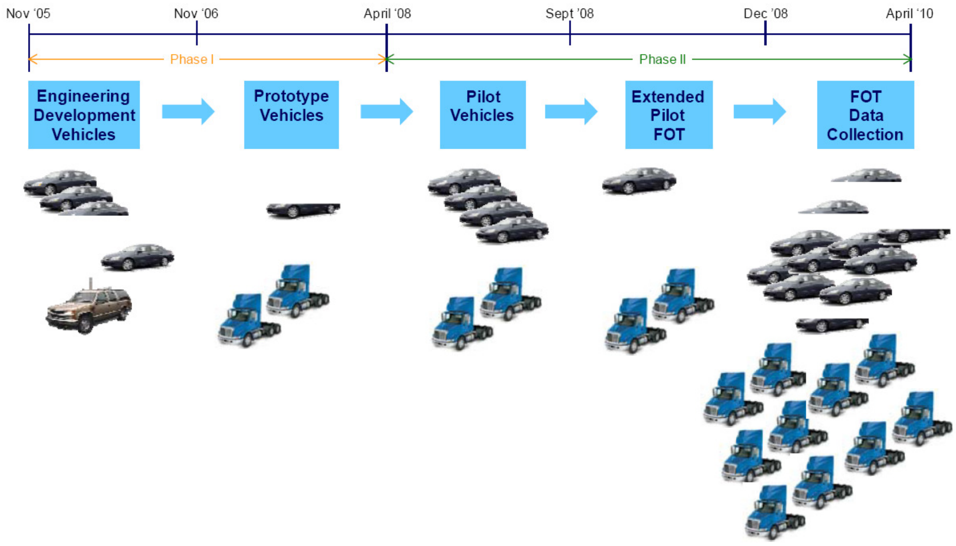


Figure 2-18 Two consecutive phases of the IVBSS FOT programme

2.12.3 Sweden Michigan Field Operational test (SeMiFOT)

The Sweden Michigan Field Operational test (SeMiFOT) is a joint project between 15 partners in Sweden and the United States. SeMiFOT is a methodological study focusing on the tools in the methodological chain needed to perform a FOT. The project started in January 2008 and ends in December 2009.

When the project ends data have been collected for each vehicle across a period of about one year. SeMiFOT includes a test fleet consisting of 18 vehicles – 11 cars and 7 trucks – running in Sweden. In total about 40 drivers are included. Six channels of video are recorded: forward, face, a cabin view that captures the driver's actions, two cameras with a 90° field of view mounted with some overlap giving about 160° field of view forward, rear camera (cars only) and blind spot camera (trucks only). The face camera is part of the eye-tracking system. Data from the Controller Area Network (CAN) of the vehicles, external accelerometers and GPS is recorded.

Since the project is still ongoing results are not available yet. However, analysis is made on: crash relevant events (i.e. crashes, near-crashes and incidents) with and without a safety system active, visual behaviour when using a system, usage of the systems and acceptance-related issues.

[https://www.chalmers.se/safer/EN/projects/traffic-safety-analysis/semifot]

2.12.4 Large-scale European Field Operational Test (euroFOT)

The large-scale European Field Operational Test (euroFOT) is a four years European project within FP7 which started in May 2008. The general objectives of euroFOT are to assess the impact from the usage of Intelligent Vehicle Systems in real traffic, and therefore to obtain indications for the deployment of ICT technologies for a safer, cleaner, and more efficient transport system in Europe.

The following approaches will characterise the operation of the planned tests within the euroFOT project:

- Tests based on normal driving: data will be collected from drivers using their personal or normally used vehicle. Travels will be free and no supervisor will be present.
- Comparison to a baseline: the project will observe parameters related to safety, economy, and efficiency according to an experimental design. This allows a comparison between baseline conditions with the system off, and a specific treatment with the system on.
- Focus on users: driving motivations will be evaluated as an additional input.
- Robust data acquisition and management: the FOTs will develop methods for permanent acquisition and transmission of data to a data centre.
- Harmonised approach based on a general definition of methodologies for conducting and evaluating the tests.
- Objective and subjective evaluation, including the analysis of use-patterns for the systems.

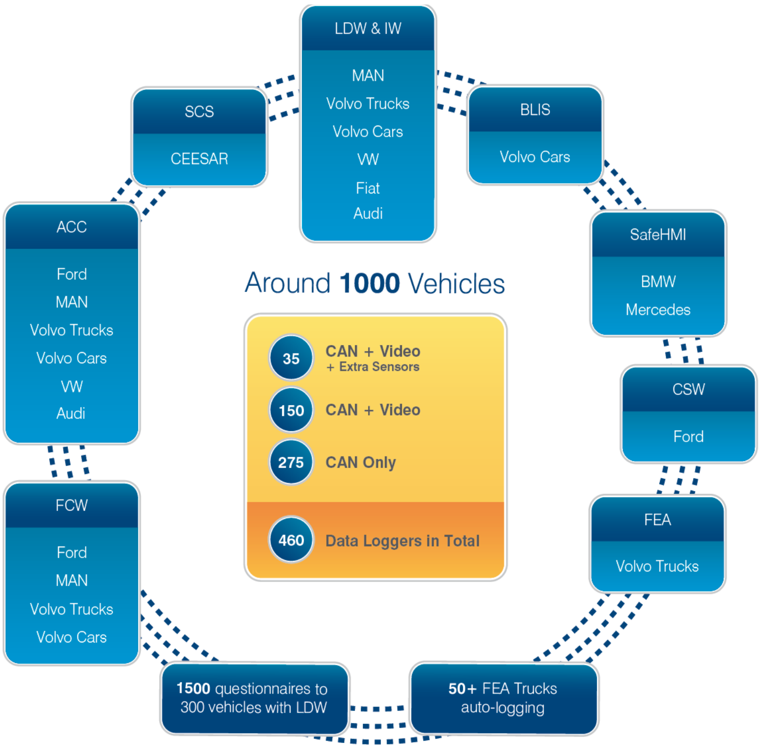


Figure 2-19 euroFOT functions and vehicles

[http://www.eurofot-ip.eu/]

2.12.5 Contribution of FOT data

FOT studies can be used to study the driver and vehicle conditions prior to a crash, near-crash or incident. By analysing FOT data normal driving behaviour can be investigated in terms of e.g. usual TTC (Time to Collision) values, distance to leading vehicle, or relative speed. That can be used for the evaluation of test scenarios and to see how representative the scenarios or use cases for real driving situations are. Accident data bases show only a small section of real world of driving.

By comparing accident causation with normal driving behaviour possible contributing factors can be verified. E.g. short TTC and inattention are considered as the causation of an accident but looking into FOT data could reveal that inattention in terms of x% “eyes of road” is present in 80% of all trips and is not a contributing factor as itself but only in combination with short TTC.

Other contributing factors could be detected by checking accident type related incidents with respect to driver behaviour, vehicle performance and environment. Thus systems can be checked: Do they act on right contributing factor and causation (e.g. do they warn only at inattention and short TTC but only at inattention which could annoy the driver and lead to less acceptance of the system which results in a lower take rate and finally in lower total safety effects of a system. Also the more technically oriented “false alarm rates” are contributing factors in terms of user acceptance and could be assessed with respect to system performance.

FOT data can therefore potentially contribute to scenario definition by:

- investigating normal driving

- verification of contributing factors (driver behaviour, vehicle performance, environment) by comparing related incident to accident causation and therefore possible to check if the system act on the right causation.

While analysis results of previous FOTs are available for most of the projects (reports of 100 car study and IVBSS) real FOT data are so far only available from SeMiFOT (for cars) including video data (160° forward view, 90° rear-end view, driver face, cabin), eye tracking data as well as data from external sensor systems (Mobil Eye) for e.g. distance to leading vehicle or lateral position. CAN data are available but divided into “open” and “close” data. Open data include steering wheel angle, yaw, acceleration long/lat, brake/gas pedal position, turn indicator, high beam activation, etc., while distance to leading vehicle, TTC, THW, lane position, system related data (system settings, warnings) are closed data.

3 Harmonisation and selection of European accident data

3.1 Accident data: comparing sources

In order to define preliminary accident types to be taken forward by the ASSESS project, it was necessary to obtain an appropriate sample of accident data. It was important that the accident sample used was both representative of European accidents, and contained accident details at the required level in order to successfully define the desired accident parameters. From a practical viewpoint it was difficult to fulfil both these criteria. Consequently, the approach taken was to consider accident data at a “high level” (national and European level) for representativeness, and also to consider in-depth data to obtain the required level of detail.

Obtaining accident data representing as many countries or regions of Europe as possible was also considered important. With reference to the previous research reviewed for this task, accident data was sampled from areas highlighted by eIMPACT to have a high (yellow) level of road safety (good road safety performance) (eIMPACT, 2008). In ASSESS the accident sample used for Task 1.1.was taken based on these areas, However, a task was initiated within Task 1.2 to perform a check on at least two countries which were rated by eIMPACT as “orange” (intermediate road safety performance) to provide a check that the accident types relevant for regions rated as “yellow” were also appropriate for other regions of Europe.

Figure 3-1 EU country clusters based on safety performance defined within eIMPACT (from eIMPACT, 2008 Figure 13). The cluster analysis took into account a number of chosen risk variables based on the number of fatalities in 2005.

3.1.1 Types of data

In order to define accident scenarios at the required level of detail, in-depth accident data is required. For this purpose, in-depth data from the UK and Germany was used. In addition to these data, national accident data from Great Britain and Sweden were used to provide a check that the findings of the detailed level were sufficiently representative of the larger population. There was also a wish to use the European accident database CARE for comparison.

3.2 Defining comparable data

3.2.1 Data sample

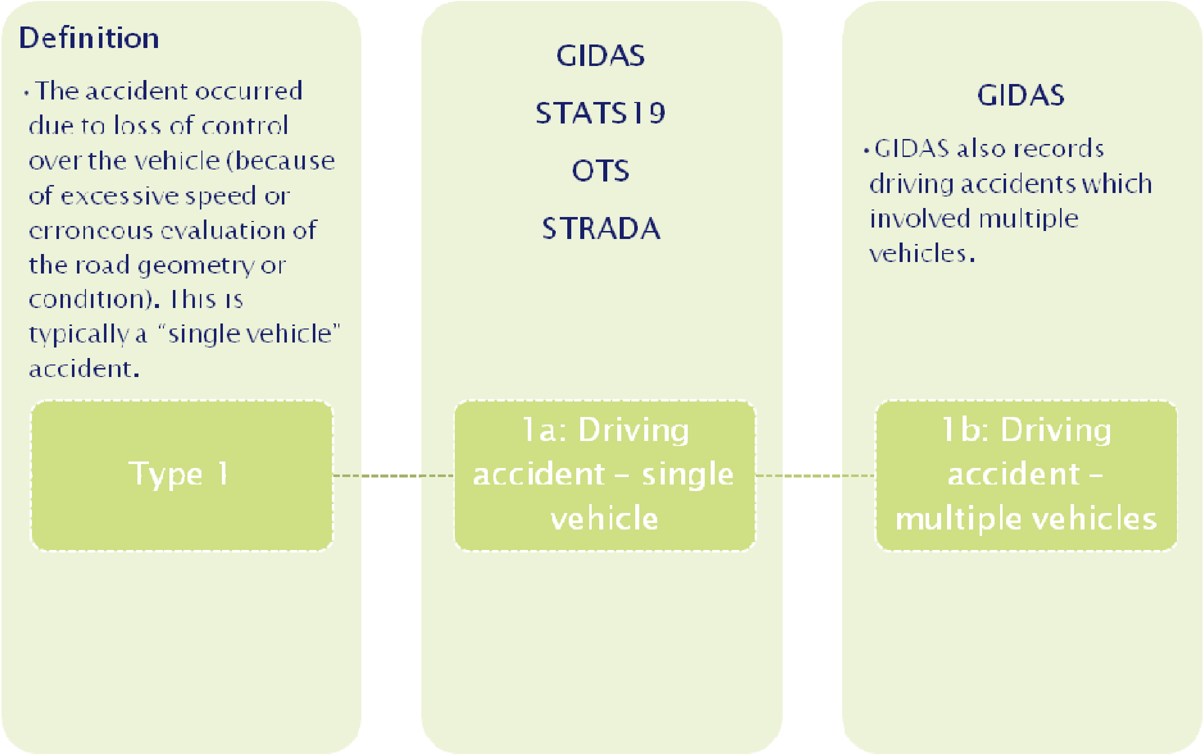
The ASSESS project is focusing on pre-crash sensing systems fitted in passenger cars therefore the data selected for analysis was ***injury accidents which involved at least one passenger car.***

3.2.2 Accident type definition

In order to compare the data, it was necessary to define a common classification which could be used to analyse and compare the different accident data samples. The accident types selected were based on those defined by SafetyNet WP5 (SafetyNet, 2008) (see extract of this report in Appendix 1). However, since the purpose of the analysis was to provide preliminary scenarios, only the first digit of the accident type was used to identify the type of conflict. This step was taken to attempt to find common categorisation criteria for all data sources. These accident (conflict) type groups can be summarized as:

- Type 1a: Driving accident – single vehicle
- Type 1b: Driving accident – multiple vehicles
- Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction
- Type 4: Accident involving pedestrian(s)
- Type 5: Accidents with parked vehicles
- Type 6a: Accidents in longitudinal traffic – same direction
- Type 6b: Accidents in longitudinal traffic – opposite direction
- Type 7a: Other accident type – single vehicle
- Type 7b: Other accident type – multiple vehicles

Type 1: Driving accident – single or multiple vehicle(s)



Definition

- The accident occurred due to loss of control over the vehicle (because of excessive speed or erroneous evaluation of the road geometry or condition). This is typically a "single vehicle" accident.

Type 1

GIDAS
STATS19
OTS
STRADA

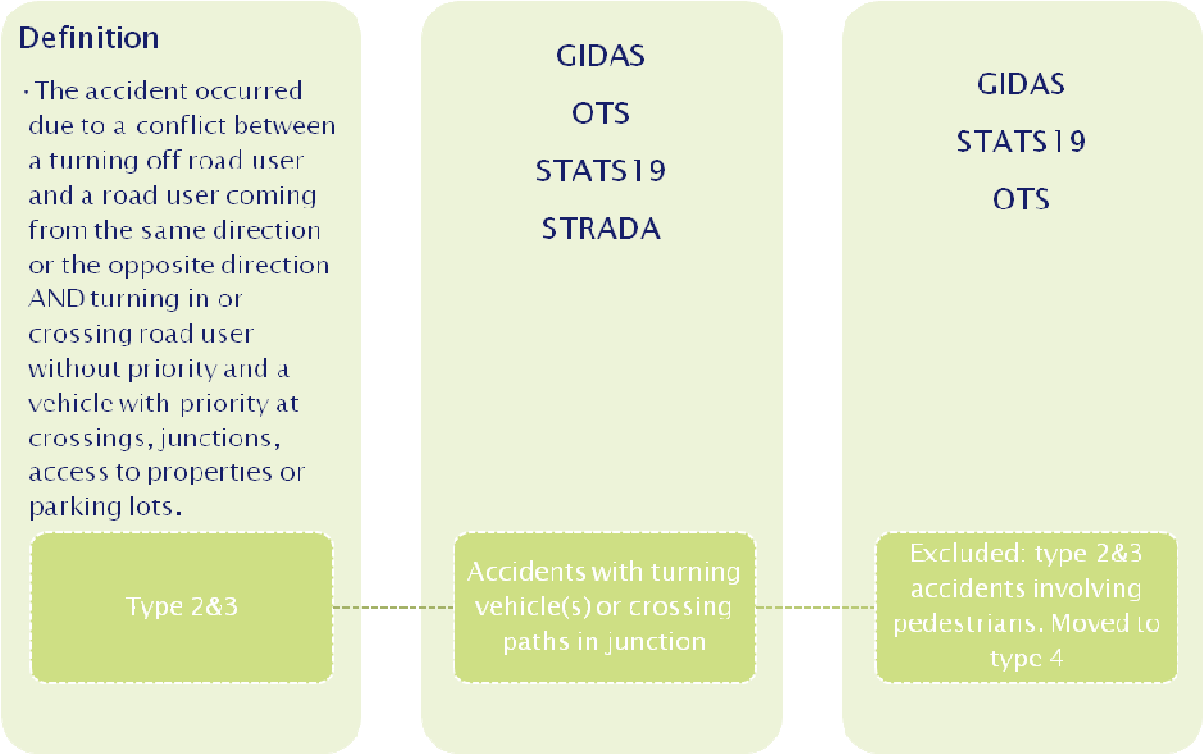
1a: Driving accident – single vehicle

GIDAS

- GIDAS also records driving accidents which involved multiple vehicles.

1b: Driving accident – multiple vehicles

Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction



Definition

- The accident occurred due to a conflict between a turning off road user and a road user coming from the same direction or the opposite direction AND turning in or crossing road user without priority and a vehicle with priority at crossings, junctions, access to properties or parking lots.

Type 2&3

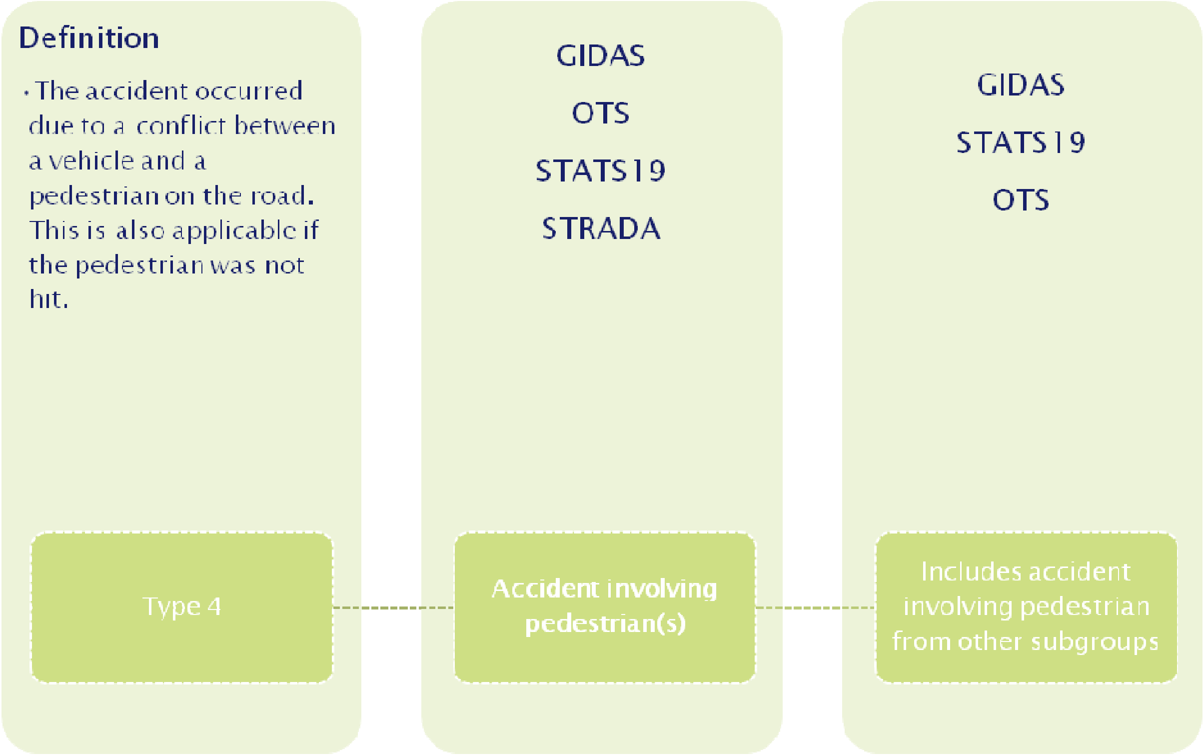
GIDAS
OTS
STATS19
STRADA

Accidents with turning vehicle(s) or crossing paths in junction

GIDAS
STATS19
OTS

Excluded: type 2&3 accidents involving pedestrians. Moved to type 4

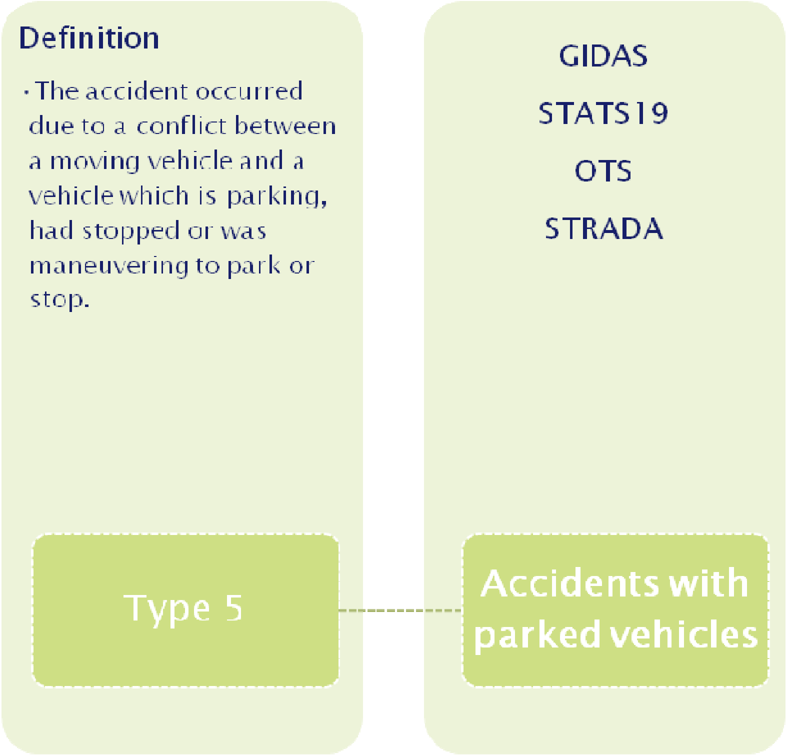
Type 4: Accident involving pedestrian(s)



Definition

- The accident occurred due to a conflict between a vehicle and a pedestrian on the road. This is also applicable if the pedestrian was not hit.

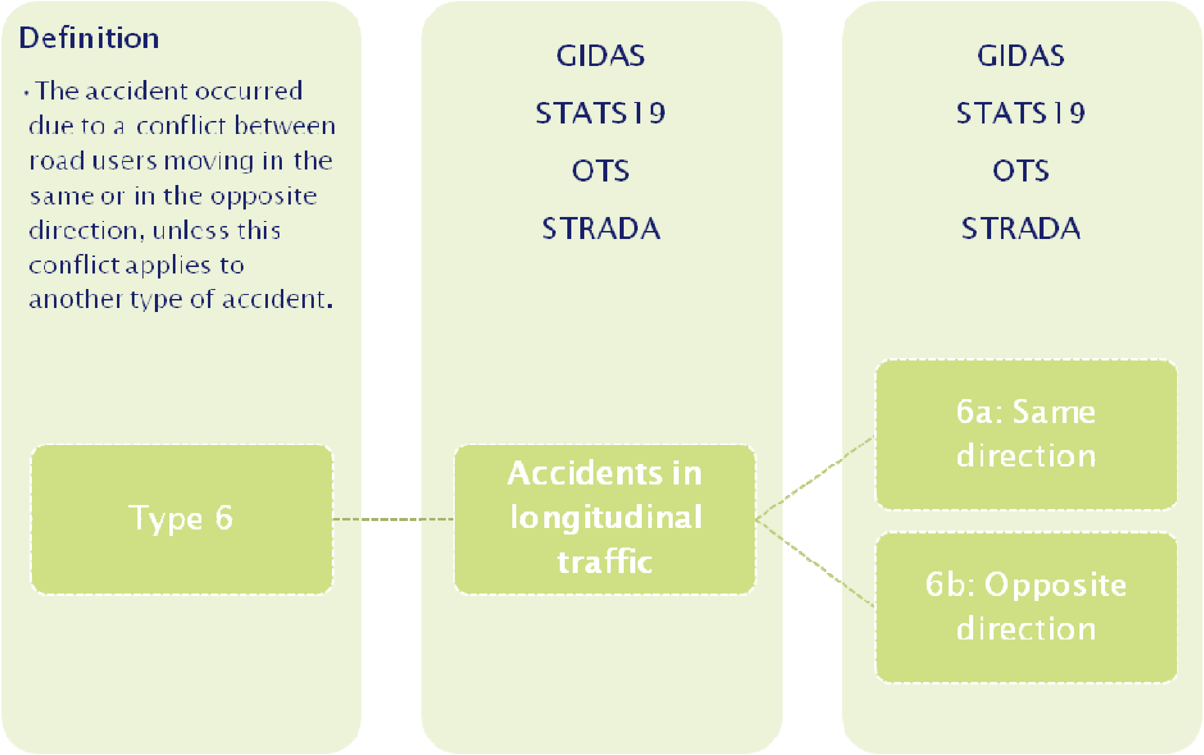
Type 5: Accidents with parked vehicles



Definition

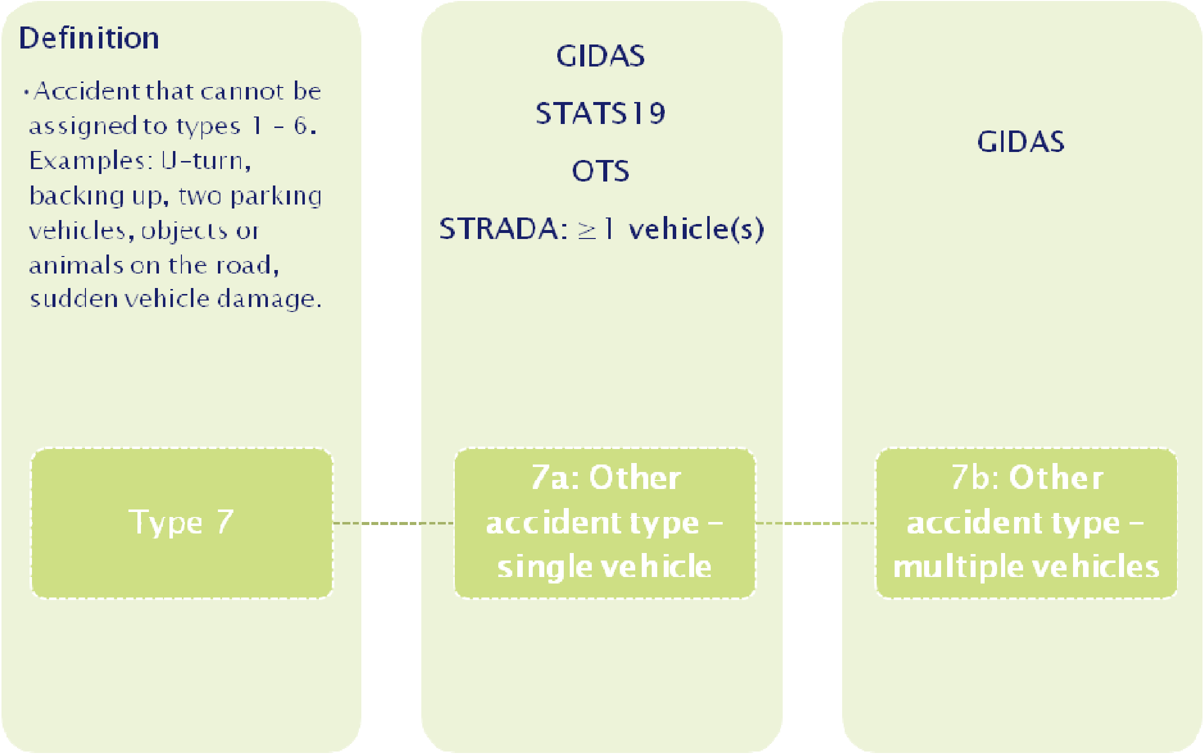
- The accident occurred due to a conflict between a moving vehicle and a vehicle which is parking, had stopped or was maneuvering to park or stop.

Type 6: Accidents in longitudinal traffic – same and opposite direction



- The accident occurred due to a conflict between road users moving in the same or in the opposite direction, unless this conflict applies to another type of accident.

Type 7: Other accident type – single and multiple vehicle(s)



- Accident that cannot be assigned to types 1 - 6. Examples: U-turn, backing up, two parking vehicles, objects or animals on the road, sudden vehicle damage.

3.2.3 Casualty severity definitions

The casualty severity definitions used for the analysis were those defined by the respective databases. The definitions of the databases are presented in Table 3-1, below.

Table 3-1 Casualty severity definitions

Database	Fatal	Severe	Slight

GIDAS	All persons who died within 30 days as a result of the accident,	All persons who were immediately taken to hospital for inpatient treatment (of at least 24 hours)	All other injured persons
OTS*	Death occurs in less than 30 days as a result of the accident	As STATS19. In practice, generally hospitalisation due to injury or AIS 2+ injury	Bruises, sprains, slight cuts whiplash, slight shock.
STATS19	Death occurs in less than 30 days as a result of the accident	Fracture, internal injury, severe cuts, crushing, burns (excluding friction burns), concussion, severe general shock requiring hospital treatment, detention in hospital as an in-patient, either immediately or later, injuries to casualties who die 30 or more days after the accident from injuries sustained in that accident	Bruises, sprains, slight cuts whiplash, slight shock.
STRADA	Death within 30 days of a road accident	According to the police at the accident scene	According to the police at the accident scene

*The OTS team assessment of the severity was used as opposed to the assessment made by the reporting police officer. This is because the OTS assessment includes retrospective consideration of the medical data.

3.3 National or "high level" accident data: accident sample

3.3.1 STATS19 (Great Britain)

STATS19 is the national accident recording system comprising details of accidents and casualties recorded by the Police or local authorities and cover all road accidents in Great Britain which involve personal injury. Accidents are those which occur on the public highway and which become known to the police within 30 days. For the purposes of this analysis, data from the period 2005 to 2008 inclusive was selected.

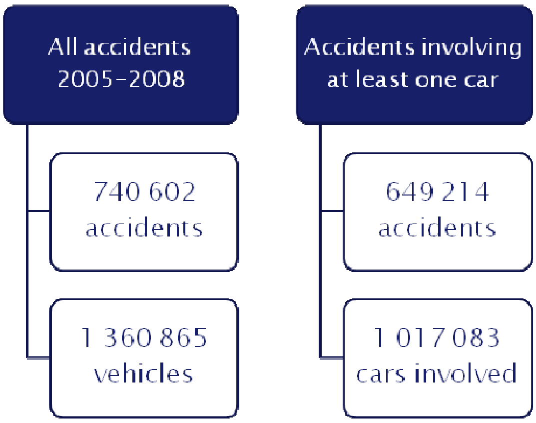


Figure 3-2 STATS19 accident data sample (2005-2008)

3.3.2 STRADA (Sweden)

The Swedish Traffic Accident Data Acquisition (STRADA) is an information system for road accidents with personal injuries (see Figure 3-3). The system includes information from the police and the emergency hospitals (71%, June 2009). Since 2003 the Swedish official statistics are based on the police records stored in STRADA. The police report road accidents involving at least one moving vehicle and a person sustained an injury.

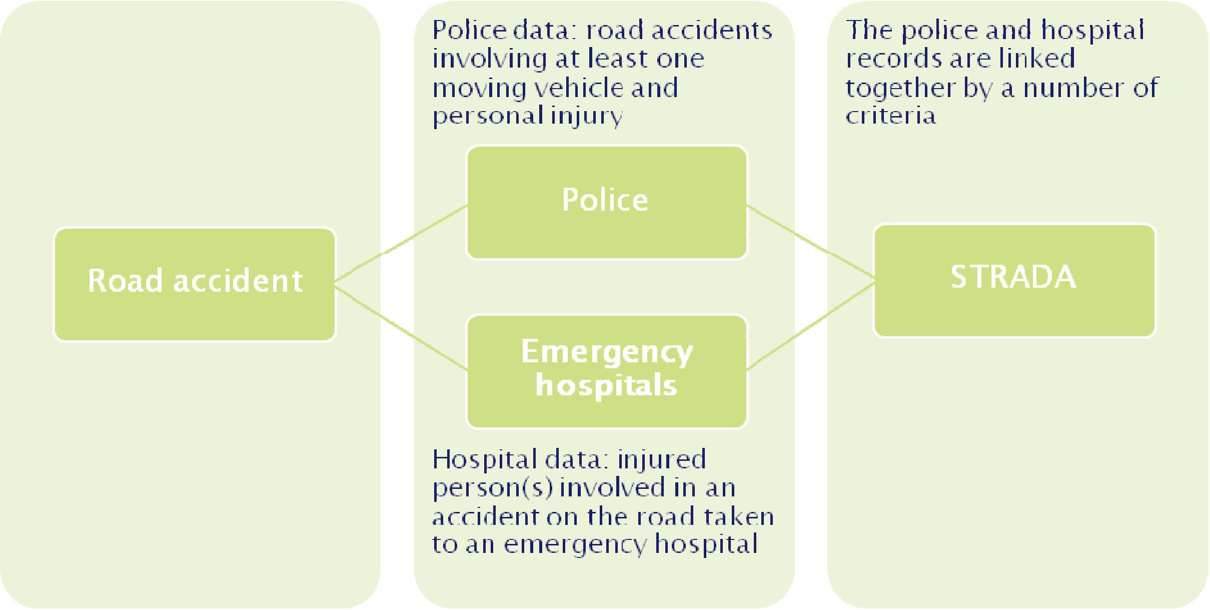


Figure 3-3 STRADA database overview

For this analysis police records from 2005 to 2008 inclusive was used. In Figure 3-4 the data sample is illustrated. Further selections were made from this sample and will be explained in Chapter 4.

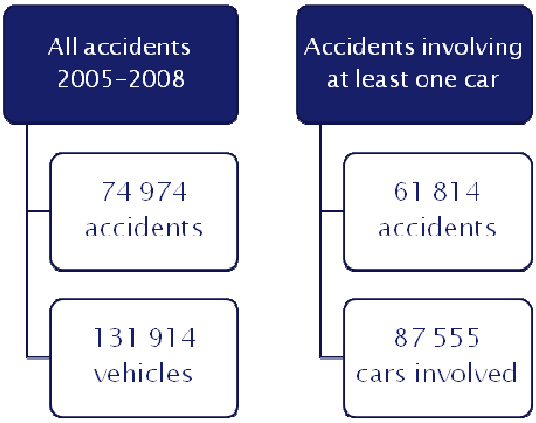


Figure 3-4 STRADA accident data sample (2005-2008)

3.4 In-depth data: accident sample

3.4.1 Germany (GIDAS)

In the German In-Depth Accident Study (GIDAS) there are accidents with casualties in Germany documented in detail. The accidents to be recorded are selected by a sampling plan which guarantees representativeness to all accidents with injuries and fatalities in Germany. Small biases to all accidents with casualties in Germany are corrected by using weighting factors.

The detailed documentation of the accidents is done by survey teams in the area around Dresden and Hanover. Weighted data from 2001-2007 inclusive is used for these analyses. The first selection is shown in Figure 3-5.

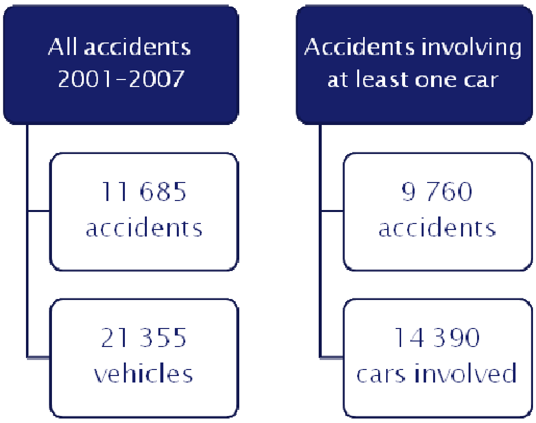


Figure 3-5 GIDAS accident data sample (2001-2007)

3.4.2 OTS (UK)

The UK OTS (On-The-Spot) database comprises in-depth accident and injury data which is collected by two teams in two sampling regions (the Vehicle Safety Research Centre (VSRC) in the Midlands of England and at the Transport Research Laboratory Limited (TRL) in the South). Investigating teams are deployed to the scene of an accident, generally within 20 minutes of the accident happening, for all road traffic accidents notified to police during the periods of operation. Therefore this data source includes damage only accidents and accidents which may not result in an injury. OTS data from 2000 (the start of the study) to July 2009 (the latest database release) was used in the analysis. In Figure 3-6 the first data sample is illustrated.

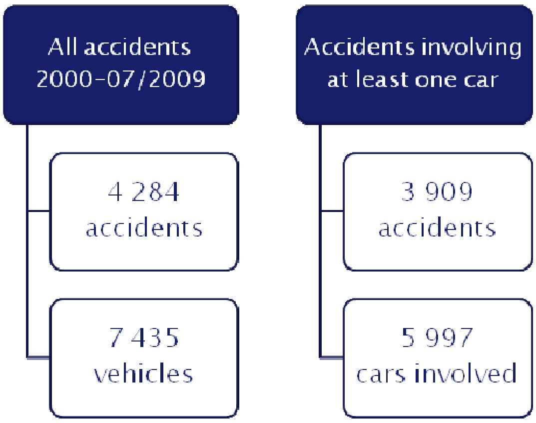


Figure 3-6 OTS accident data sample (2000-07/2009)

4 Analysis of European accident data

The purpose of the first analysis in WP1.1 was to rank the most frequent and severe accident scenarios (accident types described in Chapter 3.2.2) on a high level. It was decided that all injured people in all involved vehicles (including pedestrians) were to be taken into account rather than base the analysis on an accident severity level. The reason is that a safety system in one car can prevent injuries both in the own car but also to the counterpart in the accident. For comparing the different datasets the following steps were taken:

1. Accident type frequency according to the one digit code described in Chapter 3.2.2
2. Injury severity for all persons in all involved vehicles
3. Weight the accident frequency and injury severity by injury costs.
4. Select the bullet car with frontal deformation in first impact and compare to accident frequency by the two digit code (see Appendix 1)

The analysis is divided into two parts where the first analysis (point 1-3) include all databases explained in Chapter 3 and the result presented in this report. For analysis of point 4 GIDAS, OTS and STATS19 are used and will be presented as a pre-analysis in Task 1.2.

It was aimed at using the CARE (Community database on Accidents on the Roads in Europe) database to give an overview on the event of the accident on community level. However the CARE database offers only limited provision of the required data. For example the accident type variable, which is essential for the definition of relevant accident scenarios within ASSESS, had been removed from the database. For this reason, analysis of the CARE database within ASSESS was not practical.

4.1 Accident type distribution

In Table 4-1 presents a summary of the percentage of accidents in each accident type.

Table 4-1 Summary of accident type distribution (STATS19 is presented separate)

Accident type frequency	Type 1a: Driving accident single vehicle	Type 1b: Driving accident multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic same direction	Type 6b: Accidents in longitudinal traffic opposite direction	Type 7a: Other accident single vehicle	Type 7b: Other accident multiple vehicles
GIDAS	13%	5%	38%	7%	3%	21%	3%	4%	6%
OTS car accidents	31%	-	26%	5%	4%	23%	8%	3%	-
OTS car injury accidents	24%	-	31%	9%	2%	10%	21%	3%	-
STRADA	29%	-	28%	8%	2%	19%	7%	8%	-

GIDAS (Germany)

The GIDAS data was classified as defined in chapter 3.2.2 in order to provide information on accident scenarios. This data is based on injury accidents involving at least one car.

The most common accident scenario is “accident with turning vehicle (s) or crossing paths in junction (type 2&3)”. However, more than a fifth of all accidents with injuries involving at least one car are “accidents in longitudinal traffic – same direction”. Single vehicle accidents have a share of 17% (Type 1a and Type 7a) which was the third largest group (see Figure 4-1).

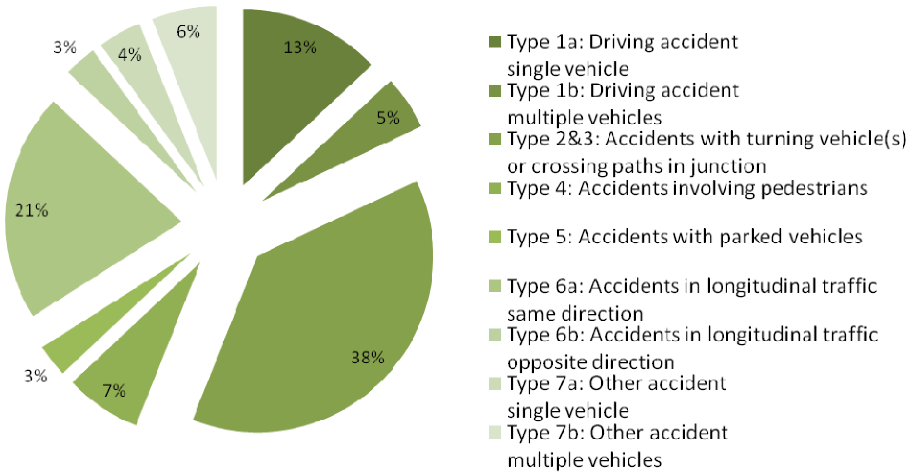


Figure 4-1 GIDAS accident type distribution (9 760 injury accidents involving at least one car, 2001-2008)

OTS (UK)

For the OTS data, the main accident scenario types were allocated to groups to match the accident types described in Chapter 3.2.2. For all accidents involving at least one car, the main accident scenarios were: Type 1: single vehicle accident (31%); Type 6: accidents in longitudinal traffic (31%), and Type 2&3: Turning off/in and crossing paths (26%). For accidents in Type 6, rear-end accident scenarios accounted for 17% of all accidents (see Figure 4-2).

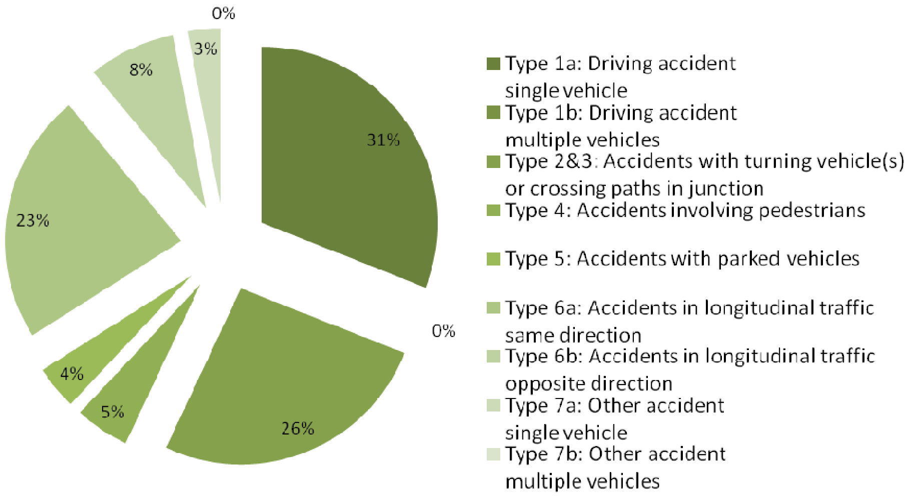


Figure 4-2 OTS accident type distribution (3 909 accidents involving at least one car)

Figure 4-2 presents the accident type distribution for the OTS sample. However, to improve the comparison between this source and data from injury accidents, Figure 4-3 has been included. However, it should be noted that Figure 4-3 relates to the car severity and not the severity of the accident.

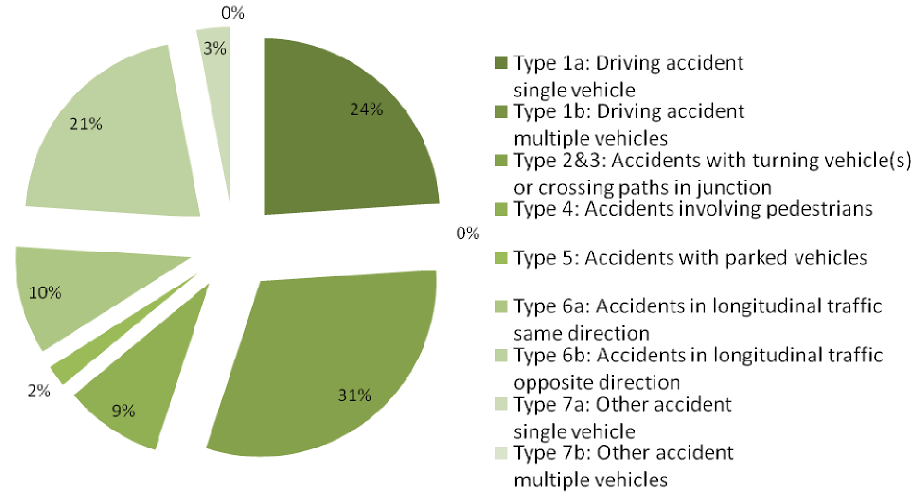


Figure 4-3 OTS accident type distribution (1 940 injury accidents involving at least one car where at least one car occupant was injured)

STATS19

For STATS 19, the accident data was not subdivided into accident types described by the first digit of the accident type as described in Chapter 3.2.2. This was because this data source contained data which is not directly compatible with the classification method, However, by comparing similar criteria, based on the manoeuvre of the first (most severely impacted) car in the accident with the manoeuvre of the other vehicle in the accident, it was possible to produce an analysis which was used to compare to the findings of the in-depth data analysis (see Table 4-2).

Table 4-2 STATS19 Accident type distribution

Manoeuvre of car	Other_Manoeuvre	Fatal	Serious	Slight	Grand Total	%Fatal	%Serious	%Slight
03 Waiting to go ahead but held up								
	18 Going ahead other	29	466	11,840	12,335	0.4%	0.8%	2.4%
07 Turning left								
	18 Going ahead other	30	1,011	10,810	11,851	0.4%	1.7%	2.2%
09 Turning right								
	00 No mutual contact	56	1,347	9,168	10,571	0.8%	2.3%	1.9%
	18 Going ahead other	489	7,141	46,761	54,391	7.2%	12.1%	9.5%
13 Overtaking moving vehicle on its offside								
	18 Going ahead other	231	1,022	3,866	5,119	3.4%	1.7%	0.8%
16 Going ahead left hand bend								
	00 No mutual contact	507	2,757	13,759	17,023	7.5%	4.7%	2.8%
	17 Going ahead right hand bend	318	1,621	6,914	8,853	4.7%	2.7%	1.4%
17 Going ahead right hand bend								
	00 No mutual contact	538	3,117	16,347	20,002	7.9%	5.3%	3.3%
	16 Going ahead left hand bend	360	1,372	4,825	6,557	5.3%	2.3%	1.0%
18 Going ahead other								
	00 No mutual contact	1,330	8,879	58,628	68,837	19.6%	15.1%	12.0%
	03 Waiting to go ahead but held up	19	556	18,592	19,167	0.3%	0.9%	3.8%
	04 Slowing or stopping	21	405	9,851	10,277	0.3%	0.7%	2.0%
	09 Turning right	101	1,631	16,859	18,591	1.5%	2.8%	3.4%
	18 Going ahead other	1,226	9,295	69,921	80,442	18.0%	15.8%	14.3%

The table provides both absolute numbers of accidents and the percentage of accidents within each severity group. The data presented here relates to all injury accidents involving a car, excluding accidents with pedestrians. To aid interpretation of the data, the groups comprising 2%-10% were coloured orange, and groups greater than 10% were coloured red. With reference to the above table, it can be seen that the highest accident groups for fatal accidents are “going ahead other” with “no mutual contact” and “going ahead other” with “going ahead other”. These groups broadly represent single vehicle accidents (Type 1) and accidents in longitudinal traffic (type 6) respectively. These same categories of accident also account for more than 10% of lesser accident severities. For serious accidents, “turning right” and “ahead other” accounts for more than 12% of serious accidents; these are accidents in which a car is turning across oncoming traffic (which falls within Type 2&3).

To aid comparison with other data sources, single vehicle accidents (included in Table 4-2, above) accounted for 28.87% of fatal accidents, 20.34% of serious and 13.00% of slight where a car was involved (13.47% of all accidents involving at least one car). These single vehicle accidents were those meeting the criteria of Type 1 accidents with all accidents involving pedestrians excluded.

Type 4 (accidents involving pedestrians) accounted for 20.27% of fatal accidents, 24.69% of serious accidents, and 12.01% of slight accidents when accidents involving at least one car were considered. Overall Type 4 accidents accounted for 14.34% of accidents involving a car.

Further analysis of this data source to analyse the other accident types at a more detailed level will be performed in Task 1.2.

STRADA (Sweden)

In STRADA, some recoding was performed to allocate the data to the accident types chosen for the ASSESS accident analysis. The STRADA database consists of 12 main groups of accidents which are presented in Table 4-3. These 12 groups have a number of subgroups attached (80 subgroups in total); these are only used for recoding in a few cases and will not be presented here.

Table 4-3 Main accident type groups in STRADA

STRADA accident type	Code	
Single vehicle accident	S	
Head on collision	M	
Accident involving overtaking	O	
Rear end collision	U	
Accident involving turning vehicle	A	
Accident with crossing path vehicles	K	
Bicycle or moped in collision with motor vehicle	C	
Pedestrian accident	F	
Other/unknown	V	
Accident with wild game	W	
Accident between moped/bicycles/pedestrian	G	Not included in sample
Accident with rail vehicle	J	

Table 4-4 show the recoded accident types from STRADA. When recoding the accident type some assumption where made in the Type 6 group. In Type 6b “O0” (other overtaking accident) was coded as opposite direction after reading a number of accident descriptions; these account for 0.01% of the total sample.

Table 4-4 Recoding of accident types from STRADA to ASSESS types

ASSESS accident type	STRADA code
Type 1a	All S
Type 1b	Non
Type 2&3	All A and all K and C3-7 (bicycles in junctions)
Type 4	All F
Type 5	V5
Type 6a	All U + O2 + C2 (bicycles in longitudinal traffic - same)

Type 6b	All M + O0 + C1 (bicycles in longitudinal traffic - opposite)
Type 7a	V0,1,3,6, C0 and all W and J (not distinguished between other single or multiple vehicle)
Type 7b	Non

In STRADA “single vehicle accidents” (type 1a) 29% is the most frequent type followed by “accident with turning vehicle (s) or crossing paths in junction” (type 2&3) 28% and type 6, “accidents in longitudinal traffic” 26% (see Figure 4-4).

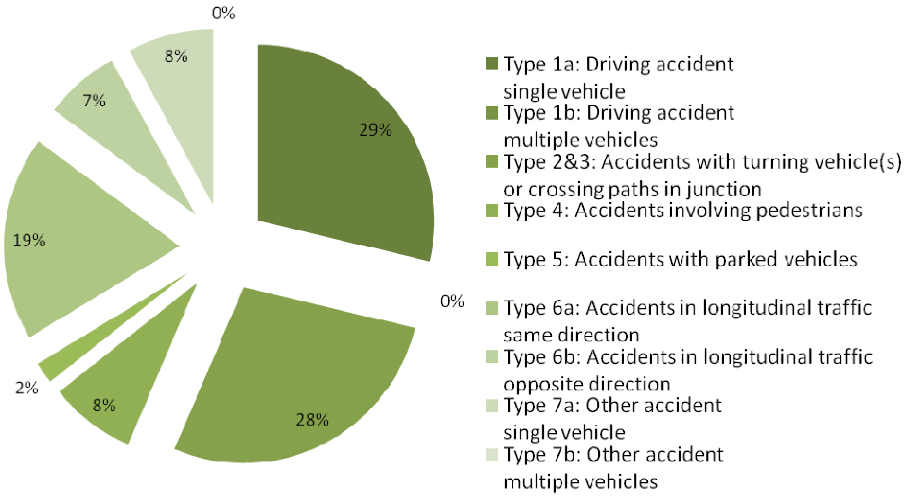


Figure 4-4 STRADA Accident type distribution (61 814 accidents involving at least one car)

4.2 Accident severity

Accidents severity is defined as the most severe injury in the accident based on all involved road users. The distributions of the accident severity from the different data sets are presented in Figure 4-5 to Figure 4-9. In Table 4-5 the result for accidents severity is presented.

Table 4-5 Summary of accident type distribution

Accident severity	Fatal	Severe	Slight	Uninjured	Unknown
GIDAS	1%	20%	79%		
OTS car accidents	2%	10%	44%	41%	2%
OTS car injury accidents	4%	18%	78%		
STATS19	1%	12%	87%		
STRADA	2%	15%	82%		1%

GIDAS (Germany)

The accident severity presented for GIDAS was based on the sample of 9,760 accidents (see Figure 4-5). In almost 80% of all injury accidents the most severe occurring injury severity was slight. Severe injuries were suffered in 20% the accidents. In 1% of all accidents with casualties there was at least one fatality.

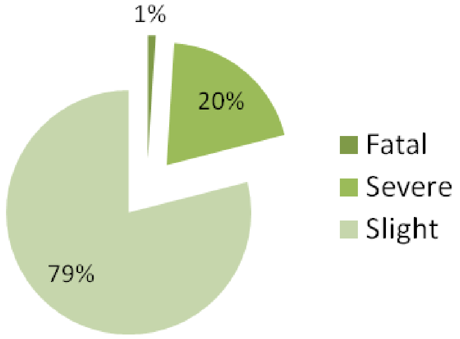


Figure 4-5 GIDAS accident severity distribution (9 760 injury accidents, 2001-2007)

OTS (UK)
Figure 4-6 presents the accident severity distribution for the OTS sample (n=3 909). However, to improve the comparison between this source and data from injury accidents, Figure 4-7 has been included (n=2 222). However, it should be noted that Figure 4-7 relates to the car severity and not the severity of the accident.

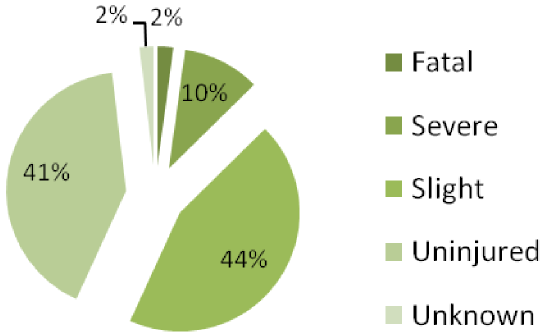


Figure 4-6 OTS accident severity (3 909 accidents, 2005-2008)

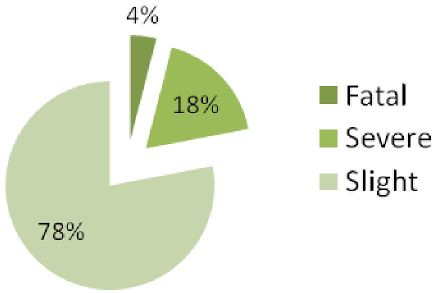


Figure 4-7 OTS accident severity (2 222 injury accidents, 2005-2008)

STATS19 (UK)
The accidents severity presented for STATS19 is based on the sample of 649 214 accidents (see Figure 4-8).

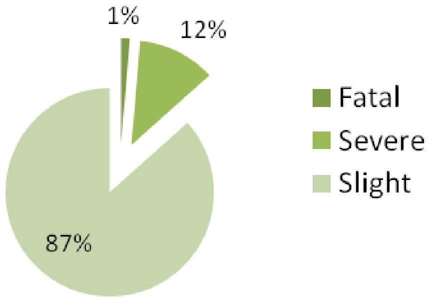


Figure 4-8 STATS19 accident severity (649 214 injury accidents, 2005-2008)

STRADA (Sweden)
The accidents severity presented for STRADA is based on the sample of 61 720 accidents (see Figure 4-9). If the sample including only known injuries is used (n=49 033) the distribution of accident severity is the same for fatal and slight but 16% for severe accident severity.

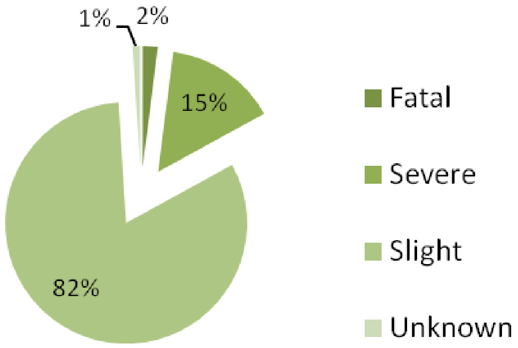


Figure 4-9 STRADA accident severity distribution

4.3 First point of impact

Concerning the first point of impact, GIDAS, OTS and STATS19 had sufficient information. STRADA do report on deformations on the car, but the underreporting and quality of the information make the data unreliable. Therefore, this analysis was not performed. A summary of the result is presented in Table 4-6.

Table 4-6 Summary of the distribution of first impact on cars

First impact on car	front	rear	side	other
GIDAS	50%	19%	30%	1%
OTS	47%	24%	26%	3%
STATS19	58%	13%	29%	0%

GIDAS (Germany)
In the sample of GIDAS there are also accidents included in which a car has no collision during the course of accident. Hence the car has no impact point. For example this is an accident in which a motorcycle rider falls off the vehicle after evading a car.
For the distribution of the impact point there are only cars with a collision considered (see Figure 4-11). Accidents with no impact are excluded for the further analyses. In Figure 4-10 there is an overview about the selected data given.

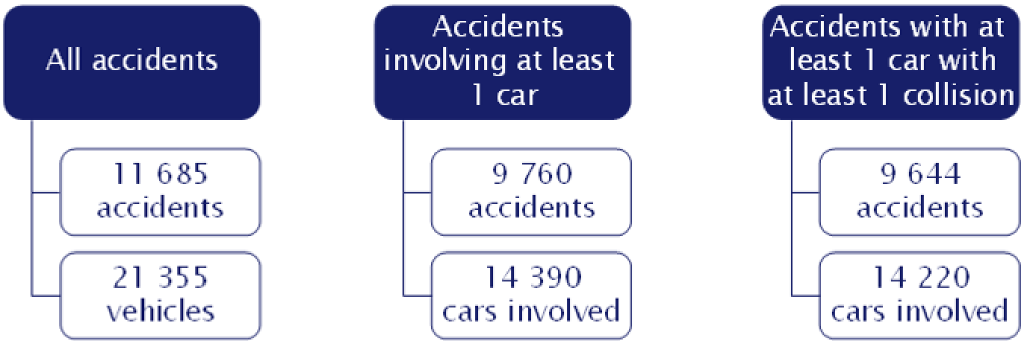


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Figure 4-10 GIDAS selection of vehicles with at least one collision (sample 2001-2007)

Figure 4-11 shows that most cars crash frontally in the initial impact (50%). Almost a third of the cars involved in injury accidents had a side impact in the first crash. The initial impact, for nearly a fifth of the cars, was a rear crash. For the remaining cars the impact point (other) can either not be determined, is the roof or underside.

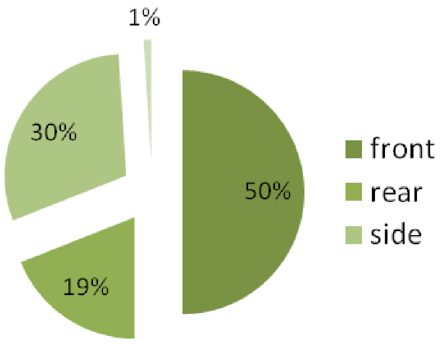


Figure 4-11 GIDAS first point of impact on car (14 220 cars in injury accidents involving at least one car with at least one collision, 2001-2007)

OTS (UK)
Figure 4-12 shows that most cars crash frontally in the initial impact (47%). Approximately a quarter (26%) of the cars sustained a side impact in the initial crash. The initial impact for 24% was a rear crash. For the remaining cars the impact point (other) was the roof or underside.

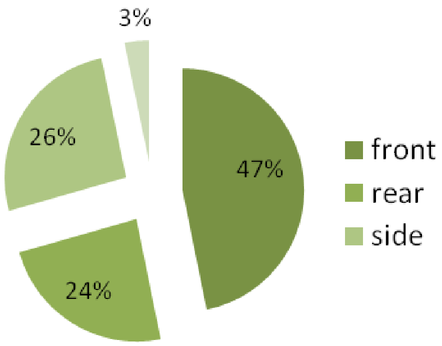


Figure 4-12 OTS first point of impact on car (5,106 cars involving at least one car with at least one collision where the impact point was known, 2005-07/2008)

STATS19 (Great Britain)
The STATS19 sample was based on 1 017 082 cars in injury accident (see Figure 4-13). With reference to this figure it can be seen that frontal impacts account for 58% of accidents, followed by 29% for side impacts and 13% for rear impacts.

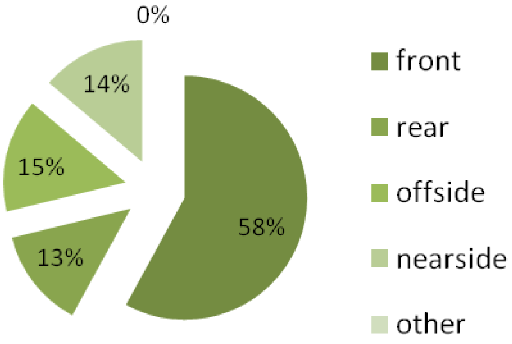


Figure 4-13 STATS19 first point of impact on car (1 017 082 cars in injury accidents, 2005-2008)

4.4 Accident type by first impact point

The distribution of the accident type combined with the first impact point on cars provides additional information about the situation in the first crash. By using the impact point it is known with which part the bullet vehicle collides with the opponent in the initial impact. The accident type additionally provides information about the accident scene.
In GIDAS and OTS the necessary information about the first impact point and the accident type is available. The results based on the combination of these variables are presented in Table 4-7 to

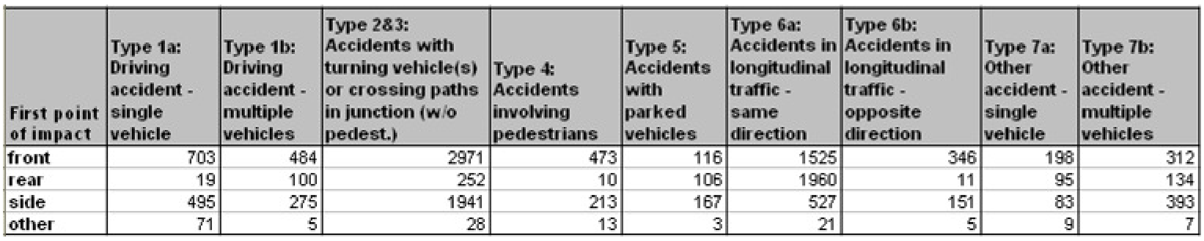
Table 4-10. To aid interpretation of the data, the groups comprising 2%-10% were coloured orange, and groups greater than 10% were coloured red.

This analysis shows that for GIDAS, the most frequently occurring first point of impact was frontal for Type 2&3 (Accidents with turning or crossing paths) and Type 6a (accidents in longitudinal traffic – same direction), side impact for Type 2&3 and rear for Type 6a. For OTS, the most frequently occurring first point of impact was frontal for Types 1, 2&3, and 6a and side for Type 6a.

GIDAS (Germany)

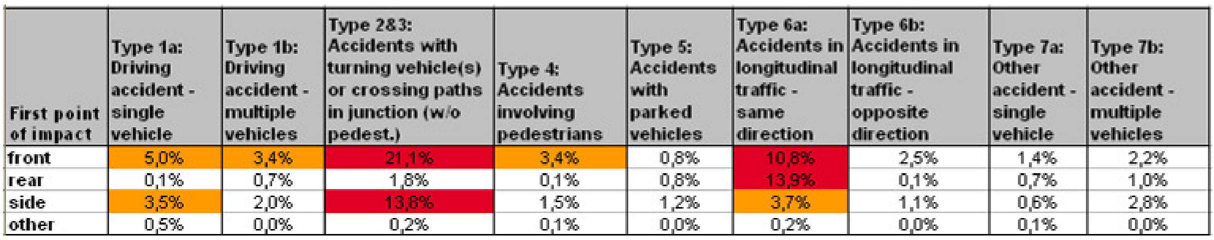
The tables 4-7 and 4-8 show that most of the cars involved in accidents with injuries initially crash with the front in accidents at intersections (21%). This crash and accident type is followed by initial rear impacts in accidents in longitudinal traffic –same direction (Type 6a) with a share of about 14%. The third largest group with nearly 14% are cars with an initial side impact in accidents at junctions (Type 2&3). Cars having a front impact in the first collision in an accident of Type 6a are the fourth largest group (11%).

Table 4-7 Count of GIDAS first point of impact by accident type (14,220 cars in injury accidents involving at least one car with at least one collision, 2001-2007)



First point of impact	Type 1a: Driving accident - single vehicle	Type 1b: Driving accident - multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic - same direction	Type 6b: Accidents in longitudinal traffic - opposite direction	Type 7a: Other accident - single vehicle	Type 7b: Other accident - multiple vehicles
front	703	484	2971	473	116	1525	346	198	312
rear	19	100	252	10	106	1960	11	95	134
side	495	275	1941	213	167	527	151	83	393
other	71	5	28	13	3	21	5	9	7

Table 4-8 Percentage of GIDAS first point of impact by accident type (14,220 cars in injury accidents involving at least one car with at least one collision, 2001-2007)



First point of impact	Type 1a: Driving accident - single vehicle	Type 1b: Driving accident - multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic - same direction	Type 6b: Accidents in longitudinal traffic - opposite direction	Type 7a: Other accident - single vehicle	Type 7b: Other accident - multiple vehicles
front	5,0%	3,4%	21,1%	3,4%	0,8%	10,8%	2,5%	1,4%	2,2%
rear	0,1%	0,7%	1,8%	0,1%	0,8%	13,9%	0,1%	0,7%	1,0%
side	3,5%	2,0%	13,8%	1,5%	1,2%	3,7%	1,1%	0,6%	2,8%
other	0,5%	0,0%	0,2%	0,1%	0,0%	0,2%	0,0%	0,1%	0,0%

OTS (UK)

The tables 4-9 and 4-10 show that most of the cars involved in accidents with injuries initially crash with the front in accidents in longitudinal traffic with directions of travel in the same direction (13.9%). This crash and accident type is closely followed by turning accidents (13.7%). The third and fourth largest groups were frontal impacts in longitudinal traffic (same direction, type 6a) and single vehicle accidents (type 1), with 11.7% and 11.1% respectively.

Table 4-9 Count of OTS first point of impact by accident type (5,106 cars for which the impact point known

First point of impact	Type 1a: Driving accident - single vehicle	Type 1b: Driving accident - multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic - same direction	Type 6b: Accidents in longitudinal traffic - opposite direction	Type 7a: Other accident - single vehicle	Type 7b: Other accident - multiple vehicles
Front	567	0	697	127	89	598	260	53	0
Rear	51	0	318	29	16	709	73	17	0
Side	366	0	422	21	14	244	161	108	0
Other	94	0	1	0	2	58	0	11	0

Table 4-10 Percentage of OTS first point of impact by accident type (5,106 cars for which the impact point was known

First point of impact	Type 1a: Driving accident - single vehicle	Type 1b: Driving accident - multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic - same direction	Type 6b: Accidents in longitudinal traffic - opposite direction	Type 7a: Other accident - single vehicle	Type 7b: Other accident - multiple vehicles
Front	11.10%	0.00%	13.65%	2.49%	1.74%	11.71%	5.09%	1.04%	0.00%
Rear	1.00%	0.00%	6.23%	0.57%	0.31%	13.89%	1.43%	0.33%	0.00%
Side	7.17%	0.00%	8.26%	0.41%	0.27%	4.78%	3.15%	2.12%	0.00%
Other	1.84%	0.00%	0.02%	0.00%	0.04%	1.14%	0.00%	0.22%	0.00%

4.5 Total casualties in the accident (by accident type)

A comparison was made of the casualties in the accident, in order to find the most frequent accident types based on injury severity. In

Table **4-11** to Table 4-16 the count and percentage of each dataset is presented. The figures in percentage are the relative number of the total of each dataset.

GIDAS (Germany)

In the documentation of accidents, it is not always possible to record the injury severities of all people involved in the accident. For example, the injury severity of a person who fails to stop after an accident cannot be determined. For the analysis of the casualty severity distribution, only people with known injuries were considered. In addition, accidents involving persons with unknown injury severities were excluded for the further analyses. Figure 4-14 provides an overview of the selected data.

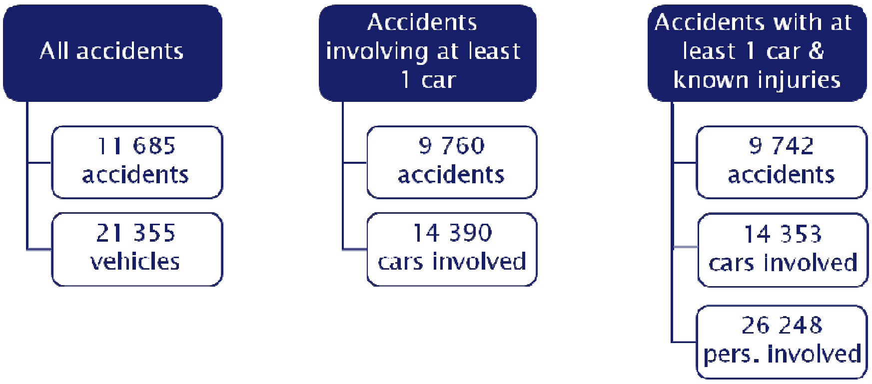


Figure 4-14 GIDAS accident sample for casualties severity comparison

In Type 1a there is the biggest number of fatalities. This number confirms the well-known fact that single vehicle accidents are associated with high injury severity. Accidents that occur in junctions cause the highest number of slightly and seriously injured persons (see Table 4-12).

Table 4-11 Count of GIDAS injury severities of involved persons by accident type in (16,315 involved persons in injury accidents involving at least one car, 2001-2007)

Injury severity of involved persons in accidents with injuries	Type 1a: Driving accident – single vehicle	Type 1b: Driving accident – multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic – same direction	Type 6b: Accidents in longitudinal traffic – opposite direction	Type 7a: Other accident single vehicle	Type 7b: Other accident – multiple vehicles
fatal	55	23	20	15	1	19	14	9	5
severe	496	227	703	224	35	247	138	112	107
slight	1118	643	4176	506	284	2905	383	343	662
uninjured	342	545	5102	939	333	4139	345	224	857
unknown	2	1	7	1	1	6	2	2	

Table 4-12 Percentage of GIDAS injury severities of involved persons by accident type in (16,315 involved persons in injury accidents involving at least one car, 2001-2007)

First point of impact	Type 1a: Driving accident – single vehicle	Type 1b: Driving accident – multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic – same direction	Type 6b: Accidents in longitudinal traffic – opposite direction	Type 7a: Other accident single vehicle	Type 7b: Other accident – multiple vehicles
fatal	0,2%	0,1%	0,1%	0,1%	0,0%	0,1%	0,1%	0,0%	0,0%
severe	1,9%	0,9%	2,7%	0,8%	0,1%	0,9%	0,5%	0,4%	0,4%
slight	4,2%	2,4%	15,9%	1,9%	1,1%	11,0%	1,5%	1,3%	2,5%
uninjured	1,3%	2,1%	19,4%	3,6%	1,3%	15,7%	1,3%	0,9%	3,3%
unknown	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%

OTS (UK)

For fatal accidents, the most severe accidents type are single vehicle accidents followed by accidents in longitudinal traffic – opposite direction. For serious injuries the most frequent accident type is single vehicle accidents followed be accidents in junctions. Considering all accidents regardless of severity (see Table 4-14), the main accident groups are again, Type 1, Type2&3 and Type 6a. The high frequency of uninjured persons is explained by that the sample from OTS includes 41% accidents with uninjured accidents severity (see Figure 4-6).

Table 4-13 Count of OTS injury severities of involved persons by accident type in (10 459 involved persons in injury accidents involving at least one car, 2000-07/2009)

Injury severity of involved persons in accidents with injuries	Type 1a: Driving accident – single vehicle	Type 1b: Driving accident – multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic – same direction	Type 6b: Accidents in longitudinal traffic – opposite direction	Type 7a: Other accident – single vehicle	Type 7b: Other accident – multiple vehicles
fatal	35	0	15	13	1	2	27	0	0
severe	186	0	178	97	12	50	130	19	0
slight	499	0	842	89	55	850	268	105	0
uninjured	1440	0	1927	340	214	2363	463	239	0

Table 4-14 Percentage of OTS injury severities of involved persons by accident type in (10 459 involved persons in injury accidents involving at least one car, 2000-07/2009)

Injury severity of involved persons in accidents with injuries	Type 1a: Driving accident – single vehicle	Type 1b: Driving accident – multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic – same direction	Type 6b: Accidents in longitudinal traffic – opposite direction	Type 7a: Other accident – single vehicle	Type 7b: Other accident – multiple vehicles
fatal	0.3%	0.0%	0.1%	0.1%	0.0%	0.0%	0.3%	0.0%	0.0%
severe	1.8%	0.0%	1.7%	0.9%	0.1%	0.5%	1.2%	0.2%	0.0%
slight	4.8%	0.0%	8.1%	0.9%	0.5%	8.1%	2.6%	1.0%	0.0%
uninjured	13.8%	0.0%	18.4%	3.3%	2.0%	22.6%	4.4%	2.3%	0.0%

STRADA (Sweden)

For accidents in Sweden, the distribution of the most severe accidents is well known; it is single vehicle accidents followed by head-on collisions. For severe accidents, it is single vehicle accidents followed by accidents in junctions (see Table 4-16).

Table 4-15 Count of STRADA injury severities of involved persons by accident type (137 936 involved persons in injury accidents involving at least one car, 2005-2008)

Injury severity of involved persons in accidents with injuries	Type 1a: Driving accident – single vehicle	Type 1b: Driving accident – multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic – same direction	Type 6b: Accidents in longitudinal traffic – opposite direction	Type 7a: Other accident – single vehicle	Type 7b: Other accident – multiple vehicles
fatal	441		216	149	13	43	433	74	
severe	3911		3303	1029	163	1563	1697	802	
slight	19498		23295	4077	1352	18662	5714	6290	
uninjured	1128		10984	2744	474	10297	2179	2478	
unknown	867		4959	1996	593	3886	1147	1479	

Table 4-16 Percentage of STRADA injury severities of involved persons by accident type (137 936 involved persons in injury accidents involving at least one car, 2005-2008)

Injury severity of involved persons in accidents with injuries	Type 1a: Driving accident – single vehicle	Type 1b: Driving accident – multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic – same direction	Type 6b: Accidents in longitudinal traffic – opposite direction	Type 7a: Other accident – single vehicle	Type 7b: Other accident – multiple vehicles
fatal	0.3%	0.0%	0.2%	0.1%	0.0%	0.0%	0.3%	0.1%	0.0%
severe	2.8%	0.0%	2.4%	0.7%	0.1%	1.1%	1.2%	0.6%	0.0%
slight	14.1%	0.0%	16.9%	3.0%	1.0%	13.5%	4.1%	4.6%	0.0%
uninjured	0.8%	0.0%	8.0%	2.0%	0.3%	7.5%	1.6%	1.8%	0.0%
unknown	0.6%	0.0%	3.6%	1.4%	0.4%	2.8%	0.8%	1.1%	0.0%

4.6 Discussion

First, it should be considered that two national representative databases with police reported accidents (STATS19 and STRADA) have been compared with two in-depth databases where professional accident investigators have coded the accidents (GIDAS and OTS). The representative sample from GIDAS has been weighted to national statistics and the OTS sample regions are considered to fit the national sample of road and vehicle types. On the other hand, the national data from STATS19 includes only accidents with injuries while OTS also includes accidents with property damage only (41% of sample).

When comparing accident types between the datasets it is important to remember that the proposed accidents types from SafetyNet (see Appendix 1) and somewhat altered in Chapter 3.2.2 are based on the conflict situation rather than the configuration of the accident. The SafetyNet code originates from the same source which is also used in GIDAS. Type 1 accidents are often considered as single vehicle accidents and this is why this group should be comparable with single vehicle accidents from other datasets. Type 2&3 accidents were merged because it made it easier to compare with other datasets; where accidents happened in or close to junctions. Type 4 accidents involved pedestrians (occurring in all accident conflict types): For GIDAS, STATS19 and OTS, those accident types in Type 2 and 6 which involve pedestrians were assigned to Type 4. For Type 6 accidents a distinction between same and opposite direction was made. This separation is probably the largest source of differences and it was considered to also examine this group as a whole group as well as the subgroups.

For GIDAS the most frequent group was accidents at junctions (38%) followed by accidents in longitudinal traffic (24%) and single vehicle accidents (17%). The distribution for OTS looking at injury accidents is similar. For OTS (all car accidents) and STRADA the single vehicle accidents are the largest group, while accidents in junctions and accidents in longitudinal traffic respectively are the second largest types (see Table 4-1).

For accident severity the datasets are very similar with fatal accidents around 2%, severe accidents around 16% and slight accident around 82%. In GIDAS the frequency of severe accidents is slightly increased. The comparison with the OTS distribution of the injury severity based on only injury accidents shows similar results (see Table 4-5). The lower distribution of severe accidents for STATS19 and STRADA could be explained by that the injury severity is coded by the police at the scene and might be underestimated.

For information about the first impact point of cars GIDAS, STATS19 and OTS data was used. In all three datasets the most common impact point in the initial collision of cars involved in accidents with injuries is front (GIDAS:50%, OTS: 47%, STATS19:58%). It is followed by side impacts (for all datasets the share is bigger than a quarter). In the least frequent group there are cars which have a rear crash in the initial collision.

The combination of the variables “impact point of cars” and “accident type” is only based on the GIDAS and OTS database. The analysis shows a similar result for both datasets. In OTS the most frequent accident type and impact point of cars is an initial rear crash in accidents in longitudinal traffic – same direction (Type 6a). In GIDAS this group is the second largest. In OTS this group is followed by cars with front crashes in accidents at junctions (Type 2&3). In GIDAS this class is the most common. The group of cars with initial front crashes in accidents in longitudinal traffic – same direction (Type 6a) is the third largest in OTS and the fourth largest group in GIDAS. In the dataset of GIDAS cars often collide (3rd frequent) with its side in accidents at junctions (Type 2&3). Cars involved in single accidents (Type 1) crashing frontally are the 4th largest group in OTS.

Accident type frequency based on the total casualties in the accident show that most casualties are caused in accidents in junction (Type2&3) and accidents in longitudinal traffic (Type 6) for all datasets (see Table 4-17). This is probably explained by that these accidents include more vehicles and also more persons.

Table 4-17 Distribution of involved persons in injury accidents by accident type.

Database	Type 1a: Driving accident – single vehicle	Type 1b: Driving accident – multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic – same direction	Type 6b: Accidents in longitudinal traffic – opposite direction	Type 7a: Other accident – single vehicle	Type 7b: Other accident – multiple vehicles
GIDAS	8%	5%	38%	6%	2%	28%	3%	3%	6%
OTS	21%	-	28%	5%	3%	31%	8%	3%	-
STRADA	23%	-	30%	6%	1%	24%	8%	8%	-

5 Ranking of preliminary scenarios

The overall injury outcome of the relevant accidents was used to rank the accident scenarios. This is important since by allocating greater weightings to more severe casualties, this takes into account both the frequency and severity of the resulting casualties. Therefore, accident scenarios which account for a lower frequency of casualties of a higher severity can be balanced with those accidents which result in a greater frequency of low injury outcomes. In terms of valuing the accident, it is the weighted casualty severity which is important.

5.1 Injury costs

Within Work Package 1, casualty and accident valuations were investigated for a range of countries. From existing work in eIMPACT an overview on casualty costs in different EU countries is available (see Table 5-1).

Table 5-1 Costs per Accident Impact (Costs/Casualty) in € for 2005 in EU 25 (eIMPACT D3, 2006, page 75)

Region	Country	Casualty Valuation [€]			Average Injury [€]	Damage Only [€]
		Fatality	Serious Injury	Slight Injury		
North/West	Austria				93.804	
	Denmark	692.143	71.546	19.528		
	Finland	1.752.000	365.000	44.300		2.700
	France	1.362.770	204.416	29.981		4.997
	Germany	1.199.780	83.454	3.652		6.989
	Ireland					1.765
	Netherlands	1.398.763				
	Sweden	1.364.503	243.430	13.637		1.013
	UK	1.565.720	175.940	13.567		
East	Czech Republic	524.310			53.654	2.838
	Estonia		36.487	650		
	Hungary	896.981	62.239	8.238		4.576
	Latvia	709.636	16.149	191		4.165
	Lithuania	564.427	45.637			
	Slovak Republic	221.530	39.344	704		
South	Italy	485.477				
	Portugal	355.483	16.663	1.111		
	Spain	227.547			30.036	

Looking on the data in the table above, large differences can be seen for different countries in all the categories. This is mainly due to different calculation techniques used in the different countries.

There is a variety of calculation techniques available, the two most common methods are:

- Willingness-to-pay (WTP) approach: This is a subjective method and based on a survey asking for what they are willing to pay to avoid an accident or a certain injury level. Therefore the valuation also accounts for elements like pain, grief and suffering as a result of the accident. The result is very much depending on the design of the questionnaire.
- Cost-of-damage (COD) approach: This approach is based on the total estimated amount of economic losses caused by any physical impact. Generally, the losses are quantified via the decline of gross national product. This includes medical and emergency costs and lost productivity of killed or disabled persons. But this approach does not account for elements like pain, grief and suffering and therefore typically leads to lower numbers than the WTP approach.

There is a general trend for high income countries to use the WTP approach or at least to include a component reflecting these costs. Nevertheless, within the EU25 the COD approach still is used by the majority of countries.

Within WP1.1 the casualty costs will be used mainly for calculating overall accident scenario importance balancing of high frequent scenarios with low casualty implications and low frequent scenarios with high casualty implications. Therefore, absolute cost values are not required, but information is required on the ratios between the different casualty valuation levels. Based on the data in Table 5-1 weighting factors were calculated by setting the costs for fatalities to "1.0" and calculating the relative weight of the other injury categories per country accordingly. Table 5-2 shows the resulting weighting factors per country. For this calculation, only ten countries out of Table 5-1 were used, since for the others the full range of data was not available. In Sweden, the valuations also incorporate the WTP approach. Therefore the numbers represent the physical as well as the psychological consequences of the casualties (see Table 5-2).

Table 5-2 Calculated weighting factors

Region	Country	Population [Mio]	Casualty Valuation [€]			Weighting Factors		
			Fatality	Serious Injury	Slight Injury	Fatality	Serious Injury	Slight Injury
North/West	Denmark	5,4	692.143	71.546	19.528	1	0,10	0,0282
	Finland	5,3	1.752.000	365.000	44.300	1	0,21	0,0253
	France	63,4	1.362.770	204.416	29.981	1	0,15	0,0220
	Germany	82,3	1.199.780	83.454	3.652	1	0,07	0,0030
	Sweden	9,0	1.364.503	243.430	13.637	1	0,18	0,0100
	UK	60,9	1.565.720	175.940	13.567	1	0,11	0,0087
East	Hungary	10,1	896.981	62.239	8.238	1	0,07	0,0092
	Latvia	2,3	709.636	16.149	191	1	0,02	0,0003
	Slovak Republic	5,4	221.530	39.344	704	1	0,18	0,0032
South	Portugal	10,6	355.483	16.663	1.111	1	0,05	0,0031

With reference to the weighting factors presented in Table 5-2, still a large range can be observed. In order to have one common set of weighting factors applicable to all different accident databases for the scenario analysis, an averaging by country population was calculated. This lead to the following proposed average casualty cost factors (see Table 5-3).

Table 5-3 Average casualty cost weighting factors

Injury Level	Average Weighting Factor
Fatal	1,0
Serious Injury	0,11
Slight Injury	0,011

In order to provide additional confidence to the proposed approach, a sensitivity study should be performed concerning the weighting factors in Task 1.2. Introducing variation to the proposed weighting factors the resulting changes to the final accident scenario importance should be analysed.

5.2 Application of weighting factors to accident data

After reviewing the accident and casualty costs, it was decided to use casualty valuations (where this was available) to assess the total casualty outcome of the accident scenarios. In order to consider the occurring injury severities in an accident a value is assigned to every accident. This value is calculated based on the casualties in the accident and the weighting factors for considering the injury costs (from Chapter 5.1). The size is calculated with the following the formula:

Number of slightly injured persons· 0.011 + Number of seriously injured persons · 0.11 + Number of fatalities · 1

By using this formula every accident obtains an additional value. Again the distribution of the accident type is generated. But this time the frequency of the accident types is determined by using the assigned values which consider the accident severity. A summary of the weighted distributions for the different dataset are presented in Table 5-4. The weighted distribution of the accident type for each dataset is visualized in the diagram in Figure 5-1 to Figure 5-4.

Table 5-4 Summary of accident type distribution based on injured persons in all involved vehicles in accidents involving at least on car by injury cost weighting factors (STATS19 is presented separately)

Injury severity of involved persons in accidents with injuries	Type 1a: Driving accident single vehicle	Type 1b: Driving accident multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic same direction	Type 6b: Accidents in longitudinal traffic opposite direction	Type 7a: Other accident single vehicle	Type 7b: Other accident multiple vehicles
GIDAS	23%	10%	27%	8%	1%	15%	6%	5%	4%
OTS	31%	-	22%	13%	1%	9%	22%	2%	-
STRADA	34%	-	22%	7%	1%	11%	19%	6%	-

GIDAS (Germany)
For the distribution of the accident type weighted with the injury costs there are only accidents involving persons with known injuries considered (cp. Figure 4-14). Accidents involving persons with unknown severities are excluded, which hold a share of less than 0.2%. The injury weighting factors are calculated and added as described in the preceding sections. The accident type frequency weighted with injury costs is shown in Figure 5-1. Single vehicle accidents are most frequent (28%). This group is composed of Type 1a and Type 7a. The second largest group are accidents at junctions (27%). Counting the whole Type 6 group (accidents in longitudinal traffic) together this is the third largest group (21%).

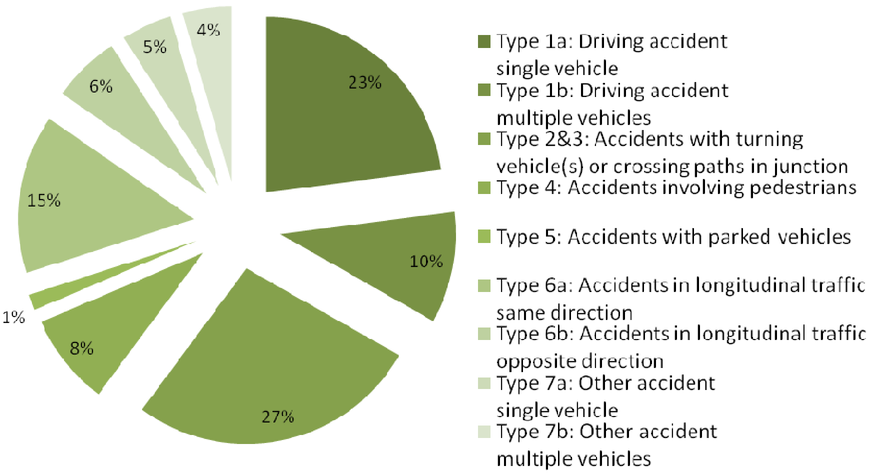


Figure 5-1 GIDAS accident type distribution weighted by injury costs (9 760 injury accidents involving at least one car – 532 accidents weighted with injury cost factors, 2001-2007)

OTS (UK)

The accident type frequency weighted with injury costs for OTS is shown below.
Single vehicle accidents account for the largest percentage (31%). The second largest group are accidents in the Type 6 group (accidents in longitudinal traffic). The third largest group is accidents at junctions (22%).

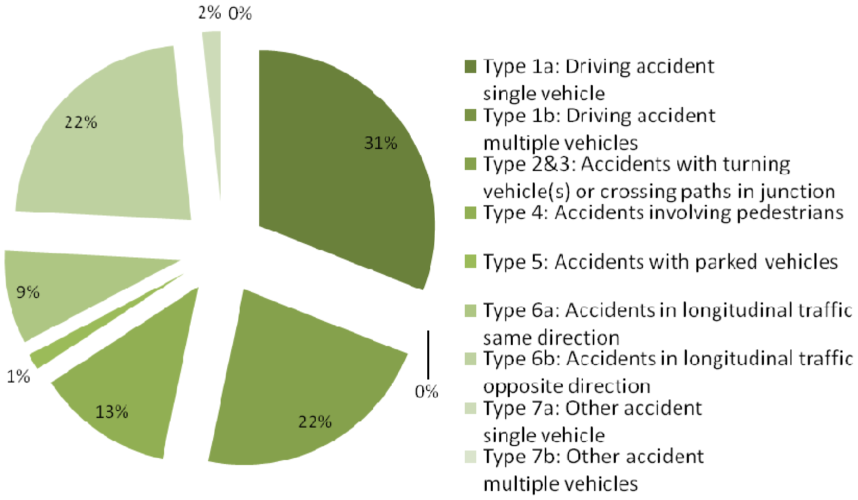


Figure 5-2 OTS accident type distribution weighted by injury costs (3 909 injury accidents involving at least one car 2000-07/2009)

STRADA (Sweden)

Since the cost calculation is based on injury severity for all road users involved in accidents with at least one car involved the accidents with unknown injuries were removed from the sample. Approximately 20% of the accidents were removed from the sample (see Figure 5-3).

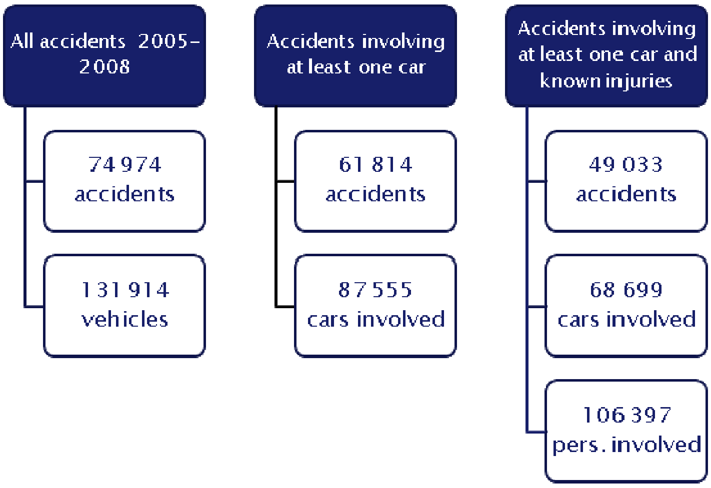


Figure 5-3 New data sample for STRADA, accidents with known injuries on all persons

The new distribution of accident type frequency is shown in Figure 5-3. Single vehicle accidents are still the accident type which is most frequent (34%). Counting the whole Type 6 group (accidents in longitudinal traffic) together this is the second largest group (30%). Using the subgroups for Type 6 makes accidents in junctions the second largest group and head on collision the third (18%).

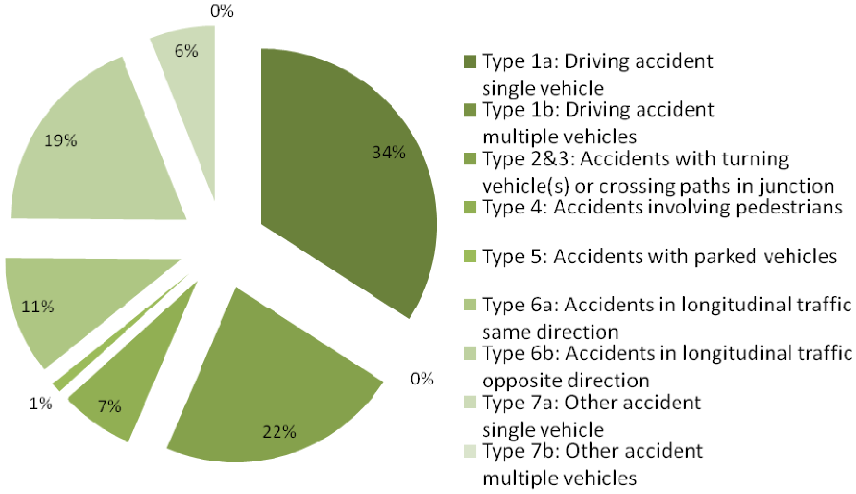


Figure 5-4 STRADA accident type distribution weighted by injury costs (49 033 injury accidents involving at least one car, 2005-2008)

Comparison with the dataset including the accidents with unknown injuries was performed. The persons with unknown injuries were assumed to have the same distribution as severe, slight and uninjured. No addition to the fatal group was made because STRADA is updated with all persons that are fatally injured in road accidents. The differences between the two samples are presented in Table 5-5. The difference does not change the distribution of the accident types with the highest weighted accident severity.

Table 5-5 Comparison on accidents type distribution between accidents including unknown injuries (n=61 814) and accidents with known injuries (n=49 033) in STRADA

Accidents including:	Type 1a: Driving accident – single vehicle	Type 1b: Driving accident – multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction (w/o pedest.)	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic – same direction	Type 6b: Accidents in longitudinal traffic – opposite direction	Type 7a: Other accident – single vehicle	Type 7b: Other accident – multiple vehicles
known injuries n=49 033	*34%*	–	*22%*	*7%*	*1%*	*11%*	*19%*	*6%*	–
unknown injuries n=61 814	*29%*	–	*24%*	*9%*	*1%*	*12%*	*18%*	*7%*	–

STATS19 (Great Britain)

For STATS19, the Great Britain national data was examined according the vehicle manoeuvre (first referenced car) and the manoeuvre of the other vehicle. This provided a proxy for the accident type and allowed the representative data to be compared to the findings from the in-depth analysis.

The total numbers of casualties in the accident were adjusted by multiplying the number in each severity group by the ratio presented in Table 5-3. This effectively gave fatal casualties more weighting than serious and serious more weighing than slight.

The result of this weighted ranking was then examined to determine those vehicle manoeuvres which resulted in the greatest percentage of casualty cost. Table 5-6 below presents the results.

Table 5-6 STATS19: Vehicle manoeuvre and greatest percentage of total weighted accident severity

Manoeuvre of car	Manoeuvre of other vehicle	% Total casualty cost
09 Turning right	00 No mutual contact	2.0%
09 Turning right	18 Going ahead other	7.9%
16 Going ahead left hand bend	00 No mutual contact	4.3%
16 Going ahead left hand bend	17 Going ahead right hand bend	2.7%
17 Going ahead right hand bend	00 No mutual contact	4.6%
17 Going ahead right hand bend	16 Going ahead left hand bend	2.3%
18 Going ahead other	00 No mutual contact	23.8%
18 Going ahead other	09 Turning right	2.2%
18 Going ahead other	18 Going ahead other	14.0%

This shows that the greatest proportion of casualty cost are for accidents which have “no mutual contact” (34.7% of casualty cost for the main accident groups; matched to Type 1 accidents) and accidents in which both participants had a manoeuvre of “going ahead other/right/left” (19.0% of total casualty cost in the main accident groups). In this case, this value comes from the sum o f 2.7%, 2.3% and 14.0%. This group is approximately aligned to Type 6 (accidents in longitudinal traffic) but includes all sub-types of this accident category as rear end accidents cannot be distinguished from frontal collisions with the available data; further analysis will be performed in Task 1.2. Turning accidents account for 10.1% of the total casualty costs for the main accident groups (Type 2&3; turning accidents).

5.3 Discussion

Throughout the analysis the three main groups identified as accident and injury producing accident types are Type 1 “single vehicle accident”, Type 2&3 “accidents with turning vehicle(s) or crossing paths in junction” and Type 6 “accidents in longitudinal traffic”. The results show that for Type 6 accidents, those which occur in longitudinal traffic (same direction) are more frequent (see Table 4-1), but that when the casualty valuations are applied, those which occur between vehicles travelling in opposite directions predominate (see Table 5-4).

When applying cost weighting factors for injury severity the results are more divergent between the datasets. For GIDAS (28%), OTS (31%), STRADA (34%) and STATS19 (35%) the highest frequency is single vehicle accidents (Type 1a for all databases except GIDAS Type 1a and Type 7a for GIDAS). GIDAS is followed by accidents in junctions, Type2&3 (27%) and accidents in longitudinal traffic, Type 6 (21%) while OTS and STRADA show second highest values for accidents in longitudinal traffic 31% and 30% respectively. Taking the numbers from STATS19 on Type 1 accidents and looking at Table 5-7 for the other datasets it can be concluded that single vehicle accidents have the highest impact on injury cost for injured persons.

For the GIDAS, OTS and STRADA data, the accident types were ranked according to their frequency. For comparing single vehicle accidents in GIDAS Type1a and Type7a were merged (23% and 5%). In the first comparison (see Table 5-7) accidents in longitudinal traffic which occurred in the same and opposite direction were merged because in the analysis of OTS and STRADA it was more difficult to distinguish between these subgroups. In the second comparison the subgroups were included in the ranking (see Table 5-8).

Table 5-7 Distribution and ranking of the accident types weighted be injury costs for injury accidents (ranking with merged Type 6 group)

Database	Injury severity of involved persons in accidents with injuries	Type 1a: Driving accident single vehicle	Type 1b: Driving accident multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6: includes 6a same direction and 6b opposite direction	Type 7a: Other accident single vehicle	Type 7b: Other accident multiple vehicles
GIDAS	frequency	23%	10%	27%	8%	1%	21%	5%	4%
	ranking	1	4	2	5	7	3	-	6
OTS	frequency	31%	-	22%	13%	1%	31%	2%	-
	ranking	2	-	3	4	6	1	5	-
STRADA	frequency	34%	-	22%	7%	1%	30%	6%	-
	ranking	1	-	3	4	6	2	5	-

In summary the following ranking of the accident types can be made based on the mean values of the rankings of the three databases, this ranking include the merged Type 6 group.

Rank	Accident type
1	Type 1a: Driving accident - single vehicle
2	Type 6: Accidents in longitudinal traffic (6a and 6b included)
3	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction
4	Type 4: Accidents involving pedestrians

Based on accident type distribution weighted for the injury costs it can be concluded that the most frequent accident type is “single vehicle accident” which shows a high percentage in all databases. OTS show same percentage for Type 1 and Type 6 accidents but the decimal gives Type 6 the highest ranking. The ranking considering all databases by using the mean value of the rank order and shows that the second ranked accident type is “accidents in longitudinal traffic”. In OTS it comes first together with Type 1 and in STRADA accidents of Type 6 come second, only in GIDAS it comes third. Accidents at junctions come third in the overall ranking. In GIDAS it comes second and in STRADA it comes third.

Table 5-8 Distribution and ranking of the accident types weighted be injury costs for injury accidents (ranking include subgroups 6a and 6b)

Database	Injury severity of involved persons in accidents with injuries	Type 1a: Driving accident single vehicle	Type 1b: Driving accident multiple vehicles	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction	Type 4: Accidents involving pedestrians	Type 5: Accidents with parked vehicles	Type 6a: Accidents in longitudinal traffic same direction	Type 6b: Accidents in longitudinal traffic opposite direction	Type 7a: Other accident single vehicle	Type 7b: Other accident multiple vehicles
GIDAS	frequency	23%	10%	27%	8%	1%	15%	6%	5%	4%
	ranking	1	4	2	5	-	3	6	-	-
OTS	frequency	31%	-	22%	13%	1%	9%	22%	2%	-
	ranking	1	-	3	4	-	5	2	6	-
STRADA	frequency	34%	-	22%	7%	1%	11%	19%	6%	-
	ranking	1	-	2	5	-	4	3	6	-

In summary the following ranking of the accident types can be made based on the mean values of the rankings of the three databases. This ranking includes subgroup 6a and 6b separated.

Rank	Accident type
1	Type 1a: Driving accident - single vehicle
2	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction
3	Type 6b: Accidents in longitudinal traffic - opposite direction
4	Type 6a: Accidents in longitudinal traffic - same direction
5	Type 4: Accidents involving pedestrians

When separating the Type 6 subgroups in the comparison the most frequent accident type is still “single vehicle accident” which is ranked as number one in all databases. The second largest group is in this comparison is Type 2&3 “accidents in junctions” which is also the case for GIDAS but in STRADA it is ranked third and in OTS it is ranked fourth. Type 6b “accidents in longitudinal traffic – opposite direction” is the third largest group in this comparison where OTS also shows a high share.

In both comparisons above “accidents involving pedestrians” follow after the three highest ranked groups (Type 1, 2&3 and 6). This is probably explained both by the fact that the distribution of this type is only around 5-10% in all databases and that there are normally less people injured in these accidents because the pedestrian is often injured but not the vehicle occupants (see Figure 4-1 to Figure 4-4).

Important factors to keep in mind when comparing these datasets are:

- The road geometry, traffic rules, vehicle stock, total population etc. differ in the acquisition areas of the accident data
- STATS19 could not be considered on the accident type level because of difficulties in finding comparable accident types.
- Both STATS19 and STRADA use police reported injury severity from the accident scene (fatally injured persons that die within 30 days of the crash is updated in the database).

The results concerning first impact point of cars based on GIDAS, STATS19 and OTS show the same ranking (see Chapter 4.3). Most of the cars involved in accidents with injuries initially sustain a frontal crash. A side crash in the initial collision comes second and a rear impact of the cars come third. The combination of first impact point and accident type shows similar results for GIDAS and OTS (see Chapter 4.4).

Table 5-9 Ranking of accident type by the first impact point

Rank	GIDAS	OTS
1	Front impact in Type 2&3	Rear impact in Type 6a
2	Rear impact in Type 6a	Front impact in Type 2&3
3	Side impact in Type 2&3	Front impact in Type 6a
4	Front impact in Type 6a	Front impact in Type 1

On the first two ranks GIDAS and OTS share the same impact point and accident type but in different order. As in the accident type, the frequency the accident type 2&3 is in GIDAS more common than in the other databases. This behaviour can also be seen in combination with the impact point. Front impact of cars involved in an injury accident of type 6a comes third in OTS. In GIDAS this group comes fourth. In GIDAS on the third rank there are again accidents of Type 2&3 but involving cars with initial side impacts. In OTS this group is on rank 5.

For ASSESS, pre-crash systems already on the market are to be considered for test procedures. Both of the systems available to ASSESS are pre-crash systems for accident avoidance and mitigation in frontal direction. The analysis shows that the largest accident groups relevant to these systems are Type 6 accidents and Type 2&3. Further accident parameters are required to define representative scenarios which can be used to assess the system performance in realistic conditions.

6 Conclusions

6.1 Preliminary ranking of accident scenarios

According to the analysis the following ranking of accidents types based on injury cost is concluded.

Rank	Accident type
1	Type 1a: Driving accident - single vehicle
2	Type 6: Accidents in longitudinal traffic (6a and 6b included)
3	Type 2&3: Accidents with turning vehicle(s) or crossing paths in junction
4	Type 4: Accidents involving pedestrians

The analysis has confirmed that the systems selected within ASSESS are relevant with respect to the current casualty problems, with Type 6 and Type 2&3 accidents being relevant to the ASSESS pre-crash systems. Even though accidents involving pedestrians are an important group to consider despite the low frequency this will not be analysed further in ASSESS. Further analysis in Task 1.2 will define the accident parameters at a more detailed level.

6.2 Recommendations for Task 1.2

Since ASSESS consider pre-crash sensing systems in frontal directions further analysis should be performed on the Type 2&3 and Type 6 groups. The result of the analysis in Task 1.2 should, if possible, deliver information on the following parameters;

1. Vehicle
    a. Driving speed
    b. Closing speed to opponent when normal driving
    c. Impact speed
    d. Relative distance to leading vehicle when normal driving
    e. Relative angle when driving
    f. Collision angle
    g. Impact location
    h. Acceleration (absolute and relative)
    i. Position
2. Driver behaviour
    a. Secondary task
    b. Manoeuvres
    c. Reaction on warnings
3. Road layout
4. Environmental conditions
    a. Weather conditions
    b. Road conditions
    c. Light condition (including sun position, e.g. driving against the light)
5. Type of vehicle/target/object
6. Collision deformation classification (CDC)
7. (Time to collision (TTC) as an indicator of system performance, e.g. for minimum TTC during the test if crash was avoided, but it is not a crash indicator)

As these parameters are directly linked to test facility capabilities and assessment method development further studies done under task 1.2 will be conducted in close cooperation with WP3, WP4 and WP5 leaders.

References

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Risk Register

Risk No.	What is the risk	Level of risk[1]	Solutions to overcome the risk
WP1.1	Preliminary accident scenarios not sufficiently detailed for Wp3&4..	2	WP1 to liaise with WP3/4 and produce more detailed data (Task 1.2) according to more specific needs of these WPs.

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[1] Risk level: 1 = high risk, 2 = medium risk, 3 = Low risk

Appendix 1 SafetyNet accident type definitions

Attached is an extract of the deliverable 5.5, Glossary of Data Variables for Fatal and Accident Causation Databases containing the accident classification system.