SafetyNet Final Activity Report

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Acronym: SafetyNet
Title: Building the European Road Safety Observatory

Integrated Project, Thematic Priority 6.2 “Sustainable Surface Transport”

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1. Contents

2. Executive Summary

SafetyNet is an Integrated Project funded under the Sixth Framework Research Programme. It has 21 Partners from 18 countries and has the goal of developing the framework for the European Road Safety Observatory. The project started in May 2004 and was completed in October 2008.

The need for a European level Observatory was first recognised in the EC 2001 Transport White paper and described in more detail in the 3rd Road Safety Action Plan (2003) where it stated *"The Commission intends to set up a European road safety observatory within the Commission as a pilot project funded from the EU budget. This observatory will coordinate all Community activities in the fields of road accident and injury data collection and analysis."*

This statement determined the basis for the SafetyNet project.

The European Road Safety Observatory is a system that brings together harmonised accident and other safety data to support evidenced based decision making for European and National level road and vehicle safety policymakers. The data and knowledge can be accessed through a website (www.erso.eu). Supporting this direct access to data is a broad ranging system of Macroscopic and In-depth data and a data analysis functionality. This large scale activity incorporates data harmonisation, assessment of data availability, gathering of pre-existing and new data and data analysis.

The principle areas of work and achievements are listed in the Table below.

Macroscopic Data	
CARE database	Extension of CARE from 15 to 27 EU Member States + Norway, Switzerland and Iceland
	Development and routine publication of Annual Statistical reports and factsheets on 12 different topics
	Estimating of accident under-reporting levels in 6 countries
	Development of Common Accident Data System
Exposure data	Development of standard protocols for exposure data
	Review of data availability and usability
	Recommendations for future collection of exposure data
	Pilot studies for exposure data gathering in selected countries
Safety Performance Indicators	Review of the State of the Art for SPIs
	Guidelines for gathering SPIs
	Comparisons of countries based on selected SPIs
	Recommendations for future SPI collection
In-Depth data	Recommendations for transparent and independent road accident investigation
	A Fatal Accident Database comprising 1300 cases with fully developed protocols and analysis.
	An In-Depth Accident Causation Database comprising 1000 cases with fully developed protocols, a new accident causation classification system (DREAM 3.0) and an overview analysis of the data.
Safety Information System	A website to provide access to data, knowledge and the SafetyNet project website including webtexts on 17 topical road safety subjects
Data Analysis	Application of time-series analysis, multi-level models and other analysis tools to CARE, Fatal Accident and other data to demonstrate appropriate statistical approaches for comprehensive analyses.

As determined in conjunction with the European Commission the Observatory will become an activity conducted routinely by DG-TREN and the data and knowledge from the ERSO website will be incorporated within the DG-TREN site.

3. SafetyNet Contractors

Project Steering Committee

- Vehicle Safety Research Centre, Loughborough University, UK
- National Technical University of Athens, Greece
- Centre d'Etudes Technique de l'Equipement du Sud Ouest, France
- SWOV Institute for Road Safety Research, Netherlands
- Institut National de Recherche sur les Transports et leur Sécurité, France
- Institut Belge pour la Sécurité Routière, Belgium

Partners

- Bundesanstalt für Straßenwesen, Germany
- Centrum Dopravního výzkumu, Czech Republic
- Chalmers University, Sweden
- University of Rome, Italy
- Finnish Motor Insurers' Centre, Finland
- Institute of Transport Economics, Norway
- Közlekedéstudományi Intézet Rt, Hungary
- Kuratorium für Schutz und Sicherheit, Austria
- Laboratório Nacional de Engenharia Civil, Portugal
- Medical University of Hanover, Germany
- Road Directorate - Ministry of Transport - Denmark
- Swiss Council for Accident Prevention, Switzerland
- Technion - Israel Institute of Technology, Israel
- TNO, Netherlands
- TRL Limited, UK

Affiliated Partners and Key Sub-contractors

- Agència de Salut Pública Barcelona, Spain
- University of Valencia, Spain
- University of Hasselt, Belgium

3.1. Evidenced based road safety policy-making – the background to SafetyNet

3.1.1. 2001 Transport White Paper

In 2002 the European Commission published its White paper on transport[1]. In this document it sought to put the road user at the heart of transport policy and it recognised the necessity to reduce the toll of road casualties. It reported data from 2000 identifying that over 40,000 people were killed each year, on the roads in the 15 Member States of the EU. The number was expected to increase upon the enlargement of the EU by a further 10 Member States that was planned to take place in 2004. A further 1.7 million people were injured in road crashes and the total economic cost to society had been estimated as exceeding €160 billion. The White Paper established the objective to reduce the total number of fatalities by 50% by the year 2010.

3.1.2. Evidenced based road safety management

Increasingly there has been the acknowledgement that a rigorous road safety management process has to be based on evidence and routinely policy-makers require impact assessments of the likely outcomes of their policies to justify implementation. This normally involves an assessment of the costs to society of implementation together with the overall benefits both in terms of casualty savings and economic returns. Once implemented it is best practice to review the short and long-term outcomes to ensure the benefits were achieved in reality.

In a report, also published in 2002[2], the OECD identified a number of key stages in an effective road safety management process.

- Vision – what is the broad goal that the process will move towards?
- Problem Analysis – understanding the magnitude and nature of all aspects of the road safety problem;
- Target Setting – What precisely are the quantitative objectives of the programme?
- Developing countermeasures – identifying the mechanisms to address specific aspects of the road safety problem;
- Establishing and implementing the programme;
- Monitoring of progress and evaluation of short and longer term outcomes

Many of these steps involve the application of safety data, whether to measure and characterise the road safety problem, to support the development of counter-measures, to form the basis of demanding but achievable targets or to measure outcomes. This data may take several forms though, totals of casualty numbers can give an assessment of the overall problem and with time can be used to measure trends but measures of accident risk are more meaningful when comparing countries with large and small populations.

Accident data gathered as part of the routine police procedures when investigating a crash will be insufficient in explaining more detailed aspects to accident causation and injury prevention, more detailed data is needed to support the development of technical or engineering solutions. Other types of safety data can be more effective and rapid than accident data when evaluating the outcomes of new policies.

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[1] European transport policy for 2010: time to decide, European Commission, Luxembourg 2001

[2] Safety on Roads - What's the Vision? OECD. Published by : OECD Publishing

Policy making is the primary user of road safety data but it has applications across the domains of many types of stakeholder. Road casualty trend monitoring and progress to targets is an important and primary function but road operators, the automotive industry, insurers, police, road safety advocates and other specialist groups all have a need for data.

The need for accident and safety data was first recognised in the 2001 Commission White paper but it was the 2002 Road Safety Action Plan[3] that fully registered the need to establish a European Road Safety Observatory (ERSO) with the purpose of bringing together all Community activities in relation to safety data and knowledge. The exchange of data between countries would take place under the auspices of an agreement made within the Council of Ministers in 2003[4]. As a result of this the SafetyNet project was initiated to assemble the framework of the Observatory and to develop a set of harmonised approaches to safety data. Furthermore it would develop a base of state of the art knowledge concerning key areas of road and vehicle safety policy-making. Primarily ERSO would be directed to policy-makers at EU and Member State levels but it was recognised that there were many other stakeholders who would have an interest including automotive manufacturers, road operators, police, insurers, NGOs and other safety advocates. The project started on 1 May 2004 and was completed on 31 October 2008.

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[3] EUROPEAN ROAD SAFETY ACTION PROGRAMME, Luxembourg: Office for Official Publications of the European Communities, 2003. ISBN 92-894-5893-3. COMMUNICATION FROM THE COMMISSION, COM(2003) 311 final

[4] Council conclusions on 5 June 2003 (Council doc. 10753/1/03 REV 1 – discussion on the road safety action programme – conclusion #8):

> *[The Council] urged Member States to co operate fully with the Commission in its efforts to carry out comprehensive analysis on the basis of appropriate data collection with particular attention to accident data, data on research and development, road safety performance indicators, risk exposure variables, investigation of accident causes and trauma data. In this respect, the comparability and harmonisation of data and the wide dissemination of data and knowledge to the decision makers and to the public is a priority, whilst respecting legal requirements in the field of privacy and data protection; […]*

4. SafetyNet Overview

The key areas of research conducted within the project were:-

Research and Development activities

- Further enhancement and exploitation of Care including extension to the 10 new Member States;
- Development of a methodology to gather risk/exposure data and integrate it to disaggregated datasets;
- The design and implementation of a Europe-wide network for periodical measurements of Safety Performance Indicators;
- Recommendations for independent road accident investigation;
- Development and implementation of a fatal accident database;
- Development of an in-depth accident causation database

Horizontal activities

- Provision of a Safety Information System to serve as a gateway for the information gathered together within the project
- An example set of validation data analyses demonstrating the effectiveness of the co-ordinated approach to accident data

The Observatory broadly would comprise two parts, the external facing, web-based repository of data and knowledge and the internal system of data gathering, data assembly and harmonisation activities to ensure a consistent institutional database. Initially the Observatory development was directed to the data concerning the existing 15 EU Member States and the additional 10 States who joined on January 2004. During the course of the project a further two States joined the EU and the scope was extended to include these countries as well as Switzerland, Iceland and Norway. The Observatory was formally launched at a project conference that took place in Rome in May 2008.

4.1. *Methodology for data development*

The development of institutional databases involves a standard series of stages as shown in Figure 4.1.

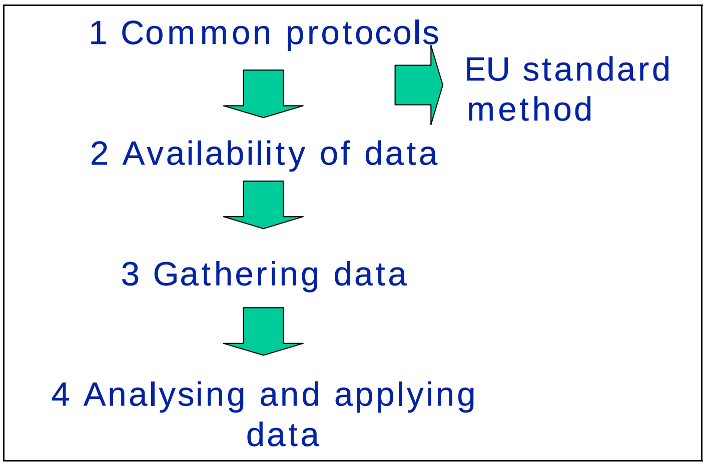


Figure 4.1: Process of data harmonisation

1. The specification of the variables, values and data structure will be defined. This can take the approach of identifying the areas of overlap where all component datasets can be transformed to a common format or alternatively the ideal data specification can be defined and existing procedures be modified to gather that data. Within the

context of the ERSO these common protocols are taken to represent the standard European specifications.

2. Not all data is available in each Member State, it may be unavailable or partially available and a key step is to verify this status. Depending on availability it may be the data can be recoded using systematic transformation rules or a new procedure for gathering it may need to be implemented.

3. The third stage is to gather the data, normally either from administrations or using newly developed processes or teams. Data has to be validated and assembled into a coherent structure that can subsequently be used for application to policy-making.

4. The final stage is to apply the data to specific research and policy issues. In part this means identifying the data as a relevant tool for policy purposes and ensuring it is accessed and utilised. While it is often the case that much safety data can have a wider applicability than is normally utilised it is also normal that analysis questions can be hugely varied and it is difficult to predict the exact data needs of future analysis at the point when data protocols are being defined. It is therefore essential to have a routine feedback from data application to data acquisition and to ensure data gathering is a dynamic and evolving process.

At the commencement it was clear that some safety data tools, such as the national accident databases, were relatively well developed while others such as exposure measures were less so. Some types of data such as safety indicators and in-depth data were effectively still at the experimental level and, since access to the CARE dataset was heavily restricted, there was little experience of pan-European accident analysis.

4.2. Scope of the SafetyNet project

The SafetyNet activities were divided across three main work areas dealing with macroscopic data, in-depth data and data application. The CARE database was to be developed and used to develop annual statistical outputs; data describing exposure, used to evaluate risk, was to be harmonised and gathered at a pilot level; a range of safety performance indicators were to be specified and gathered from Member States; the pan-European approaches to accident investigation were to be evaluated and recommendations made for future practise; a new set of in-depth fatal and accident causation data was to be developed and gathered on a pilot basis; a website to provide access to safety data and knowledge was to be implemented and a set of data analyses, based on harmonised data, was to be conducted.

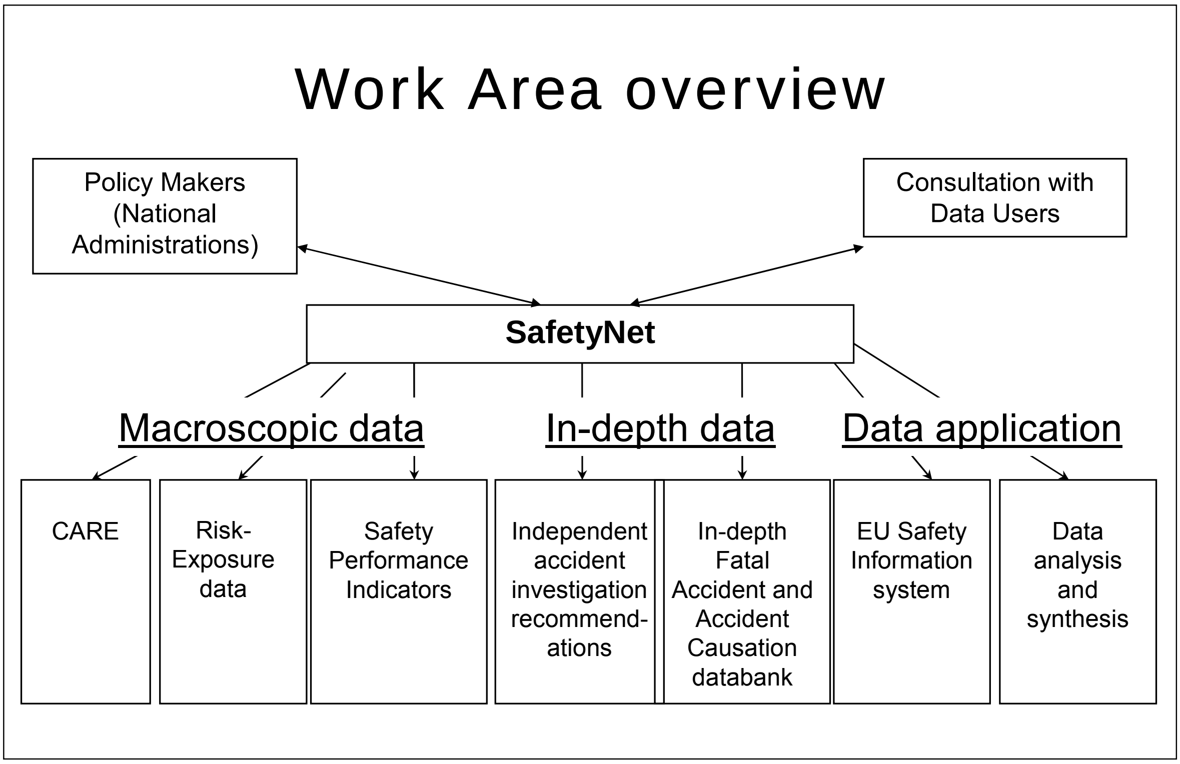


Figure 4.2: SafetyNet areas of work

Additionally the project was to develop strong links with policy-makers within the Member States and this was achieved through the CARE and Safety Performance Indicators National Experts Groups.

5. Enhancement and Exploitation of CARE accident data

5.1. Overview

As part of its work with macroscopic data SafetyNet deals with the further **enhancement and exploitation of the CARE system**, the European Community database with disaggregate data. Under that perspective, all SafetyNet outputs in this area aim at contributing to the further development of the CARE system as a complete and powerful tool for road accident analysis, which will additionally contain a comprehensive set of end-products with compatible statistics, useful for the improvement of road safety in the European Union. Within the SafetyNet life-cycle, the work carried out was supplementary to the tasks for the development of the CARE system by the European Commission.

On this purpose, a methodology of **five distinct tasks** was adopted. Firstly, the compatibility improvement of data from fifteen EU countries (10 new Member States at the time of the beginning of SafetyNet and additionally Bulgaria, Iceland, Norway, Romania and Switzerland) to CARE was carried out through the development of appropriate transformation rules, to be applied on existing national road accident data. A process similar to the CAREPLUS 1 and 2 methodologies was used, fulfilling the priority of the European Commission DG - TREN to have progressively compatible data for more EU countries and form a more complete picture on the road safety level in Europe.

Another task in this area concerned the identification of possible **links between the CARE accident data and the outcomes of other SafetyNet work**, as well as of other relevant projects. In particular the possibilities to integrate part of the work carried out addressing Risk and Exposure Data, Safety Performance Indicators and also in-depth accident data in the CARE framework were examined, offering new possibilities to improve the understanding of the accident population at macroscopic level. When these data become available at EU level, there will be a need to adapt the CARE system to incorporate them. Furthermore, synergies between the work to develop CARE and subsequent accident data analysis were identified, allowing for time-series and multilevel analyses of CARE accident data, but also of medical data gathered in the framework of national studies on underreporting in eight EU countries. Finally the establishment of links between the CARE system and the SUNflower +6 methodology was examined.

The **development of a comprehensive set of statistical outputs with comparable statistics**, useful for the support of decisions aiming to the improvement of road safety in the European Union was also an objective. These statistical outputs concern Annual Statistical Reports and 12 Basic Fact Sheets, as well as a recommendation for a set of Aggregate Data Files, all based on data derived from the EU CARE road accident database. Various types of road accident data users, ranging from road safety analysts to the wider public, form the target audience to which these statistical outputs are addressed and thus, their content and format was accordingly defined.

Furthermore, the improvement of accident data compatibility throughout Europe was attempted through the establishment of a recommendation for a common framework for road accident data collection, among all EU countries. After the elaboration of this **Common Accident Data Set** (CADaS), every EU country wishing to update its data collection system will be able to optionally and gradually use this common set. Thus, progressively, more and more common road accident data from the various countries will be available in a uniform format and in this way CARE, the European data base with disaggregate data on road accidents will gradually contain more compatible and comparable data, allowing for more reliable analyses and comparisons across the European countries.

Finally, the development of a **method to estimate the numbers of non-fatal casualties in Europe** more accurately was attempted, by addressing the under-reporting issue, as well as the differences of injury classification in the different national systems. This was accomplished through national studies in eight EU countries, attempting to identify the underreporting level for each casualty severity (killed, seriously injured, slightly injured) with a uniform methodology and additionally, by attempting to introduce a new common measurement unit for the identification of the road accident casualties in the European countries: the number of hospitalised persons.

5.2. Compatibility improvement of data from the new Member States

With the accession of the 10 new Member States in the European Union in 2004 (**Estonia, Malta, Cyprus, Latvia, Lithuania, Czech Republic, Slovakia, Slovenia, Hungary and Poland**) there was a need to have the new countries accident data available into the existing CARE system in order to form a more complete picture on the road safety level in the EU. Additionally, accident data from certain states of the European Economic Area (**Norway, Switzerland, Iceland**), but also from **Bulgaria** and **Romania** were progressively incorporated into CARE, which in this way will be enhanced and extended, allowing the establishment of a broad and compatible accident database, a more comprehensive set of road safety analyses and comparisons among all countries at EU level.

To that purpose, the following **five step methodology** based on the CAREPLUS structure has been developed, in order to appropriately transform the national accident data from the EU countries and make it compatible to the CARE system.

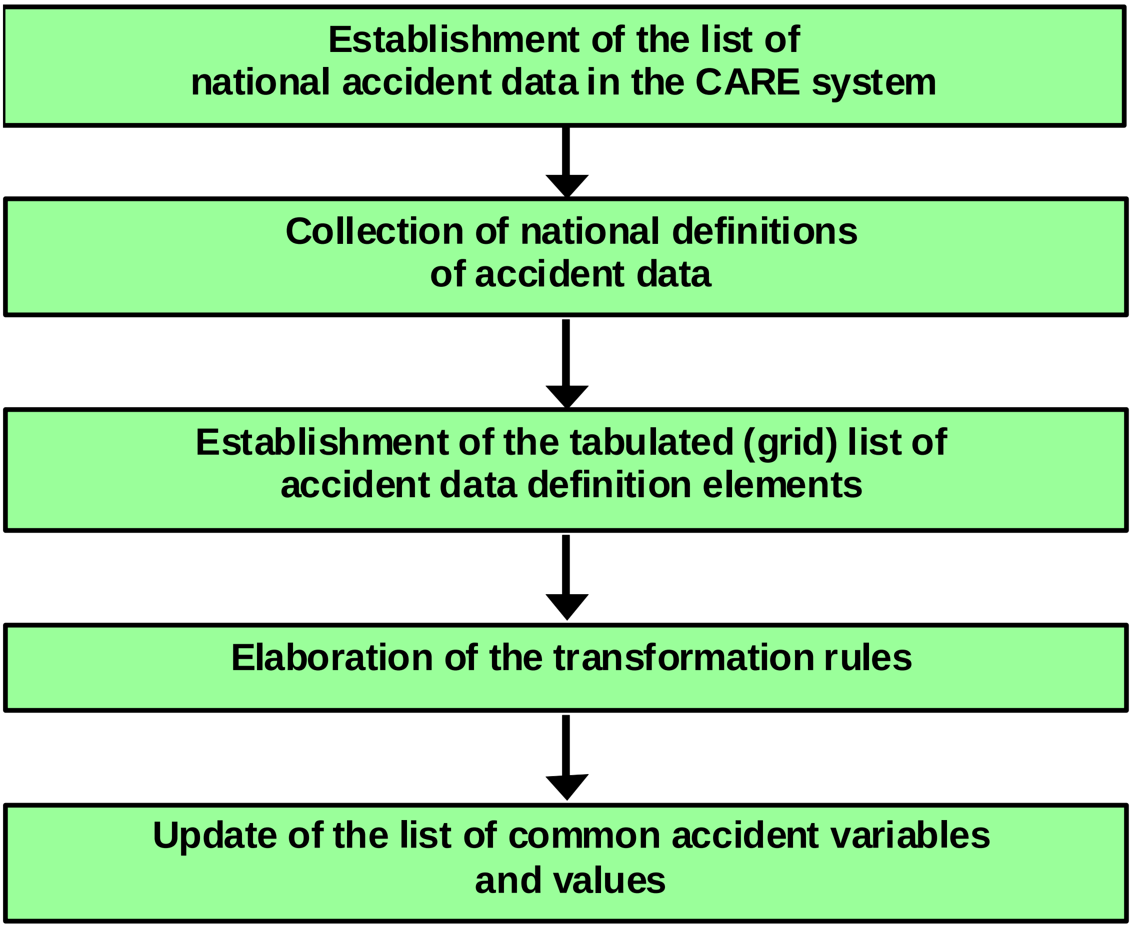


Figure 5.1: Five step method for CARE harmonisation

As in the CAREPLUS projects, which were designed to improve the comparability of national road accident statistics, held in the European Union road accident database CARE, this was achieved by restructuring existing national road accident files within the CARE system, rather than harmonising the collection methods of EU countries. Appropriate procedures were developed to **transform original national road accident variables into common road accident variables**, which can subsequently be compared among all or most EU countries.

It should be noted that obtaining comparability will leave unchanged differences in the reporting level of accidents, or variations in data quality that already exist between Member States' road accident systems.

Within this framework the **basic working principles** of CAREPLUS were used to develop the appropriate transformation rules for the road accident data of the 15 additional EU countries:

1) Compatibility with the national road accident data was examined only for the **existing common CARE variables and values**.

2) For these common variables and values, the **definitions were collected in both native language and English** and information on their relation to some predefined definition interpretations was collected through the Grids. However, definitions of the non-common national variables and values were also recorded and are included in this Deliverable.

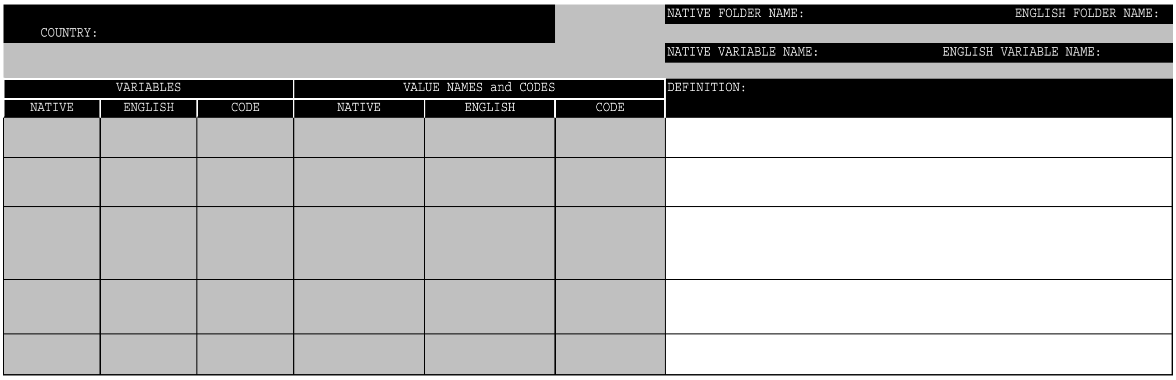
3) In some cases, **qualitative information** regarding the collection of some national variables and values was also recorded (frequency of specific data collection, reliability of data collected, etc.), supplemented by more general information on the national road accident data collection system, enabling the identification of any particularities that could assist the appropriate development of the respective transformation rules.

4) **Transformation rules** for the common variables and values were established using the same procedure and format as in the CAREPLUS project.

5) In certain cases, **recommendations** were made **for additional national variables or values** that could be considered for inclusion into CARE at a next stage. This mostly concerned variables and values that were similar among the national accident databases and were common in most of the examined countries. However, further investigation should also consider whether these are also included in the national databases of the 14 EU countries, data of which is already included into the CARE system.

Initially, a **complete list of the common national accident variables and values** already incorporated in the CARE system and the relevant definitions was established.

At a second stage, the **full description of the national road accident database** of the countries was recorded. More specifically, all the national road accident variables and values, along with the related definitions were collected by all new Member States, as well as Norway, Switzerland, Iceland, Bulgaria and Romania using the following appropriate template.



COUNTRY:

NATIVE FOLDER NAME: ENGLISH FOLDER NAME:

NATIVE VARIABLE NAME: ENGLISH VARIABLE NAME:

VARIABLES			VALUE NAMES and CODES			DEFINITION:
NATIVE	ENGLISH	CODE	NATIVE	ENGLISH	CODE	

Figure 5.2: Country template

This information was collected in both native language and in English and in several cases it was accompanied by sketches (i.e. for the accident or collision type variables) and information on the quality and collection methodology of the national variables. Additionally, **technical information on the linkage process of the variables** included in different folders of the national databases was recorded, allowing for better understanding of the database structure and the interrelation of the different variables.

The entire information collection process was **coordinated by the European Commission** and took place through the **national representatives, members of the CARE Experts Group**. Necessary links were established between the partners and the national Experts during the CARE Experts Group meetings and especially during the CARE Experts Group meeting in 2004 and 2005, an official request was addressed by the EC to the national Experts to provide a first set of necessary information on their national road accident database, the variables and the values collected at national level and the related definitions. This first set was initially exploited by the partners, who subsequently were working more closely with representatives of the countries for which they were responsible. In general, all national representatives provided significant assistance to the work of the Task 1.1 partners and only in exceptional cases, some difficulties were temporarily confronted either with the establishment of contact with the appropriate persons or with delays in the provision of the necessary information.

At the same time, the **tabulated lists (Grids)** of the national accident data definition elements developed within the CAREPLUS projects and already filled-in for the 15 EU countries were also filled-in for each examined country, in close collaboration with the national Experts. In these Grids, the national definition components for the common values of the common CARE variables are summarised and the availability of each component for each Member State is indicated. Grids can be considered as the "building" blocks for developing at a next stage the transformation rules. In the following figure a part of the Grid is presented.

	CARE European road accidents database																
National definition components																	
	A	**B**	**D**	**DK**	**E**	**F**	**FIN**	**GB**	**GR**	**I**	**IRL**	**L**	**NI**	**NL**	**P**	**S**	**IS**
DATA AVAILABILITY :																	
information collected in country	x	x	x	DK	E	x	x	GB	GR	I	6	x	NI	NL	x	x	
exact data value provided to CARE	x	x	x	x	x	x	x	GB	x	x	6	x	NI	x	x	x	
data value can be derived in CARE	x	x	x	DK	E	x	x		GR	I		1		NL	x	x	
value included in another value :																	
car or taxi	A	B	D			F	FIN				2				P	S	
light vehicle												L					
VALUE IN VARIABLE :																	
vehicle type			D		E	F		GB	GR	I	IRL		NI		P		
element type	A	B		DK			FIN					L		NL		S	
transport type															P		
DEFINITION COMPONENTS :																	
motor vehicle				DK	E			GB	GR	I	IRL	L	NI	NL			
three wheeled vehicle				DK				GB	GR	I	IRL		NI				
four wheeled vehicle				DK	E			GB	GR	I	IRL	L	NI	NL			
type B driving licence required				DK	E			GB	GR	I	IRL	L	NI	NL			
with a trailer				DK	E			GB		I	IRL		NI	NL			
without a trailer				DK	E			GB		I	IRL		NI	NL			
VEHICLE WEIGHT :																	
light vehicle					E												
gross weight more than 400 kg				DK													
gross weight of less than 3.5 tonnes				DK													
NUMBER OF SEATS :																	
vehicle with no more than 8 passenger seats				DK	E			GB	GR	I	IRL	L	NI	NL			

Figure 5.3: Extract of grid

The elaboration of the appropriate transformation rules through the analysis of the national databases (description, content and definitions), as well as the exploitation of the information collected using the Grids was the next step of the methodology.

Common variables and values are derived from the original national variables and values using transformation rules. These **transformation rules** are logic statements, which contain the Boolean operators, for example, “AND” (intersection), "OR" (union) "=" (equal) and "NOT EQUAL". As an example, for the CARE value “Injury Severity Person: Killed” the transformation rule for Poland is the following:

Injury Severity Person: Killed = C [(killed on the spot: yes) OR (killed within 30 days after accident: yes)] OR D [(killed on the spot: yes) OR (killed within 30 days after accident: yes)]

During this process, **interrelation between the CARE database and the national variables and values** was examined, based on the variables and values definitions, as well as on the structure of the national database. On this purpose, specific templates were developed, allowing for a common format of the transformation rules between the countries. The definitions of the national variables and values were analysed and it was examined whether they could identically match with the respective CARE variables and values or a combination of more than one variables and values was necessary. In this latter case, associated variables were formulated.

An **associated variable** is one that is not included in the common variable list, but its values are incorporated in the transformation rules to get common variables and values. As an example, the associated variable “Car or Taxi” has its transformation rules for Poland as follows:

National values: Car = B [(vehicle type: 4 TO 5)] and Taxi = B [(vehicle type: 6)]

CARE value: Car or Taxi = B [(vehicle type: 4 TO 6)]

The finalisation of the transformation rules was completed through an **iterative process** between the SafetyNet partners and the national Experts from each country, as additional information was often required, clarifications on the variables and values definitions were necessary, as well as verification of the rules at several stages of the work. The final validation of the transformation rules took place by the Member State but also by members of the EC CARE administration.

Finally, additional variables and values from the national databases, which are considered useful and important for road Accident analyses at European and national level, are recommended to be included in the existing list of common CARE accident variables and values. In this way the respective Glossary of definitions is updated and enriched, incorporating new road accident elements.

With the finalisation of the transformation rules for the fifteen European countries, these can be applied on the national road accident datafiles that are sent to the EC CARE administration and comparable accident data will be soon available for 29 EU countries. Currently there are already data for 5 new countries in the CARE system.

Concerning the experiences attained from the work with these countries, it was evident that all governmental correspondents clearly perceived the importance of becoming an active partner of the European CARE road accident database. Moreover, the study of different national database structures, as well as the definitions of the variables, has provided **insight on different ways to analyse an accident** and to identify different perspectives on the possible use of the analysis outcomes.

Additionally, the integration of data for more countries will provide a wider spectrum for future projects in order to:

- Work on further elements of comparisons between the Member States
- Broaden the subsets of comparable countries (by category, by population etc)
- Assess more precisely the different road safety policies in any country.

Part of this work was also exploited when dealing with the improvement of accident data compatibility throughout Europe. The information from the Grids filled-in for these fifteen countries was used, and the recorded structures of the national accident data collection systems were analysed, allowing for the identification of the different fill-in systems and the links between the various road accident variables. Special attention was given to the national road accident variables and values that are not currently included in the CARE database, exploring the opportunity to embody the most useful for analysis and the most common ones among the examined countries, into the recommendation for the common data set.

5.3. Links with in-depth, exposure, SPI and other data files

The identification of possible links between the CARE accident data and the outcomes of other SafetyNet activities, as well as of other relevant projects such as Sunflower was attempted.

Regarding **risk/exposure data** (RED) the work carried out aimed at providing comparable RED, in accordance to the existing CARE accident data, in order to enable comparisons and/or use of RED data for producing risk estimates at EU level. All necessary links to the CARE database, concerning its structure, variable and value definitions etc were established and more detailed information included in the CARE database was exploited in order to compare variables, values and definitions as well as propose general transformations to obtain usable sets of RED.

A set of risk exposure data was also exploited together with the existing CARE accident data in order to produce a number of **basic risk indicators**. These indicators were included in the various editions of the Annual Statistical Reports and Traffic Safety Basic Facts. More specifically, population and motorway length data were mainly used in combination with accident data and allowed for the calculation of appropriate indicators across the EU.

With reference to the links of CARE accident data with the **Safety Performance Indicators**, in order to define and establish appropriate SPIs on several road safety issues, among other factors, the CARE data availability and needs were taken into account. In order to conclude to the variables and values used for the SPIs the definitions of the relevant CARE variables and values were thoroughly examined, as well as information on their quality, completeness and availability. As an example, concerning the SPIs on **Protective Systems**, wearing rates of seat belts and helmets were proposed for various road users and vehicle types. The respective disaggregate data on road accident casualties are available on the CARE database for many countries and years. These data could well be used in conjunction with analytical data on protective system use in order to produce interesting statistics.

Links with in-depth data were established within the framework of the recommendation for the Common Accident Data Set (CADaS), in order to identify and define common variables and values to be used at the common part regarding macroscopic data of CADaS and the Glossary for in-depth investigation. This interaction resulted to the formulation of two consistent and compatible up to a certain extent accident data collection systems. Although the aim of each system is different (macroscopic data collection and in-depth data collection), the data elements were developed in a compatible way maximizing the potential for exploiting these data at a European level. Macroscopic data allow for the identification of accident trends and the conduction of accident related studies (i.e. identification of hazardous locations) while in depth data provide better understanding of accidents (accident mechanisms, causation etc). As the implementation of countermeasures and policies is based upon studies that use both macroscopic and in-depth data, the improvement of data availability and compatibility between the two systems further enhances the potential for exploitation of these data at a European scale.

Furthermore, the enhanced CARE data provided new input for conducting additional Time Series and Multilevel analyses on selected road safety topics, as the most important source of accident and casualty data for these analyses were coming from the CARE database. Regarding the **identification of geographical dependencies** using CARE data and enforcement data in Greece, the effects of speed infringements and alcohol controls on the accident and fatality number for each Greek county were analysed and the availability of CARE accident data in disaggregate form (by county - NUTS 3 level) proved very useful for the identification of the correlation between enforcement measures and fatality numbers.

Regarding **modelling injury under-reporting** in seven European countries, the information and data on the under-reporting level for non-fatal casualties in several EU countries was exploited. On that purpose national accident data from police reports were brought together with hospital data in each country and on the basis of these results, the subsequent analysis assessed the extent and the variation of the underreporting problem in different countries.

Finally the possibility to **combine the SafetyNet outputs with the footprint methodology** developed within the framework of the SUNflower (+6) project was explored. A common SafetyNet - SUNflower workshop titled "Setting the stage for the European Road Safety Observatory", took place aiming at addressing the connection between policy questions, knowledge and data. Presentations targeted on specific road safety topics (i.e. "Powered two-wheelers road safety"), in which CARE accident data were combined with other types of data defined within the SUNflower (+6), revealed the indicate how the SUNflower methodology can be applied on road accident data allowing for the formulation of a more complete picture of the road safety level and subsequently facilitating decision making.

5.4. Development of Statistical reports and Analysis notes

The exploitation of the EC CARE database can also be optimised through the development of a **comprehensive set of statistical outputs with comparable statistics**, useful for the support of decisions aiming to the improvement of road safety in the European Union. These outputs concerned **Annual Statistical Reports** and **Traffic Safety Basic Facts**. Additionally, the recommendation for the development of a set of **Aggregate Road Accident Data Files** has been developed to allow the CARE users to have direct access to useful sub-sets of CARE data. The basis for all these products are road accident data retrieved from the CARE database. Various types of road accident data users, ranging from road safety analysts to the wider public, form the target audience to which these statistical outputs are addressed and thus, their content and format was accordingly defined.

The development and dissemination of the various outputs took place in **three distinct steps**: Initially, the exact set of statistical reports and analysis notes was defined. Then, the identified Annual Statistical Reports, Basic Fact Sheets and Aggregate Data Files were prepared and finally, based on the experience attained through the preparation of these statistical outputs, establishment and promotion of this complete set of analysis techniques took place. This methodology allowed for maximum flexibility and potential with regard to analysis of the information available in the system and thus, opened up a whole set of new possibilities in the field of accident analysis.

In order to define the set of statistical reports and analysis notes, several existing **international databases were evaluated**. Relevant information for each of these databases (Fatality Analysis Reporting System - FARS, Community database on Accidents on the Roads in Europe - CARE, United Nations Economic Commission for Europe - UN/ECE, World Health Organisation - WHO, EUROSTAT, International Road Traffic and Accident Database - IRTAD, European Conference of Ministers of Transport - ECMT) were collected and assessed. FARS (Fatality Analysis Reporting System of NTHSA) in particular is highly comparable with the CARE database as it also uses disaggregate road accident data. Additionally, in order to define the content of the outputs in terms of road accident variables and values used, the needs of the several road accident data stakeholders in seven EU countries (AT, CZ, DK, EL, HU, NL, UK), as recorded in a relevant Grid developed in SafetyNet WP1, as well as the respective information collected by the CARE Experts Group through a questionnaire on the road accident data collection, were also considered.

Following this review, it was decided that Annual Statistical Reports and several Annual Basic Fact Sheets will be produced both in electronic and paper form, based on disaggregated accident data retrieved from CARE. Additionally, a set of Aggregate Accident Data Files will also be produced, allowing the CARE user to have direct access to useful sub-sets of CARE data. During the 4.5 years of SafetyNet **five editions of Annual Statistical Reports and Annual Basic Fact Sheets** have been developed on an annual basis and were presented to the public in electronic and paper form. The basis for all these products are road accident data retrieved from the CARE database.

These deliverables were enhanced each year by the outputs of other SafetyNet activities, using also the latest available CARE data. There were several links to other areas of work within the project:

- The national accident data from new Member States of the European Union and other countries are progressively being added to the CARE database. Data from more countries will bring a broader view of road safety in Europe. In the Basic Fact Sheets 2007 and 2008, up to five new member states were included: Czech Republic, Estonia, Hungary, Malta and Poland and data from more countries will also be available for future editions.

- Risk Exposure Data is necessary to compare the safety situation between countries. Using available exposure data such as population and length of road network in combination with the CARE accident data, appropriate risk indicators are developed, allowing for more accurate comparisons among countries.

All five editions of the Annual Statistical Report and Basic Fact Sheets were reviewed by the members of the CARE Expert Group and the SafetyNet Steering Committee (SafetyNet internal quality system), before they were submitted to the European Commission.

The recommendation for Aggregate Data Files was another output, which will allow **users of road accident data outside the CARE structure to have access to aggregate road accident data** retrieved by the CARE database. This recommendation to the European Commission concerned the structure, the format and the size of these data files that could be useful for road safety analyses.

5.4.1. Annual Statistical Report

The Annual Statistical Report is a document consisting of a **large number of Tables and Figures** with data retrieved from the CARE database, which are not further analysed or commented. The definitions of the variables used in the Annual Statistical Report are included at the end of the report.

The chapters comprising the Annual Statistical Report, as well as the related Tables and Figures have been selected by looking at the main interests of several potential road accident stakeholders. The project partners closely collaborated with the EC-CARE administration, in order to identify which types of data/information are comparable among countries and which are open to misinterpretation. Therefore, detailed Tables and Figures containing accident data and data about injured persons were excluded from these deliverables and only numbers of fatalities and numbers of fatal accidents were used.

Every year, the Annual Statistical Report was compiled with the last available data from the CARE database and in every new edition new Tables or Figures were added, in order to get a more comprehensive picture of the road safety level in Europe. At the beginning of the SafetyNet project the CARE database included 14 EU countries. The latest (fifth) edition of the Annual Statistical Report already includes 19 out of EU 29 countries. Moreover, during the development of the various editions within the last years, more common variables and values defined within the framework of the CAREPLUS 2 project were gradually included and the latest edition consists of more Tables and Figures than the previous editions.

Each edition of the Annual Statistical Report contains road accident **data for the previous ten years and more detailed data for the last available year**. Fatality rates for the majority of European member states (EU-25) are only presented in the "Overview" chapter of the Report.

The fifth edition of the Report (Annual Statistical Report 2008) consists of 56 Tables and 28 Figures with the most interesting combination of CARE road accident data on the following major topics:

- Overview – major issues
    - EU-25 – Developments (also includes data other than CARE)
    - Interesting Details
- Time Series – last 10 years
    - General time series
    - Time series related to mode of transport
    - Time series related to person age and gender
- Fatalities 2006
    - People involved
    - Modes of transport
    - Accident characteristics
- Fatal accidents 2006
    - Various periods of time (month, day of week, hour of day)
    - Type of area / road
    - Type of junction
    - Weather conditions

The chapter "Overview – major issues" includes the overall description of the road safety situation in the EU, the development of fatalities in the countries over time and interesting details about the distribution of fatalities in the EU by gender, area type and mode of transport is provided. Country comparisons about children and senior citizens fatalities are also available in this section.

In order to monitor trends, time series about fatal data from the last 10 years are used in the chapter "Time Series – last 10 years". Behind general time series (e.g. "Annual number of fatalities by country") more specific series about mode of transport, age and gender are presented.

The next chapter "Fatalities 2006" contains Tables and Figures with data from 2006 or the last available data from each country. This yearly dataset is analysed in several directions in the following pages. The sub-chapters "People involved", "Mode of transport" and "Accident characteristics" reflect the hierarchical structure of road accidents.

As fatal accidents are currently the only comparable data beside fatalities among EU Member States due different levels of injury underreporting in the countries, in the chapter “Fatal accidents 2006” fatal accidents are analysed for different accident related attributes like time, area type, type of junction and weather conditions. In contradiction to fatalities no correction factors are applied to the number of fatal accidents for countries which do not use the 30 day definition for fatalities.

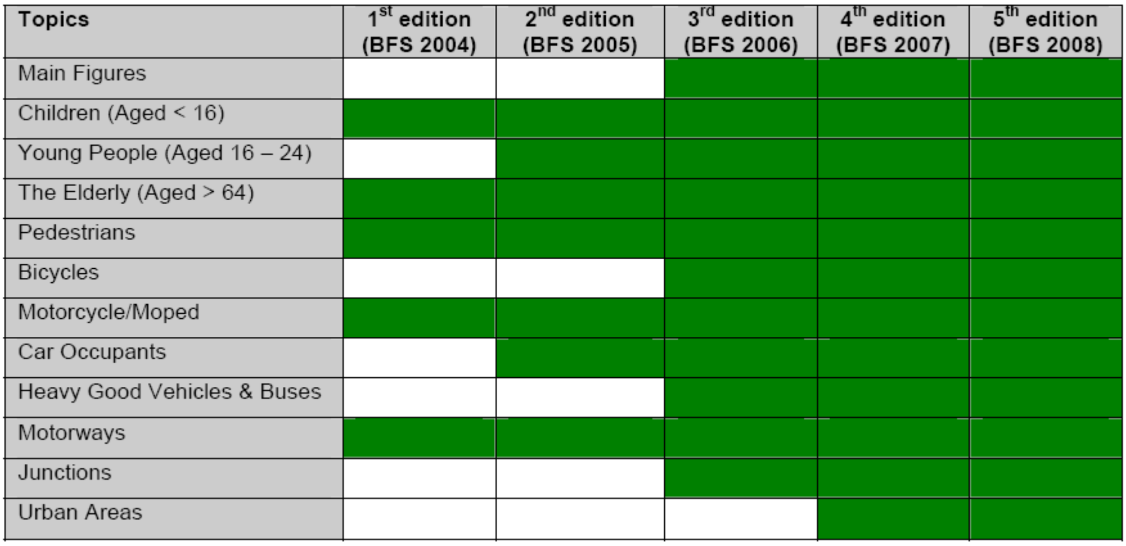
5.4.2. Traffic Safety Basic Facts

The Traffic Safety Basic Facts present detailed road accident information for different road safety related areas and road user groups in a simple and comprehensive way, as they contain **Tables and Figures together with some principal analysis and basic comments**.

The development of the Traffic Safety Basic Facts follows some **basic guidelines** to assure their acceptance by the public:

- Only data on **fatalities and fatal accident** are used in the Traffic Safety Basic Facts, as data on other casualty types incorporated into the CARE database is not reliable due to different definitions and levels of underreporting and is also not comparable among different EU member states, due to different definitions used.
- The Traffic Safety Basic Facts should not exceed a length of **approximately 15 pages**, as they should be easy to read and should not include in-depth analysis, as they are addressed to the wide general public and press and not only to people specialised on road safety.
- The most interesting findings are outlined in the **"highlight boxes"**, as this attracts the attention of the readers to focus at these issues and notice the relevant data in Tables and Figures.
- Each Traffic Safety Basic Fact starts with a **time series** of the specific issue where the last decade is examined, as this allows a comparative overview throughout the years and also indicates the trends for the same period.
- In order to develop appropriate accident rates and allow comparison between different EU countries, available **exposure data** (e.g. population, length of road network etc.) from other international databases are combined with accident data from CARE, with Eurostat and IRTAD being the main sources.

During the life cycle of the SafetyNet project the number of Traffic Safety Basic Facts rose from 5 to **12 different Basic Facts**. The following topics were examined in the five different editions:



Topics	1st edition (BFS 2004)	2nd edition (BFS 2005)	3rd edition (BFS 2006)	4th edition (BFS 2007)	5th edition (BFS 2008)
Main Figures			🟩	🟩	🟩
Children (Aged < 16)	🟩	🟩	🟩	🟩	🟩
Young People (Aged 16 – 24)		🟩	🟩	🟩	🟩
The Elderly (Aged > 64)	🟩	🟩	🟩	🟩	🟩
Pedestrians	🟩	🟩	🟩	🟩	🟩
Bicycles			🟩	🟩	🟩
Motorcycle/Moped	🟩	🟩	🟩	🟩	🟩
Car Occupants		🟩	🟩	🟩	🟩
Heavy Good Vehicles & Buses			🟩	🟩	🟩
Motorways	🟩	🟩	🟩	🟩	🟩
Junctions			🟩	🟩	🟩
Urban Areas				🟩	🟩

Figure 5.4: Evolution of basic fact sheets

Each edition of the Basic Facts was revised and updated, including more recent data, more variables and values for more countries. The Traffic Safety Basic Facts 2008 include the data for **five additional EU countries**: Czech Republic, Estonia, Hungary, Malta and Poland.

As an overview of the latest edition of the Traffic Safety Basic Facts 2008 in terms of content, the Basic Fact regarding **“Main Figures”** presents the reduction of EU road fatalities since 2001 and shows the gap between the actual result and the target of halving the number of deaths on the roads by 2010. After an overview of fatalities in Europe by country on the level of EU-25 the "Main Figures" Basic Fact presents the evolution of fatalities over the last decade and also the change in fatality rate in each of the EU-25 countries. Also a geographical representation of fatality rates is presented. Fatality data are spilt by age and gender, type of road, mode of transport and road user type as well as by seasonality, day of week and time of day.

Children form a road user group at relatively high risk. In the **"Children"** Basic Facts introductory information is presented using general Tables and Figures on the number of child fatalities and comparisons with rates per million children, million population and total fatalities. Additional information on age and gender of children fatalities is also presented. Fatality data are split by vehicle group, mode of transport and further on by type of road. Through this detailed breakdown, information is available for example on pedestrian or pedal cycle accidents. The Basic Fact provides detailed and varied information on child road users, with data on road types (also rural and urban roads), the distribution of drivers, passengers and pedestrians and information on frequencies for time of the day, day of week and also seasonality.

The **"Car Occupants"** Basic Fact deals with drivers as well as passengers of cars and taxis. Data on car occupants are split between drivers and passengers in many chapters. In the introductory part, the number of fatalities per country and year is mentioned as well as rates; fatality rates per million of population and in proportion to national totals. More detailed analyses have been made considering age and gender, road types and time. The time related Tables include fatalities by time of day, day of week and month.

The **"Pedestrian"** Basic Fact begins with general information on fatalities per country and year, which is further presented in details, in relation to million people and total fatalities. It includes data on pedestrian fatalities in relation to age and gender and information by day of week and seasonality. The relation with age is particularly interesting for pedestrians, as children and elderly people form a considerable proportion of fatalities and also the light conditions are taken into account.

The **"Motorcycles and Mopeds"** Basic Fact presents the number of fatalities among occupants of motorcycles and mopeds, using also respective data from car and pedestrian fatalities for comparison. It contains general data on fatalities of motorcycle and moped occupants, i.e. fatality rates by million inhabitants and the national fatality totals. Data on fatal accidents is presented in the form of overviews for different modes of transport. The distribution of occupant fatalities by age and gender is presented for motorcycles and mopeds, as well as for car occupants. An important note concerns the separation between riders and passengers, as well as a chapter on seasonal distribution, which is a very important variable for motorcycles and mopeds accidents analyses. Additionally, there is information on distribution by road networks (motorways and area type), rural and urban area and junction types.

In the **"Motorways"** Basic Fact the fatalities on motorways per country are presented as absolute numbers and as rates per million inhabitants. In order to enable comparisons, fatalities on motorways were also described at the rate of existing kilometres of motorways in the several countries. Important information is the distribution of fatalities on motorways by the total number of road accident fatalities and the comparison with the number of fatalities on other roads. Tables on fatalities by collision type, vehicle group and fatalities by age and gender, modal split and lightning conditions complement this information.

Road users aged 16 - 24 are pooled to form the category **"Young People"** and data such as fatalities per country and in proportion to fatality totals are the starting point of the respective Basic Fact. Tables and Figures by age and gender complement the overview. Data on the mode of transport is included and the split by person group (drivers, passengers and pedestrians) provides additional insights. Information on fatalities by type of road, time of day, day of week and seasonality round out the data presented for this road user group.

"Elderly people" defined as people aged 65+ are the topic of another Basic Fact and in some cases this group is compared with middle-aged people (45 - 64), for example when comparing fatalities by country or by road type. The chapters of this Basic Fact are similar to the ones of the "Young People"; there is information on fatalities by country, fatalities in proportion to fatality totals and the above mentioned comparison to middle-aged people. Fatality rates are also available according to age and gender, the different road user types and road types. Information on distribution by time of day, day of week and seasonality has been presented in the same way as in the other Basic Facts.

Regarding the **“Bicycles”** Basic Fact the number of bicycle fatalities is presented in absolute numbers and also as fatality rates by country. It also describes the percentages of bicycle fatalities in the total number of road accident fatalities. The “Bicycle” Basic Fact also comprehends an analysis regarding bicycle fatalities by age and gender, as especially for children and elderly the bicycle as mode of transport increases their mobility. Bicycle fatalities are also described by road network in terms of area type and in a special way in terms of junctions. Tables and Figures on day of week and month of year complement this information.

The **“Heavy Good Vehicles & Buses”** Basic Fact deals with fatalities of goods vehicles of over 3.5 tons maximum permissible gross vehicle weight. Road traffic accidents involving heavy good vehicles (HGVs) tend to be more severe than other accidents because of the great size and mass of these vehicles. In general the fatalities are described for the several EU-countries in absolute numbers broken down by HGVs and buses or coaches. This Basic Fact also compares the fatality rates (fatalities per million inhabitants) and the proportion of fatalities in accidents involving HGVs and buses or coaches. The time related Tables and Figures include information about time of day and day of week and seasonality. The accidents involving HGVs and buses or coaches are furthermore described by type of road, age and gender and nationality of vehicles to describe the proportion of fatalities in accidents involving foreign vehicles.

The **“Junctions”** Basic Fact presents the fatalities at junctions per country in absolute numbers and as rates per million inhabitants. Additionally, the distribution of fatalities at junctions by the total number of road accident fatalities is described. Information about the area type (inside or outside urban area) and on mode of transport, person class and gender and lightning conditions is provided.

The **“Urban Areas”** Basic Fact initially presents an overview of the total number of urban road fatalities by country, the proportion of the total number of fatalities and the ratio of urban road fatalities per million inhabitants by country. More detailed information regarding age and gender and traffic involvement (driver, passenger, pedestrian) are also included. The time variables show the distribution of urban road fatalities by day of week and by months.

5.4.3. Aggregate Data Files

Apart from the five editions of Annual Statistical Reports and Annual Basic Fact Sheets, the recommendation for the development of a set of **Aggregate Road Accident Data Files** was planned to allow a broader group of road accident data users to have direct access to useful sub-sets of CARE data.

At present, access to the CARE accident database of the European Commission is limited to only **three officially nominated organizations or bodies** in each EU Member State, usually being National Governmental Authorities, Universities or Research Institutes. These organisations are appointed by the High Level Group on Road Safety and queries on the database are performed using a secured network connection. Additionally, some pre-defined static reports based on data derived from CARE are available on the CARE website. Aggregate Data Files will allow users of accident data, **currently outside the CARE structure**, to have access to aggregated road accident data retrieved by the CARE database.

The development of these Data Files is based on certain **criteria**. In order to avoid misleading interpretations, the variables included have to be selected very carefully, taking into consideration both data availability and completeness throughout the years. Additionally, specificities regarding the variables definitions in some countries should also be taken into account when comparing data for different countries.

Considering all the constraints but also the various needs for road safety analyses, a **recommendation on the structure, the format and the size of these data files** was formed, in such way that they will be useful to all potential road accident data users. A first set of 6 - 8 Aggregate Data Files is proposed to be initially prepared, divided into five main categories, according to the type of the variables that these files comprise: those referring to the person, those referring to vehicle, those referring to road environment, those referring to accident and those referring to more general circumstances. More specifically, the following Data Files are proposed, named according to the basic information they provide: Road user, Driving license, Vehicle type, Vehicle manoeuvre, Road environment, Junction type, Accident/collision type, Region/seasonality. Each of these Data Files consists of 5 - 6 variables, besides the variables Country, Year and the Measurement Unit (fatalities or fatal accidents).

The collaboration of the SafetyNet partners with the **members of the CARE Experts Group** under the coordination of the EC has been very important for the initial development, the continuous improvement and in particular the finalisation of the content, structure and the overall enhancement of the various Task outputs. The national representatives of this group are experts who know exactly which types of data are important and whether national accident data published in the several reports are correct or misleading. Their feedback and suggestions on the various editions of the statistical documents during the SafetyNet life-cycle proved very accurate, as they allowed for the identification of more road safety topics, but also of new approaches for using the existing information.

5.5. Improvement of accident data compatibility throughout Europe

Existing European road accident data are not always comparable among the various countries, mainly due to the **different national accident data collection systems**. Data variables and values are currently collected under different definitions in the EU countries, the various accident data collection forms have different structures and the relevant data fill-in systems cannot be compared. Both accident data quality and availability are affected and consequently, data analyses and comparisons among the various EU countries are not always reliable, even for some of the common CARE variables and values.

Within SafetyNet the **improvement of accident data compatibility throughout Europe** was attempted. As harmonisation of accident data at national level (apart from the EC level) could be very beneficial for road accident analysis, using more common variables and values across the European countries, a Common Accident Data Set (CADaS) and methodology were established, to be used by any EU country that wishes to update their national road accident collection system.

A two-stage approach was adopted to achieve this, as it can be seen at the following diagram. On one hand, the data required for road accident analysis in several EU countries was identified and on the other hand, the current potential of the national data collection systems was recorded. The basic common accident data collection set and methodology were derived through an iterative process that took into account both data availability and usefulness, with the participation of experts and Governmental representatives.

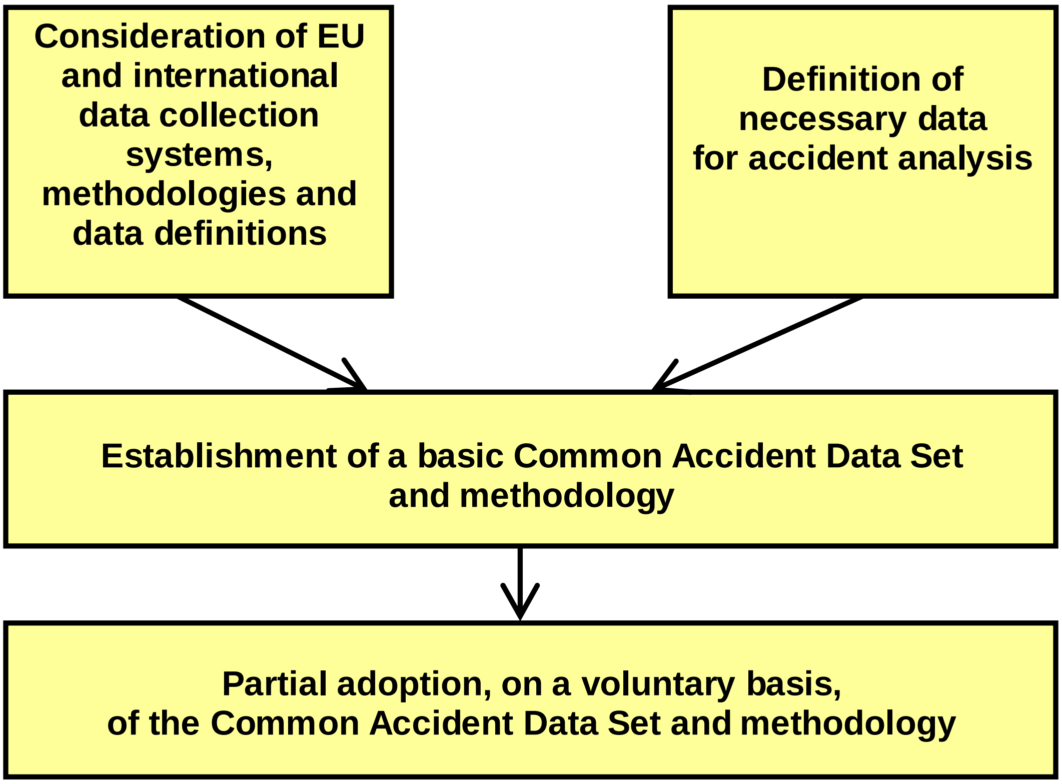


Figure 5.5: Development of common accident data set

In order to establish a basic accident data collection set and methodology, **information concerning the existing national collection systems**, as well as the identification of the needs for road accident data is required. Within this framework, a questionnaire to collect information about the national accident collection forms, methodologies and data definitions in all EU countries was prepared. This questionnaire was developed jointly by all active partners in this area, who contributed significantly to its further improvement. In the next phase, the recording and examination of national road accident data took place. Data elements, as well as the respective definitions used in each national system, were gathered and analysed in order to identify good practices in general, but also detailed variables and values for accident analysis. The results were exploited in the formulation of a recommendation for a Common Accident Data Set.

Moreover, the **identification of the needs for road accident data** was considered important for the establishment of a concrete proposal. To that purpose, the needs of the main stakeholders from several EU countries were recorded. According to the specific circumstances in each country and the specific needs of each stakeholder, different needs were expected to be recorded, thus this activity took place at both national and local level. The main interest groups were Public Services (Police, Hospitals etc), Central Governmental Authorities (Transport, Health), Local Governmental Authorities, Research Institutes and Industry (including transport associations). **An appropriate Grid was developed** to establish a list of various stakeholders by country and then identify their needs for accident data. By filling-in this Grid for several stakeholders, the maximum needs were defined for each country and these were further compared, in order to identify the minimum/common needs for all countries examined. Exceptional needs recorded, such as those of cyclists in the Netherlands could also be considered, but not for all countries. This Grid was distributed to all and was filled-in for the countries of the active partners in this task (Greece, United Kingdom, Austria, Netherlands, Denmark, Hungary and Czech Republic).

After thorough co-examination of all the information that had been collected, the formulation of a complete recommendation for a Common Accident Data Set (CADaS) was carried out. This iterative process considered both data availability and usefulness, but also the currently used CARE variables and values and the experience of other international data files (US - MMUCC, WHO).

The recommendation for a Common Accident Data Set consists of a minimum set of standardised data elements, which will allow for comparable road accident data to be available in Europe. In this way, more variables and values with a common definition will be added to those currently included in the CARE database, maximising thus the potential of CARE and allowing for more detailed and reliable analyses at European level. CADaS is structured in a simple way, without levels of hierarchy, constituting in fact the record layout of the data set to be transferred to the EU. CADaS refers to the set of data to be voluntarily transmitted by each country to the EU, which should be derived from the national road accident data collection system. Moreover, the variables and values of CADaS may be considered as recommendations for national police road accident data collection reports.

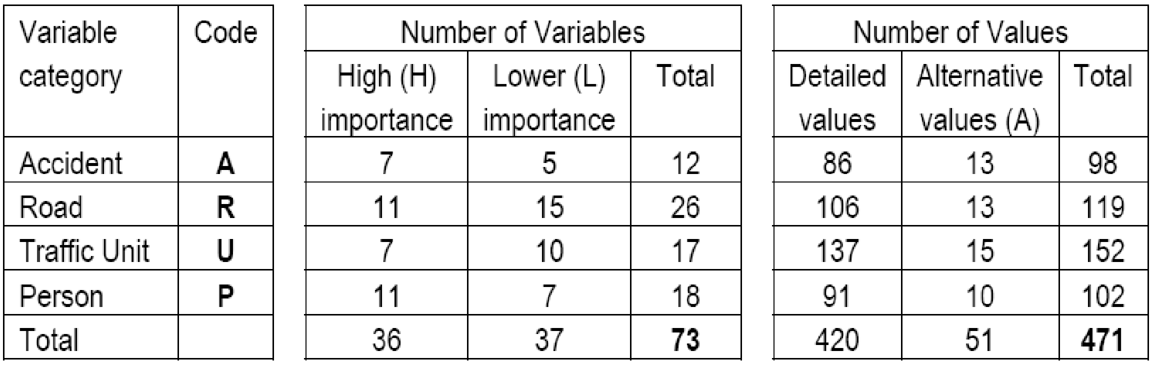
CADaS consists of 73 variables and 471 values. The selection of these variables and values resulted from a balanced consideration of several basic criteria,

- variables and values must be comprehensive, concise and useful for road accident analysis at EU level,
- the level of detail of the variables and values should correspond to all data useful for macroscopic data analysis
- each country should have the possibility to choose alternative level of detail of the various variables and values.

Data which are impossible or very difficult to be collected are not retained in the CADaS; however, the future perspective of using certain variables and values was also taken into account, even though those data are not currently collected by most of the countries. Existing CARE variables and values are of first priority within CADaS and additionally, CADaS variables and values refer to casualty road accidents.

The CADaS variables are divided into four basic categories: Accident related variables, Road related variables, Traffic unit related variables and Person related variables. Several variables include two distinct types of values, referring to different level of detail: Detailed values, concerning information at the highest level of detail and alternative values, concerning information at a more aggregate level of detail, when more detailed values are not available.

The number of variable and values contained in the CADaS are presented at the following Table:



Variable category	Code	Number of Variables			Number of Values		
		High (H) importance	Lower (L) importance	Total	Detailed values	Alternative values (A)	Total
Accident	**A**	7	5	12	86	13	98
Road	**R**	11	15	26	106	13	119
Traffic Unit	**U**	7	10	17	137	15	152
Person	**P**	11	7	18	91	10	102
Total		36	37	**73**	420	51	**471**

Table 5.1: Total variables and values in CADaS

For each of the variables included in the **CADaS**, the following information is presented:

Variable Label: The label of the proposed variable, consisting from the category identifier (A, R, U or P), the numbering and the name of the variable. The importance of the variable for road safety analysis is also added: (H) for variables of high importance and (L) for variables of lower importance.

Variable definition and scope: A brief description of the variable is provided, followed by the importance and usefulness of the variable, explaining the rational lying behind its selection.

List of values: The attribute values to each variable are listed.

Value labels: Each value is identified by the code of the variable, followed by a number which corresponds to each value and its name. The (A) code is added next to the variable category code for the alternative value, when is the case.

Value definitions: The definition of each value of the variable is provided, indicating also any particularities of the value and any relevant assumptions regarding its collection.

Data Format: The way in which each variable has to be provided. Data formats concern:
- the possibility to attribute one or more values to a variable,
- the format of the value (code, number, text).

The adoption of the CADaS recommendation by the European countries is a very important step towards the success of this Task. One of the CADaS advantages is that it can be **adopted gradually by EU countries**, without presupposing any changes in a country's national data collection system; however, any part of it (variables, values, definitions and data formats) can be implemented within an existing national collection system, increasing thus the compatibility of the national road accident data with the respective CARE data. If one country decides to start using the CADaS protocol, it can transform its national data into the CADaS data by using appropriate transformation rules and eventually transmit the transformed data to the EC. Consequently, the level of adoption of the CADaS can vary according to any national needs and/or particularities and can be performed during any time in the future.

In the following Figure, the **current, intermediate and future** (based on the CADaS adoption) **processes** of the national road accident data files are presented. Using both (current and future) approaches ensures compatibility of the accident data among EU countries and the main difference of these two approaches is related to the degree of involvement of the country in the process.

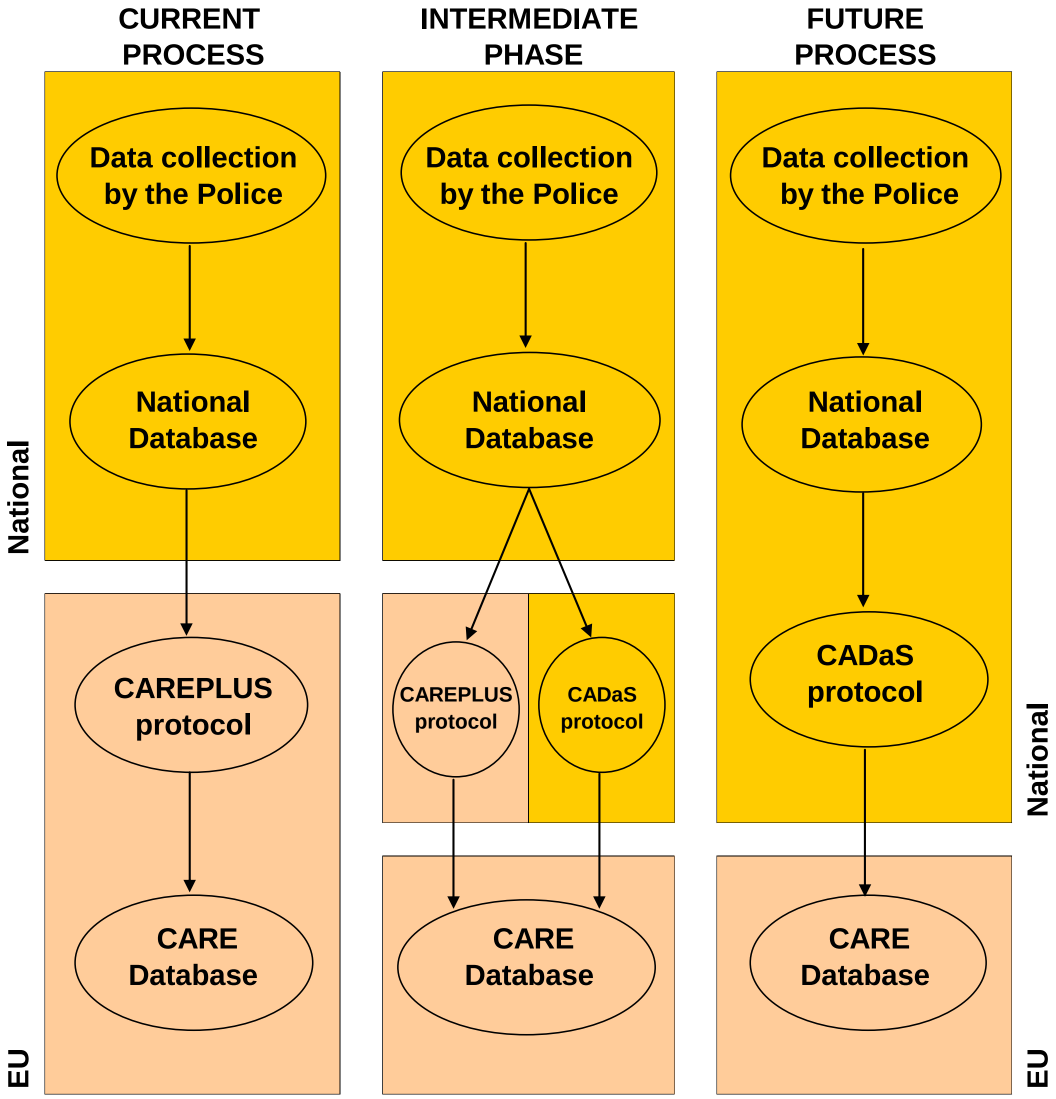


Figure 5.6: Implementation of common accident data set

Taking into account that many Member States may partially adopt CADaS, an intermediate phase is also necessary, during which, countries may use a part of the CADaS in order to transform specific variables and values at national level and transmit the rest of the data in the current format in order to be transformed using the CAREPLUS protocol. According to the proposed future process, transformation of the national accident data (based on the CADaS protocol) will be performed at the national level and the derived CADaS variables and values will be transmitted to the EC, where they will be included in a more automatic way into the CARE database. This process will allow for more common variables and values but also for higher quality, given that the **national authorities better perceive any particularities related to national data collection**, and subsequently can better identify the interrelation between the collected and the CADaS variables.

The output of CADaS consists of a **Reference Guide** with several **Appendices**, as well as a **Data List**, in which the proposed variables and the related values are also presented with indicative levels of hierarchy, in case some countries wish to use a similar structure at the national collection system.

5.6. Estimation of the real number of road accident casualties

The final objective of SafetyNet in relation to CARE has been to estimate the actual numbers of road accident casualties in Europe from the CARE database by addressing two issues:

- the under-reporting in national accident databases and
- the differences between countries of the definitions used to classify injury severity.

Currently, the only comparable measurement units available in CARE are the numbers of fatal accidents and of people killed, where the degree of under-reporting is acceptably small in most EU Member States and there is a common definition. The same is not true, however, of non-fatal accidents and of casualties who are not killed. As a result, at present **the numbers of non-fatal accidents and of people seriously and slightly injured cannot be compared** in different Member States. In addition, the definition of injury severity differs among member states, so that a casualty which would be recorded in one country might not be recorded in another. Equally, a casualty which might be recorded as 'seriously' injured in one country might be recorded as 'slightly' injured in another.

As a result of this lack of comparability, **international comparisons of road safety focus entirely on fatal accidents and fatalities**, which form only a small minority of the totals. It is highly desirable to extend these comparisons to include the full range of injury severities. In order to overcome the inconsistencies in the reporting of non-fatal casualties, SafetyNet has:

1. estimated the under-reporting level for non-fatal casualties by developing a uniform methodology and applying it in several EU countries,
2. estimated the number of serious casualties per country according to a new common measurement unit.

The work began by agreeing a **common methodology** that would be applied by all partners working on this question. Studies were carried out in 8 countries according to this methodology, and the report contains detailed descriptions of the individual studies. In each study, files of police and hospital records were assembled for the road accidents that occurred in a common area. These files were compared to identify matching records, i.e. those casualties who were present in both files. For these matching records, certain medical details were added to the police records: length of stay in hospital and injury severity (specifically the Maximum Abbreviated Injury Score (MAIS), an internationally accepted summary measure of injury severity).

Two matrices presented in the following Figures were subsequently prepared to summarise the outcome of each study, one based on injury severity and the other on length of stay. These matrices were brought together for analysis, and conversion factors for each study were estimated in a consistent way. These factors allow the actual number of serious casualties in each country to be estimated consistently from police accident statistics.

Matrix 1

road user type		Length of Stay		police coding
car occupant pedestrian pedal cyclist motorcyclist other	X	out-patient overnight 1-3 days >3 days not coded *(not matched in medical records)*	X	fatal serious slight not coded *(not matched in police records)*

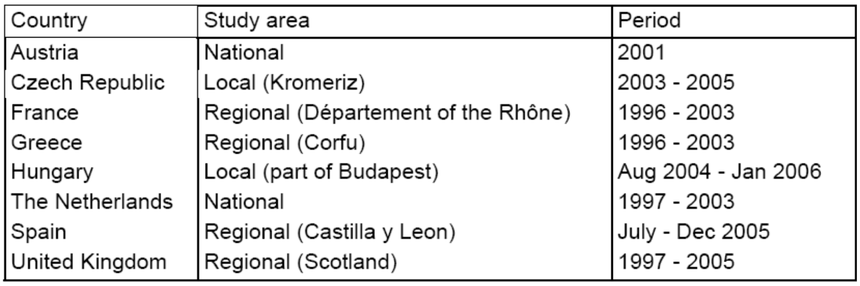
Matrix 2

road user type		MAIS		police coding
car occupant pedestrian pedal cyclist motorcyclist other	X	1-6 not coded *(not matched in medical records)*	X	fatal serious slight not coded *(not matched in police records)*

Table 5.2: Assessment of under-reporting and "serious" injury

The **new common measurement unit** for counting serious casualties could be based on either injury severity or length of stay. It is concluded that the most robust definition is of a **non-fatal casualty with MAIS>=3 (inclusive)**. Initial comparisons have been made of casualty data adjusted by the conversion factors estimated by the national studies.

The **coverage of the studies** varied widely, influenced to some extent by whether hospital data had to be collected directly (as in the Czech Republic and Hungary) or were already available from files that had been compiled by national or regional authorities. The size of the datasets varies widely, depending on the size of the study area and the period included. The studies are summarised below.



Country	Study area	Period
Austria	National	2001
Czech Republic	Local (Kromeriz)	2003 - 2005
France	Regional (Département of the Rhône)	1996 - 2003
Greece	Regional (Corfu)	1996 - 2003
Hungary	Local (part of Budapest)	Aug 2004 - Jan 2006
The Netherlands	National	1997 - 2003
Spain	Regional (Castilla y Leon)	July - Dec 2005
United Kingdom	Regional (Scotland)	1997 - 2005

Figure 5.7: Under-reporting studies

Ideally, these studies would have covered complete countries and so been truly national. Only 2 studies were really representative at a national level, consequently the question arises in the remaining 6 countries of whether conversion factors estimated from sub-national studies can be generalised to the national data. The answer must vary from country to country, but in general the larger the study area the more likely the conversion factors are to be nationally representative.

The new common measurement unit is a non-fatal casualty with MAIS>=3. Most of these are recorded by the police as seriously injured, but the studies show that the police record some as slightly injured. Consequently, according to this definition the number of casualties C in a particular country is estimated as:

C = N1 * police reported serious casualties +
N2 * police reported slight casualties

where N1 and N2 vary from country to country. The overall factors from 7 studies are shown below (they could not be estimated in Austria because of data limitations). N2 is considerably smaller than N1 and hence is multiplied by 10 in this figure.

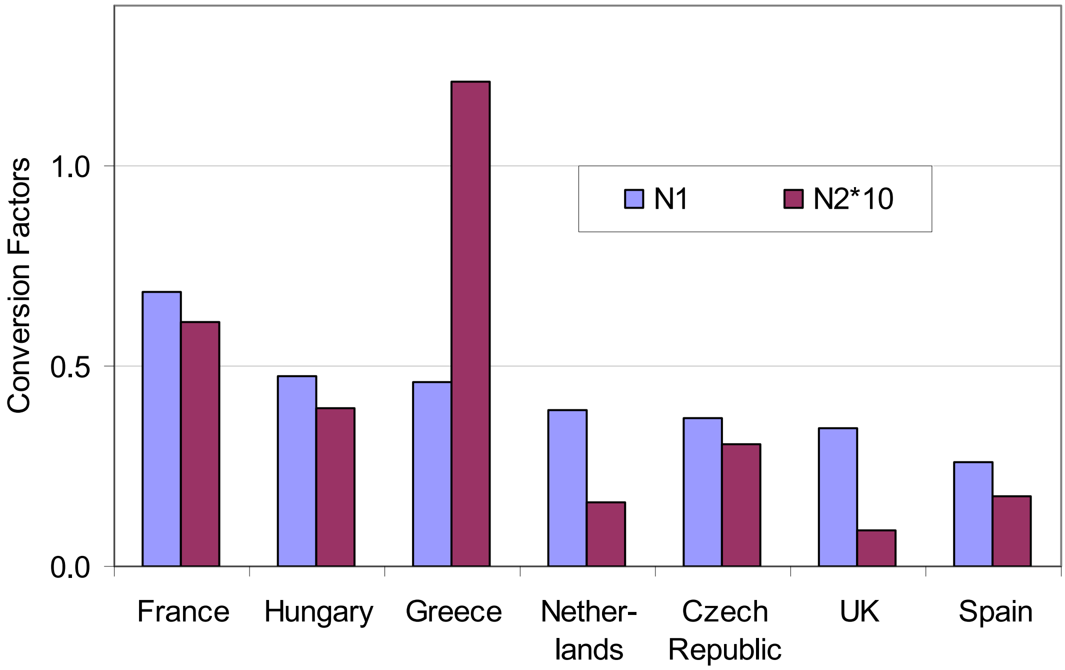


Figure 5.8: Conversion Factors for MAIS>=3, all road users

It was originally envisaged that the conversion factors would be generalised to other countries, in order to increase the utility of the CARE database. However, the results have led to the conclusion that this would not provide reliable results. The only satisfactory approach would be to carry out comparable studies in as many countries as possible.

The results from the Dutch and UK studies have also shown that the conversion factors can change through time as police accident reporting practices evolve. Thus, studies need to be repeated regularly to update the factors.

In summary, the research into under-reporting that has been carried out in the course of SafetyNet represents a **significant step forward** and allows for the first time the number of severely injured casualties to be compared meaningfully between countries. The goals of the research were ambitious, but the practical problems that were encountered have meant that some could not be achieved fully. The lessons that have been learnt will allow this type of study to be carried out more effectively in future.

The central problem of this type of study is of obtaining **access to anonymised medical records**. Access to these records for research purposes is often problematical. Modern linkage techniques such as those used in this study, however, make these data increasingly valuable. Ways need to be found to persuade the custodians of these data to allow them to be used for purposes that support the broader aims and welfare of society.

6. Risk Exposure Data

6.1. *Overview*

The integration of risk exposure variables is an essential complement to any road safety analysis. The use of "Risk Exposure Data" makes it possible to analyse road safety indicators not only in terms of issues but also as "Risk levels" and "Probability" of accident occurrence and fatalities.

It is currently recognised by most experts that road accidents have random and independent characteristics that give them the properties of random variables. As such, statistical laws traditionally used for this type of variable can be applied. Usage of statistical techniques would allow comparisons of accident populations in the EU that differ widely in size. Road safety analyses, which can be based on the probabilistic properties of the accident and fatality occurrences require the knowledge and the use of the concepts of exposure, risk and accident rates.

Therefore, the main purpose of SAFETYNET concerning exposure data consists in establishing a European common framework for a set of Risk Exposure Data comparable over the Member States having a usable risk exposure data collection applicable to the existing CARE accident database. This work was conducted in five stages:-

1. acquiring reliable information about the current **state of the art in risk and exposure data** at a theoretical level

2. **identifying** the data collection methods, definitions and comparability of RED over the 25 EU Member States by the mean of a survey, leading to a **first classification of the Members States** according to their own RED gathering, usability and comparability**.**

3. establishing a RED common framework, taking into account the definitions, data collections and registration systems over the Member States, and providing when possible transformation rules

4. making a pilot study of RED use among a panel of chosen countries, as a demonstrator of data collection and process and results analysis

5. proposing recommendations and guidelines for RED, to Member States intending either to organize or to modify their own RED use

Each of these stages was conducted in close cooperation with the members of the CARE National Experts group who were able to assist with the provision of information about national practises and to support the pilot studies.

6.2. *State of the art*

A state of the art report was produced exploring the concepts of exposure and risk, as well as the theoretical properties of the various exposure measures in use in road safety. The full report can be found at http://www.erso.eu/safetynet/fixed/WP2/Deliverable%20wp%202.1%20state%20of%20the%20art.pdf. The report provided an overall picture of the existing methods for collecting exposure data for national risk estimates, and the potential of international risk comparisons, by accessing exposure data through International Data Files.

In order to meet these objectives, the following methodology was adopted:

- Firstly, an exhaustive bibliography review was carried out and a bibliography database on risk and exposure data was developed.
- Additionally, a set of National Reports was created by the institutes involved in the analysis, providing representative examples of exposure data availability, collection methods and use from seven representative European countries: Denmark, France, Greece, Hungary, Norway, the Netherlands and Portugal.
- Furthermore, a separate survey was devoted to the investigation of the International Data Files, as far as exposure data availability and quality is concerned. The survey was carried out by means of personal interviews with the maintainers of the related databases of the following organizations: EUROSTAT, ECMT, UNECE, IRTAD and IRF.

From the results of the analysis, it was deduced that comparing risk rates, especially at international level, is a complex task. Both accident counts and exposure measures present some theoretical and practical limitations and are subject to estimation errors, which may compromise their usability. Ideally continuous exposure measurements of different road user categories in different modes and different road environments are required in order to provide detailed exposure estimates to the level of disaggregation of the respective accidents data. In practice, such measurements are not possible, therefore, road safety analyses need to compromise to some approximations of the actual exposure, which may have limits to the accuracy and representativity. Different exposure measures may be used, according to data availability and quality, as well as the context of the analysis. It should be noted that no general rule can be adopted on the preferred measures of exposure.

However, it can be deduced that the most appropriate measures of exposure appear to be vehicle- and passenger-kilometres of travel, because they are closer to the theoretical concept of exposure and can be available, in theory, to a satisfactory level of detail. However, other exposure measures are often used, namely the vehicle fleet and the drivers' population, the road network length, the fuel consumption, as well as the entire population, mainly because they involve less complex collection methods.

The theoretical features of the various exposure measures were then analysed in detail. In practice, however, the availability, quality and disaggregation level of exposure measures may be compromised by limitations and particularities of the respective collection methods.

6.2.1. How are RED collected?

The main sources of exposure data include travel surveys; traffic counts systems, vehicle fleet register, driving licenses registers, roads registers and population registers.

- Travel surveys are carried out in most European countries, in order to collect information on traffic and mobility patterns. From the data collected (namely distance travelled, time spent in traffic and number of trips), vehicle- (actually driver-) and passenger-kilometres estimates can be obtained. The main advantage of national travel surveys (compared to other collection methods) is that these surveys have persons as a unit, making it possible to compare groups of persons, and are usually designed to achieve a high level of data disaggregation by person, vehicle and road network characteristics. However, travel surveys normally use sample-based self-reporting information collection methods; consequently a number of possible biases (sampling, non response or measurement errors) may occur and should be treated accordingly where possible.

- On the other hand, in most countries traffic counting systems are in place, providing data on traffic volumes, which are used to obtain vehicle kilometres estimates. An important advantage of using this method is that the seasonal variations of exposure can be captured, as the measurements are usually continuous over time. However, this method does not allow distribution of the exposure by person characteristics. Additionally, this method is also sample-based, in the sense that measurement points are placed on specific sections of the main road network, which may or may not be representative of the entire road network, and usually local or urban roads are not included. Problems may also be encountered in the automatic classification of vehicles.

The two methods discussed above present different advantages and limitations, but they are the only methods that can produce detailed vehicle- and person-kilometres estimates. However, because of the difficulties in the implementation and operation of such systems, in most countries other indicators are used as RED:

- Vehicle fleet and driving licenses registers are also used to calculate alternative exposure measures. The problem when using such registers to estimate risk is that these are certainly very crude estimates of exposure, giving quite uncertain risk estimates. It should be noted that data from such databases are known to lead to some (but often uncalculated) overestimations, due to insufficient updating of the registers. Registers can contain details of vehicles that are no longer used on the road but are still counted as being part of the national fleet.

- Road registers are often used to calculate the length of roads as an exposure measure. However, in most countries the available information concerns the main road (motorways, national and rural roads etc.), whereas information on roadway geometry is less available, and regional/local road length estimates are less available.

Having analysed examples of implementation of the above methods in the selected European countries, the following conclusions are drawn:

- The features and specifications of each method may vary significantly among countries
- the availability, disaggregation and comparability of exposure measures (in terms of definitions, variables and values) is quite diverse
- the disaggregation level theoretically possible for an exposure measure is seldom achieved in practice
- data from different sources (collection methods) are often used to produce a national exposure estimate, i.e. different data sources may function complementarily for the calculation of a single exposure measure
- In general, it is not always clear how the exposure estimates are obtained from the "raw" data collected by means of the various methods.

According to the above, it can be deduced that the national exposure and risk estimates may not always be comparable at EU level.

6.2.2. How far are RED available?

In most countries some national exposure estimates are available, which are collected, exploited and published through the International Data Files (IDFs) in the field of transport and road safety. The main IDFs involved in road accident and exposure data EU are the following: Eurostat, ECMT, UNECE, IRTAD and IRF. These data files are useful and provide accessible aggregate data sources, as a result of several decades of important data collection efforts. However, they have different objectives; they collect different data in different forms and structure, in some cases by different national sources, and are maintained by organizations with different scopes and policies. Consequently, the availability of exposure data among the data files varies significantly, in terms of both countries and years available, and variables and values available.

The two methods discussed above present different advantages and limitations, however they are the only methods that can produce detailed vehicle- and person-kilometres estimates. However, because of the difficulties in the implementation and operation of such systems, in most countries other indicators are used as RED:

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A subsequent review of exposure data obtainable within the IDFs revealed the following:
- the exposure data available in the IDFs are in a much more aggregate form than the exposure data collected at national level Accordingly, the more disaggregated national exposure data are not exploited within the context of IDFs.
- Significant differences are observed among the IDFs in the published figures for each exposure measure; these differences are more important for the more "sophisticated" exposure measures (i.e. vehicle and passenger kilometres). These differences are partly due to the different national sources and definitions used. Another reason may concern insufficient data quality control within the IDFs.

6.2.3. First conclusions from bibliography

Summarising, the availability and quality of risk exposure estimates in the EU Member States varies significantly, and is related both to the exposure measures used and the characteristics of the respective collection methods.

In particular, significant efforts are made at national level to improve data availability, disaggregation and reliability. However the lack of a common European framework for the collection and exploitation of RED limits significantly the comparability of the detailed national data. On the other hand, the International Data Files containing road safety related data, including RED, provide useful aggregate information in a systematic way and are currently the only sources allowing international comparisons, however more effort is required to further improve the availability and quality of these data.

It can be deduced that a series of problems, namely poor data availability, insufficient reliability, inappropriate disaggregation and limited accessibility are the main limitations to the full exploitation of risk and exposure data at European level. It is also clear, from the analysis presented in this Report, that the most useful RED are the least available. Further work and research should focus on improving data compatibility and availability, namely through a common framework including common data requirements, definitions and collection methods.

6.3. First classification of Member states according to RED

For a first approach of classification linked with usability of RED, usability itself needed to be defined, as a consequence of availability and compatibility:

- **Availability** is defined as relevant data on country level that is ready for use. It was distinguished between fully available and partly available data, where the former refer to data readily available, and the latter refer to data that are available but not complete for all subsets.

- **Compatibility** is defined as a property of data ensuring the possibility of comparisons. In order to be compatible, the variables must be defined in the same way as in EUROSTAT or CARE, or if not, be specified so that subsets of the data (specific variable values) may be compared.

- **Usability** can be defined as data that was at least partially available and partially compatible.

According to those definitions, nine Risk Exposure Data indicators were examined:
- Population
- Road length
- Vehicle fleet
- Driver population
- Vehicle kilometres
- Person kilometres
- Number of trips
- Time in traffic
- Fuel consumption

Each Member State was invited to provide information over the availability and usability of RED, which lead to the following conclusions.

6.3.1. Incompatible indicator

The indicator "fuel consumption" is not considered to be compatible with CARE.

The main problem with fuel consumption as a RED indicator is that road transport use seldom can be distinguished in fuel consumption data. Moreover many countries that do distinguish between consumption for transport and other types of fuel consumption, seldom distinguish between transport modes so that road traffic can be separated out. Still, even if fuel consumption is not regarded as compatible as a RED indicator alone, many countries use fuel consumption data in combination with other data sources to estimate road traffic volumes.

6.3.2. Unavailable indicators

"Person kilometres", "number of trips", and "time-in-traffic" are the three indicators which are not commonly available in the EU member states and thus not considered with regard to usability and compatibility.

Person kilometres, which can be regarded as a highly adequate RED indicator, is not considered usable because of lack of availability. It is possible that further information from member states can alter the picture, and it is also possible that person kilometres could be included in the common framework because of its adequacy and the fact that it will probably be more available in the future. It is also possible for many countries to give estimates on person kilometres based on data from vehicle kilometres and passenger counts. Furthermore, if more countries will conduct national travel surveys in the future, which is quite likely, data on person kilometres will be more easily available.

In the same way, the number of trips and time in traffic will be potentially available from national travel surveys, but few countries that conduct national travel surveys today in fact give such estimates.

6.3.3. Usable indicators

Finally, five indicators that were classified as possibly usable indicators:

- Population
- Road length
- Vehicle fleet
- Driver population
- Vehicle kilometres

Population figures have often been used to derive risk estimates, and such figures are available for all countries, and in general are compatible with CARE. There are however, some issues involved when using population figures in risk estimates. These are concerned with the number of foreigners residing within the borders of a country, the number of illegal immigrants and the amount of tourist/transit traffic. The possible problems created by these issues are modest and probably solvable, but they should nevertheless be taken seriously. In small countries like Luxembourg and Belgium, the proportion of foreigners is large, and if not taken into consideration, it may lead to biased estimates.

Also amongst **driver population** figures there are some issues that may create biases when utilised for risk estimations. One issue is that the unit in licence registrations sometimes are persons (drivers) and sometimes licenses. This may be trivial and not a problem, but it should nevertheless be considered when making risk estimates. Another possible problem is the fact that deceased drivers may not be removed from the register. A third possible problem is the number of foreigners/immigrants/tourists that may constitute substantial proportions of the population of specific driver groups. For instance, due to large tourist traffic, the number of licensed motorcycle drivers may not be a good indicator for motorcycle traffic in some countries. If such issues are taken into consideration, driver population figures may be a fairly good indicator of traffic exposure and thus applicable for risk estimations and risk comparisons.

Concerning data on the **vehicle fleet**, all countries have data and a number of countries have data fully compatible with CARE for a number of variables. There are however, also some challenges when utilising vehicle fleet data for risk estimations, related to some vehicle types missing in some countries. Such problems should however be possible to solve by using similar subsets of CARE data. Withdrawal of vehicles which are no longer in use may be a problem in some countries. Registration procedures of immigrant vehicles and de-registration of emigrant vehicles are unclear in many cases, and should be examined in more depth if vehicle fleet figures are to be used in risk calculations based on CARE.

Road lengths are available and considered compatible for most countries. There are, however, limitations to the applicability of road length as risk exposure indicator. Some countries can give figures of motorway lengths but not of the total road network. Consequently risk can only be estimated as motorway accidents per motorway length. Other countries may have figures of the total road network, but do not have separate figures for motorways. In such countries only total accidents per total road length can be estimated. So, even if road lengths are available and compatible with CARE for most countries, the compatibility between countries may be somewhat restricted.

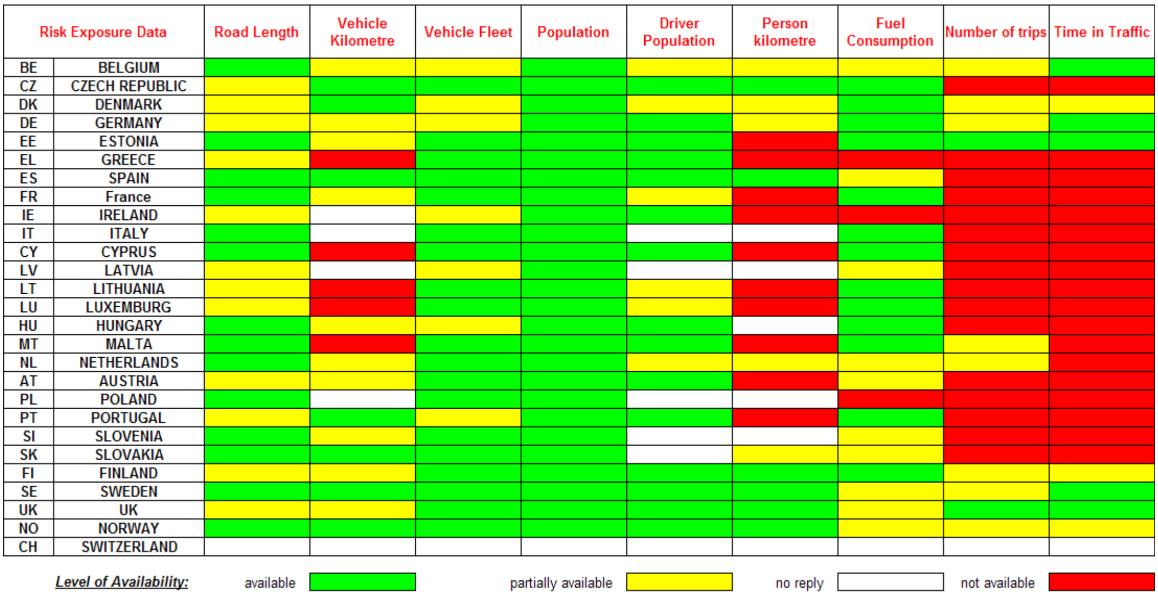
None of the indicators population, driver population, vehicle fleet or road length is in itself a good indicator of traffic volume. Population data are only valid for comparisons if the level of motorisation is the same; the number of cars is only valid if the average driving distances are the same and road lengths are only valid if annual daily traffic per kilometre of road is the same. Nevertheless, for some countries comparisons based on these indicators could give at least an ordinal ranking of risk levels between countries. Such a ranking would of course be even more reliable if risk estimations based on the different indicators give the same results. Furthermore, it is also possible to envisage some joint measure based on these indicators that perhaps could be used; i.e. a measure combining these indicators. One could perhaps argue that some weighted estimate of road lengths and the number of vehicles could be a proxy for traffic volume that could be more valid as exposure than either the road length or the number of vehicles in themselves.

Among the indicators that are regarded as usable here, vehicle kilometres travelled is the indicator that could be regarded as most valid from a methodological point of view. **Vehicle kilometres** are in fact a measure of traffic volume; the other indicators are mere proxies of traffic.

The methods used for producing vehicle kilometres data varies greatly between countries. Some are based on traffic counts and road lengths (annual daily traffic x kilometre of road), others use vehicle fleet data and fuel sales/consumptions; some use travel surveys and vehicle fleet data etc. Increasingly, countries are starting to use odometer recordings registered at periodic vehicle inspections to estimate vehicle kilometres, (Denmark, Latvia, The Netherlands, Finland, and Sweden). Such a method is easy to adopt, and probably quite accurate, but ought to be complemented by other methods in order to give valid estimates for traffic volumes within the borders of each country. In spite of this limitation of the method, adopting this method will to a large extent ensure that traffic volume data of different countries are comparable, because the data are collected in the same way in different countries. If one could find a uniform way of estimating the amount of traffic carried out abroad, this could perhaps be a method to recommend for the future (and it seems anyway to be increasingly popular today). The work currently going on within the framework of UNECE will possibly lead to recommendations of ways to harmonize traffic volume data based on odometer recordings.

6.3.4. Synthesis

A first classification of the data to identify availability and usability of the indicators has been produced and is summarised below. Indicators that seem to be usable have been distinguished from those that seem not to be usable, based on the information available so far. The following table summarises the topic:



Risk Exposure Data		Road Length	Vehicle Kilometre	Vehicle Fleet	Population	Driver Population	Person kilometre	Fuel Consumption	Number of trips	Time in Traffic
BE	BELGIUM	🟩	🟨	🟨	🟩	🟨	🟨	🟨	🟨	🟩
CZ	CZECH REPUBLIC	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥
DK	DENMARK	🟨	🟩	🟨	🟩	🟨	🟨	🟩	🟨	🟨
DE	GERMANY	🟨	🟨	🟨	🟩	🟩	🟨	🟩	🟨	🟩
EE	ESTONIA	🟩	🟨	🟩	🟩	🟩	🟥	🟩	🟩	🟩
EL	GREECE	🟨	🟥	🟩	🟩	🟩	🟥	🟥	🟥	🟥
ES	SPAIN	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥
FR	France	🟩	🟨	🟩	🟩	🟨	🟥	🟩	🟥	🟥
IE	IRELAND	🟨	⬜	🟨	🟩	🟩	🟥	🟥	🟥	🟥
IT	ITALY	🟩	⬜	🟩	🟩	⬜	⬜	🟩	🟥	🟥
CY	CYPRUS	🟩	🟥	🟩	🟩	🟩	🟥	🟩	🟥	🟥
LV	LATVIA	🟨	⬜	🟨	🟩	⬜	⬜	🟨	🟥	🟥
LT	LITHUANIA	🟨	🟥	🟩	🟩	🟨	🟥	🟩	🟥	🟥
LU	LUXEMBURG	🟨	🟥	🟩	🟩	🟨	🟥	🟩	🟥	🟥
HU	HUNGARY	🟩	🟨	🟨	🟩	🟩	⬜	🟩	🟥	🟥
MT	MALTA	🟩	🟥	🟩	🟩	🟩	🟥	🟩	🟨	🟥
NL	NETHERLANDS	🟩	🟨	🟩	🟩	🟨	🟨	🟨	🟨	🟥
AT	AUSTRIA	🟨	🟨	🟩	🟩	🟩	🟥	🟨	🟥	🟥
PL	POLAND	🟩	⬜	🟩	🟩	⬜	⬜	🟥	🟥	🟥
PT	PORTUGAL	🟨	🟩	🟨	🟩	🟩	🟥	🟩	🟥	🟥
SI	SLOVENIA	🟩	🟨	🟩	🟩	⬜	⬜	🟨	🟥	🟥
SK	SLOVAKIA	🟩	🟩	🟩	🟩	⬜	🟨	🟨	🟥	🟥
FI	FINLAND	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟨	🟨
SE	SWEDEN	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟩
UK	UK	🟨	🟨	🟩	🟩	🟩	🟩	🟨	🟩	🟩
NO	NORWAY	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨	🟨
CH	SWITZERLAND	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜

Level of Availability: available 🟩 partially available 🟨 no reply ⬜ not available 🟥

Figure 6.1: Exposure data usability

6.4. *A common framework and recommendations for collection of future exposure data*

6.4.1. Common framework

The common framework describes an approach to gather a harmonised set of exposure data at a pan-European level. It therefore covers the specification of the indicators and any transformation rules as well as other aspects to gather them in a harmonised form. Further detailed information was required to ensure compatibility with the CARE accident database.

The review of availability had identified that the most valuable indicators had the least availability, despite this all measures were considered as candidates for inclusion within the common framework in order to establish a direction for future exposure data gathering.

Firstly, the availability and compatibility of risk exposure data were examined in detail, on the basis of the information gathered by the CARE Experts and found in the international literature and processed by means of the grids. In addition to the global indicators that were studied, each variable of each indicator was also reviewed in respect of the possibilities of disaggregation. Although the information is in some cases incomplete or difficult to confirm, a comprehensive overall assessment was than possible and was carried out for an important number of countries and for all indicators and variables.

In this section, the results of the detailed assessment of exposure data availability and compatibility are summarised, in order to identify comparable sets of exposure data among countries. These comparable data sets correspond to the current potential for a common framework of risk exposure data in Europe. Due to the factors mentioned above (missing information, unconfirmed information etc.), the common framework is presented in two ways:

- a set of data that is comparable or that can be made comparable by means of transformation rules

- a set of data that is comparable or that can be made comparable by means of transformation rules, including data that is probably comparable but this needs to be confirmed.

The proposed common framework is based on a number of synthesis considerations.

- First of all, a "raw data" approach was opted for.
- Therefore, only the collection methods that provide the raw exposure data were included in the common framework, given that data resulting from complex calculations or combinations of methods and sources are unlikely to be comparable. In any case, assessing the comparability of such data would be a very complex task.
- Moreover, only the variables for which a common CARE definition is available are examined, given that the final objective of this work is the identification of data that can be usable with CARE.

Population data are confirmed as available in all countries that responded to the grid survey.

As regards **road length** data, data concerning motorways are comparable among an important number of countries. On the contrary, road length data per area type or region were confirmed as comparable only for a few countries. For a number of additional countries comparability for these two variables needs to be confirmed, however the respective data can be used with caution until confirmation is possible.

Vehicle fleet data are also comparable for a satisfactory number of countries, at least for the basic vehicle types available in CARE. This number is increased when including the data that still need confirmation as regards the definitions. In a few cases a correction coefficient needs to be developed (e.g. FR, PT). Rather surprisingly, vehicle age data were found to be comparable only for a limited number of countries and will not be very usable in the common framework.

The comparability of **driver population** data is very satisfactory, as almost all countries that provided information indicated comparable data per driver age, gender and license age. Given the limited availability of alternative (or more sophisticated) exposure data per person characteristic, it is thereby indicated that it will be extremely useful to collect this data at an international level (it is reminded that previous SafetyNet research showed that driver population data are not collected / published by any International Data File).

When examining the more sophisticated exposure measures, the results are less encouraging.

Vehicle kilometres collected by surveys are only comparable for about 6-7 countries, for specific vehicle and road types and only when including the data whose compatibility was not confirmed. It is also quite remarkable that no compatible data is available per person characteristics, although travel surveys are designed to have persons (or in this case drivers) as measurement unit. The same image is obtained when examining data collected by traffic counts. It is interesting to note that a couple of countries use both methods. Overall, only data for motorways and vehicle types can be considered as (at least partly) comparable.

Concerning **person kilometres**, only 6-7 countries can be considered to have comparable data, although this comparability can be confirmed for fewer countries in general (in a couple of cases comparability can not be confirmed for any country). For some countries, comparisons per person characteristic are possible. Other partly usable variables concern passenger cars and two-wheelers.

Finally, **number of trips** and **time in traffic** are considered as hardly usable indicators; in each case, variables comparability cannot be confirmed for more than 3-6 countries. The only variables that could be currently exploited in international comparisons of an adequate number of countries would be person age and gender.

The results of this work have been used to propose an overall guide for international risk comparisons using CARE data and risk exposure data. An important amount of detailed information was gathered and analysed on that purpose. This guide concerns the number of countries that can be reliably compared in terms of risk exposure, for each indicator and each variable, whereas the type of data transformation rule is provided when possible for data not directly comparable. It recommends that more specific transformation rules should be developed by the competent national administrations.

Reader is invited to see the detailed tables in Deliverable 2.3 Common Framework, and for full information with detailed description of all data features, collection methodologies features, data definitions etc., the Annex should be consulted too.

6.4.2. Recommendations

Based on the State of the art review, the analysis of availability of exposure indicators and the usability assessment SafetyNet has proposed recommendations for countries intending to improve or start collection of risk exposure data.

Those recommendations may be classified in three families:

Recommendations on harmonisation for existing data

- It is necessary to harmonise the way of defining and collecting RED.
- The priorities in data harmonisation need to be considered first
- A "CAREplus" type of process could be implemented for each exposure indicator
- EUROSTAT definitions should be applied to the global exposure indicator, CARE definitions should be applied to the variables and values
- The cooperation between existing official representatives for road safety and exposure data should be exploited and strengthened (e.g. the Eurostat network for Transport Statistics, the CARE Experts).
- Each country should provide a comprehensive description of the data sources and calculations used for vehicle and person kilometres
- The actions needed for the improvement of the national road, vehicle and driver registers include updating, handling duplicate entries and linking with other data sources
- Data quality control procedures should be intensified in the International Data Files

Recommendation for collecting new data

- A pan-European data collection system should be established focusing on vehicle and person kilometres and including different data collection processes
- Traffic counts at European level would provide continuous traffic measurements over time, which could be used for monitoring exposure. Guidelines for the operation of these counts should be produced
- The creation of European driver and vehicle registers with selected disaggregate data should be examined.

Thematic recommendations

- The actions needed for the improvement of the national road, vehicle and driver registers include : updating, handling duplicate entries and linking with other data sources
- Availability of active drivers' licenses, if possible by age group, must be an objective
- A telephone-based travel survey is to be preferred to other types of data collection for the purpose of obtaining representative data to calculate person kilometres.
- Definition of trips, including off-road (pedestrian, bicycles) must be harmonised
- It is necessary that all countries carrying out surveys or traffic counts are able to provide documentation on the survey or counts system design and features.

For all those recommendations, **ERSO should have a major role**, and SafetyNet recommends that:

- ERSO should serve as a gateway for enhancing and monitoring the data harmonisation process
- Eventually, ERSO would become the first international data source with truly comparable exposure data. Information should of course also be available at the EUROSTAT homepage.

6.5. Pilot study

The main target of this study was not mainly to obtain results for the pilot countries, but to illustrate the use of RED when informing policy makers about the relationship between a road safety issue and local circumstances.

More precisely, objectives were:

- To identify and locate difficulties in data collection or data processing, in order to identify the boundaries of what could be done with currently available data.
- To illustrate the value of RED use in order to help road safety policy orientation and also to identify the limits of the use of specific risk ratios.
- To demonstrate the power of RED use for comparative analysis.

In order to have a wide view of what could be really done, six countries were chosen, they were as diverse as possible in term of geography, membership of EU, population, etc…, which led to the following choices:

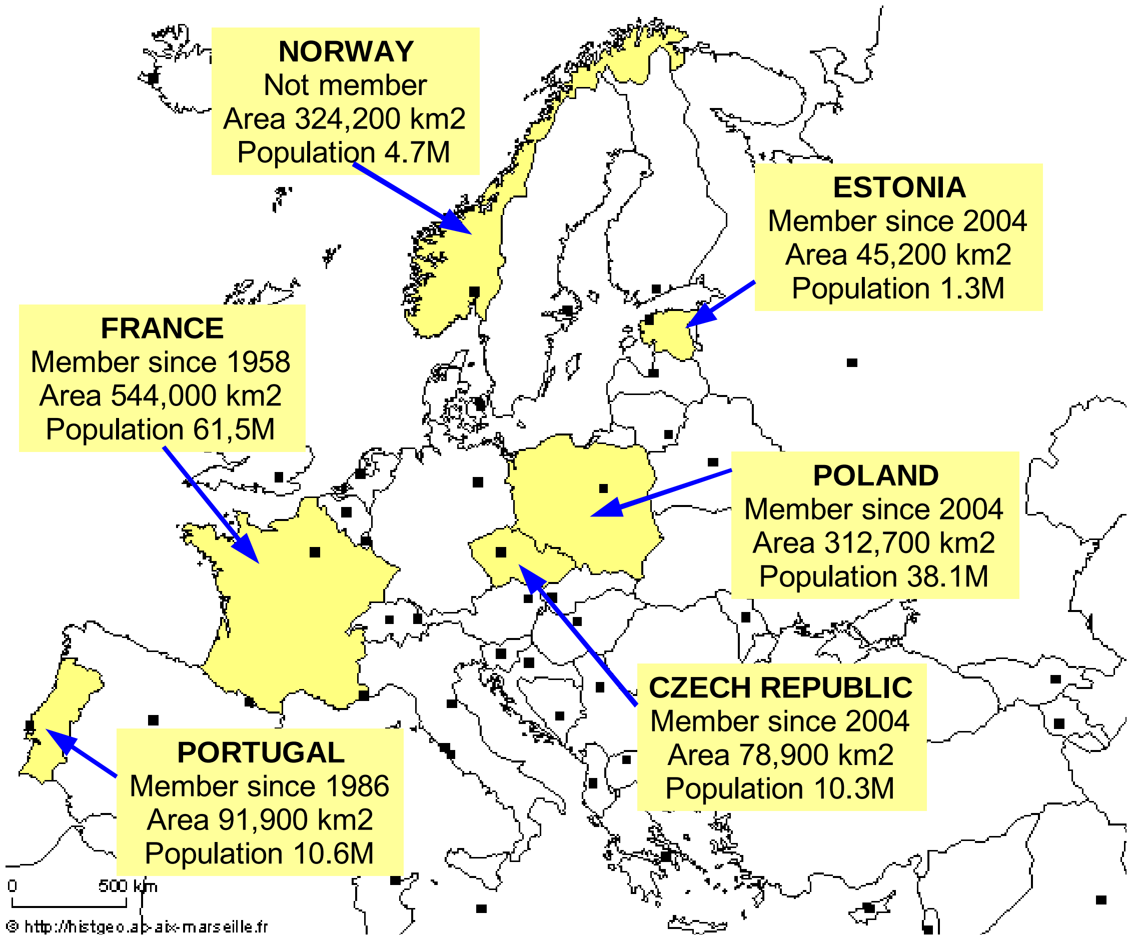


Figure 6.2: Pilot countries for exposure data

On the basis of a questionnaire sent to each pilot country to collect risk exposure data, the study was focused around several themes, namely:

- Main figures
- Age
- Heavy good vehicle and buses
- Motorcycles
- Motorways
- Car occupants

We will not enter here in the detailed results of the approach, which are not the aim of study. Further to the results a pilot study showed, and confirmed, some major points of methodology:

- Some RED essential for pertinent comparison are missing (eg. number of veh km)
- The choice of a type of RED may change totally the conclusions of the analysis
- There is a balance to be made between the level of disaggregation, necessary for a more detailed approach, and the size of the sample and care is needed regarding interpretation of the results
- Only comparisons with RED will support conclusions regarding whether a given situation is due to local circumstances or general tendencies.

7. Safety Performance Indicators

7.1. Introduction

The 2003 European road safety action program stated the target of having halved the number of road fatalities by 2010 (EC, 2003). This encouraged Member States to adopt national road safety plans that put road safety at the top of their political concerns. Many countries have developed and are currently enacting their national safety plans (EC, 2006). It is generally accepted that the safety plans and targets need to be monitored periodically, to verify the progress made and to adopt necessary changes based on recent trends observed (OECD, 2002).

Monitoring the progress, road safety is usually assessed in terms of crashes, injuries or their social costs. However, simply counting crashes or injuries mostly does not offer enough insight in underlying processes. Typically, crashes and injuries are only the tip of the iceberg, because they occur as the 'worst case' of unsafe operational conditions of the road traffic system. At the same time, those managing road safety need to take into account as many factors that affect safety as possible or, at least, those factors that they are able to adjust or control. Hence, safety performance indicators other than accident/injury numbers are required to provide a means for monitoring the effectiveness of safety actions applied.

A report written by a group of European road safety experts in 2001 (ETSC, 2001) detailed the reasons for the need of safety performance indicators. Among others, they stated that, in order to develop effective measures to reduce the number of crashes/ injuries, it is necessary to understand the processes that lead to crashes. Safety performance indicators can serve this purpose.

Safety performance indicators (SPIs) are the measures reflecting those operational conditions of the road traffic system which influence the system’s safety performance. The purpose of SPIs is to reflect the current safety conditions of a road traffic system, to measure the effect of various safety interventions, and to compare the safety performance of different road traffic systems (e.g. countries, regions, etc). High quality SPIs can be invaluable tools in future knowledge- and data-driven policy making in the EU.

The ETSC report (2001) strengthened the need for the development of a set of road safety performance indicators (SPIs) in the European Union (EU), which was further supported by the European road safety action program (EC, 2003). Both sources defined seven road safety related areas, for which the development of SPIs is required. These areas were: alcohol and drugs; speed; protective systems; daytime running lights; vehicles; roads; and trauma management. These areas were stated as core issues for road safety activity in Europe, based on the potential of different road safety domains for promoting road safety as well as on the experiences and data available in the countries.

Next, in the period 2004-2008, a study was undertaken aimed at developing SPIs for the seven predefined areas. The study was performed within the EC-funded project SafetyNet. The study's goal was to develop meaningful SPIs that, on the one hand, would have a solid basis and, on the other hand, could on the short term realistically be applied in the EU, given the availability of relevant data now and in the future. The SafetyNet team has worked closely with representatives from each of the 27 Member States, complemented with representatives from Norway and Switzerland. The representatives provided the necessary data for their respective countries as well as feedback on the study's results.

This summary gives an overview of the developed indicators, explaining the methodology of developing meaningful and applicable indicators, and showing – as examples – some results of applying the indicators to a number of European countries.

7.2. Methodology – basic model

The place of SPIs in a safety management system was originally illustrated by New Zealand's Land Traffic Safety Authority (LTSA, 2000) and then later by ETSC (2001). The original model defined the essential elements of a safety management system: safety measures/programs, safety performance indicators (as intermediate outcomes), the numbers of crash fatalities/injuries (as final outcomes), and the social costs of crashes/injuries. This model allocated SPIs on the level of intermediate outcomes but did not differentiate explicitly between SPIs and the concrete outcomes of programs or countermeasures.

The SPI Theory report by the SafetyNet team (Hakkert et al., 2007) provided further methodological fundamentals for SPI development. A core issue in the development of SPIs was that they should be able to reflect unsafe operational conditions of the road traffic system and should therefore be of a more general nature than direct outputs of specific safety interventions. In order to demonstrate a more general character of SPIs and their independence from interventions, the layer of 'intermediate outcomes' was further divided into 'operational conditions of the road traffic system' and 'outputs' (from measures/ interventions).

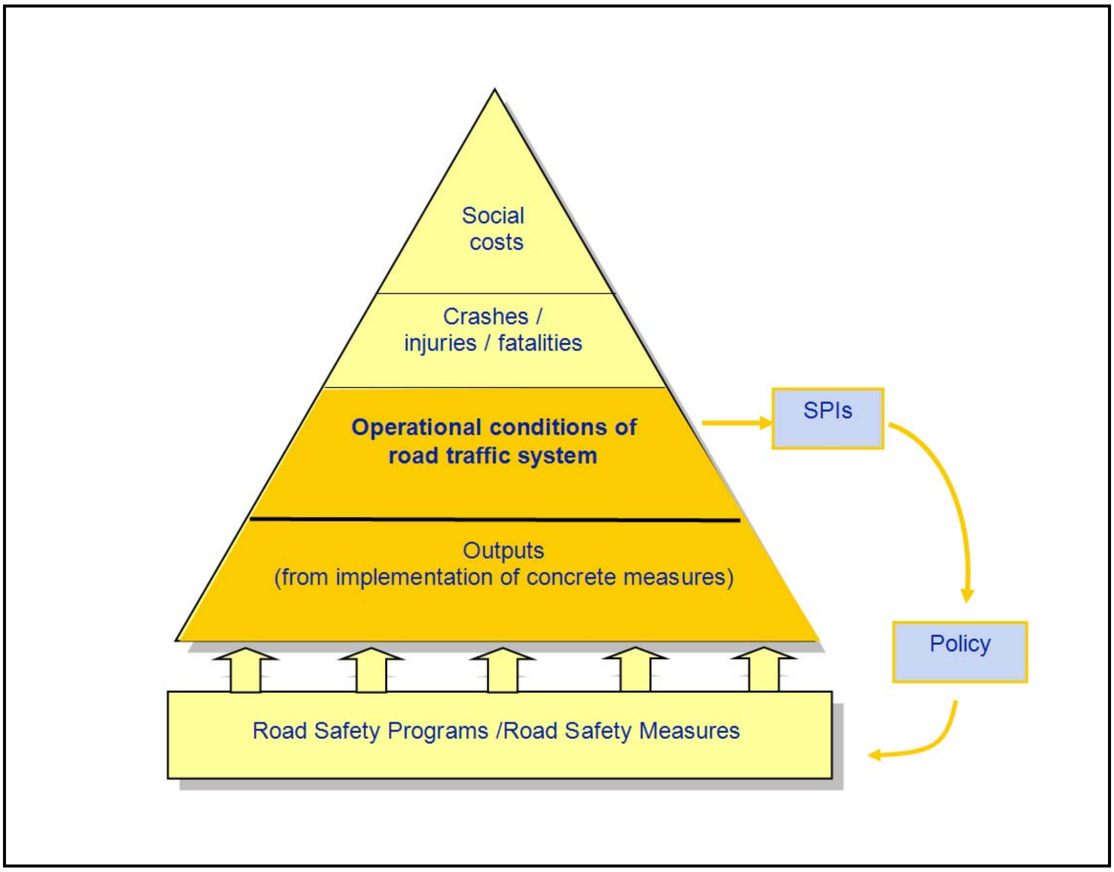


Figure 7.1: Place of SPIs in safety management system (adapted from LTSA (2000) and ETSC (2001)).

The SafetyNet concept of the place of SPIs in a safety management system is shown in Figure 8.1. Ideally, SPIs should reflect the unsafe operational conditions of the road traffic system and be sensitive to their changes. For example, in the case of speeding, the unsafe operational conditions of the road traffic system (i.e. speeding) are affected by outputs from a road safety program or specific safety measures (e.g. speed enforcement). The *outputs* are the physical deliverables of the intervention (e.g. speed cameras), whereas the *outcomes* should be seen in improving the operational conditions (e.g. lower level of speeding), which can be measured by SPIs. The improved operational conditions will result in crash or injury reductions, whereas the whole process should reduce the social costs. Consequently, the definition of SPIs suggested by the SafetyNet team was as follows (Hakkert et al., 2007): safety performance indicators are the measures (indicators) reflecting those operational conditions of the road traffic system which influence the system's safety performance.

The purpose of SPIs is:

- to reflect the current safety conditions of a road traffic system (i.e. they are not necessarily considered in the context of a specific safety measure, but in the context of specific safety problems or safety gaps);
- to measure the effect of various safety interventions, but not the stage or level of application of particular measures;
- to compare the safety performance of different road traffic systems (e.g. countries, regions, etc).

7.2.1. A common development procedure for SPIs in seven safety-related areas

A common procedure for the development of SPIs was used to make the process more consistent across different road safety areas (Hakkert et al., 2007). When SPIs are developed for a certain safety area, they should reflect the factors contributing to road crashes and injuries and characterize the scope of the problem identified. Developing SPIs should begin with a definition of the problem, i.e. the operational conditions of the road traffic system which are unsafe and lead to crashes and injuries as the 'worst case', and continue with a conversion of this information into a measurable variable. Under normal circumstances the optimal indicator for an issue is a direct indicator. However, often this cannot be realized, for example due to a lack of appropriate data. In that case indirect variables which describe the problem can be used as indirect indicators. If this is not possible either, the problem can be divided into several sub-problems and the indicator can be established for each of those. When the measurement is possible only for outputs of certain road safety measures, the limitations of this consideration should be clearly stated. This way, the difference between the *ideal* and the *realizable* SPIs is recognized.

Seven problem areas were selected for the development of SPIs:

- Alcohol and drugs;
- Speed;
- Protective systems;
- Daytime running lights (DRL);
- Vehicles (passive safety);
- Roads;
- Trauma management.

For each of these areas, SPIs were developed according to the above described common development procedure (Hakkert et al., 2007). Note that the seven areas are related to different levels of the road safety system. While the areas alcohol and drugs, and speed address road safety problems (or unsafe system conditions), the areas DRL and protective systems reflect countermeasures which are intended to prevent crashes or to reduce crash consequences, respectively. The areas roads and vehicles are related to a wide area of road safety interventions, whereas alcohol and drugs or speed are related to human behaviour as the cause of crashes. The area trauma management presents an additional category of road safety issues.

7.2.2. Applying the developed SPIs in Europe

A prerequisite for using SPIs for comparisons or monitoring is that the underlying data is of sufficient quality and that its collection is done in a harmonised fashion. To aid countries in setting up or upgrading their SPI data collection systems, the SafetyNet SPI team developed an SPI Manual (Hakkert and Gitelman, 2007). This Manual demonstrates existing practices for their measurements, provides best practice examples (when available), and details the procedures which are necessary to collect and process the required data for the estimation of the SPIs' set on a national level.

Questionnaires were sent to the 27 Member States (plus Norway and Switzerland) to collect the data available and to reflect the current measurement practices, in each one of the predefined safety areas. The developed SPIs were verified for their applicability based on the responses to these questionnaires (SafetyNet, 2005).

7.3. Results

For each of the identified areas, one or more safety performance indicators were developed. This section will first present the developed indicators. Next, per indicator area, some of the underlying considerations will be discussed. Finally, per area, some examples of country comparisons will be given using the data received from the 29 European countries studied. In view of the available space, examples will only be given for the areas alcohol and drugs, speed, protective systems, and daytime running lights. More country comparisons on basis of the developed SPIs can be found in Vis and Eksler (2008).

7.3.1. Results – SPI overview

Table 7.1 gives an overview of the SPIs developed for each one of the areas.

Safety area	Developed indicators
Alcohol and drugs	Alcohol percentage of fatalities resulting from crashes involving at least one *driver* impaired by alcohol Drugs percentage of fatalities resulting from crashes involving at least one *driver* impaired by drugs other than alcohol
Speed	The average speed either during daytime or during the night The percentage of speed limit offenders.
Protective systems	Daytime wearing rates of seatbelts in front seats (passenger cars + vans /under 3.5 tons) in rear seats (passenger cars + vans /under 3.5 tons) by children under 12 years old (restraint systems use in passenger cars) in front seats (HGV + coaches /above 3.5 tons) Daytime wearing rates of safety helmets by cyclists, moped riders and motorcyclists
DRL	DRL usage rate for all roads together, per road type, per vehicle type
Vehicles (passive safety)	Combined crashworthiness/ vehicle age measure of the passenger car fleet

	Measure for the safety of a vehicle fleet's composition due to incompatibility within the fleet
Roads	Road network percentage of appropriate current road category length per theoretical road category Road design EuroRAP Road Protection Scores
Trauma management	Availability of Emergency Medical Services (EMS) stations number of EMS stations per 10,000 citizens and per 100 km length of rural public roads Availability and composition of EMS medical staff percentage of physicians and paramedics out of the total number of EMS staff number of EMS staff per 10,000 citizens Availability and composition of EMS transportation units percentage of Basic Life Support Units, Mobile Intensive Care Units and helicopters/planes out of the total number of EMS transportation units number of EMS transportation units per 10,000 citizens number of EMS transportation units per 100 km of total road length Characteristics of the EMS response time demand for EMS response time (min) percentage of EMS responses meeting the demand average response time of EMS (min) Availability of trauma beds in permanent medical facilities percentage of beds in trauma centres and trauma departments of hospitals out of the total trauma care beds total number of trauma care beds per 10,000 citizens Furthermore, a combined indicator was developed to measure a country's overall performance for Trauma management.

Table 7.1: SPIs developed for each safety area

7.3.2. Alcohol and drugs

The use of alcohol and drugs by road users, especially drivers of motor vehicles, increases the risk of a road crash considerably (Elvik and Vaa, 2004; Hakkert et al., 2007). Consequently, most countries ban the use of these psycho-active substances among drivers, or set low legal limits for blood alcohol and drug concentrations. The SPIs for alcohol and drugs can be used by road safety authorities and politicians in assessing the needs for and the effects of countermeasures such as legislation, enforcement, education and publicity.

7.3.3. SPI for alcohol and drugs

Theoretically, the 'ideal' SPI of the alcohol and drug related road toll would be the prevalence and concentration of impairing substances among the general road user population. In practice, however, major methodological problems are associated with this SPI, even when used within one country and when including only alcohol as a psychoactive substance. One judicial impediment is the fact that in some countries (i.e., the UK and Germany) mandatory random testing of road users by the police is prevented by law. In other countries, random breath testing for alcohol is allowed, but random testing for drugs other than alcohol is not allowed. Problems will only increase when all EU countries will have to agree on a common sampling and testing protocol and when psychoactive substances other than alcohol will have to be included. Moreover, rather large samples are required to obtain reliable results, because in most countries the prevalence of psychoactive substances in the general driver population is likely to be low in statistical terms.

Since the 'ideal' SPIs for the use of alcohol and drugs cannot be uniformly implemented throughout the EU, more feasible, indirect SPIs were chosen, as presented in Table 8.1. It must be noted that crash data lie at the basis of these indicators, which should in general be avoided when developing road safety performance indicators.

7.3.4. Country comparisons – example for alcohol

The SPI for alcohol could be determined for 26 countries of a total of 29. Only Ireland, Malta and Luxembourg could not provide data. Values for the alcohol SPI (the percentage of fatalities resulting from crashes involving at least one driver impaired by alcohol) vary from 3.4% in the Czech Republic to 72.2% in Italy.

A basic question here is whether the huge variation between the countries' scores is real or due to methodological reasons. Sørensen et al. (2008) have studied the quality of the above data in five selected countries (Czech Republic, Austria, France, Sweden, and Norway). They conclude that there is reason to believe that the data used as basis for the calculation of the alcohol SPI may be incomplete in many countries. They therefore advise currently not to compare the alcohol SPI results across countries. Strict harmonization of definitions, data collection and data analysis methods is required to make the SPI results comparable.

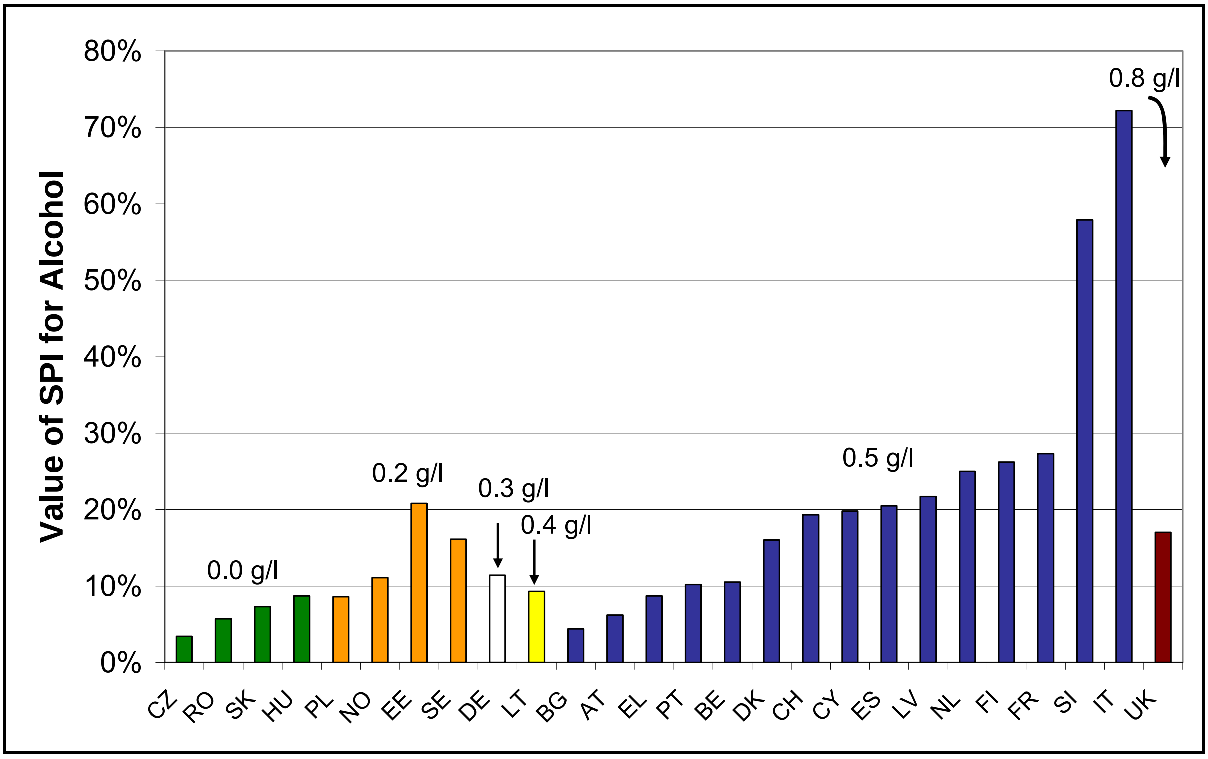


Figure 7.2: Most recent values for the SPI for alcohol

Figure 8.2 shows the most recent SPI values determined from data that countries could provide. Colours indicate the same BAC legal limits. For most countries 2007 figures were not available and values for earlier years were used. Regarding alcohol, from the 26 countries that provided data, eight countries have been able to produce data for 2007 (CZ, RO, PL, SE, LT, BG, PT, LV), for twelve countries the most recent data stems from 2006 (BE, DE, EL, ES, FR, CY, AT, SI, SK, FI, UK, NO), five countries have data for 2005 (DK, EE, HU, NL, CH), and one country has data for 2004 (IT).

Since the SPI value is expected to relate to the national legal limit of blood alcohol concentration (BAC), it is reasonable to group countries according to the legal limit and rank them within these groups. Another argument is that most countries provide data for drivers above the legal alcohol limit. As seen from Figure 7.2 this limit varies from 0.0 to 0.8 g/l BAC. The difference in legal limit may have two opposite effects. On the one hand, the higher the limit, the lower the percentage of drivers who should be above this limit. On the other hand, if low legal limits have deterrent effects, there may be relatively less drivers above the legal limit in countries with low legal limits.

7.3.5. Speed

Speed is one of the main causes of crashes and has a direct influence on crash severity (OECD, 2006). According to different estimates (OECD, 2006; TRB, 1998), speed was found to be a major contributory factor in around 10% of all crashes and in about 30% of fatal crashes. Due to the massive character of speeding and inappropriate speeds, managing drivers' speed has a high safety potential. The relation between speed and crashes is abundantly studied in the literature. In their recent review of speed-crash rate studies, Aarts & Van Schagen (2006) conclude that the safety effect of a particular change in speed depends on the type (and thus characteristics) of the road. They conclude from the reviewed studies that a 1% increase in speed results approximately in 2% change in injury crash rate, 3% change in severe crash rate, and 4% change in fatal crash rate. Different measures must be combined to reach the objective of speed reduction, including actions on speed limits, road design, drivers' education, enforcement, and in-car technologies (OECD, 2006).

7.3.6. SPIs for speed

International comparisons of speeding performances should only be carried out for roads of similar category and for which similar methods of speed data collection are used. In this respect, only comparisons concerning motorways are presented in this document, as it is the type of road showing the more similarities between countries. Still, several comparability issues are remaining, such as the different speed limits, different methods of data collection and the different categories of vehicles and periods of measurement that are considered.

The speed data is collected by a speed survey. Setting up the survey, the issues to be considered are: which locations are suitable for speed measurement; which road types should be considered; how to sample the set of measuring locations; which time periods are valid for speed measurements; and how to determine speeds for different types of vehicles on the basis of identified requirements for speed measurements (Hakkert and Gitelman, 2007).

7.3.7. Country comparisons – example for speed

Speed has systematically been monitored in many EU countries. However, the possibility of international comparison is limited, mostly due to the huge variability in the ways the countries conduct their surveys (Vis and Eksler, 2008). In addition, road classifications and speed limits vary between countries, making the comparisons more difficult. Despite the restrictions, a comparison of speeds on motorways is feasible, accounting for relative similarity of road and traffic conditions on these road types across Europe.

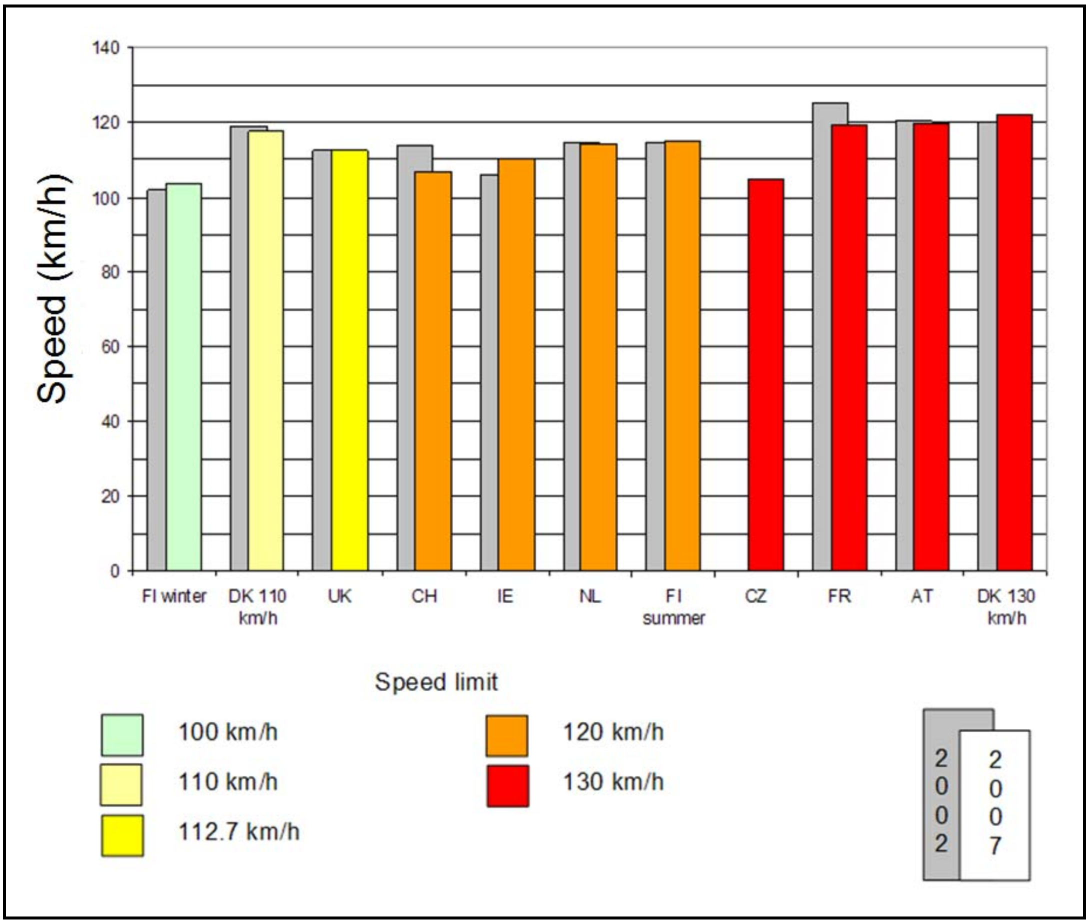


Figure 7.3: Average speed of light vehicles on motorways in 2007 (coloured) and 2002 (gray).
(CH, CZ, DK: all types of vehicles are considered. CZ, IE, AT, NL: figures from 2006. IE: speed limit in 2002 was 112.6 km/h (70 mph). DK: in 2002, the speed limit for all motorways was 110. Since 2004 about 50% of the motorways have a new speed limit of 130 km/h.)

Figure 8.3 shows the average speed of light vehicles on motorways for the year 2007, compared with the average speeds five years earlier in 2002. The different speed limits are indicated by different colours. For Denmark and the Netherlands, only monthly indicators were available. The annual figures that are reported on the graph are simple averages of these monthly figures but not official indicators reported by Danish or Dutch authorities.

Unsurprisingly, the motorways with the highest speed limits (Austria, France and Denmark) are showing the highest average speeds. The 2007 average speed on these motorways is approximately 10 km/h below the speed limit. The latter observation is also valid concerning Ireland and Switzerland. It should however be noted that all types of vehicles are included in the speed indicators for Switzerland, which likely has the consequence of significantly lowering the average speed comparing to a 'light vehicles-only' situation. The scheme is really different for Finland's 100 km/h motorways and the UK where the average speed is slightly higher than the speed limit. The worst result in terms of differential between average speed and the speed limit is encountered on Denmark's 110 km/h motorways, where the average speed exceeds the speed limit by more than 5 km/h. In contrast, the average speed in the Czech Republic is impressively low in comparison with the speed limit but this indicator, similarly to the Swiss one, includes all types of vehicles and not only light vehicles.

7.3.8. Protective systems

The use of seat belts is the single most effective means of reducing fatal and non-fatal injuries in motor vehicle crashes. It reduces the death rate of car occupants by at least 40% (ETSC, 2001). According to (TRB-TRIS, 2002), child restraint seats are 71% effective in reducing fatalities among children under the age of 5, but misuse and improper use is a critical problem both in the US and EU (Hakkert et al., 2007). Studies on the effect of motorcycle and moped helmets were carried out mostly in the 1980s and concluded that the risk of death is more than halved if a helmet is worn (Hakkert et al., 2007). The effectiveness of helmets for cyclists has been studied for decades, and they are known to reduce the risk of severe head injury by about one-third. The use of seatbelts has regularly been assessed in several European countries since 1970 (e.g. Switzerland, France, Germany) parallel to the introduction of seatbelt-related regulations.

7.3.9. SPIs for protective systems

In this domain, a direct SPI was defined as the day-time wearing rate of protective systems in traffic, according to the system's types. The SPIs directly measure the use of protective systems which mitigate crash consequences for the road users' health.

The SPIs are estimated by means of a national observation survey, in which the measurements should preferably be classified according to main road types, such as motorways, other rural roads and urban roads. The values for major road types should then be aggregated into one indicator (of each type) for the country. International or regional comparisons of the use of protective systems use rates are important tools for recognizing deficiencies, setting priorities and stimulating efforts at the political level (Hakkert and Gitelman, 2007).

7.3.10. Country comparisons – example for protective systems

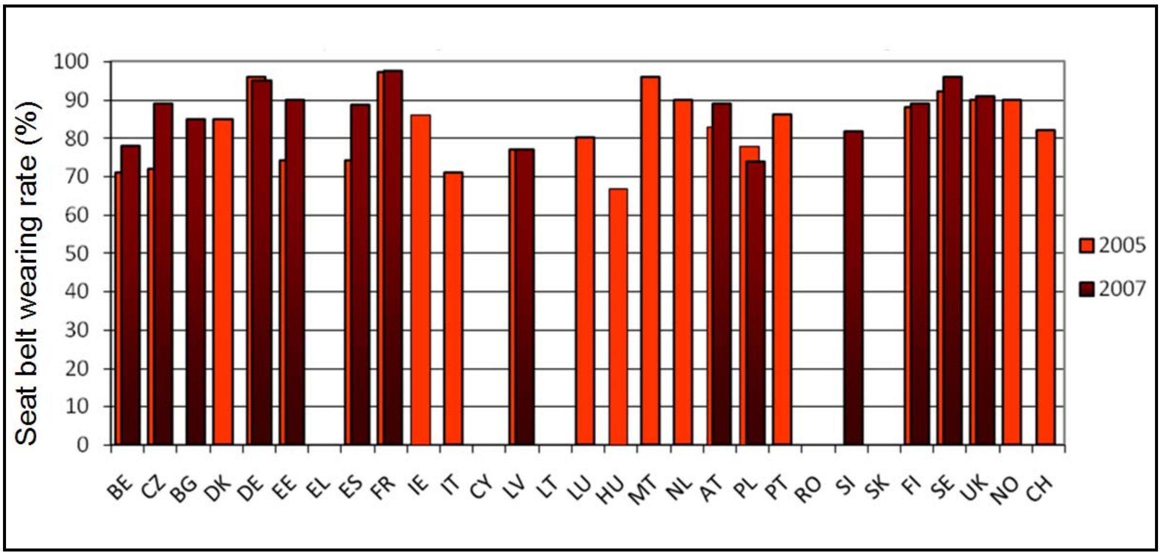


Figure 7.4: Daytime seat belt wearing rate on front seats of passenger cars and vans under 3.5 tons in 2007 and 2005.

(LU: 2003; LV, MT: 2006; DK, DE, EE, IT, FR, PT, LU, CH: only driver wearing rates considered; FR: vans not included; IT, LV, MT, PL, PT does not fit fully to defined requirements.)

Figure 8.4 shows that only Germany, France and Malta register wearing rates above 95%, while the rates under 75% are registered in Belgium, Czech Republic, Estonia, Spain, Hungary and Poland. The rates in Slovakia, Lithuania and Greece, where the surveys have not been performed yet, are presumably even lower, as foreshadowed by available data on the indirect indicator (usage rates by accident fatalities).

7.3.11. Daytime running lights

Many crashes occur because road users do not notice each other in time or do not notice each other at all. Use of daytime running lights (DRL) for cars in all light conditions is intended to reduce the number of multi-party crashes by increasing the cars' visibility and making them easier to notice (Elvik and Vaa, 2004). The problem of visibility is especially pertinent to mopeds and motorcycles. Moreover, the use of DRL could increase the reliability of the estimation of other motorized road users' moving direction, distance and speed (Hakkert et al., 2007).

A recent study commissioned by the European Commission involved a meta-analysis of 41 studies of the DRL effect for cars and 16 studies of the effect for motorcycles (Elvik et al., 2003). This study showed that for cars DRL reduced the number of daytime injury crashes by 3 to 12%, and for motorcycles by 5 to 10%. An EC consultation paper (DRL, 2006) stated the life-saving potential of DRL to be in the order of 3 to 5% of the annual number of road fatalities in the EU.

Presently, 14 Member States have mandatory rules on the use of DRL in force, with different requirements (DRL, 2006). However, the use of DRL indicators is not common in the road safety decision-making practice.

7.3.12. SPI for daytime running lights

The DRL indicator is defined as the percentage of vehicles using daytime running lights. An estimate of this percentage should be based on a national observation survey of the DRL use. The SPI value is estimated for the whole sample of vehicles that were observed in the country. Additional values are calculated for different road categories and for different vehicle types. The road categories to be considered are: motorways, rural roads, urban roads, and DRL-roads, where the term 'DRL-roads' denotes the road categories where the usage of DRL is obligatory. For example, in Hungary, DRL-roads are certain roads outside built-up areas. The vehicle types to be considered are: cars, heavy goods vehicles (including vans), motorcycles and mopeds.

7.3.13. Country comparisons – example for daytime running lights

The DRL usage rates can be considered for 11 countries, as presented in Table 8.2. In the countries where automatic DRL was already introduced a long time ago (e.g. Sweden, Norway), the DRL usage rate is close to 100%, according to expert estimates. In such countries, monitoring the DRL usage rate as a behavioural SPI does not have practical implications any more.

Country	Year	Motorways	Rural roads	Urban roads	DRL roads
Austria	2006	95%	97%	88%	93%
Czech Republic	2007	99%	99%	99%	99%
Estonia	2004	99%	100%	99%	99%
Latvia	2007	-	98%	98%	98%
France	2004	35%	24%	-	30%
Hungary	2005	95%	84%	5%	-
Switzerland	2004	51%	48%	46%	48%
Bulgaria	2007	95%	90%	90%	-

Poland	2007	100%	100%	100%	100%
Sweden	2007	100%	100%	100%	100%
Finland	2007	100%	100%	100%	100%

Table 7.2: DRL usage rates on different road types

In Austria, Czech Republic, Estonia and Finland, the use of DRL is obligatory for all vehicle types, on all road types, and all year long. In Hungary, this is also the case, but only for roads outside urban areas. DRL is recommended in France, the Netherlands and Switzerland.

DRL usage rates are highest in those countries and for those road types where the use of DRL is obligatory. In Hungary, for example, DRL usage is high on roads outside urban areas, while on roads inside urban areas, where the use of DRL is not compulsory, the usage rate is only 5%. Austria, the Czech Republic, Estonia and Finland have high DRL SPI values for all road types. Switzerland has the highest usage rate among those countries where DRL is not compulsory.

7.3.14. Passive vehicle safety

The passive vehicle safety SPI relates to the level of protection offered by the vehicles which constitute the fleet in a country. Improvements in passive safety do not affect the occurrence of crashes, but help to minimise the consequences when they happen. According to Hakkert et al. (2007), the unsafe operational conditions could be defined as:

- the presence within the fleet of a number of vehicles that will not protect the occupant well in a collision (lacking crashworthiness);
- the presence within the fleet of a number of vehicles with an increased capacity to inflict injury (lacking compatibility).

The first condition can be characterised by two features of a country's vehicle fleet: average age and its average EuroNCAP score. There is ample evidence that newer cars are safer than older cars. For example, Thomas and Frampton (2003) indicated that a large part of the reduction in driver fatalities in newer cars was due to vehicle safety measures. Frampton et al. (2002) use national casualty figures from the UK that show an 18% decrease in fatalities in newer cars. EuroNCAP is widely used as an indicator of passive safety for individual vehicles to give consumers a guide to the crashworthiness of specific makes and models. For example, Lie and Tingvall (2000) reported that cars with a three- or four-star rating are approximately 30% safer, compared to cars with a two-star rating, and that there was a strong and consistent overall correlation between EuroNCAP scoring and risk of serious and fatal injury.

The second condition relates to the proportions of vehicles of different types and weights that make up the total fleet. The composition of the vehicle fleet gives an indication of the likely compatibility problems, which result from collisions between vehicles of different mass and/or geometry. These problems result in well-recognised effects on occupant outcomes in crashes, with, typically, the occupants of smaller or lighter vehicles being more at risk from severe injuries (Hakkert et al., 2007).

Developing the passive vehicle safety SPIs, the countries were asked to send data containing the entire vehicle fleet database according to vehicle type, make, model and year of first registration, as it stood in 2003. For each country, an overall average EuroNCAP score was awarded for each country and combined with the share of new passenger cars in the fleet. This constituted the first vehicle SPI.

In addition, the composition of the vehicle fleet was analysed in terms of the fleet unsafety due to the share of three types of three vehicle types within each country's fleet: passenger cars, heavy goods vehicles, and motorcycles. Higher shares of motorcycles and heavy goods vehicles are associated with expected more severe crash outcomes. The second vehicle SPI is formed by this fleet compatibility measure. Country comparisons using these vehicle SPIs are described by Hakkert et al. (2007).

7.3.15. Roads

SPIs for roads aim to assess the safety hazards caused by infrastructure layout and design. Two SPIs for roads were developed, one to asses the road network and the other to assess the road design. The road network SPI indicates whether the present road category is appropriate, given the urban areas that it connects. Connections between these urban areas are assessed by comparing the theoretically required road category with the actual road category. The rationale behind the road network SPI and the application of this indicator to a number of countries – the Netherlands, Israel, Greece and Portugal – is described by Weijermars et al. (2008).

The road design SPI is the percentage of appropriate current road category length per theoretical road category (Hakkert and Gitelman, 2007). It determines the level of safety of the existing roads. The road design SPI is based on the EuroRAP Road Protection Score (RPS). The RPS is a measure for the protection that is provided in relation to three main crash types: run-off road, head-on impacts and severe impacts at intersections. EuroRAP designed a method to calculate the RPS for each road segment or route, expressed in one to four stars, depending on a number of road characteristics. For more information on EuroRAP RPS see Lynam et al. (2004).

7.3.16. Trauma management

Trauma management refers to the system which is responsible for the medical treatment of injuries resulting from road crashes. It covers the initial medical treatment provided by Emergency Medical Services (EMS) at the scene of the crash and during the transportation to a permanent medical facility, and further medical treatment provided by permanent medical facilities (hospitals, trauma centres). There is a consensus in the professional literature that the appropriate management of road casualties following the crash is a critical determinant of both the chance of survival and, on survival, the quality of life (Elvik and Vaa, 2004; EC, 2006; Hakkert et al., 2007). Conversely, improper functioning of the post-crash care leads to more fatalities and severe injuries, which could be avoided.

In general, the international comparisons of the trauma management systems should be performed with caution due to a variety of definitions, legislations and systems, which are available for both the emergency and in-hospital trauma care, in different European countries. However, based on the best practice recommendations in the field of post crash care (ETSC 1999), a number of features can be named which are definitely associated with better performance of the trauma management system. They are: shorter response time by EMS; higher competence level of the EMS staff; standardisation of the EMS vehicles; adequate hospital trauma care.

Based on the above considerations and accounting for the limited data available in different countries, a set of trauma management SPIs was developed (Hakkert et al., 2007). The countries can be compared using selected trauma management SPIs, for instance by availability of the EMS stations, by availability and composition of the EMS medical staff, by availability and composition of the EMS transportation units, by characteristics of the EMS response time or by availability of trauma beds in permanent medical facilities (see Vis and Eksler, 2008). Furthermore, a combined indicator was developed to measure a country's overall trauma management performance relative to other countries. The combined indicator attributes each country to one of five levels of the trauma management system's performance such as: 'high', 'relatively high', 'medium', 'relatively low' or 'low'. The trauma management SPIs were estimated for 20 countries (Vis and Eksler, 2008).

7.4. Conclusions and recommendations

In summary, safety performance indicators for seven road safety related areas were developed within the EU-funded project SafetyNet. The goal was to develop them such that, given the available data, they could be widely applied within the EU, now and in the future. This turned out to be a difficult task. For some areas (seat belt use and helmet wearing, and the use of daytime running light) performance indicators are straightforward, and reasonably good data is available in Europe. For other areas (speed behaviour and the use of alcohol and drugs), however, the development of performance indicators suffers heavily from lack of data. In the case of alcohol and drug use legislative limiting conditions in some of the bigger European countries make it necessary to use crash-related data for the calculation of SPIs. This should normally be prevented when developing SPIs, but even then, data of sufficient quality is lacking throughout Europe. For two areas (trauma management, but even more so for roads), completely new theories had to be developed. Especially for roads, much more effort is required in the future for the development of reliable safety performance indicators. In addition, also for this topic reliable data is generally not available in Europe.

The major bottleneck in the development and application of reliable road safety performance indicators in Europe is the general lack of data of sufficient quality. To help the countries in setting up new data collection systems or in improving existing ones, the SafetyNet SPI team developed an SPI Manual (Hakkert and Gitelman, 2007). This SPI Manual aims to assist countries in establishing the systems of data collection that are necessary for producing national SPIs in each of the predefined safety fields, and to make them comparable on a European level. We recommend that the countries use this Manual as a basis for starting or improving the use of SPIs in their country. High quality SPIs can be invaluable tools in future knowledge- and data-driven policy making in the EU. The SafetyNet SPI team is confident that the developed SPI theory can form a good basis for future developments in this area.

7.4.1. References – Safety Performance Indicators

1. Aarts, L. and Van Schagen, I. (2006). Driving speed and the risk of road crashes: a review. Accid. Anal. Prev., doi:10.1016/j.aap.2005.07.004.
2. DRL (2006). Saving Lives with Daytime Running Lights (DRL). A Consultation Paper, DG TREN E3, Brussels, 1 August 2006.
3. Elvik, R., Christensen, P., and Olsen, S.F. (2003). Daytime running lights. A systematic review of effects on road safety, TØI report 688/2003.
4. Elvik, R. and Vaa, T. (2004) The Handbook of Road Safety Measures. Elsevier Science, Oxford.
5. European Commission (2003) *Saving 20 000 lives on our roads: A shared responsibility*, European Road Safety Action Programme. (Halving the number of road accident victims in the European Union by 2010: A shared responsibility) Communication from the Commission, COM(2003) 311 final.
6. European Commission (2006). European Road Safety Action Programme. Mid-term review. European Commission, COM(2006) 74 final, 22 February.
7. European Traffic Safety Council, ETSC (1999). Reducing the Severity of Road Injuries through Post Impact Care. European Transport Safety Council, Brussels.
8. European Traffic Safety Council, ETSC (2001) *Transport safety performance indicators*, European Transport Safety Council ETSC, Brussels.
9. Frampton, R., Welsh, R., and Thomas, P. (2002) Belted Driver Protection In Frontal Impact – What Has Been Achieved And Where Do Future Priorities Lie? Procs 46th AAAM conference, Tempe, Arizona.

10. Hakkert, A.S. and Gitelman, V. (Eds.) (2007). Road Safety Performance Indicators: Manual. Deliverable D3.8 of the EU FP6 project SafetyNet.
11. Hakkert A.S., Gitelman V., and Vis, M.A. (Eds.) (2007). Road Safety Performance Indicators: Theory. Deliverable D3.6 of the EU FP6 project SafetyNet.
12. Lie, A. and Tingvall, C. (2000) How do EuroNCAP results correlate to real life injury risks – A paired comparison study of car-to-car crashes. International IRCOBI conference on the biomechanics of impact, Montpellier, France .
13. LTSA (2000). Road Safety Strategy 2010. National Road Safety Committee, Land Traffic Safety Authority, Wellington, New Zealand.
14. Lynam, D., Hummel, T., Barker, J., and Lawson, S.D. (2004) European road assessment programme, EuroRAP 2003 Technical report, AA Foundation for Road Safety Research, Farnborough, UK.
15. OECD (2002). Safety on roads. What's the vision? Organisation for Economic Co-operation and Development, Paris.
16. OECD (2006). Speed management. Organization for Economic Co-operation and Development, European Conference of Ministers of Transport.
17. Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A., Jarawan, E., and Mathers, C. (Eds.) (2004): *World Report on Road Traffic Injury Prevention*, World Health Organisation, Geneva.
18. SafetyNet (2005). State of the art Report on Road Safety Performance Indicators, May 2005, Deliverable D3.1 of the EU FP6 project SafetyNet.
19. Sørensen, M., Assum, T., Eksler, V., and Tecl, J. (2008) Safety Performance Indicator for Alcohol: Data Quality in Selected Countries and Comparison with Other Alcohol Indicators. Deliverable D3.10a of the EU FP6 project SafetyNet.
20. Thomas, P. and Frampton, R. (2003) Real-world Crash Performance of Recent Model Cars – Next Steps in Injury Prevention. International IRCOBI conference on the biomechanics of impact, Lisbon, Portugal.
21. TRB (1998). Managing speed; review of current practice for setting and enforcing speed limits. Special report 254. Transportation Research Board, National Academy Press, Washington, DC.
22. TRB-TRIS (2002). *Safety study: the performance and use of child restraint systems, seat belts and air bags for children in passenger vehicles*, volume 2: case summaries, NTSB, Washington, USA.
23. Vis, M.A. and Eksler, V. (Eds.) (2008a) Road Safety Performance Indicators: Updated Country Comparisons. Deliverable D3.11a of the EU FP6 project SafetyNet.
24. Vis, M.A., Gitelman, V., and Hakkert, S. (2008b) Development of road safety performance indicators in the European Union. Proceedings of the GAMIT 2008 Conference, Gdánsk, Poland, April 2008.
25. Weijermars, W.A.M. (ed.) Safety Performance indicators for Roads: Pilots in the Netherlands, Greece, Israel and Portugal. Deliverable D3.10c of the EU FP6 project SafetyNet.

8. Recommendations for transparent and independent road accident investigation

8.1. Overview

When a crash occurs the prime objective of those responsible for aspects of the transport system is to understand the reasons for the crash in order to ensure that systematic lessons are learnt and the quality of the system is improved to reduce future crash risk. Additionally the judicial process across all EU member states is such that there is a search for responsibility and culpability. A normal part of the follow up to a crash is an investigation to gather key information and to elucidate the causes. Nevertheless despite the commonality of purpose there is a variety of approaches between member states and across transport modes.

The need for accident investigation has been recognised for a long time as part of the judicial process, it is normal for most countries to follow up crashes with an investigation into the causes and with the intention of allocating blame. Occasionally crashes are investigated as part of the quality assurance approach within the mode of transport.

Transport modes such as aviation, rail and marine have relatively few crashes each year however the possibility of large numbers of casualties or considerable property destruction is high due to the size of many of the vehicles and the numbers of passengers that can be carried. In the case of these transport modes there is a strong international dimension to the construction and operation of the vehicles and within Europe agreements have been made to provide a basis for safety related accident investigations. In these modes it is important to take every opportunity to identify ways to improve the systems and virtually all collisions, including non-injury and very low injury level collisions, can be routinely and manageably investigated.

In the case of road transport there are much larger numbers of crashes occurring in each EU Member State each year and it is impractical to investigate each one. Furthermore the majority of crashes involve little or no injury or cost to society and there becomes limited value from further investigations once a certain level has been reached. However EU Member States have developed a range of approaches relating to the investigation of certain types of crash.

Each Member State conducts judiciary related investigations into the causes of fatal road crashes with the intention of identifying blame. In some instances these are conducted by independent expert investigators appointed by the courts, in other cases they are may be conducted by highly trained police investigators. Often the court will determine blame on the part of individuals but sometimes it may also be able to refer inherent inadequacies of the transport system to relevant stakeholders.

All transport modes recognise the need to ensure that safety interventions are based on the clearest understanding of the causation factors of crashes and use accident data as part of the evidence base. Amongst rail, marine and aviation crashes are so few that all of the available accident case data is used to support policy development. Road transport crashes however are much more numerous and individual accident investigations may not be representative of the complete accident population, indeed it is possible that a generalisation from a single crash may result in misleading and inappropriate countermeasures. For the purpose of generating the evidence base for road transport safety improvements it is necessary to gather accident data based on a systematic and statistically valid plan. This plan can be targeted at specific information needs so that meaningful data is gathered in the most appropriate manner.

This section of the SafetyNet report contrasts the accident investigation approaches employed within each of the transport modes and identifies common factors. The key issues of independence and transparency of accident investigations are discussed and the SafetyNet recommendations for the key actions in implementing a pan-European accident investigation system for safety improvements are presented. The recommendations are in four groups:-

1. **Institutional**, referring to the structure and functioning of the body responsible for road safety investigations;
2. **Operational**, detailing how the body carries out investigations;
3. **Data**, addressing issues surrounding the storage, retrieval and analysis of data generated by investigations; and
4. **Development of Countermeasures**, dealing with how investigation conclusions should be presented, used and disseminated

8.2. Aviation accident investigation in European Union

In the field of civil aviation, there are two *specific* European Directives:

1. *Council Directive 94/56/EC of 21 November 1994 establishing the fundamental principles governing the investigation of civil aviation accidents and incidents*; and
2. *Directive 2003/42/EC of the European Parliament and of the Council of 13 June 2003 on occurrence reporting in civil aviation*

The purpose of a safety or accident investigation, the methods and practices, as well as the definitions have been set by the International Civil Aviation Organisation (ICAO) since the 1944 Chicago Convention. Accident investigations in Europe and worldwide rely on the Chicago Convention Annex 13. The first version of the Annex 13 was drafted in 1951; the current version (9th) was agreed upon in 2001.

The European Directives' focus is on the structural, financial and functional independence of the investigating body. National laws adapting the international and European requirements concerning the independence of the safety investigation and of the investigation body exist in all studied Member States, namely in Germany, France, Italy, Finland, Sweden and United Kingdom. All these Member States have an independent civil aviation accident investigation body.

8.3. Maritime accident investigation in European Union

In the field of maritime transport, there is one *general* European Directive:

1. *Council Directive 1999/35/EC of 29 April 1999 on a system of mandatory surveys for the safe operation of regular ro-ro ferry and high-speed passenger craft services*

The purpose of a safety or accident investigation, the methods and practices, as well as the definitions have been set by the International Maritime Organisation (IMO). The accident investigation in Europe and worldwide tends to respect the IMO Code for the Investigation of Marine Casualties and Incidents, agreed upon by the Resolution A849/20 from 1997.

The European Directive structures the maritime transport in a quite general manner. It is not specific to accident investigation and does not require the Member States to establish an independent investigation body. However, the Directive's aim is to ensure the harmonised enforcement of some principles agreed upon within the IMO, particularly the IMO Code for the Investigation of Marine Casualties and Incidents. The IMO Code states that ideally an investigation on a marine casualty should be separate from, and independent of, any other form of investigation. Therefore, while the Member States have no formal obligation to establish an independent investigation body for the investigation of marine casualties, this remains an objective. National laws adapting the international and European recommendations concerning the independence of the safety investigation and of the investigation body exist in Germany, France, Finland, Sweden and United Kingdom.

8.4. Rail accident investigation in European Union

In the field of rail transport, there are three *general* Directives:

1. *Council Directive 91/440/EEC on the development of the Community's railways amended by the*
2. *Directive 2001/12/EC of the European Parliament and of the Council of 26 February 2001*; and
3. *Directive 2004/49/EC of the European Parliament and of the Council on safety on the Community's railways*

The purpose of a safety (or accident) investigation, the methods and practices as well as the definitions is set by the 2004 Directive. It requires the Member States to establish an independent accident investigation body. The European Directives' structure the rail transport in a quite general manner. The International Union of Railways (UIC) uses the European definitions for its Safety Database project. National laws adapting the European requirements concerning the independence of the safety investigation and of the investigation body exist or were, at the time of the study, shortly to be acted in all studied Member States.

8.5. Road accident investigation in European Union

In the field of road transport, there are no European Directives or Regulations nor any other international legal framework. National laws on safety or accident investigation and the investigation body exist in France, in Finland and in Sweden.
Italy, Germany and United Kingdom have opted for separate investigation bodies for different transport modes. France has opted for separate investigation bodies for civil aviation and maritime, while all the land transports are investigated by one body. Finland and Sweden both have a single investigation body for aviation, marine and rail accidents. These bodies investigate also other major accidents whether they involve a mode of transport or not and may investigate major road accidents. Normally the road traffic accident investigation within these bodies is limited to accidents in commercial transport. In addition, Finland and Sweden have also a separate system for investigating road traffic accidents.

It is clear that road accident investigations differ from the accident investigation in other transport modes. Only three of the Member States, whose accident investigation practices were assessed, have a legal national framework applicable to road accident safety investigation. In France, only a few accidents involving road traffic vehicles are investigated each year. In Finland and in Sweden, all fatal road accidents are investigated. In recent years, 300-350 fatal road accidents were investigated annually in Finland and some 400-450 in Sweden.

The bulk of the research in road safety in all involved Member States, with the exception of Finland and, to a lesser extent, Sweden, is therefore made by research bodies that do not have most of the features of an independent body. Namely, they lack the legal status of a body responsible for conducting safety or accident investigations.

8.6. Is the apparent lack of independence of road accident investigations a problem?

The requirement of independence for accident investigating entities in the public transport modes results from the specific characteristics of (accident investigation in) those transport modes. Independence of an investigation body can thus be understood as a means of assuring its impartiality—and that of the investigations it conducts. However, the independence of the investigation body and that of the investigation processes do not thoroughly cover the question of the quality of investigations. The quality of the investigation work relies certainly on the impartiality of the investigating body and the processes, but also on the qualifications and experience of the investigators, as well as the investigation methods they use or the accident data they gather.

While the work on the notion of independence was clearly called for by the European Commission, it appeared at this point of the project that it was not suitable for exploring all the relevant aspects of accident investigation processes. Not independence, but transparency can best describe these aspects of accident investigation. Transparency means that such relevant information on the investigation, which allows a quality assessment, is available. The concept of transparency applies to databases and all other accident investigation results: data, case studies or accident reports and any other subsequent data. Consequently, it was decided that the aspects better covered by the concept of transparency would also be examined thoroughly (SafetyNet, 2006a).

While independence, in the very stringent sense defined above, might best suit accident investigation bodies in public transport modes, it is not necessarily suitable as such for road accident investigation. Investigation bodies also frequently cooperate with similar bodies from other countries or with other stakeholders (manufacturers, operators, regulators, consumers etc.) in some accident investigations and such interrelations can enhance their investigation competence.

Correspondingly, in road transport the joint research and investigation activities conducted in European Union, that result in the adoption and use of international methods and standards can further transparency and finally provide a highly useful, common European framework for road accident investigation. Therefore, the process of building an accident investigation and road safety community through Commission supported research programmes is important in creating interrelations between research institutes and in creating progressively a body of common European accident investigation methods, standards, data and knowledge.

8.7. Advancing towards best practice recommendations

The partners produced several outlines for recommendations for transparent and independent accident investigation. Two small-scale pilot consultation exercises checked their appropriateness and relevance to users as they were being prepared. These consultation exercises consisted of interviews with certain key stakeholders, and a questionnaire. Key findings were that it would be feasible to establish an independent body for road accident investigation, but that the benefits of doing so should be explicitly stated and the legal framework within which such a body would operate should be clearly defined from the start, to prevent problems with existing institutions that already investigate road accidents.

It was also clear from the responses to the preliminary consultations that the cost of establishing and running any proposed accident investigation body would be a fundamental issue. The issue of cost could well determine the political response to proposal to create such a body. Based on existing investigation projects the cost of running investigations ranged from €1,000 – €2,600 per accident. While the financial burden of investigating, for instance, all fatal accidents could well be acceptable in some economically strong Member States, which have a relatively small number of fatal accidents, this might not be the case for all Member States. Undoubtedly, it is possible to put in place investigation systems relying on adequate sampling plans.

A set of thirty-eight recommendations were detailed in a document (SafetyNet, 2006b), representing the culmination of our knowledge gained from reviewing the current procedures for investigating road accidents in commercial companies, police forces, existing independent road accident investigation bodies as well as those for rail, civil aviation and maritime accident investigation. These draft recommendations proposed the establishment, in all Member States, of a body for undertaking transparent and independent accident investigations, and/or for supervising already existing investigation activities; gathering and managing accident investigation data and exploiting these data for research and road safety enhancement purposes.

The draft recommendations focussed on four categories of issues:

1. **Institutional**, referring to the structure and functioning of the body responsible for road safety investigations;
2. **Operational**, detailing how the body carries out investigations;
3. **Data**, addressing issues surrounding the storage, retrieval and analysis of data generated by investigations; and
4. **Development of Countermeasures**, dealing with how investigation conclusions should be presented, used and disseminated

8.8. Streamlining the recommendations

The partners organised a workshop in Brussels March, 27th 2007 with the aim to consult a variety of road safety stakeholders on the appropriateness and necessity of those draft recommendations, applicable to and aiming to assure the independence and transparency of road accident investigations and the subsequent investigation data. Sixty persons including the organising partners attended the workshop. Forty-seven attendees were not involved in the process of drafting the recommendations and out of these forty filled the workshop questionnaire. The workshop attendees and questionnaire respondents represented fifteen different EU Member States and three other nationalities. In terms of professional background, researchers and safety investigators were best represented, but people from policy making, manufacturing and insurance industries and judiciary sector were also present (SafetyNet, 2007).

The workshop was divided into five sessions. The first introduced the SafetyNet project, its Work Package 4 and the work performed during the first three years of the project. Each of the four following sessions presented one cluster of the draft recommendations. External speakers were also invited to present their views on accident investigation. Each session was concluded by a general discussion and an invitation to fill in the relevant parts of the questionnaire. The external presentations, discussions, questionnaire responses and all other comments were constructive. The workshop allowed a large amount of good quality feedback to be gathered.

Some of the feedback confirmed what had already been discovered in the six-month consultation period that followed the publication of the draft recommendations. Other feedback, from sectors less familiar to WP4 partners, was new. All feedback was however useful in preparing the finalised recommendations. While the majority of the draft recommendations were judged appropriate and necessary by at least 65% of the respondents (26 questionnaire respondents out of 40), three individual recommendations received a lower approval rate varying from 58% to 63% (23 to 25 respondents). In some cases the formulation of an individual draft recommendation was unclear, leaving too much room for interpretation. In these cases, the recommendation was reformulated and then the opinion of stakeholders checked.

In other cases, individual recommendations were judged appropriate and necessary for the investigation of certain types of accidents and not appropriate or necessary for the investigation of certain other types of accidents. In these cases, the finalised recommendations now clearly state the type of accident and the type of accident investigation, an individual recommendation applies to. More specifically, it was decided that the finalised recommendations should clearly state that their primary focus is on the investigation of a sample of *routine* accidents.
Finally, the most widely approved draft recommendations were included as such or in a slightly revised form among the finalised recommendations, while the most problematic draft recommendations were heavily reworked or not included at all. The feedback gathered during the consultation period, at the workshop and the further feedback that was gathered between June 2007 and April 2008, helped to considerably enhance the finalised WP4 Recommendations.

8.9. The finalised recommendations

The finalised Recommendations for Transparent and Independent Road Accident Investigation present the conclusions of four years of combined efforts of more than 20 persons, involved in road safety research, representing seven different organisations from as many European Union Member States. They establish the requirements for conducting and promote the creation of transparent and independent road accident investigations in all Member States according to a common European investigation methodology. Such investigations would address the need to have detailed, public, transparent and independent road accident data available at European level (SafetyNet, 2008).

Redefining the scope of the finalised set of recommendations to the investigation of a sample of routine accidents has allowed the recommendations to focus specifically on the issues most important to this level of investigation. Some aspects of independence remain very much topical when it comes to safety oriented road accident investigation. These investigations need to be conducted independently from conflicting regulatory, commercial or other interests. The accident investigators themselves need a specific legal status guaranteeing that they can accomplish their work. Above all, the transparency of safety oriented road accident investigations appears clearly as a key characteristic.

These shifts in the relative importance of issues mean that the number of operational recommendations (from eleven to eight recommendations) was not reduced as much as the institutional recommendations (from nine to five recommendations), those relative to data storage and protection (from seven to three recommendations) or those concerning the reports, countermeasures and dissemination (from eleven to four recommendations). These shifts are visible also in the major recommendations chapter of the Deliverable D4.5, chapter that merely points out the most salient differences that need to be considered, when addressing the need to set up an investigation scheme for major road accidents; in all these shifts mean that the number of recommendations has come down from nearly forty to twenty-one.

8.10. The Recommendations for Transparent and Independent Road Accident Investigation

Recommendation 1
A European safety oriented road accident investigation programme should be established whereby Member States conduct safety oriented investigations and contribute data to a European road accident database.
Institutional recommendations:
Recommendation 2
Safety oriented road accident investigations should be conducted with as much openness and transparency as possible.
Recommendation 3
The European safety oriented road accident investigation programme should be independent. Accident investigations could be conducted in cooperation with, but should not be influenced by stakeholders whose vested interests lie in the data collected.
Recommendation 4
The European safety oriented road accident investigation programme should have sufficient financial resources and should not rely on external funding to conduct any individual accident investigation.
Recommendation 5
Each Member State should identify a geographical area in which they shall conduct safety oriented road accident investigations. Sampling plans should be developed, according to the European Programme, enabling harmonised data to be fed in a European database.
Recommendation 6
Safety oriented road accident investigations should be carried out by one or more dedicated multidisciplinary teams. Each team should have a core group of permanent members with specialist knowledge across the relevant areas of accident investigation and sufficient road safety experience. Investigators should also receive comprehensive training in accident investigation to ensure uniform standard of investigation across the Member States.

8.10.1. Operational recommendations:

Recommendation 7
The investigation team should be notified of accidents at the same time as the emergency services or as soon as reasonably possible to allow a timely response.
Recommendation 8
Data should be collected about the human, vehicle and environment components of a road accident in sufficient detail to conduct a safety oriented road accident investigation.
Recommendation 9
It is best practice to:

a. visit the accident scene and examine the road environment as soon as is reasonably practical (either while vehicles are in their post crash rest position or within a few days of the accident)
b. examine the vehicle, either at the scene or in a recovery garage
c. speak to the involved road users and witnesses and employ trained medical personnel to collect injury data (e.g. use hospital data)

Recommendation 10
Investigators should use standardised tools and be provided with adequate equipment to collect data in a systematic way.
Recommendation 11

Safety oriented road accident investigation data should be kept separate from the judiciary inquiry. Investigators should not be called to court as expert witnesses on a case they are investigating or have investigated.

Recommendation 12

Member States should define, in the framework of their respective legal system, the legal status of the investigation that will enable the investigators to carry out their task in the most efficient way and within the shortest time. Road accident investigators should be given the right, either through legislation or otherwise and where appropriate in cooperation with the authorities responsible for the judicial enquiry including the police, to access all evidence relevant to the investigation.

Recommendation 13

The purpose of the investigation and criteria for data collection should be disclosed to all people and agents involved in the accident investigation. They should receive honest and open explanations about what the investigation is for and who will use the data collected. The answering of questions should be optional and the contact details of those conducting the investigation should be disclosed to the road users and witnesses involved.

Recommendation 14

A European investigation manual should be developed to document the common investigation methodologies and the data to be collected, enabling individual Member States to conduct safety oriented road accident investigations in a harmonised manner. The document should be published in the official languages of the European Union and be freely available in order to reinforce the openness and transparency of investigations.

8.10.2. Recommendations on data storage and protection:

Recommendation 15

A European road accident database should be developed to record the safety oriented road accident investigation data collected in each Member State. Each Member State should be responsible for the accuracy and completeness of their data.

Recommendation 16

Accident data that is collected for the purposes of safety oriented road accident investigation and the resulting analysis should not be used to give evidence about fault or blame including in a court of law.

Recommendation 17

No data containing information that would lead directly to the identification of persons involved in the accident should be released to a third party. Data may be made available for research or analysis purposes but this should be restricted to a format which does not permit identification or attribution.

8.10.3. Recommendations on reports, countermeasures and dissemination:

Recommendation 18

Reports should be based on the analysis of the European road accident database. They should also include recommendations designed to prevent reoccurrence and document the evidence upon which these recommendations are based (for example, the number of accidents and type of statistical analysis).

Recommendation 19

An annual report concerning the investigation activities over the elapsed year should be published. These reports should include summary results of investigations conducted in Member States and information on recommendations developed at EU level.

Recommendation 20

Recommendations for countermeasures, developed from aggregate accident data, should be addressed to the European Commission, who shall take the necessary measures to ensure that these recommendations are duly taken into consideration, and, where appropriate, acted upon.

Recommendation 21

The aggregate and annual reports should be made publicly available within an appropriate time scale at both National and European level.

These Recommendations for Transparent and Independent Road Accident Investigation and the work performed by the Work Package 4 partners should be viewed as the starting point for future projects aiming to implement a European safety oriented road accident investigation programme and working towards a common European accident investigation methodology.

8.11. Bibliography

While road transport and all road transport related industries are extraordinarily important to European economy and societies—for instance in terms of impact to European employment—the relatively poor road safety record—the number of accidents, those killed and injured, material damage and other socio-economic costs—constitutes a major socio-economic problem. Albeit road safety was for a long time ignored, when compared to the issue of safety in the public transport modes such as rail, air and maritime, it has emerged in recent years, fortunately, as an issue on all political decision-making levels.

Largely due to this low intensity political history of road safety issues, there is, for road accident investigation for example, a range of accident investigation procedures and protocols in place across European Union. However, as European Union Member States work towards meeting both their own road safety targets and those set by the European Commission; it may be that these existing investigations are no longer entirely suited to assisting policy-makers and practitioners in the decision-making processes. In order to assure that decisions and policies are based on adequate road accident investigation data across Europe, there is a need to harmonise the existing accident investigation processes.

From this perspective, the aim of SafetyNet Work Package 4 (WP4) was to design best practice recommendations to be implemented in different phases of road accident investigation processes. These investigation processes were understood to incorporate the development and management of road accident related data capture processes, data collection, storage and management, as well as the use of any data resulting from these activities. The recommendations WP4 now has developed aim at providing road accident investigation practices with the optimum transparency and independence throughout the European Union.

8.11.1. Independence and transport accident investigation

The WP4 partners have, in order to devise these recommendations, worked on the notion of independence as requested by the call drafted by the European Commission. In relation to safety research and transport accident investigation in the public transport modes, the concept of independence seems to be rather well defined (SafetyNet, 2005).

In these activities a certain amount of independence—independence of the entity, that of the accident investigators or researchers and of the investigation or research itself—seems vital for the impartiality and the quality of the investigation and research process and their results. Therefore, an accident investigation body should not be subject to outside control in the pursuit of its mission. It should be separate from other bodies, public or private, having financial or other interests in the results of its investigations. It should not take instructions from other bodies or outside personalities. It should have adequate control over the use of its investigation results. Finally, it should be financially autonomous and its members be qualified and independent themselves.

In the European Union, there are several Directives or Regulations, as well as a White Paper, a Communication from the Commission and a Work Programme, that concern transport safety and transport accident investigation.

9. Fatal Accident and Accident Causation Databases

9.1. *Overview*

SafetyNet produced two crash databases processes which dealt with different aspects of the European accident problem. These were a Fatal Accident database at intermediate level and an in-depth Accident Causation Database.

In essence, the main purpose of the Fatal Accident Database was to build an effective data gathering structure to ensure that specific data on fatal crashes can be gathered in a systematic and routine manner to assist in the development of countermeasures. The activity has included the development of a broad ranging intermediate level, fatal crash database by obtaining reports of police fatal crash investigations from a number of EU Member States (including France, Germany, Finland, The Netherlands, United Kingdom, Italy and Sweden). The data itself is of an intermediate level of detail but covering a representative sample of fatal crashes in each country. There have been no new investigations but research teams from each partner country have brought together available information from within the existing police and other emergency services structure. The data from these investigations describe the environmental, vehicle and driver factors to provide a description of the whole crash. Specific areas of data describe the overall crash circumstances, driver and vehicle characteristics, specific road infrastructure features, and descriptions of other crash participants.

In total, data on 1, 296 fatal accidents were obtained and these data have been extensively analysed. The analysis includes a general appraisal of the Fata Accident situation in the participating Member States but also includes assessment of key factors including analysis by road-user type and accident type.

The second database (the Accident Causation Database) involves data obtained from at-scene or “nearly at-scene” accident investigations. Information from these investigations was complimented by data from follow-up interviews with crash participants to determine critical events and contributory factors to the accident occurrence. A method for determining accident causation, known as DREAM 3.0 was developed.

In total, data on some 1,006 individual crashes have been collected and individually analysed (using the DREAM 3.0 methodology). Aggregated data have also been analysed. This involved assessment of key factors including analysis by road-user and accident type The data from the accident causation study can be used for a variety of reasons. For example, the data are needed to provide policy-makers and regulators with data that can be used in decision making for road safety policy and regulation. It is intended that the data can also be used in the development of new in-vehicle technology and in particular, accident avoidance systems – for example, to address the following research questions;

- What are the factors that contribute to crash causation?
- What are common accident scenarios?
- What are the technological countermeasures?
- What are the predicted effects of the technological countermeasures?

9.2. *Accident Database*

A project database was developed for both accident systems which links together the human, vehicle and environmental data collected for each accident. The SafetyNet Database system consists of a software application written in Visual Basic for Application

(VBA) completely embedded inside a Microsoft Access 2003 Data Base Management System (DBMS).
The application is made up of two completely separate parts that have the same structure with regards to user interface forms and database tables and relationships: these are known as the Input Application (IA) and the Output Application (OA).

Using the Input Application, each partner could insert and modify data, images and pictures of its own road accidents. Using the Output Application, it is now possible to view accidents data and images inserted by all partners participating in the project.

The Input Application is a local application that works offline during the data entry and editing, as well as the Output Application during the road accidents browsing. When data transferring is requested, the Input Application and the Output Application can connect to the central server through a Secure File Transfer Protocol (SFTP).

A central database implemented on a MySQL Server DBMS has been created with databases structures similar to the ones of IA and OA. This database now contains all road accident information inserted from different partners in local Microsoft Access databases which have been sent to the central server with an upload operation. The central server is equipped with backup and redundancy mechanisms to ensure a secure data storage.

The last release of the application was v.2.1. Further information regarding the database can be obtained from the WP5 Data Glossary (**SafetyNet Deliverable D5.5**).

9.3. Fatal Accident Database

The objective for this part of SafetyNet was to gather details of over 1000 fatal accident cases, investigate methodological and statistical problems that might arise when analysing the data, find solutions for these problems and present example analyses.

The information provided in the Fatal Accident Database represents a major advance in the knowledge of the nature and circumstances of fatal accidents within the EU. The information could be used as the basis for the development of countermeasures for fatal accidents within the EU - the data have been systematically collected according to defined sampling plans in participating Member States and hence the data are broadly representative of these Member States.

In the main, the data were derived from strictly factual police reports of fatal accident investigations although in certain cases, alternative sources of information were used including insurance investigation reports. The data recorded described the highway, vehicle and road-user factors to provide a description of the whole crash. The level of detail recorded was considerably greater than is currently obtainable in the CARE or CAREPLUS 2 specification. Approximately 100 – 150 variables with 500+ items of data were typically gathered for each accident investigated. Specific areas of data described the overall accident circumstances, driver and vehicle characteristics, specific road infrastructure features and descriptions of other crash participants.

A pilot and review activity took place before the main data collection phase commenced. During the main phase, the data were gathered and recorded onto a database which was specifically developed for the project. The main data collection period involved collection of a representative sample of between 2% and 10% of the fatal crashes in each country (depending on the magnitude of the fatal accident population). In the end, 1298 fatal accident cases, involving at least 1 fatality per accident case were collated, entered onto the database and subsequently analysed.

9.3.1. Detailed Objectives

The project is being developed with close attention to the following objectives:

(a) To set up the building blocks for a continuous European process of fatal accident data collection, coding and analysis

The main purpose was to build an effective data gathering structure, (involving all participating partners), to ensure that specific data on fatal crashes could be gathered in a systematic and routine manner. It was specified that the data should be collected in a number of EU member states using completely compatible methods although it was acknowledged that there would be slight variations between teams according to differences in local infrastructure. The data were recognised as at an 'intermediate' level of detail (compared to CARE on the one hand and national in-depth studies on the other). No new investigations were conducted in the task.

(b) To create a broad ranging, intermediate level, fatal accident database

The data recorded described the environmental (including road infrastructure, e.g. crash barriers, road signs etc.), vehicle and road-user factors to provide a description of the whole crash (for example, similar to FARS and UK Stats19 databases). Approximately 100 – 150 variables in total for each case (accident/vehicle/ occupant/other records) were agreed by the partners as being 'core data elements' that could be collected by all. This included around 500 pieces of information per case. It should be stressed that the data were not be selected according to a "lowest common denominator" approach; instead partners were challenged to gather a variety of information types. Additional interpretative information was also specified including a basic list of 'events' (essentially causation and contributory factors). To support the concept of integrated datasets, variables that were common to both Fatal and Accident Causation databases were identified and these are specified in the data glossary (Deliverable D5.5).

(c) To create an independent data set (collected by unbiased parties)

Care was taken when interpreting information gathered from within the judicial process where the attribution of blame is a primary objective. Discussions within SafetyNet concerning the Databases have also demonstrated the importance of independence and transparency.

(d) To use the information collected to contribute knowledge and information relevant to road and vehicle safety policy at EU and national level

It was recognised that data from the fatal accident study are required for a variety of reasons. First and foremost, the data are needed to provide the EC with data that can be used in decision making for road safety policy and regulation. Therefore, some fundamental questions need to be addressed for example:

- Which road users are killed?
- What are the circumstances?
- What are the countermeasures?

It was recognised that the data could be used by a multitude of stakeholders in the road transport system but specifically road infrastructure experts, highway engineers and vehicle designers. It was intended that the data would be used to evaluate trends and to conduct inter-country comparisons where possible. There could be a link to national activities since most safety actions take place under subsidiarity concerns.

The data collection areas for the accidents included Member States with larger road crash fatality populations in Europe (Italy, France and Germany) as well as northern (Sweden, Finland) and middle European (UK, Netherlands) countries. Independent groups with no interest in commercial aspects of the study outcomes will conduct all data gathering and accident investigation activities, listed below;

- Vehicle Safety Research Centre (VSRC), Loughborough University, UK (task 5.1 co-ordinators)
- Netherlands Organisation for Applied Scientific Research (TNO), Delft, Netherlands
- Institut National de Recherche sur les Transports et leur Sécurité (INRETS), Lyon, France
- Chalmers University of Technology (Chalmers), Gothenburg, Sweden
- Accident Research Unit at Medical University Hanover (ARU-MUH), Hanover, Germany
- The Finnish Motor Insurers' Centre (VALT/FMIC), Helsinki, Finland
- Department of "Idraulica, Trasporti, Strade", University of Rome (DITS), Rome, Italy

9.3.2. Methodology Overview

(a) Workshop on data requirements

A workshop was held in October 2004 entitled "Establishing Requirements for a New European In-Depth Accident Causation Database". The aim of this workshop was to provide the future users of accident data the opportunity to feed into the process of identifying general and specific research and policy questions which future accident databases will be expected to address. This process was useful for both of the two databases. A report was produced to summarise the workshop which focussed on the issues raised during the workshop session on the general and specific requirements for accident causation information and the subsequent feedback session on this topic. The nature of the issues that arose could be divided into 8 categories (information domains), which included:

1. Pre-crash factors
2. Road infrastructure
3. Driver behaviour/human factors
4. Other road-users' behaviour
5. Vehicle technology
6. Passive safety considerations
7. Cost benefits
8. Other

As may be expected there was some overlap in the questioning that was suggested for each information domain, due to differences in the workshop participants' understanding and pre-conception of the definition of each. Inter-domain relationships were also of interest.

The feedback from the workshop has been constantly referred to whilst developing the data variables to ensure consistency with user needs.

(b) Consultation of National Experts

Data requirements were also sought from National Experts in the EU Member States. Information and background on the project was presented to the National Experts in November 2004 and their feedback requested on data needs and requirements according to the nature of the project. All feedback was taken on board during the variable development process.

(c) Research questions to ask of the data

Research questions to ask of the data were discussed by the partners and were summarised into three main categories as detailed below.

General

- What kinds of vehicles are involved in fatal accidents (age, type)?

- What kinds of features in road infrastructure are involved in consequences of fatal accidents (trees, guide rails, poles…)?
- What kinds of features in road infrastructure are involved in fatal accidents (lane arrangements, speed limits)?
- Which type of roads are fatal accidents most commonly occurring on?
- Which gender/age is more likely to be killed in fatal accidents?
- Which hours (or day period) are the most dangerous in terms of number of fatal accidents?
- Questions on the age and model of cars that CARE can't answer.
- Were there any technical vehicle breakdowns before the crash?
- Were there visibility limitations that could prevent laser, radar or positioning (e.g. GPS) systems to work?

Design improvements/countermeasures

- Which fatal accidents can we do something about technically (vehicle or road infrastructure)?
- Which protective measures have the highest benefit for reducing fatal accidents?
- What type of countermeasures could save lives?
- Dependent on results of vehicles involved, systems and regulations should be developed for specific road users.
- Dependent on results of accident manoeuvre information, we should be able to determine which detection systems/assistance are needed.
- Which barriers were broken before the accident? It should answer which driver assisting equipment should be developed (red light detector, lane departure, etc.).

Causal factors

- Which "accident type" (e.g. single vehicle-, meeting-, cross-section accident etc.) is most commonly fatal?
- Which "collision type" (e.g. frontal-, side-, rear end collision or roll over) is most commonly fatal?
- What are the most common causes of fatal accidents? (situation, environment, alcohol etc.)
- How do weather conditions affect road accidents?

9.3.3. Methodology - Determination of Data Variables

To start this process, a review of the existing procedures and protocols in EU Member States and the US was undertaken to ensure that the project would benefit from best practice. Existing procedures and protocols that were examined in detail included the UK Cooperative Crash Injury Study (CCIS), the UK On-the-Spot Project (OTS), the German In-Depth Accident Study (GIDAS), the US Fatal Accident Reporting System (FARS), and the Swedish Factors Influencing the Causation of Accidents and Incidents project (FICA).

An initial data variable list was produced containing 1138 variables. This was reviewed and exclusions were made for variables that were outside the project objectives, e.g. injury related criteria. After close examination of the remaining 193 potential data variables, a provisional variable compilation list ensued.

In order to determine which variables should be collected in the database, each variable was discussed in turn under the main headings of accident level, roadway level, vehicle level, and road user level. The partners reviewed the provisional variable list during email circulation and at the technical meetings.

Each variable on the list was reviewed by each partner against specific questions. These included:

- Is the definition of each data variable suitable?
- Would collecting this data variable contribute usefully to the aims and objectives of the project and therefore is it deemed necessary to collect the data variable?
- Can the data variable be collected with respect to the determined definition?
- What is the expected reliability of the proposed data variable?
- What proportion of cases (per partner) could this data variable be gathered for?

The decision was made that if the proportion of cases for a data variable was less than 30% for all partners in total, then the partners would consider removing the variable concerned. Additionally, if the number of positive partner responses for collecting the data variable was less than 50%, then careful deliberation needed to be given as to whether the variable was to be retained on the prospective list or not.

Each 'potential' variable that had not already been agreed upon was discussed. This process included discussion for each variable's inclusion and definition, and partners' comments regarding possible problems with the collection of particular variables.

The list received numerous iterations after lengthy and energetic discussions, with constant revisiting of the objectives of the projects and the needs of the data users, as well as taking into account the partners' comments regarding possible problems with the collection of particular variables. After preparation of the final variable list, the preparation of the glossary and database commenced.

9.3.4. Overview of Results

The SafetyNet project collected 1296 retrospective fatal accident cases from the years 2003 and 2004. Cases were collected from 7 countries and included all road and road user types. **Deliverable D5.7** contains substantial analyses of data according to specific themes.

Data included in this basic fact sheet reflects the work completed by the analysis of CARE data as this provides the reader with stand alone results and the ability to compare with the overall European data.

Road accident fatalities in Europe
Included in the Fatal sample are 1449 fatally injured road users from the EU-7 sample, this is approximately 1.5% of the total EU fatalities over the same period (2003/4). The proportion of fatalities increases to ~3% when considering only the EU-7 countries covered by the partners. The following extracts of more detailed analyses produced within the project illustrate the data that is available and can be compared with that obtainable from the less detailed CARE database.

Impairment
Impairment records for the three road user groups (Drivers, Riders and Pedestrians) shown in figure 10.1 illustrate that approximately 10 to 13% of each group are under the influence of Alcohol, Drugs, Medication or a combination of sources.

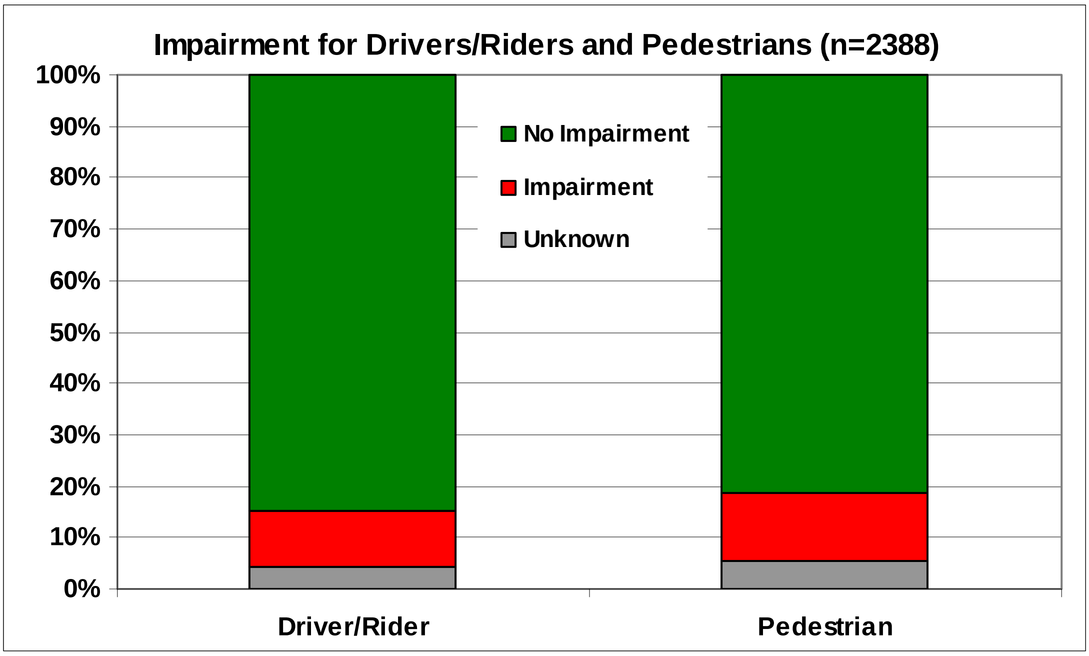


Table 9.1: Impairment records for Drivers, Riders and Pedestrians
(N=2,388, analysis excludes vehicle passengers))

The numbers of road users and type of impairment is shown in Table 9.2.

	Road user classification		
Impairment type	**Driver**	**Pedestrian**	**Total**
Alcohol	132	26	158
Combination	14	1	15
Drugs	15	2	17
Drugs and alcohol	9	0	9
Fatigue	37	0	37
Medication	13	2	15
None	1809	211	2020
Other	9	3	12
Unknown	91	14	105
Total	2129	259	2388*

Table 9.2: Types of impairment for 2388 Drivers, Riders and Pedestrians
*(*analysis excludes vehicle passengers)***)**

The most common cause of impairment was alcohol, as determined by the national protocols for the country of the crash, followed by fatigue.

Type of car body style

Passenger cars involvement is recorded in 1023 accidents from the total dataset of 1296, approximately 80% of all accidents.

Body Type	Car Total	Occupant total	Fatal occupant total		Total Fatal
			DRV	PASS	
Hatchback	699	1155	251	156	407
Saloon	321	575	129	78	207
Estate	140	241	37	25	62
Derivative	42	56	14	4	18
MPV	42	73	11	11	22
4x4/SUV	39	67	4	7	11
Sports	37	55	12	7	19
Convertible	13	19	3	1	4
Unknown	11	16	4	2	6
Total	**1344**	**2257**	**465**	**291**	**756**

Table 9.3: Frequency of Fatal occupants by passenger car body type

Table 10.3 shows, for each passenger vehicle body-type, the total number of occupants and the total fatalities recorded. Additionally data is shown for the disaggregation of driver and passenger fatalities by the 8 vehicle body-types.

Accident Manoeuvre

Figure 10.1 illustrates the types of accidents recorded for passenger cars using the accident classification system. Driving Accidents (those which occur with an initial single vehicle loss of control), account for the largest proportion while junction accidents calculated from turning in/crossing and turning off accidents are the second most frequent accident type at 23%.

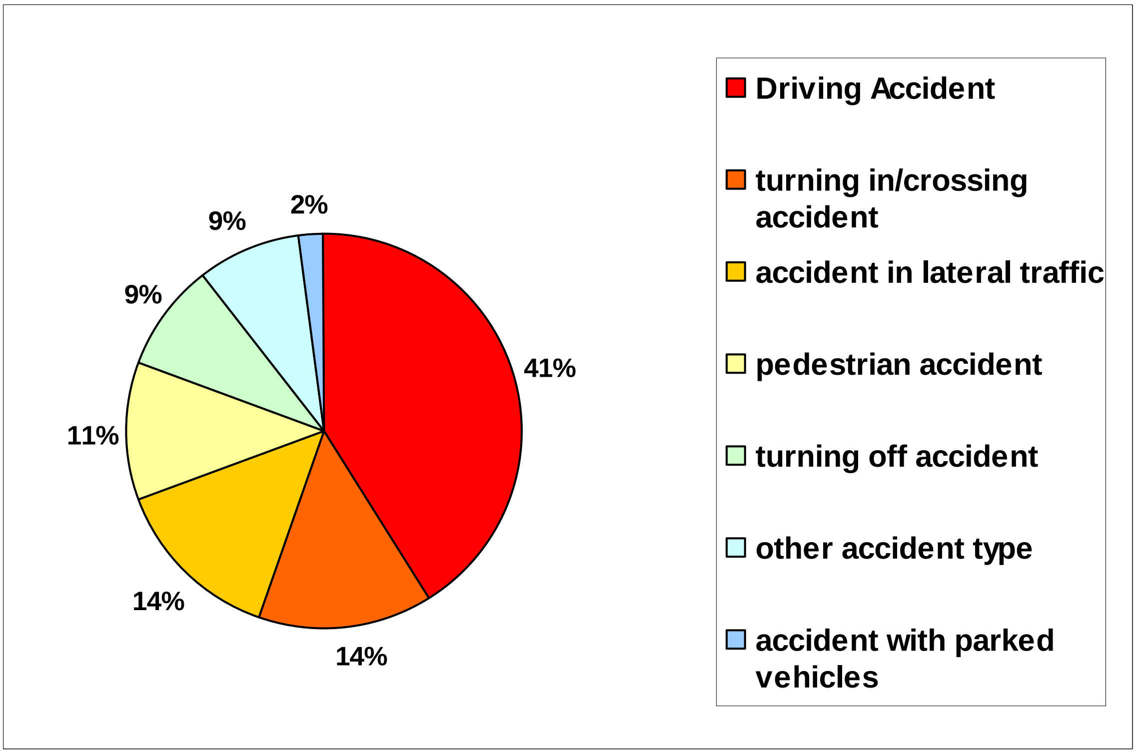


Figure 9.1: Accident type by Accident Classification System (GDV)

Events

The most harmful event is an individual occurrence within a crash sequence And each crash can be sub-divided into a number of such events.
The analysis of first 'event' for passenger car SVA's is as shown in figure 10.2.

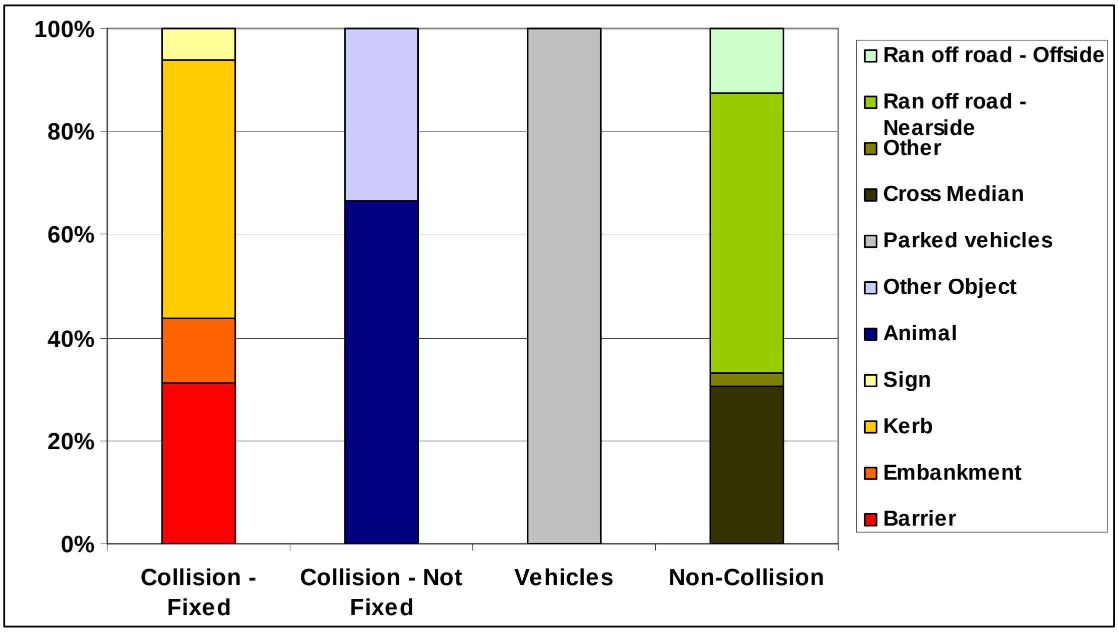


Figure 9.2: Passenger Car SVA by first event in accident

The analysis shows that 4 main event types are present which include 'collision with fixed objects', 'collision with non-fixed objects', 'collision with other vehicles' and 'non-collisions'. The 'other vehicle' event type shows that 3 cars collided initially with parked and unattended vehicles

Car occupants in single vehicle accidents – location of injuries

An analysis of the body regions most 'harmfully' injured in SVA's can be seen in figure 10.3. The most 'harmfully' injured body region is usually the body region that was injured that caused fatality to the vehicle occupant.

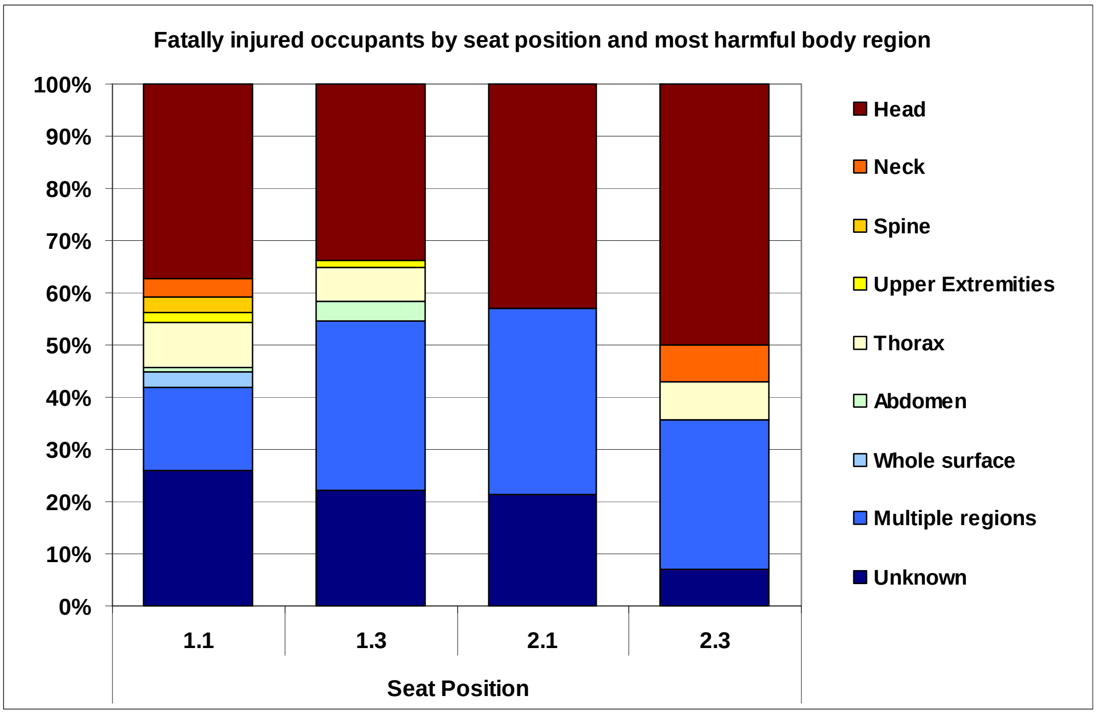


Figure 9.3: Passenger car SVA occupant injury region by seat position

As can be seen from figure 10.3, the head is the most severely injured body region for fatally injured passenger car occupants in SVA's accounting for anything between 34% and 50% of all injured body regions. Multiple body regions (those where a number of severe injuries cause a fatality or the cause of death is unclear due to the complexity of injuries) account for the second largest group with an average of ~28% across the 4 seat positions.

Pedestrian age and time to death

Age/time in hospital	<10 N=2	10-19 N=1	20-29 N=4	30-39 N=1	40-49 N=5	50-59 N=11	60-69 N=11	70-79 N=21	80+ N=25
1-5 days	100	100	50	100	40	63.6	81.8	47.6	52
5-10 days	0	0	50	0	40	27.3	0	9.5	0
11-15 days	0	0	0	0	0	0	0	4.8	0
16-20 days	0	0	0	0	0	9.1	0	9.5	8
>20 days	0	0	0	0	20	0	18.2	28.6	40
Total	100	100	100	100	100	100	100	100	100

Table 9.4: Pedestrian age and time till death (%)

Table 10.4 shows the 10 year age banding for pedestrian fatalities and compares this with the 'time in hospital' variable. This variable records the length of stay in hospital and will, for this sample, record the time until death.

The proportion of each age group for the length of hospital stay is shown with a clear shift towards older pedestrians surviving longer in hospital before eventually dying from injuries received. This result indicates that perhaps elderly pedestrians are involved in less violent impacts and reach hospital easily; however injury complications due to age eventually cause mortality.

9.3.5. Fatal Accident Database Discussion and Conclusions

The aim of SafetyNet was to develop a European Fatal Accident database which would allow examination of road, vehicle and highway factors implicated in fatal accidents within the EU. In total, 1,296 fatal accident cases were collected from the 7 participating EU member States using a standardised protocol. The data from these accident cases have been collated, entered onto a database and analysed according to a number of selected research domains. Thus analysis includes a general data overview, an analysis of the nature and circumstances of fatal passenger car accidents, fatal pedestrian accidents and fatal two-wheeler accidents.

A concern has been raised regarding the use of multi-source data in the Fatal Accident Database. The raw data sources vary between police reports, judiciary records, road authority data and insurance reports. This varied approach raised questions regarding the independence of the data. However, the task began by setting a level of data to be collected from a sample of source material this approach ensured that all partners could collect fatal accident case data to the same level. The effect of bias on the data is therefore considered minimal by the partnership.

The study itself clearly demonstrates that the development of a European Fatal Crash database is a realistic prospect and the SafetyNet partnership strongly recommend that a future activity should be conducted using the protocol developed. Clearly the data have limitations in that there were only 7 EU member states participating in the data collection but this could easily be overcome given appropriate resources and assessing the wider capability and willingness to collect such data from a wider partnership. The data clearly have a number of purposes for policy-makers in national administrations and the EC and for other stakeholders. Whilst the method used has limited application to the vehicle manufacturers, it is suggested that a sufficient level of detail exists within the database for the data to be useful for local and regional highway authorities where even a case-by-case review of individual accident cases would be useful.

9.4. Fatal Accident Causation Database

SafetyNet has also been responsible for the development of a method for assessment of causal factors and the development and population of an accident causation database including 1,006 individual cases. The accidents were investigated using an analysis approach known as the SafetyNet Accident Causation System (SNACS) to categorise the causal factors that lead to the crash, SNACS is a slight modification of Driving Reliability and Error Analysis Method (DREAM) which will be described later.

The justification for this task is that a lack of data pertaining to accident causation impedes the development and refinement of in-vehicle technological systems aimed at accident mitigation. There is also a requirement for a greater understanding of driver behaviour in different road environments. Data are needed to both assess the performance of existing systems and in the further development of systems of the future. Therefore, a harmonised, prospective “on-scene” method for recording the root causes and critical events of road crashes was deemed necessary. Where appropriate, this included interviewing road users in collaboration with more routine accident investigation techniques. The database should enable multidisciplinary information on the circumstances of crashes to be interpreted to provide information on the causal factors. The development of the data-recording method is now described.

9.4.1. Development of DREAM 3.0

DREAM 3.0 is a major research tool that as been developed for the determination of accident causation. The development process has been relatively rigorous and protracted but needs to be considered in detail. DREAM 3.0 is based on the Cognitive Reliability and Error Analysis Method (CREAM) which was in turn initially designed to determine the causes of industrial accidents. CREAM was later adapted to suit the road traffic domain and the resulting tools were called the Driving Reliability and Error Analysis Method (DREAM and the SafetyNet Accident Causation System (SNACS). The DREAM and SNACS methods both have a Human-Technology-Organisation perspective, which implies that accidents happen when the dynamic interaction between people, technologies and organisations fails in one way or another and that there are a variety of interacting causes creating the accident.

9.4.2. Methodology development process

DREAM 2.1 was first used in the Swedish project Factors Influencing the Causation of Accidents and Incidents (FICA). When it was established that DREAM 2.1 would be used in SafetyNet, DREAM 2.1 was translated into English and adapted to suit the traffic environment in the participating countries. This adapted version was called SafetyNet Accident Causation System (SNACS) and uses the same method, accident model and main structure of the classification system as DREAM 2.1 while some of the individual genotypes have been altered.

Both DREAM 2.1 and SNACS 1.1 have been successfully used as a tool for accident analysis in Sweden as well as in other European countries and are being applied extensively throughout the SafetyNet accident investigations. During this practical work some suggestions for improvements have been put forward. Both DREAM 2.1 and SNACS 1.1 were therefore revised by a reference group including researchers in psychology, human factors, accident analysis and driver behaviour.

The revision resulted in DREAM 3.0 which is adapted to meet the needs of practitioners all over Europe (DREAM 3.0 can of course also be used in other parts of the world but due to country-specific differences further adjustments might then be needed). DREAM 3.0 uses the same accident model as the earlier versions while the classification scheme and the method has been somewhat adjusted.

With regards to the classification scheme in DREAM 3.0, the majority of genotypes are left in their original form and where needed, are clarified by improved definitions. A few new genotypes have been added and a few old ones have been removed, due to merging or exclusion. In connection with the revision, a literature review was conducted in order to investigate the empirical support for the links between the genotypes. A reliability test was also conducted with the aim to examine the inter-coder agreement of DREAM 3.0.

9.4.3. The classification scheme

The classification scheme of DREAM comprises a number of observable effects in the form of human actions and system events called phenotypes (known as critical event in SNACS). It also contains a number of possible contributing factors which may have brought about these observable effects. The contributing factors are called genotypes and are organised according to the driver-vehicle/traffic environment-organisation triad. The driver category consists of genotypes related to possible problems with cognitive functions such as observation, interpretation and planning. It also includes more general states of temporary and permanent person-related factors that can contribute to an accident (e.g. inattention). The vehicle/traffic environment category consists of vehicle and traffic environment related genotypes, while the organisation category consists of genotypes related to organisation, maintenance and design. Besides the phenotypes and genotypes mentioned above, the classification scheme in DREAM also includes links between phenotypes and genotypes, as well as between different genotypes. The grouping of phenotypes and genotypes is shown in table 10.5.

		Genotypes		Phenotypes
HUMAN		TECHNOLOGY	ORGANISATION	
Driver		Vehicle	Organisation	
Observation	} in accordance with COCOM	Temporary HMI problems	Organisation	Timing
Interpretation		Permanent HMI problems	Maintenance	Speed
Planning		Vehicle equipment failure	Vehicle design	Distance
Temporary Personal Factors			Road design	Direction
Permanent Personal Factors		Traffic environment		Force
		Weather conditions		Object
		Obstruction of view due to object		
		State of road		
		Communication		

Table 9.5: Overall grouping of the genotypes and phenotypes in DREAM

9.4.4. The Method of DREAM 3.0

The method in DREAM is fully bi-directional which means that the same principles can be used for analysing past accidents as for predicting future ones. With regards DREAM 3.0, the focus is however on retrospective analysis of accidents that have already occurred. The classification scheme is therefore organised to make this as easy as possible. Furthermore, the method contains several stop rules, e.g. well defined conditions that determine when the analysis should come to an end. These stop rules are necessary as the classification scheme represents a network (rather than a hierarchy) and the analysis or prediction could go on forever in the absence of these rules.

9.5. Development of the SafetyNet Accident Causation Database

The purpose of SafetyNet was to create an independent crash investigation protocol, a methodology to categorise the causal factors and computer **system** for data input, storage and analysis used to collect and examine in-depth road crash causation data so that the main risk factors leading to a crash could be identified. Six partners contributed to the accident investigations and represent a number of EU Member States (including; Germany, Italy, The Netherlands, Finland, Sweden and the United Kingdom). The database developed includes 1,006 accident cases, 1,833 vehicles (64 % passenger cars) and 2,428 individual road users. An on-scene approach for collecting the data has mainly been used in which investigation teams visited the accident scene shortly after the accident occurred. The data collected included information about the road environment, the vehicle(s) and the road users involved. Where possible, interviews were carried out (according to an interview guide) with drivers and other road users.

9.6. Data Analysis

The data analysis of the SafetyNet Accident Causation Database can be divided into two parts; individual case analysis and aggregated factors analysis**. Deliverable D 5.8** contains substantial analyses of the data according to specific themed areas.

The analysis of an individual case is performed on vehicle level (including pedestrians) and is based on the information collected from the accident scene and the interviews. The

SafetyNet Accidents Causation System (SNACS 1.2) which is one of the precursor methods to DREAM 3.0 was used to analyse the individual cases stored in the database.

An example of an individual case analysis based on DREAM 3.0 is illustrated in Figure 10.4. The corresponding accident scenario is as follows: Driver A is driving above the 70 km/h speed limit on a road. When A enters a sharp curve, which is incorrectly cambered and the surface is covered in gravel, the vehicle starts skidding. A tries to control the skid but fails and the vehicle comes to rest upside down in a ditch. Driver A is a 19-year old man (has had a driving licence for 1 year), was not tired or distracted, was not under the influence of alcohol, drugs or medication. He drove an older Volvo in good condition.

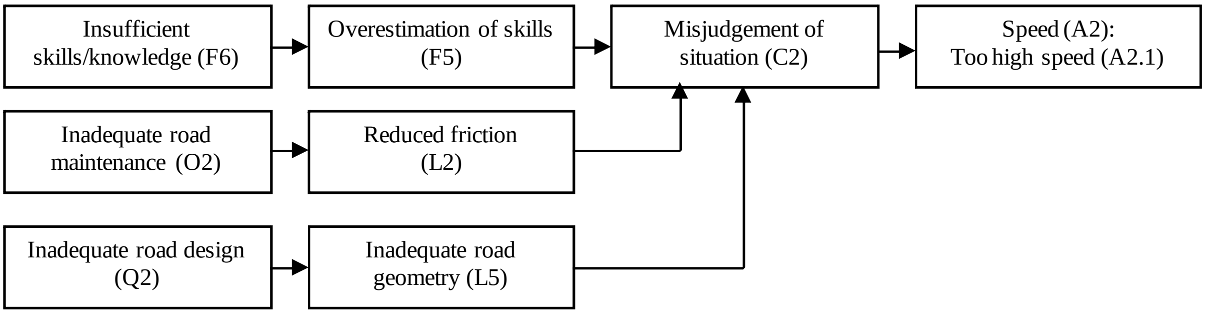


Figure 9.4: Example of an individual case analysis of a run off the road accident in a sharp curve (based on DREAM 3.0)

While the analysis of an individual case results in a chart of interlinked contributing factors, the analysis of aggregated cases is performed by superimposing individual charts in order to find common causation patterns for a selected group of cases. The selection of cases can be performed in a number of different ways depending on the research question. The analysis of aggregated cases in the SafetyNet Accident Causation Database is in progress and the initial data analysis is described below. An example of superimposing of cases (analysed with SNACS 1.2) from the analysis group vehicle-leaving-lane trajectories (further described below) is illustrated in Figure 10.5.

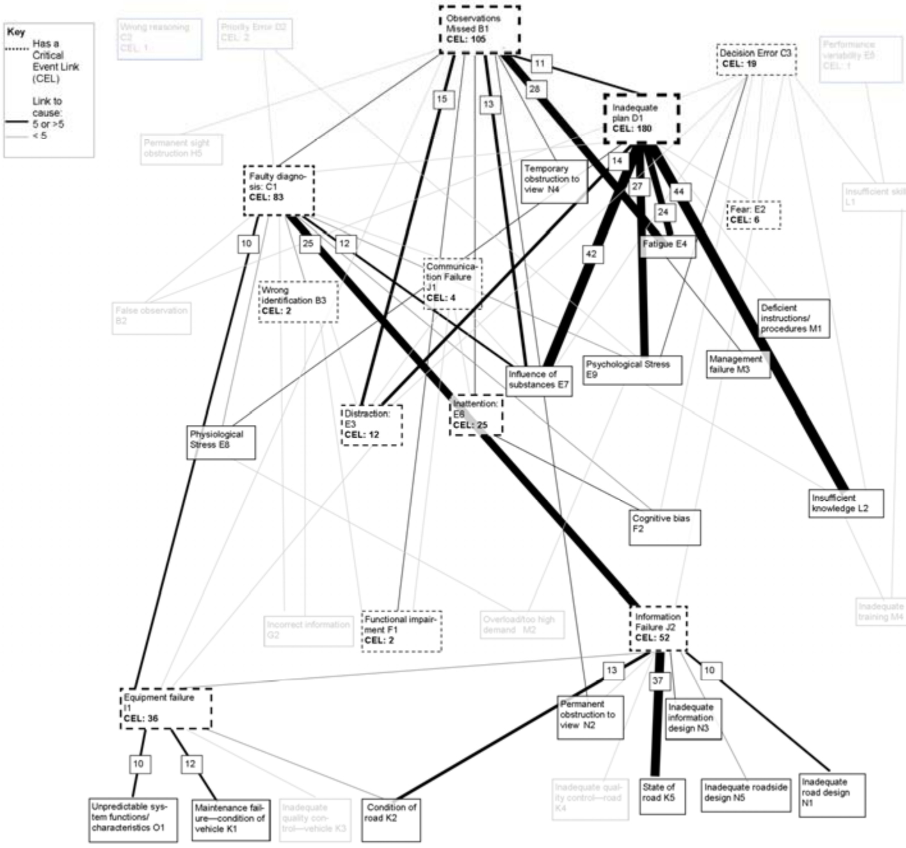


Figure 9.5: Example of a causation pattern for vehicle-leaving-lane trajectories (based on SNACS 1.2)

9.6.1. Initial data analysis - taxonomy

Since the analysis is causation focused rather than outcome focused, accident data was sorted into other groups than suggested by the traditional accident outcome based taxonomies. The main approach chosen was therefore to base the analysis on a combination of accident context and vehicle trajectory. Since an accident can contain more than one trajectory, (i.e. there will be one trajectory per involved vehicle), the sorting was performed on a vehicle level.

Prior to sorting the vehicles according to trajectory, all accidents involving Slower moving Vulnerable Road Users (SVRU), i.e. pedestrians and bicyclists, were sorted into a separate group because accidents involving SVRU is believed to have different causation patterns and characteristics, compared to single or multiple motorised vehicle crashes.

Except the SVRU group, the sorting resulted in three main accident context and vehicle trajectory based groups. Each main group was divided into subgroups relating to conflict scenario, participant or counterpart, for further analysis. The subgroups for each main group are described in more detail under each heading.

Vehicle leaving its lane

A vehicle-leaving-lane trajectory represents driving situations where the vehicle leaves its lane by crossing the lane boundary either to the left or the right. There are two subgroups, depending on whether the manoeuvre was intentional (e.g. driver actively changing lane or initiating an overtaking of another vehicle) or unintentional (driver drifting out of lane or losing control).

Figure 10.6 illustrates typical outcome scenarios initiated by vehicle-leaving-lane trajectories which can lead to a conflict with another vehicle or the vehicle running off the road. In scenario 1a the vehicle leaves its lane by crossing the median line intentionally (i.e. starts to overtake another vehicle) and collides with a vehicle travelling in the opposite direction. In scenario 1b the vehicle leaves its lane by intentionally crossing a lane marker (i.e. initiating a lane change manoeuvre) and collides with a vehicle travelling in the same direction. Lane departures where the initial crossing of a lane marker or median line is unintentional include the vehicle colliding with a vehicle travelling in the opposite direction (scenario 2a) and running off the road to the nearside or offside (scenarios 2b and 2c).

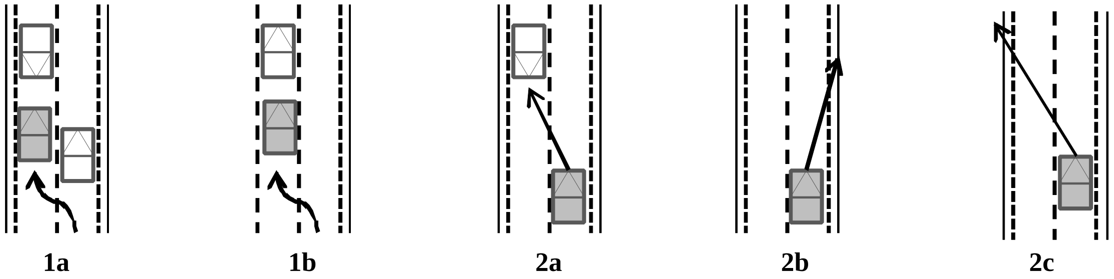


Figure 9.6: Typical outcomes scenarios following vehicle-leaving-lane trajectories
Conflicts between vehicles following an intentionally leaving lane trajectory either to overtake another vehicle (1a) or due to a lane change (1b). Conflict between vehicles (2a) or road departures (2b-2c) following an unintentionally leaving lane trajectory by drifting out of lane or loss of control, (subject vehicle is grey).

Vehicles are not included in vehicle-leaving-lane category if they first collide with a vehicle or an object in its own lane and then exit the lane – these vehicles will be included either in the 'vehicle encountering something while remaining in its lane' or 'vehicle encountering another vehicle on crossing paths' groups (see below).

Vehicle encountering something while remaining in its lane

This trajectory group represent vehicles encountering something in its own lane which typically result in a front or rear end collision for the subject vehicle. The main group is divided into four subgroups, depending on whether the conflict is with another vehicle, an animal or an object.

Figure 10.7 illustrates typical outcome scenarios following a trajectory where a vehicle encounters something in its own lane. In scenario 1 the subject vehicle is striking a lead vehicle, in scenario 2 the subject vehicle is rear ended by another vehicle. In Scenario 3 the subject vehicle is struck by a vehicle which has left its lane and in scenario 4a and 4b the subject vehicle is frontally striking object other than a vehicle.

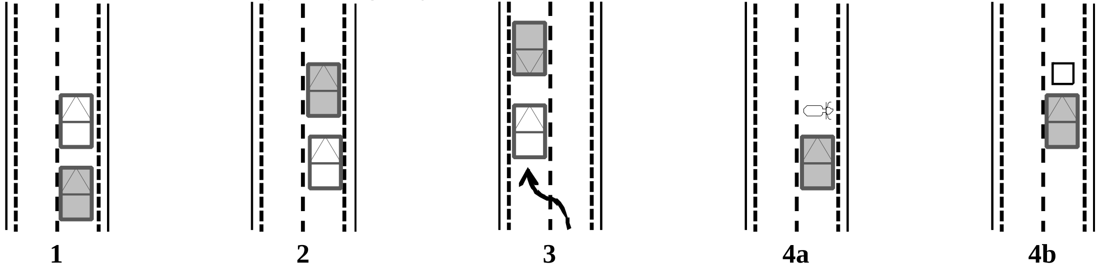
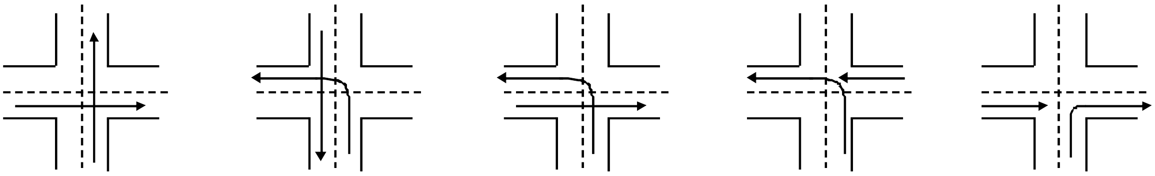


Figure 9.7: Typical outcome scenarios for vehicle encountering something while remaining in its lane
1; striking lead vehicle, 2; being rear ended by another vehicle 3; being struck by a vehicle which has left its lane, 4a-4b; frontally striking object other than vehicle (subject vehicle is grey).

Vehicle encountering another vehicle on crossing paths

A crossing path crash is defined as a traffic conflict where one moving vehicle cuts across the path of another, when they were initially approaching from either lateral or opposite directions in such a way that they collided at or near a junction. The typical outcome is an intersection crash, but reversing from a driveway type crashes are also included.

Figure 10.8 illustrates the four subgroups which are divided into; Straight Crossing Paths (1. SCP), Left Turn Across Path-Opposite Direction (2. LTAP-OD), Left Turn Across Path-Lateral Direction (3. LTAP-LD) and Merge conflicts, (Left Turn Into Path (4a. LTIP) and Right Turn Into Path (4b. RTIP)



1. SCP **2. LTAP-OD** **3. LTAP-LD** **4a. LTIP** **4b. RTIP**

Figure 9.8: Typical outcome scenarios for vehicle encountering another vehicle on crossing paths *Straight Crossing Paths (1. SCP), Left Turn Across Path-Opposite Direction (2. LTAP-OD), Left Turn Across Path-Lateral Direction (3. LTAP-LD), Merge conflicts, Left Turn Into Path (4a. LTIP) and Right Turn Into Path (4b. RTIP)*

9.6.2. Initial data analysis - summary of vehicle grouping

Since the analysis of aggregated cases is in progress the causation patterns can not be presented for each group. According to the grouping of vehicles presented above the vehicles included in each group is distributed as shown in Figure **9.9: Number of vehicles for each group selected for analysis of aggregated cases**.

	SVRU	Leaving lane	Remaining in own lane	Crossing paths	Total
Agricultural vehicle	-	-	4	1	5
Bicycle	96	-	-	-	96
Bus / Minibus	11	4	10	10	35
Car / MPV	134	277	396	357	1164
Motorcycle / Moped	11	27	36	105	179
Other	2	2	8	6	18
Pedestrian	91	-	-	-	91
Train / Tram	2	-	-	8	10
Truck	11	37	59	28	135
Unknown	-	-	1	-	1
Van	11	14	43	22	90
Total	369	361	557	537	1824*

Figure 9.9: Number of vehicles for each group selected for analysis of aggregated cases
**9 vehicles are excluded from the selection.*

Illustrative analysis

The illustration analysis below shows the main causes of leaving lane accidents. It demonstrates the level of detail available to classify the nature of the key causation factors that are commonly associated with leaving lane crashes.

Figure 10.10 shows that the most commonly occurring links between the critical event and first level cause for leaving lane vehicles is ‘Direction’ to ‘Inadequate plan’ (A6-D1) and ‘Speed’ to ‘Inadequate plan’ (A5-D1). This makes ‘Inadequate plan’ (D1) the most commonly occurring first level cause for the leaving lane vehicles with a 35% share as shown in the figure. The second most common 1st level cause is ‘Observation missed’ (B1) with 18%. ‘Observation missed’ (B1) is linked most frequently with ‘Direction’ (A6) and the A6-B1 link occurs 57 times.

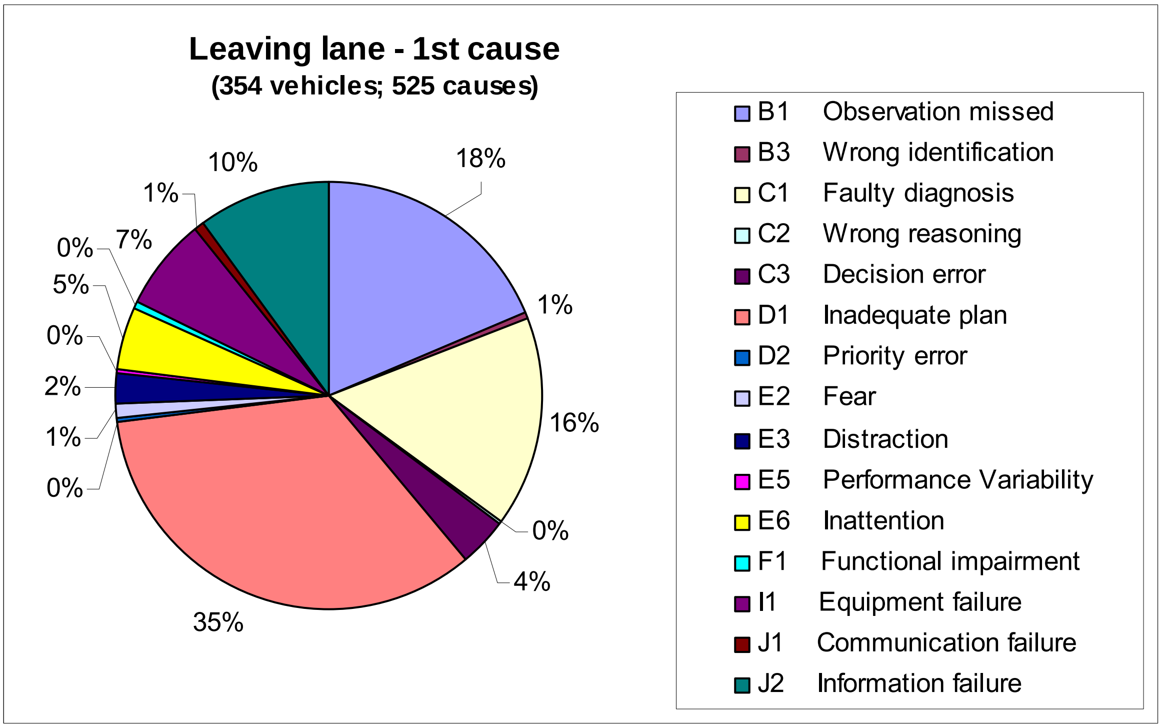


Figure 9.10: Distribution of 1st level cause in all leaving lane cases

Figure 10.10 also shows that ‘Faulty diagnosis’ (C1) occurs relatively frequently as a 1st level cause (16%) and it can be seen that ‘Faulty diagnosis’ (C1) has fairly strong links with the critical events ‘Speed’ (A5-C1), ‘Direction’ (A6-C1) and ‘Force’ (A3-C1) with 36, 24 and 16 links respectively.

Discussion and Conclusions

The aim of the SafetyNet was to develop an in-depth European accident causation database to find the risk factors that contributes to road accident occurrence. The work performed was closely related to already existing accident investigation activities within the partnership including multidisciplinary teams with many years of experience within the field. The main outcome was to investigate some 1,000 accidents from six EU Member States according to a harmonised methodology discussed previously.

Despite the high level of expertise within the investigation teams it was discovered that cultural differences and differences in the road traffic system and definitions resulted in some challenges. The general variables had to be clearly defined and revised several times to discard any confusions and differences in interpretations among the investigators. Several quality review meeting was conducted to ensure that the classification scheme was clear and explicit enough to be used extensively within Europe. During the work suggestions on clarifications and additions/removal of contributing factors were made resulting in an updated version of the method (SNACS 1.2) that was used throughout the project. However, further development was needed and the final version DREAM 3.0 has gone through an extensive literature review and a reliability test.

Trying to understand the contributing factors to accident occurrence throughout Europe has been shown to be a complex task. The new way of thinking in accident prevention compared to injury prevention demand understanding of cognitive processes and driver behaviour. Nevertheless, it has been shown in the project that when sufficient training has been undertaken and the threshold for the understanding of the classification scheme is reached by the investigators the inter-coder agreement can be considered acceptable.

The initial aggregation analysis is performed on a vehicle level rather than on accident level. The subgroups under each heading may not be completely intuitive, since they do not follow the traditional outcome based categorisation in passive safety. However, the taxonomy is hypothesised to present the clearest differences in causation patterns between each of its three main groups as well as their subgroups. Also, sorting on trajectories facilitates comparison with existing, outcome oriented crash databases, since they usually contain detailed vehicle trajectory information. It is believed that the aggregation of each analysis by describing the frequency of accident contributing factors and their relationship as shown on the example identifies the main determiners how and why accident occurs in sufficient detail to be used for further traffic safety development.

The data from the accident causation study are required for a variety of reasons. For example, the data are needed to provide policy-makers and regulators with data that can be used in decision making for road safety policy and regulation. It is intended that the data can also be used in the development of new in-vehicle technology e.g. accident avoidance systems and road design.

The next step in the development of DREAM 3.0 could be to use the method in a wider range of countries and eventually adjust the classification scheme to fit to non-European countries. Even when DREAM 3.0 is used within Europe it is important to remember that the classification scheme should not be seen as fixed or static. Instead it should be adjusted in order to fit the needs of different projects as well as the future needs required by the road traffic development.

Review of In-depth Accident Causation Methodology

The methodology was reviewed both internally (by SafetyNet partners) and externally (by stakeholders invited to a methodology workshop held in Gothenburg on 19th June 2008).

In summarising the outcomes of the 'external' review, a number of positive comments were received that cover the general work practices used in the determination of the basic dataset and subsequent data collection processes. It was generally accepted by the workshop attendees that the approach taken for the development of the data variables and the use of regular case review or training sessions was a good method of achieving high quality data that is both reliable and accurate.

Questions were raised regarding sampling of data - at the most basic level the workshop attendees agreed that the data collected from the 6 or 7 countries (depending on task) could not be representative of the EU27. A related finding was subject of European representativity and a requirement for more European Member States to be involved in such a study.

In summarising the outcomes of the 'internal' review, the two databases could be considered a pilot study for the development of larger scale European fatal and causation studies in the future: Some of the potential difficulties have already been faced, not least of which is the complexity involved in getting 6 or 7 countries collecting data to the same level. It is therefore useful to understand how these complexities could multiply as more countries are added to future studies.

A legacy of SafetyNet should be the methods and working practices used to complete the tasks. Therefore the lessons learnt should be documented for future reference in similar projects where additional countries could be more easily incorporated into a framework.

As a final remark, it was very encouraging to find that the overwhelming majority of workshop attendees and questionnaire respondents agreed that they would like access to the data. This shows that there is both the apparent need for the two types of data collection activities that form SafetyNet and that there is significant confidence that these two activities will provide useful and reliable data for research purposes.

10. European Road Safety Information System

Figure 10.1: ERSO logo

The European road safety information system that was developed within SafetyNet contains road safety related information from the member states and a few other, interested countries. The main outcome of this sub-project is the European Road Safety Observatory website, ERSO, which can be found at www.erso.eu.

10.1. Objectives and strategy

The primary objective of this sub-project was to develop a European Road Safety Information System with relevant and internationally comparable information (data and knowledge) for (road safety) professionals.

It was decided to shape the information system in the form of a website. For the population of the site with high-quality web texts, an Editorial Group was installed. The Editorial Group comprised of renowned European road safety experts.

To cater the website set-up and content to the user's needs, two user group tests were carried out, and the outcomes were used to improve the website. Furthermore, the success of the information system depends strongly on its name and brand identity. To make sure that the targeted user was aware of the ERSO website's existence, a number of promotional activities were undertaken. To ensure the website's fame, high quality standards were maintained for the website usability and content.

10.2. Work performed

The work was organised and performed in a number of separate, but linked activities. The main activities were:

- Website development and maintenance
- Editorial Group
- User Group testing
- Promotional activities
- SafetyNet and the SUNflower methodology
- Preparation of transfer of the ERSO website to the EC, DG-TREN

The work performed in each of these activities will now be discussed.

10.2.1. Website development and maintenance

A good website is geared to the user's needs and developing a good website requires the definition of the targeted user, defining the required functionality, implementing this functionality, testing the user's needs, and adapting the intermediate versions of the website to these observed needs.

The main target groups of the European road safety information system were defined as road safety policy makers, at local, regional, national and European level. Other target groups are researchers (institutes and universities), non-governmental organisations (like ETSC), private companies (insurance companies, car industry), and press officers.

Typical information that supports professionals at the local, regional, national and European level includes answers to questions like:

- What do others regard as main traffic safety problems and how do they assess them? What is known about the impact of these problems on road safety? How does my country compare to other countries on relevant road safety indicators?
- How should I measure traffic safety and its developments?
- What are successful ways of tackling certain problems?
- Which quantitative goals are ambitious enough and feasible?
- What can I effectively and efficiently strive for? Which improvements can I reach?

To cater to the users' needs and expectations, the ERSO website was based on four pillars: Knowledge, Data, Links and SafetyNet.

Welcome to the European Road Safety Observatory

The European Road Safety Observatory (ERSO) is an essential website for all European road safety pro
ERSO is the gateway into a central resource of European road safety data, knowledge and links

Figure 10.2: ERSO pillars

The construction of the ERSO website consisted of the addition of new web texts by the Editorial Group, the inclusion of SafetyNet deliverables, and – in some cases – web texts on basis of reports delivered by other sub-projects of SafetyNet. Furthermore, sections such as a news section, a calendar of events and a list of relevant projects around Europe have been maintained and updated regularly.

During the course of SafetyNet, the ERSO website had a 'keep me informed' and a 'contact' button. The former provided the service of being added to the mailing list of the ERSO newsletter. This newsletter was issued four times during the final phase of the SafetyNet project. The 'keep me informed' button provided the user with the possibility to ask road-safety related questions to the SafetyNet consortium. These two services were regularly used.

The ERSO website contained an area accessible to SafetyNet partners only ('members area'). This password protected part of the website was used by the project partners to share project information, like management reports, meeting agendas and minutes, presentations, et cetera. All technical maintenance and editorial work for this part of the website was done within this WP.

The improvements to the website were based on the recommendations from a number of User Group tests (see below).

10.2.2. Editorial Group

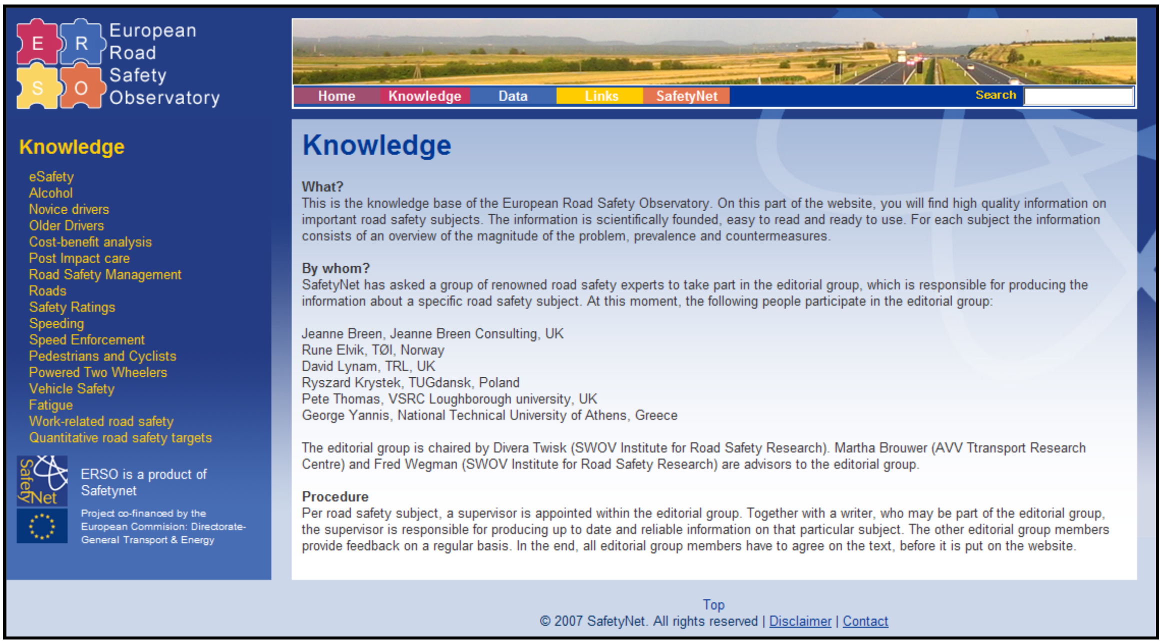
The Editorial Group created, together with an Authors Group, content for the knowledge part of the road safety information system. During regular meetings, the Group planned to deliver a number of comprehensive texts on road safety related topics. SafetyNet output and Editorial Group output would together form the basis for the Road Safety Observatory.

The members of the Editorial Board were selected on the basis of seniority in the field, and in terms of expertise as a group they should cover the major fields of traffic safety. Initially, the Editorial Board consisted of the following persons: Jeanne Breen (Jeanne Breen Consulting), Ryszard Krystek (TU Gdansk), David Lynam (TRL), Rolf Krupp (BASt), Jean Pierre Medevielle (INRETS), Rune Elvik (TØI), George Kanellaidis (NTUA),and Pete Thomas (VSRC Loughborough University). In the period May 1, 2004 to May 1, 2008, Dr. Krupp and Dr. Medevielle left the Editorial Board and Prof. Yannis replaced Prof. Kanellaidis.

The Authors Group was not a fixed group. The author of each webtext was appointed to write the text under the guidance of one of the members of the Editorial Group. Two other Editorial Group members were designated as Peer Reviewers. The Peer Reviewers have the status of an advisor. Before a text was placed on the ERSO website, it was reviewed by each member of the Editorial Board and was "signed off" by the Editorial Group as a collective, preferably during one of the Editorial Board meetings.

The Editorial Group worked according to strict procedures that were developed in the earlier phase of the SafetyNet project. These procedures concerned web text choice, development and sign-off procedures and were meant to ensure the highest possible web text quality.

To make sure the texts would be suitable for use within ERSO, the Editorial Group defined the boundary conditions for the development of suitable web text during their first meetings. These boundary conditions concerned their structure, level of detail and the use of data, writing style, language, manner of referencing sources, and lay-out items. ERSO web texts were written for road safety professionals, at all levels. They therefore had to be as simple as possible, while respecting scientific principles, and covering all aspects of the topic. Scientific debate was not to be included in the text.



Knowledge

What?
This is the knowledge base of the European Road Safety Observatory. On this part of the website, you will find high quality information on important road safety subjects. The information is scientifically founded, easy to read and ready to use. For each subject the information consists of an overview of the magnitude of the problem, prevalence and countermeasures.

By whom?
SafetyNet has asked a group of renowned road safety experts to take part in the editorial group, which is responsible for producing the information about a specific road safety subject. At this moment, the following people participate in the editorial group:

Jeanne Breen, Jeanne Breen Consulting, UK
Rune Elvik, TØI, Norway
David Lynam, TRL, UK
Ryszard Krystek, TUGdansk, Poland
Pete Thomas, VSRC Loughborough university, UK
George Yannis, National Technical University of Athens, Greece

The editorial group is chaired by Divera Twisk (SWOV Institute for Road Safety Research). Martha Brouwer (AVV Ttransport Research Centre) and Fred Wegman (SWOV Institute for Road Safety Research) are advisors to the editorial group.

Procedure
Per road safety subject, a supervisor is appointed within the editorial group. Together with a writer, who may be part of the editorial group, the supervisor is responsible for producing up to date and reliable information on that particular subject. The other editorial group members provide feedback on a regular basis. In the end, all editorial group members have to agree on the text, before it is put on the website.

Top
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Figure 10.3: ERSO knowledge section

The Editorial Group produced 17 web texts on main road safety related topics, and updated one of the web texts of the course of the project (see the figure above).

10.2.3. User Group testing

The consultation of the targeted users is essential for the development of a high quality Information System. The contents of such a system must match the subjects that the targeted end user is interested in and the system must be intuitive in its use. Therefore, the ERSO team performed three rounds of User Group tests over the course of the project. The first test was performed after the first project year. It involved three groups: the National Experts from the EU Working Groups on CARE and RSPIs, the attendants of the first SafetyNet plenary meeting and the User Group of the former EC-funded project ROSEBUD.

At the end of the second project year, a second large User Group test was performed. This test took place during the first SafetyNet conference. The large-scale evaluation study aimed to investigate whether the 2007 version of the website was in line with the users' needs. The study was conducted in the period January 2007 – June 2007. In this test three methods were used:

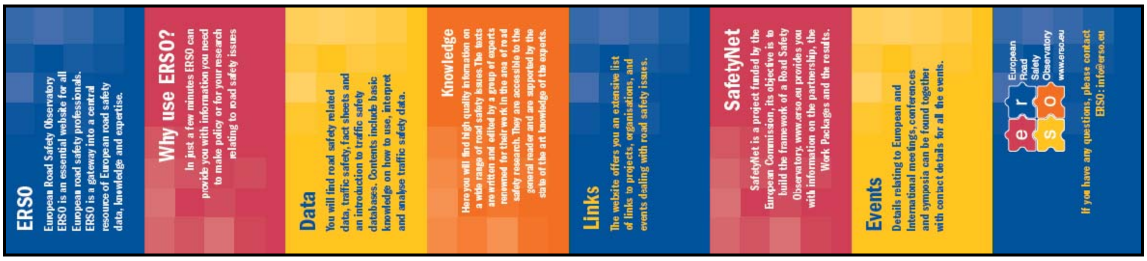
- Heuristic evaluation, whereby the website's quality was assessed on the basis of an expert analysis of its lay-out, organisation and content;
- An online questionnaire, consisting of questions about opinions and experiences, but also including small tasks (scenario's) to assess whether information was easy to find and easy to understand;
- User feedback: an onsite observation of the use of the website.

108 users completed the online questionnaire. Half of the group were from western and southern European regions. Potential users from middle European countries are underrepresented in the sample.

The user feedback results were based on observation from 8 persons. In general, this part of the study showed that the website is highly appreciated and clearly fulfils the need for complete, detailed and reliable information on road safety. However, the study also indicated some weaknesses that should be improved. The identified weaknesses and proposed solutions were summarized in a project report and were used to improve the ERSO website.

10.2.4. Promotional activities

Making a high-quality, easy-to-use website is not enough for the website's success. It is essential that people know that the website exists and where it can be found. To cater for this, several promotional activities were undertaken during the reporting period. These activities were part of a well-thought-through promotion plan.



ERSO

European Road Safety Observatory
ERSO is an essential website for all European road safety professionals. ERSO is a gateway into a central resource of European road safety data, knowledge and expertise.

Why use ERSO?

In just a few minutes ERSO can provide you with information you need to make policy or for your research relating to road safety issues

Data

You will find road safety related data, traffic safety, fact sheets and an introduction to traffic safety databases. Contents include basic knowledge on how to use, interpret and analyse traffic safety data.

Knowledge

Here you will find high quality information on a wide range of road safety issues. The texts are written and edited by a group of experts renowned for their work in the area of road safety research. They are accessible to the general reader and are supported by the state of the art knowledge of the experts.

Links

The website offers you an extensive list of links to projects, organisations, and events dealing with road safety issues.

SafetyNet

SafetyNet is a project funded by the European Commission, its objective is to build the framework of a Road Safety Observatory. www.erso.eu provides you with information on the partnership, the Work Packages and the results.

Events

Details relating to European and International meetings, conferences and symposia can be found together with contact details for all the events.

European
Road
Safety
Observatory
www.erso.eu

If you have any questions, please contact ERSO: info@erso.eu

Figure 10.4: ERSO promotional sheet

Following the promotion plan, three specific promotion activities were undertaken. First, promotion material in the form of a flyer in 'business card' format was designed and printed. These cards were distributed by SafetyNet partners at conferences and meetings. Second, four ERSO newsletters were issued and send around to those that expressed their interest in either being regularly informed or in the SafetyNet Conferences (in November 2007, February 2008, May 2008 and October 2008). Third, an ERSO Promotion Pack was developed and made available through the ERSO website. This pack consists of an ERSO flyer, an ERSO logo, an ERSO newsletter, a standard ERSO presentation, and an ERSO press release. These products could be and were used by anyone acting as an 'ERSO ambassador'. In particular, all SafetyNet partners were regarded as ERSO ambassadors and were stimulated during meetings to act as such. Also the National Experts, the country representatives in the EU Working Group on RSPIs, were asked to take up this role.

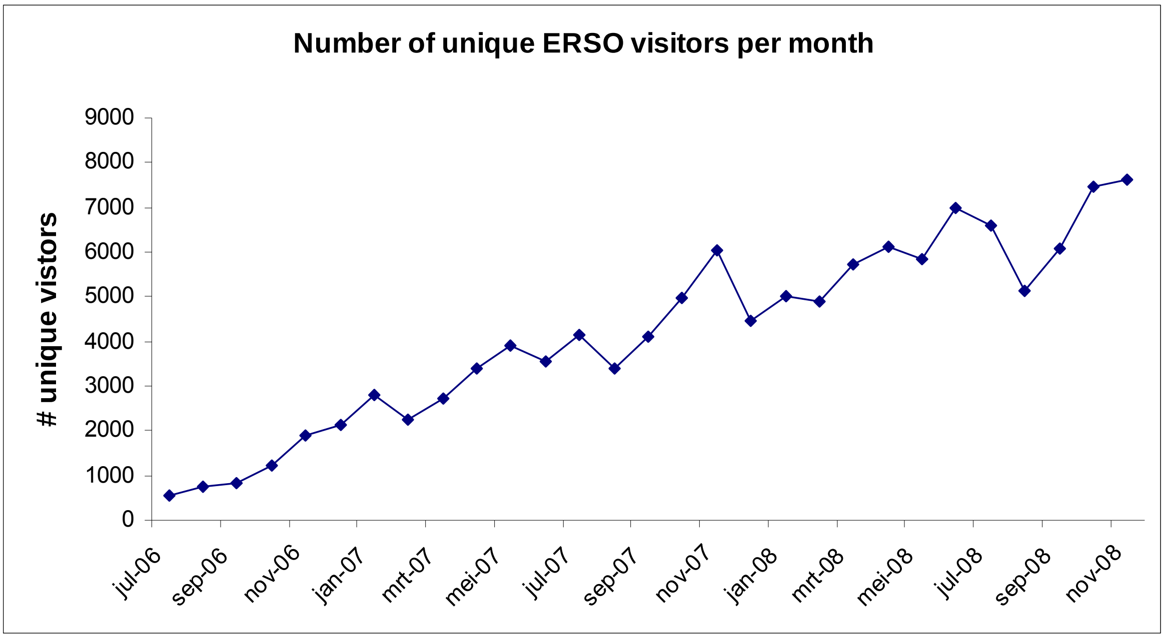


Figure 10.5: ERSO website hits

Promotional activities and the offering the right material go hand in hand in attracting new visitors to the website and keeping those visitors interested. The number of visitors has steadily grown since the launch of the ERSO website in May 2006. The figure above shows the stunning growth in the number of monthly visitors from right after the website launch to today. The unremitting growth shows the need for high-quality and ready-to-use road safety related information

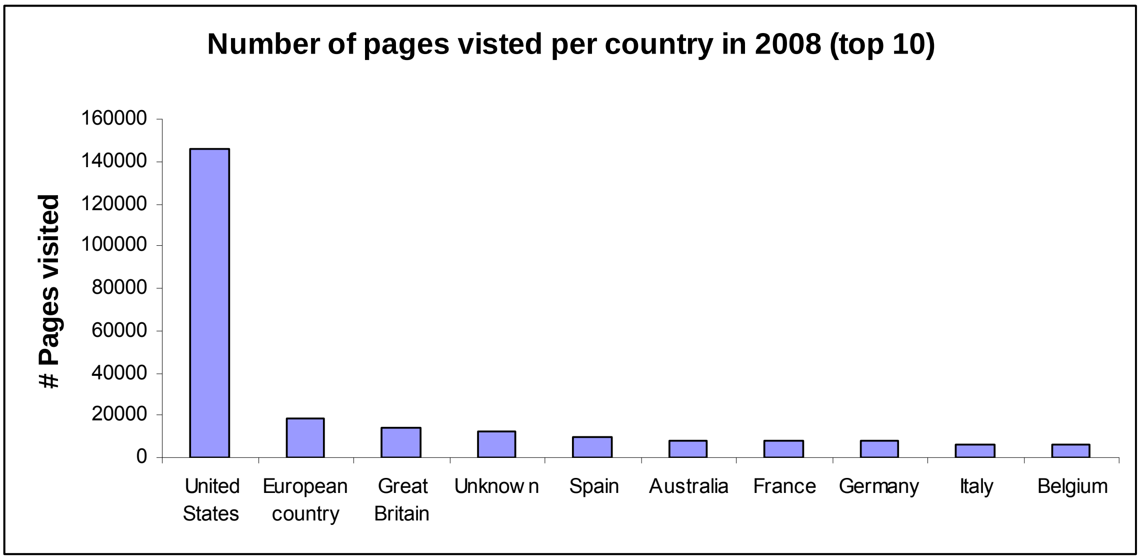


Figure 10.6: ERSO pages visited per country

In 2008, the ERSO website was visited by people from 153 countries around the world, from every continent. The above figure shows the top 10 of countries that visited the website in 2008, ranking according to the number of pages visited. There was much interest from the United States. This interest is comparable to that from all EU member states combined. Visitors reach the ERSO website through search engines and bookmarks, but also through links in other websites. One way to measure the importance of a website is to monitor the amount of external website that link to it. In 2008, 1089 websites linked to the ERSO website.
Clearly, the ERSO website has gained much interest and appreciation from people all over the world.

10.2.5. SafetyNet and the SUNflower methodology

During the SafetyNet project, it was recognised that the project as a whole would benefit from another integrating activity. Such an activity would look at all SafetyNet activities and would add more structure, connecting the work within the, distinctly organised activities. It was found that the SUNflower approach, which was developed earlier, could be used to serve this purpose. Therefore, within this sub-project a new activity was started to cater for further developing the SUNflower approach en applying it to the outcomes of the SafetyNet project. Various activities were undertaken, which are described below.

A SafetyNet-SUNflower workshop was held on June 1, 2007 at Amsterdam Schiphol Airport, the Netherlands. The goal of the workshop was to answer the question how countries can better understand their current road safety status, and can be assisted with data- and knowledge-driven policy making to further improve road safety in the future?

The workshop was attended by 30 road safety policy makers and researchers from 14 different EU countries and Israel, and by representatives of DG TREN and OECD/ECMT. In his concluding speech, Fred Wegman (SWOV) observed that SUNflower can be of great added value to SafetyNet. Although the focus during the workshop was on the pyramid structure, SUNflower entails a lot more than just the pyramid. It is more than a benchmarking instrument, it improves our understanding of developments and consequently contributes to better policymaking. According to Wegman, the pyramid shape gives the model a stable basis. The costs are at the top since the primary objective of road safety policies is to reduce the costs of crashes to society. However, there are some important issues concerning the pyramid structure that need attention in the short term. Definitions are needed for mobility and exposure. When are they internal in the pyramid and when are they external factors? What disaggregation levels for the third dimension of the pyramid are most appropriate? Also, Wegman remarked, there is more work to be done in describing or developing clear indicators for the different levels of the pyramid or for the links between them.

To follow up on these observations and questions, it was decided to perform within the ERSO sub-project a new study into the application of the SUNflower approach in Europe. The study was performed by Fred Wegman (SWOV), Jacques Commandeur (SWOV), Etti Doveh (Technion), Vojtech Eksler (CDV), Victoria Gitelman (Technion), Shalom Hakkert (Technion), David Lynam (TRL), and Siem Oppe (SWOV). It was aimed at the development of a knowledge-based framework for comprehensive benchmarking of road safety performances and developments for a country or other sub-national jurisdictions. An exploratory method was used to accomplish this. The study was limited to readily available data; no additional data was collected. The work resulted in a report that was also published in glossy booklet format.

10.2.6. Preparation of transfer of the ERSO website to the EC, DG-TREN

During the reporting period it became clear that DG TREN would renovate its website. Assuming that the new DG TREN website would not be up-and-running by the end of SafetyNet, SWOV offered to host the ERSO website during a reasonable transition period, be it without the 'keep me informed' and 'contact' services or any other time-consuming parts. After this period, the set-up of the ERSO website allows for a smooth transfer of information to DG TREN.

11. Data Analysis and Synthesis

11.1. Objectives

A final objective of SafetyNet was to investigate a number of methodological and statistical problems that might arise when analysing the data, find solutions for these problems and present example analyses.

11.1.1. Questions in road-safety

Many important questions with respect to road-safety concern the development of the number of casualties over time. As examples:

- Has the number of fatalities decreased?
    - Is the latest reduction in fatalities what was to be expected in the preceding years?
    - If not, what explanations can be given for this change in trend?
- What is the prognosis for the next years?
    - How will the fatalities develop if everything goes on as it does now?
- Has driving a motorbike become more dangerous in the recent years?
    - How did the distance travelled on motorbikes develop?
    - Did the number of accidents and/or fatalities behave accordingly?

When answering these questions, one has to analyse *time-series data*. This means analysing a whole series of data of the same type (*e.g.*, number of fatalities, population size, or distance travelled) which are repeatedly measured (e.g. monthly or yearly).

A different type of question might concern differences between regions:

- Do regions with more enforcement measures have safer roads?
    - Do measures in one region influence the neighbouring regions as well?
- Are there differences with respect to the safety behaviours and attitudes between regions?
    - Are these differences reflected in the accident or fatality numbers?
    - Do they lead to different acceptance with respect to e-safety technology?

The data to be used in order to answer such questions may show a geographical structure. Regions are nested within countries and counties within regions. Neighbouring regions might be more similar to each other than regions that are situated at the other end of the country.

Finally, questions might concern the accident events themselves:

- What are risk and protection factors in severe accidents?
    - Which parts of the vehicle provide protection in severe accidents?
    - Which actions of drivers can protect the occupants in their vehicles?
    - Are older people more at risk to die when involved in a severe accident?
- Are there different types of severe accidents?
    - Do these types occur under different road conditions?
    - Do they involve different type of drivers (e.g.: in terms of age, impairment…?)

To answer these questions, one has to rely on relatively detailed *accident data*. As depicted in Figure 11.1., these data typically have a hierarchical structure, because they describe road-users, vehicles, and accidents with some road-users having been seated in the same vehicle and some vehicles having been involved in the same accident.

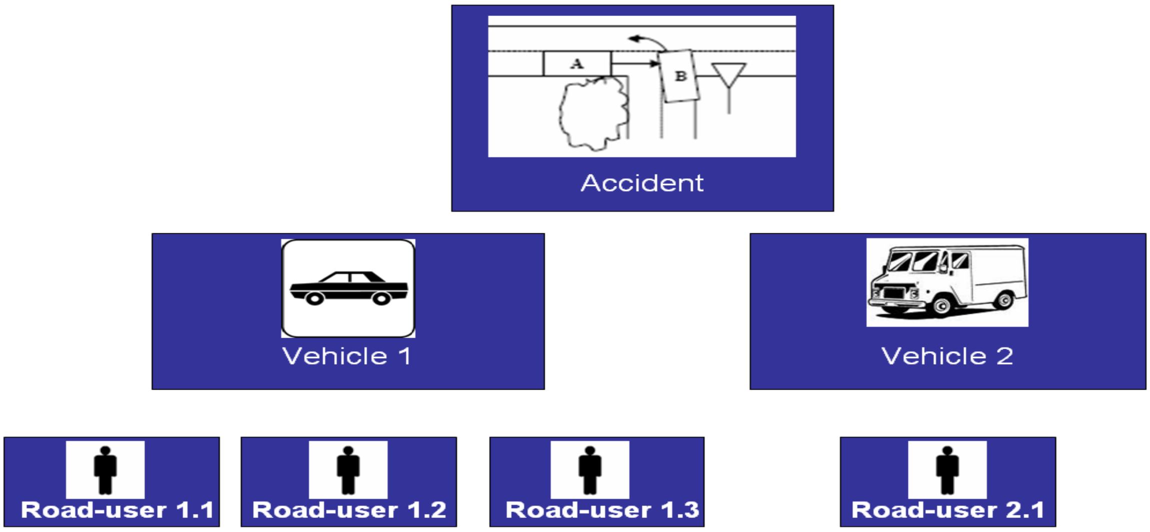


Figure 11.1: The hierarchical structure of accident data

SafetyNet has an objective to investigate these three different types of data-structures – time series data, geographic data and hierarchical accident data – to answer the question whether they require special treatment when they are statistically analysed. The problem with these data is called *dependency* and will be shortly sketched here (for details see D7.4 and D7.9).

11.1.2. Dependency in statistical models

Most statistical techniques are based on building a simplified model to describe the data. Factors that are assumed to play a role (e.g. whether a road-user wore a seatbelt or not) can be introduced in this model. Statistical tests are then used to evaluate whether this actually allows the model to describe the data better. These tests rely on the general assumption of the independence of the observations involved. Examples for problems with dependencies are grouped data (some cases are more similar to each other than to others) or data on a time line (data that were observed more closely to each other in time are more similar than those observed at distant moments), or periodic data (data from the same month over different years resemble each other). These dependency structures pose a problem for standard statistical techniques.

Deliverable D7.4 offers a review of various statistical methods that are appropriate to handle these problems, and investigates how serious is the problem posed for conducting statistical tests on time-series data and hierarchical data. Two types of hierarchical data have been considered, namely geographical hierarchies (e.g.: regions within countries and counties within regions; see D7.4 and D7.8) and accident data (see D7.6 and D7.9). The problem has been addressed for all types of data-structures, and two types of statistical techniques – time series analyses and multilevel analyses data were presented as solutions. As can be seen in Table 11.1, the conclusions for time-series data are much stronger than those for hierarchical structures.

	Time-series	Hierarchical (accident)	Hierarchical (geographical)
Potential problem for statistical tests	Large	Small	Medium
Methods for solution	Time series analysis	Multilevel modelling	Multilevel modelling
Applicability	Well applicable	Difficult to apply	Possible to apply

Table 11.1: Three types of dependency structures

11.2. Results

The work in SafetyNet was dedicated to three different data structures: (1) Time series data, (2) Geographical data, and (3) In-depth accident data. Data structures (2) and (3) both have a hierarchical structure, and were therefore candidates for multilevel modelling. In the remainder of this document, we will describe specific issues for each of the three structures and the results obtained.

11.2.1. Time series data

All over the world road safety policy makers want to understand why the number of road casualties changes, and how this can be influenced by effective strategies. Policy makers try to estimate the effects of safety measures or other factors on the number of casualties. The changes over time in either the number of fatalities, fatal accidents, serious accidents or the number of Killed or Seriously Injured (KSI) is used as a guide, and for future years safety targets are expressed in such terms. Analysts try to understand the yearly, or monthly, changes in the number of casualties. A common way of doing this is to look at the time series of the number of casualties, and try to match these figures with important influencing factors. This is a complex and sophisticated profession, called time series analysis. The description of the mathematical techniques used can be found in D7.4, while D7.5 is meant as a manual to apply these methods. In this chapter we briefly explain some essential insight gained in SafetyNet and give examples of applications of the methods.

11.2.2. Risk ratios under consideration of exposure data

The most important factor explaining road safety is mobility (distance travelled). Mobility can change enormously over the years, or months, and differences in road safety between countries are known to be strongly correlated to mobility.

The preferred way to relate road safety data to mobility is by using survey data on person distance travelled or vehicle distance travelled. Unfortunately, many countries do not have these data available, in which case proxies are used, *e.g.*, passenger car fleet, oil sales, demographic data, or a combination of those.

An example is shown in D7.10, Chapter 3. There, an analysis of the development of mortality (fatalities per inhabitant) over time is given for different European countries. This is compared to motorization rate. The analysis shows how motorization rate and mortality relate, and what different patterns evolve when countries are compared.

Summarising, this chapter shows that:

- different countries reach specific motorization rates in different years (temporal landmarks);

- some of these countries exhibit their major breakpoint in fatality risk within a narrow range of motorization rate values (320-370 vehicles per 1000), implying similar social and economical conditions;
- this range is different for certain subgroups of the examined countries, indicating that some grouping of countries may be required.

These preliminary findings can serve as an adequate starting point to obtain a further understanding of why, and when, these important breakpoints are observed. Research already conducted in this field will be taken into account so as to facilitate a useful grouping of the examined countries. The ultimate objective of this research is to utilize these findings in order to make reliable predictions for countries or regions for which the major turning point has not yet occurred.

Disaggregation by country also clearly shows that different countries may show their own specific developments, and thus that disaggregation helps to better understand the development of aggregated data.

11.2.3. Simultaneous modelling of different levels of road-risk

A common way to analyse the relation between road safety data and mobility consists of simultaneously analysing mobility, accident numbers, and fatality rate. In D7.10, Chapter 2, the current state of the art of structural time series analysis is described. We illustrate the importance of changes in distance travelled, and how this affects the number of accidents or the number of fatalities. Preferably, current methods simultaneously analyse the development of distance travelled, and of the number of accidents or fatalities, so as to allow for robust forecasts of both mobility and road safety data.

Deliverable 7.7 provides a more elaborate description of this method, both in the technical sense and in the examples used. A simultaneous analysis of the time series of distance travelled, risk (accidents per distance travelled) and lethality (fatalities per accident) was carried out, both for main roads and motorways. The results show these two types of roads differ from each other in the *development* of distance travelled, risk and lethality. Importantly, the development of the accident risk and the lethality are dissociated for these tow road types. While motorways have a lower accident risk than rural roads, the lethality of those accidents that do happen is higher as compared to rural roads. The accident risk is generally decreasing, but not so much anymore for motorways. The lethality is generally decreasing, but not on rural roads.

11.2.4. Disaggregate!

When only passenger car mobility is used to explain traffic safety changes over time, the resulting models behave poorly. This is because, in any country, the safety figures not only depend on passenger car mobility, but also on two-wheeler mobility (bicycle, moped, motorcycle). This is especially true when long time series are analysed. In the Netherlands in 1950, for example, no passenger car was involved in 70% of the fatal accidents. The same is true even today, for more than 30% of the fatal accidents.

One might argue that it is more appropriate to use motorized vehicle mobility instead of passenger car mobility. Although this is indeed the case, this remains problematic in the sense that changes in modal shift (*e. g.*, from motorcycle to passenger car) induce gross changes in the number of fatalities per distance travelled, which is left unexplained by the total motor vehicle travelled. Therefore, further understanding of traffic safety development asks for disaggregation of mobility and accident data into different models for different traffic modes.

An example is given in D7.7, Chapter 5, where accidents with cars are analysed. There, a difference was made between single vehicle car accidents and car-car accidents. Car-car accidents were further stratified by type, namely frontal, rear and side impact car-car accidents. This indicated that the risk of being involved in a single car KSI accident was approximately equal to the risk of being involved in a car-car KSI accident. Risks for three different car-car-accident types were approximately equal.

Stratification by traffic mode is not the last step required to better understand road-safety developments: Driver age is a very important factor as well. Changes in demographic data indeed also affect the number of road casualties. This is particularly true for changes of the proportion of young inexperienced drivers, or of elderly vulnerable drivers out of the general driver population. A decrease in birth rate has led to a gradual decrease in the number of young drivers twenty years later, as was observed in many developed countries after the introduction of the birth control pill. The baby boom that took place after World War II is another example of a demographic change that can help understand road traffic trends. Such changes in demographics have a strong impact on road safety data.

Unfortunately, not many countries have mobility data stratified by traffic mode, or driver age, at their disposal. This is a serious drawback for modelling effective time series analysis and road safety developments. To show the impact of such data on road safety, an analysis was carried out using Dutch data, in D7.10, Chapter 4. This analysis shows how road safety time series and mobility time series can be stratified by age and gender, and simultaneously analysed. Demographic data were used to obtain mobility data per capita. The results show that in the Netherlands, the number of fatalities per traffic mode and age group can be very different. At the same time, it was investigated how well these differences could be predicted using changes in population data only. The results showed that mobility per capita, stratified by age and traffic mode, changes relatively little over time. As an example, while the number of senior citizens has increased (and will be increasing further), the distance each member of this group travelled with various transport modes changed very little. As a consequence, even when mobility data by age group are not established regularly, a relatively good estimation of changes in road safety over time can be achieved by using demographic data instead of mobility data.

11.2.5. Explaining the risk

Eventually, models are expected to incorporate other influencing factors or safety performance indicators, such as the quality of roads, seatbelt use, etc.

Ultimately, policy makers are interested in an estimation of the effect of safety measures, *e.g.*, to decide what has to be undertaken to meet their safety targets. This calls for time series analysis with explanatory variables, to relate changes in the number of casualties to changes in external factors. To carry out such analysis, it is necessary to construct an accurate model that mathematically relates accidents to the measures of interest. For example: to estimate the effect of motorcycle helmet use on the total number of fatalities, a time series of accidents, stratified by motorcycle mobility and, *e.g.*, passenger car mobility (as this is an important traffic mode involved in fatal accidents with motorcycles) is necessary.

At this stage, operational models of that type are a bridge too far, mostly, because most influencing factors are very specific. As an example of a factor that affects all accidents, weather parameters were incorporated in time series analyses. To illustrate the application of explanatory variables in time series analyses, examples are given in D7.10, Chapter 5. Two different approaches to analyse the effect of precipitation, frost and temperature on safety are illustrated there.

Again, because weather conditions may affect the distance travelled, it is desirable to analyse distance travelled and risk simultaneously. However, this is not always possible. For the region of Athens a relatively simple model was run, without taking the distance travelled into account. Such simple models nevertheless allow a reasonable differentiation of months within a year. June, for example, was shown to yield more accidents than each month of the autumn period, probably because more vehicle-kms are driven on most road networks during early summer. Intuitive expectations seem to be justified to some extent from the use of models that also utilise exposure data. In particular, it appears that low temperature during wintertime, mostly, corresponds to some reduction of the number of accidents recorded. This also appears to be the case when the total precipitation in a month increases, probably due to reduced mobility under rainy weather, but this effect is much less pronounced.

Another approach was adopted in a second analysis, based on Dutch and French data, as well as on data for the region of Athens. Monthly data on temperature, precipitation, and frost were compared to monthly accident data and data on distance travelled. Generally, weather effects on the number of injury accidents were very similar for France and for the Netherlands:

- Months with more rain see more injury accidents
- Higher temperatures are associated with more injury accidents.
- In months with frost, the number of injury accidents is lower than in other months.

For The Netherlands, a further stratification of the analysis was possible: national data and local data were analysed. The results showed that rainfall and temperature are both positively correlated to safety (more rain or higher temperature leads to more accidents) whereas frost leads to fewer accidents (at least on a national level). Although some data on distance travelled was available, the effects on distance travelled on a monthly basis was found to be insufficiently accurate to clearly distinguish between the direct effect a change in accidents as a consequence of a change in distance travelled) of an indirect effect (a change in accidents as a consequence of a change in risk). Some effects were found, though. In France, an increase in rainfall leads to a decrease in distance travelled. So the net increase in the number of accidents due to rainfall indicates an even stronger increase in risk (as the distance travelled decreases at the same time).

11.2.6. Geographical data

Road safety data are always spread out across several geographical units. These can be as small as the road-site at which the data were collected (see Section 3.1), or up to the size of whole countries (see Section 3.3). These units can also be nested into each other: Road-sites are situated within counties (or regions) which are themselves located within countries.

The following examples consist of different types of studies, but they have one thing in common: The cases that belong to the same unit (road-site, county, country) are more similar to each other than those belonging to different units. This calls for a multilevel modelling approach, which has been implemented for the most important levels.

11.2.7. Performance indicators: Drink driving

In D7.4 (Section 2.3.3) a Belgian roadside survey on drink driving was presented. In this study, drivers were stopped at test-sites that were selected randomly with respect to location and time. At each test-site, it was established whether the drivers had been drinking-driving, namely: whether their BAC (breath alcohol concentration) was below or above the 0.05 mg per litre (the legal limit in Belgium).

At the test-site level (location and time), the time of testing was the most important predictor: Drink-driving on weekend nights exceeds by far that at all other time points. At the individual level, gender and age were the most notable predictors with men between 40 and 54 having the highest risk of drink driving. It was also shown that these variables (weekend night, male, 40-54) had the same effect on both probabilities: The probability to have drunk *slightly* more than the legal limit (.05mg/l < BAC < .08mg/l), and the probability to have drunk *much* more than the legal limit (BAC > .08mg/l).

11.2.8. Enforcement Effects in Greece

In D7.4 (sections 2.3.4 and 2.5) the effects of speed infringements and alcohol controls on the accident and fatality number for each Greek county were analysed. It turned out that both enforcement measures were highly correlated (i.e. counties that executed many alcohol controls also issued many speeding infringements), and that they are together associated with lower fatality numbers. Moreover, it was shown that the enforcement measures were the most effective in those regions that had the highest accident rate in the first place. It was also demonstrated that enforcement had a stronger overall effect on the number of fatalities than on the number of accidents as such, suggesting that the accidents became less severe.

It can be said that enforcement has an important overall effect on fatal accidents This effect is uniform in all regions, maybe because drivers perceived an increased nationwide presence of the Police and improved their overall behaviour accordingly. The decrease of non-fatal accidents, however, varies across regions, depending on the local enforcement practices.

11.2.9. Spatial modelling

Still using Greek data as example, D7.8, Chapter 2, illustrates how the spatial structure of a country can be integrated in an analysis of accident data. In other words, it is demonstrated how the systematic “neighbourhood structure” in the accident/fatality data can be disentangled from those differences that occur purely at random. For this purpose, the accident and fatality numbers per county were extracted from the CARE database. This analysis showed that differences between counties with respect to the number of accidents or fatalities per inhabitant are, for some part, determined by their location: Neighbouring counties tend to be more similar than counties located far away from each other. These data can be used to create a road-safety map for the whole country. In Figure 3.1 such a roadmap is presented for the fatalities and accidents in Greece. It can be noted that the fatalities in the left panel do not show a strong spatial pattern. However, in the accidents in the right panel a strong north-south pattern is present.

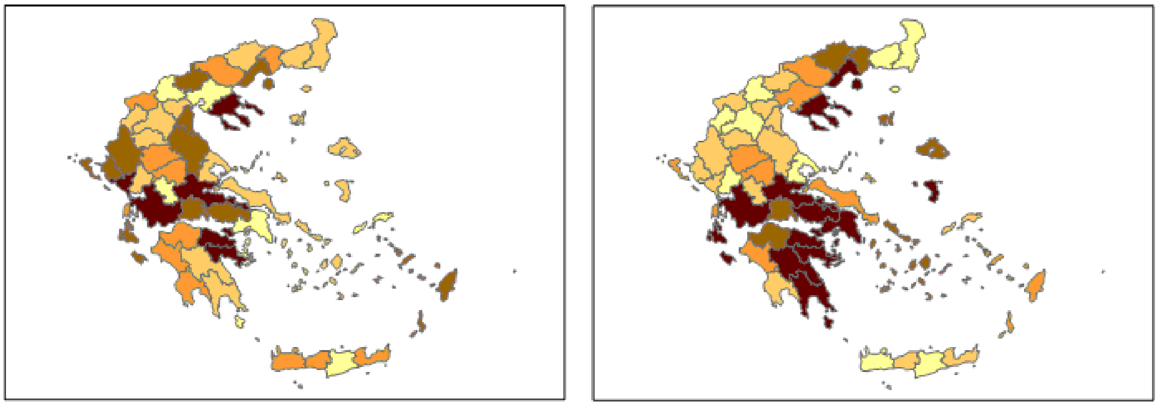


Figure 11.2: Fatalities and accidents (per population) according to spatial model

Spatial modelling can also be used to compare different descriptions of the spatial structure of a country. To set up a spatial model, one has to define which counties are neighbours and which are not. In road-safety this is not always straightforward and consists in itself of an interesting question: Is it the arithmetic distance that makes some pairs of counties more similar than others? Or is it the fact that they are connected by a road? Does it matter what kind of a road it is?

11.2.10. Safety attitudes and accidents

In D7.8 (Chapter 4), the accident data from the CARE data base were linked to the SARTRE database, which contains attitude data concerning road safety from 13 European countries. Drivers' behaviour and the underlying attitudes are amongst the most important factors in road safety. It is therefore interesting to see whether there is a relation between an accident database like CARE and a database containing data about road-safety attitudes in Europe, like the one resulting from the SARTRE project. However, CARE and the SARTE data are inherently different: SARTRE concerns the attitudes of people who did not necessarily have had an accident, while CARE is a collection of accidents involving people of whom we do not know the attitudes. To overcome this difference, both databases were aggregated to the level of country, gender, and age. As an example, the number of accidents, the number of fatalities and the answers of questions on the SARTRE questionnaire were determined for male Austrians of 18 year old.

The aggregated attitude and behaviour data from Sartre were analysed in a Principal Component Analysis and three main components were identified: Aggressiveness and Speeding, (2) Other Unsafe Behaviour (seat belt, drink driving), and (3) Perceived Control Likelihood of Control. This means that groups where many people admit to show aggressive behaviour are also those where many people admit to speed, whereas other unsafe behaviours, like drink driving and not using a seatbelt, are not necessarily shown in these groups.

As a result of the Principal Component analysis, each age gender and country group (e.g., the 18 year old male Austrians) got three scores, one for each of the three components. These scores were subsequently related to the number of accidents and fatalities for each of these groups. This yielded the conclusion that a positive attitude towards speeding and aggressiveness was more frequent in groups that also have a higher number of accidents and fatalities. This is true for men as well as for women. It is important to note that this statistical relation does not prove that the attitudes shown by young drivers actually *caused* the accidents. However, it shows that a positive attitude towards speeding and aggressiveness is most typical of the problematic groups, and might therefore be the most promising attitude to be addressed in campaigns.

11.2.11. Acceptance of new technologies: general tendency and country differences

In D7.4 (Section 2.6) the SARTRE data were also used to relate different driver characteristics to their attitudes towards different types of new technologies. The aim was to find out which type of driver supports which type of technology.

On the one hand, three driver characteristics were found to be relevant for the acceptance of new technologies. (1) Emotional driving (does the driver get emotional when driving), (2) professional driving (does the driver drive for work) and (3) economic status of the driver. On the other hand three characteristics of new technologies were found to determine their acceptance: (1) assistance and guidance (e.g., support for navigation, congestion warning),

(2) warning & intervention (e.g., speed limiting devices, fatigue warning, alcohol meter), and (3) enforcement (electronic identification, black box to identify accident causes).

Subsequently, it was tested how well these patterns actually held for the separate countries. It was shown, that the categorization of technologies and drivers held relatively well for 19 of the 23 countries[5]. There were, however, variations in the relation between them. In Table 11.2, the relation found between different technology types and driver types is indicated (first three columns) together with the deviations of single countries from that general relation.

General model of relations between driver types and technology types.			Deviations from general model per country (A to H)									
Driver types	**Technology types**	**General Relation**	Austria	Cyprus	Czech	Denmark	Estonia	Finland	France	Germany	Greece	Hungary
low economic status	Enforcement	**++**		**–**				**+**	**+**	**–**		
low economic status	warning & intervention	**++**		**–**				**+**	**–**	**–**		
low economic status	Assistance	**++**		**––**					**++**	**+**		
Driving as profession	Enforcement	**+**		**–**						**––**	**––**	
Driving as profession	warning & intervention	**+**		**––**						**–**	**–**	
Driving as profession	Assistance	**+**										
emotional driving	Enforcement	**–**							**––**			
emotional driving	warning & intervention	**–**			**++**			**––**	**––**			
emotional driving	Assistance	**+**							**––**			

Table 7.2a: Columns 1-3: General model of acceptance of different types of technology by different types of drivers (++ strong support, + support, - opposition). Columns 4-12: Deviations from general model by countries (+ / ++ stronger support than in general model, - / -- less support than in general model).

General model of relations between driver types and technology types.			Deviations from general model per country (I to S)								
Driver types	**Technology types**	**General Relation**	Italy	Netherland	Poland	Slovenia	Slovakia	Spain	Sweden	UK	Switzerland
low economic status	Enforcement	**++**	**–**							**+**	**+**
low economic status	warning & intervention	**++**		**+**				**–**		**+**	
low economic status	Assistance	**++**			**+**	**+**					**+**
Driving as profession	Enforcement	**+**						**++**		**++**	
Driving as profession	warning & intervention	**+**			**–**					**+**	**+**
Driving as profession	Assistance	**+**				**++**		**++**			**––**
emotional driving	Enforcement	**–**			**++**	**++**		**––**			**––**
emotional driving	warning & intervention	**–**			**++**	**++**		**––**			
emotional driving	Assistance	**+**			**++**	**++**		**––**			**++**

Table 7.2b: Columns 1-3: General model of acceptance of different types of technology by different types of drivers (++ strong support, + support, - opposition). Columns 4-12: Deviations from general model by countries (+ / ++ stronger support than in general model, - / -- less support than in general model).

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[5] For Belgium, Ireland, Portugal and Croatia, the general categorization of drivers and technologies did not reflect the responses given in those countries in a satisfying way.

Table 11.2: General model of relations between driver types and technology types.

Three main results in driver characteristics can be seen regarding support of new technologies.

- Low economic status drivers are most supportive,
- Professional drivers are also supportive, though less so than the above group, and
- Emotional drivers do not support new technologies (except assistance and guidance systems).

There is, however, no unique pattern of results that would hold for all countries altogether, suggesting that different strategies should be used for a successful introduction of new technologies in different countries.

11.3. Accident data

11.3.1. Analysing fatal accident data

In D7.9, a series of analyses of the Fatal Accident Database (or FAD) were presented. Analysing observations that are limited to fatal accidents means that the available information is restricted to the high-end of the accident-severity continuum. The problem with the interpretation of the information in such a database lies in the absence of a meaningful reference point to which it can be compared. Fatal accident data do not provide any information about whether the features or characteristics are *specific* to fatal accidents. As an example, front damage is the most frequent type of damage in the FAD (60%). This high proportion does not, however, allow the conclusion that front damage is particularly likely to result in an accident being *fatal.* To ascertain such a conclusion, one would need a reference point – such as the percentage of front-damaged cars in *non*-fatal accidents, to test whether frontal are indeed less frequent there. To state it otherwise, by themselves, observations from fatal accidents – whatever the level of detail they offer – do not deliver information on which characteristics are *specific* for fatal accidents. To obtain such information, data from fatal accidents have to be combined with exposure data, or with similar information from non-fatal accidents.

Contrary to the accidents themselves - which were all fatal - the severity of their consequences for the individual road-users differs. The question of knowing what differentiates the survivors of these crashes from the fatalities is interesting in its own right. The survivor group can be used as a point of reference for the fatality group and enables the identification of person-, vehicle-, or accident- characteristics that make it more – or less – likely that an individual survived despite his/her involvement in such a severe accident. One should, however, keep in mind that the analysis only informs us about the risk of dying for someone who is already involved in a severe accident. The results say nothing about the risk of becoming involved in such an accident.

When identifying risk and protection factors in severe accidents, it is important to take the types of road-users involved into account. The risk run by a road-user, whenever involved in an accident, strongly depends on (1) his/her own travel mode (i.e., whether he/she is a car occupant, a bicyclist, or a truck driver), and (2) the travel mode of the road user he/she happened to collide with in the course of the accident. A car driver's chances to die in an accident, for example, are *de facto* dramatically different depending on whether he/she collided with a bicycle, or with a heavy good vehicle. This is a general law in road accidents.

When analysing exclusively *fatal* accidents these differences become exacerbated, and care has to be taken that the cases selected offer sufficient baseline (i.e., a priori) comparability. This problem is illustrated in Figure 4.1, where for each conflict type (i.e. a road-user of a particular type with an opponent of a particular type) the percentage of survivors and fatalities is given.

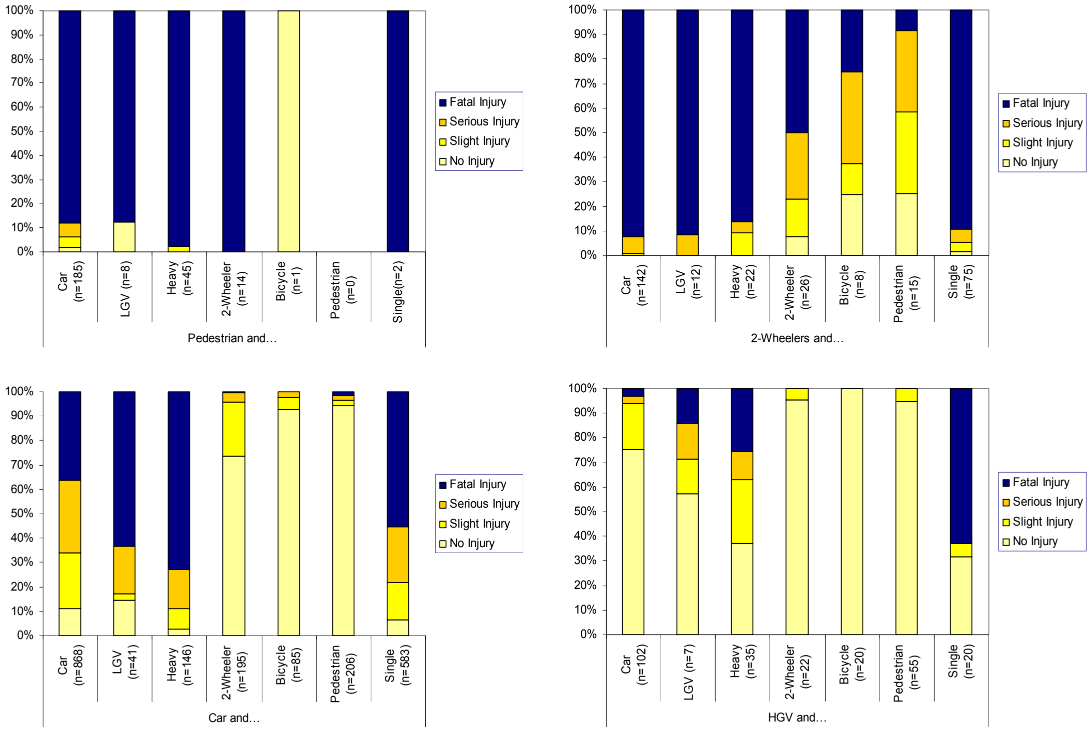

Figure 11.3: Percentage of survivors, fatalities, slightly and severely injured road-users depending on opponent type.

Upper left: Pedestrians; upper right: two wheelers; lower left: car occupants, lower right occupants of heavy good vehicles.

A single glance is sufficient to make two observations:

- The percentages of fatalities differ strongly across the different conflict types.
- Some conflict types have extreme values; either fatalities only (e.g. pedestrian-car) or survivors only (e.g. car-pedestrian).

If the accident took place between a car and a pedestrian, one can be almost certain that the car occupant survived the accident. On the contrary, if the car collided with a heavy good vehicle, that car's occupant has nearly 100% certainty to become the fatality. Generally speaking, in the case of fatal accidents data, incompatible accidents are accidents in which the risk to die is maximal for the more vulnerable of the road-users, while this risk is basically null for the relatively stronger participant[6].

In Chapter 1 and 4 of Deliverable D7.9 these and other problems are discussed in more detail, and solutions are proposed. The analyses presented in that deliverable, which take account of these problems, are described in the sections below. They aim at answering the following questions:

- What differentiates single from multiple vehicle fatal accidents?
- What is the probability of being killed, given that one is involved in a fatal accident? What factors affect this probability and thus the consequences of a severe accidents for the persons involved?

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[6] Because in incompatible accidents the outcome is the same for every road-user of a particular type (e.g. pedestrians), it is impossible to determine any further risk and protection factors for these types of accidents on the basis of fatal-accident data.

- How reliable are the injury severity scores assigned by the Police to road accident casualties? Are there any factors systematically affecting the misreporting of injury severity?

11.3.2. Contrasting survivors and fatalities in fatal accidents

The outcomes of fatal accidents for each individual road-user involved are examined in Chapter 4 of D7.9. Comparing survivors and fatalities provided indications of the risk and protection factors for road-users involved in fatal accidents. The differences in baseline risk (see Section 4.1) were taken in account in three successive steps, which each provided particular improvements in handling these methodological problems posed by the limitation of the data to fatal accidents. First the complete dataset, including the observations made on all road-user types (i.e.: car-drivers as well as pedestrians or heavy good vehicles) was analysed. The remaining analyses focused on car-occupants specifically.
Some variables emerged as “risk factors” in a consistent way for all three analyses, such as the fact that the road-user him/herself could (or could not) be considered as “senior” (i.e.: as being more than 65 years), or that the driver did not react properly to the occurrence of the accident by braking. In the specific case of car occupants, seatbelt appeared to be an important protection factor. The risk for the road-user to decease in the accident also appears to increase with the age of the vehicle. Finally, the fact that the accident took place on a road junction also leaves the road-users with increased chances to survive. The risk for car occupants also depends on the area of main damage: generally speaking, front damage is less dangerous than side damage. This is, however, only true for crashes between two cars or between a car and a light good vehicle, but not for single car crashes or crashes between a car and a heavy good vehicle. This latter result once more underlines the importance of including the transport mode of the opponent in the analysis.

11.3.3. Reliability of injury reporting

Chapter 2 in D7.9 showed that - although they were not initially meant for this - the FAD data could be very useful in detecting inaccurate reporting of injury severity under the form of misreporting (e.g.: slight injuries recorded as serious, fatalities recorded as serious injuries, and so on). Generally speaking, the analysis performed offered encouraging conclusions with respect to the quality of the reporting of injury severity, at least in the member states that took part in the FAI data-collection. Indeed, several sources of misreporting had been identified on the basis of this analysis among the first wave of the FAD data, suggesting a general pattern according to which, the more complex the road accident conditions were (e.g. more accident participants, higher traffic flow, night time), the higher was the probability of misreporting injury severity. However, running the same analysis on the second wave of data revealed a very limited number of inaccurately reported cases, indicating that most of the inaccuracies previously identified had been solved.

The remaining inaccuracies concerned mostly serious injuries, and very few systematic sources could be identified for these inaccuracies. Notably, inaccuracies were less probable when the victim was taken to the hospital. This could be due to the fact that injuries necessitating transportation to the hospital are intrinsically likely to evolve in the time span taking place between the rating of the injury by the police and its recording by the SafetyNet team.

The FAI data offer the great advantage of providing some “standard”, namely the SafetyNet injury severity score, against which the accuracy of the police records for injury severity can be evaluated. No notable inaccuracy could be identified in the second wave of the FAD data, and no systematic country variation in the few inaccuracies identified. Assuming that the SafetyNet injury records can be considered accurate, this result suggests that no major problems should be expected in terms of country comparison on the basis of different level of injury severity on the basis of the FAD data.

11.3.4. Characteristics of single vehicle fatal accidents

Single and multivehicle fatal accidents differ on a large number of variables. The drunken young man who rides his car against a tree on a Saturday night is a prototypical case, representing the idea that single vehicle accidents are caused by less responsible drivers than multivehicle ones. However, a different explanatory approach suggests that single vehicle accidents are predominantly observed when the road-conditions are such that an error of one driver is not very likely to involve another driver. The results of a multivariate analysis favoured the second approach.

Conditions of the road have been found to be the most important predictor of whether an accident involves one or several vehicles. Multivehicle fatal accidents take place on junctions and relatively busy roads, while single vehicle accidents tend to take place on empty road-sections. Roads with physically divided carriageways see more single- than multivehicle accidents occurring. This suggests that such physical divisions do in fact succeed in preventing drivers who make a mistake to involve other drivers in the accident. The effect of these variables can be summarised under the principle that road-conditions that make it less likely that two vehicles encounter each other prevent the error of one driver to involve another one and thus facilitate single vehicle accidents as compared to multivehicle accidents.

Single vehicle fatal accidents involve mostly cars. Motorbikes are less likely to be involved in single than in multivehicle accidents and heavy good vehicles are involved almost exclusively in multivehicle accidents. The cars in single vehicle accidents have more passengers and the drivers in single vehicle accidents tend to be unfamiliar with the area more often than the drivers in multivehicle accidents. Moreover, these drivers failed disproportionally often to even attempt to avoid the accident by braking or steering.

It has also been found that single vehicle fatal accidents take place especially at night and during the weekends and involve young drivers more often than multivehicle accidents. However, these effects seem to be mediated by the fact that at those times the roads are much emptier than during the week at daytime, when middle-aged and older people tend to drive.

Returning to the starting questions it was concluded that road conditions that prevent the error of one driver from affecting others are more important to understand the difference between single and multivehicle accidents than characteristics of the drivers involved.

11.4. Conclusion

SafetyNet has investigated how data-structures like hierarchical accident data, spatial data, and time-series can pose special problems in terms of statistical analysis. As a solution, the use of time-series analysis and multilevel analysis has been suggested.

Moreover, a number of additional methodological problems that are specific to the various types of data used were discussed, and solutions were offered to handle them. For time series data, for example, it has been emphasised that the development of the number of fatalities needs to be considered simultaneously with the development of the mobility – and preferably so, separately for different types of accidents. For the analysis of fatal accident data, it was emphasised that each analysis and interpretation of these data needs to take into account that this is a very specific selection: Only the worst cases are present, but not the more positive ones to compare them with.

In applying the principles that were first established, SafetyNet has presented a wide range of example analyses, representing the broad variety of questions the SafetyNet data allow to address.

11.5. The work performed

In the following, the deliverables produced in SafetyNet, relating to data analysis questions, are described. The methodological results and conclusions with respect to road safety questions will be presented in the following section.

11.5.1. D 7.4: Multilevel modelling and time series analysis in traffic safety research – Methodology

This deliverable gives the theoretical background for the two families of analyses, multilevel and time series analysis. For each technique the objectives, detailed model formulation, and assumptions are described. The technique is subsequently illustrated with an empirical example relevant to traffic safety research.

11.5.2. D7.5 :Multilevel modelling and time series analysis in traffic safety research – Manual

This deliverable contains the manual to support the methodology report in D7.4. For each technique described in the methodology report, this manual presents the instructions to fit the models on the basis of user friendly software, along with guidelines for interpreting the results. The aim of the manual is to enable the reader to conduct all analyses described in D7.4, and in this way to get hands on experience in the analysis of road safety data. To enable the reader to track every step presented, the data sets discussed in the various sections are available on the ERSO website (http://www.erso.eu/safetynet/content/wp_7_data_analysis_and_synthesis_1.htm).

11.5.3. D7.7: Multivariate time series analysis of SafetyNet data

This deliverable demonstrates the use of time series analysis techniques. In particular, structural time series models are developed and demonstrated for France and the Netherlands, as well as disaggregated models for two types of networks in France, and disaggregated models for several accident types in the Netherlands. It is demonstrated how the developments of the traffic volume, the number of accidents, and the number of fatalities can be considered simultaneously. The time series model isolates the general trend in these observed measures from short term seasonal variation and links them to the trend in exposure, accident risk and accident severity. Some interpretations are given. In addition, the performance of the time series model is compared to the performance of one classical alternative: the vectorial regression model.

11.5.4. D7.8: The CARE accident data in perspective

This deliverable relates the data from the macroscopic European accident database CARE to other, often very different types of data. It is first shown how accident data can be linked to spatial and road infrastructure data (e.g., which regions in a country are connected by roads) on the basis of Greek example data. In another section, the accident outcomes in CARE are related to hospital injury data for 5 different member states, which were gathered within SafetyNet. Furthermore, the CARE data can also be used as reference for other databases.

It is presented how the distribution of accidents in an in-depth accident database can be evaluated by comparing them to the distribution in the CARE database. Finally, the accident data for different age and gender groups were linked to these groups' road safety attitudes as measured in the SARTRE project.

11.5.5. D7.9: Analysing European in-depth data: Methodological framework and results

This deliverable is dedicated to the analysis of the Fatal Accident Database built in the framework of SafetyNet. The general aim is to demonstrate the multiple uses of these data, and to propose a set of techniques that are appropriate for the analysis of data that are limited to fatal accidents. The questions addressed concern the reliability of injury severity reporting, the differences between single and multi-vehicle accidents and the fatality risk of persons involved in fatal accidents.

11.5.6. D7.10: Understanding and interpreting road-safety developments in Europe: Integrating results from different analytical approaches

This deliverable shows how traffic safety data can be analysed to understand the development of traffic safety over time.

The report shows a number of principles of time series analysis
- The current state of the art of structural time series analysis is described. We illustrate the importance of changes in vehicle ownership and distance travelled, and how these affect the number of accidents or the number of fatalities.
- Further understanding of the development of traffic safety asks for disaggregation of the safety data into different subgroups. Such disaggregation reveals different trends for different groups.
- The development of traffic safety is shown to depend strongly on the composition of the population of a country. Changes in the demographics are related to safety, and forecasts are sensitive to this composition.
- As an example of a factor that affects all accidents, we chose weather parameters to incorporate in our models. We use two different approaches to analyse the effect of precipitation, frost and temperature on safety.

11.5.7. D 7.11: Overview and executive summary of Work Package 7

This report summarizes the activities of Work Package7. On the one hand, the most important conclusions with respect to the use of special statistical techniques for time series data and hierarchical data (accident and geographical) are given. On the other hand, each of the analyses conducted on time series data, geographical data, and fatal accident data is summarized to give a bird eye view of the most important results obtained on the basis of SafetyNet data.

12. SafetyNet Deliverables and further exploitation

The following table gives a brief overview of and links to relevant output of SafetyNet. In total the project produced 91 deliverables, some of which were for internal use only or represented intermediate results. Those listed below will have a wide application and are expected to be of significance to many parts of the road safety community who are encouraged to examine and utilise the results as widely as possible. The results fall into four main groups and within those are listed according to the level of safety data to which the deliverable refers.

Theory: These deliverables describe state of the art reviews, new protocols for specifying and harmonising data, the theory upon which many of these protocols are based and practical guidelines for use.

Data: These deliverables contain the main analyses of the safety data gathered within the project, some are intended to be updated annually, such as the Basic Factsheets and Statistical Report, while others are self-contained.

Other results: These are reports that address other, non-data related outcomes of the project.

Macroscopic	Theory and protocols	Data	Other results
	CARE Accident Data • Enhancement of the CARE accident data • Harmonising national road accident data: Development of transformation rules for 15 European countries • Linking CARE accident data with other data files • The Common Accident Data Set (CADaS) • Estimation of the real number of road accident casualties – Final report • Development of EU road accident statistics • EU Aggregate Data Files ***Risk exposure data*** • State of the art report • Risk Exposure Data Common Framework • Risk exposure data - Recommendations for collection and exploitation ***Safety Performance Indicators*** • Safety Performance Indicators: Theory • SPI Manual	***CARE Accident data*** • Annual Statistical Report 2007 • Main Figures • Children (Aged <16) • Young People (Aged 16-24) • The Elderly (Aged >64) • Pedestrians • Bicycles • Motorcycles and Mopeds • Car Occupants • Heavy Goods Vehicles & Buses • Motorways • Junctions • Urban Areas ***Safety Performance Indicators*** • Road Safety Performance Indicators: Country Profiles	***Care Accident data*** • First classification of the EU member states on Risk and Exposure Data ***Safety Performance Indicators*** • Road Safety Performance Indicators: Country Comparisons ***Other*** • SafetyNet-SUNflower report • SafetyNet Final Activity Report

In-depth	• Fatal Data Methodology Development Report • In depth Accident Causation Data Study Methodology Development Report • A glossary of the data variables collected in both task 5.1 and 5.2 • Manual for DREAM 3.0 Driving Reliability and Error Analysis Method	• Fatal Accident database and analysis report • In-depth Accident Causation database and analysis report	• Report on review of WP5
Accident investigation	• Bibliographical Analysis • Database Transparency • Recommendations for Transparent and Independent Road Accident Investigation	•	• Workshop report
Statistical analysis	• Multilevel modelling and time series analysis in traffic safety research – Methodology • Multilevel modelling and time series analysis in traffic safety research – Manual • The CARE accident data in perspective: Relation to road-safety attitudes (SARTRE), Investigation of injury reporting, Investigation of the spatial distribution of road risk	• Analysis of the Fatal Accident Investigation Database • Analysing European in-depth data: Methodological framework and results • Understanding and interpreting road-safety developments in Europe: Integrating results from different analytical approaches	• Multivariate time series analysis of SafetyNet data
ERSO website	•	•	• http://www.erso.eu/ • ERSO Promotion Pack ***Webtexts*** • eSafety • Alcohol • Novice drivers • Older Drivers • Cost-benefit analysis • Post Impact care • Road Safety Management • Roads • Safety Ratings • Speeding • Speed Enforcement • Pedestrians and Cyclists • Powered Two Wheelers • Vehicle Safety • Fatigue • Work-related road safety • Quantitative road safety targets

13. Project Summary

- Summary statements
- Go through WPs with short para on each main outcome.
- What's next?
-

The SafetyNet project represents a major initiative on the part of the European Commission to build a new data and information framework for the European Road Safety Observatory. SafetyNet has developed a range of new data and information protocols that will ensure the ERSO has a strong basis on which to build. The data itself covers both macroscopic and in-depth data types as well as some meta-data. The information resource provides state of the art knowledge in a form that is accessible to policy-makers and scientific advisors. Each type of data was at a different stage of development at the outset of the project, in several cases there were no previous activities at EU level on which to base SafetyNet and the project has had to develop completely new protocols. By the end of the project some data areas were completely mature and adapted to the full EU27 and all types of data had standard protocols and had been validated.

13.1. Specific achievements of the SafetyNet project

13.1.1. CARE - Community database on Accidents on the Roads in Europe

The CARE database is regarded for practical purposes as the definition of the European Accident population. SafetyNet has enhanced CARE in a number of ways.

CARE database

The CARE database has been substantially enhanced by the SafetyNet project. At the outset it covered just 15 Member States, by the end of the project transformation rules had been developed for a total of 27 Member States as well as Norway, Switzerland and Iceland.

CARE reports

At the commencement of the project there were no standard statistical outputs from CARE that were routinely produced. SafetyNet developed a range of standard annual reports and factsheets that were extended and enhanced at each fresh annual publication. The final set of publications is below.

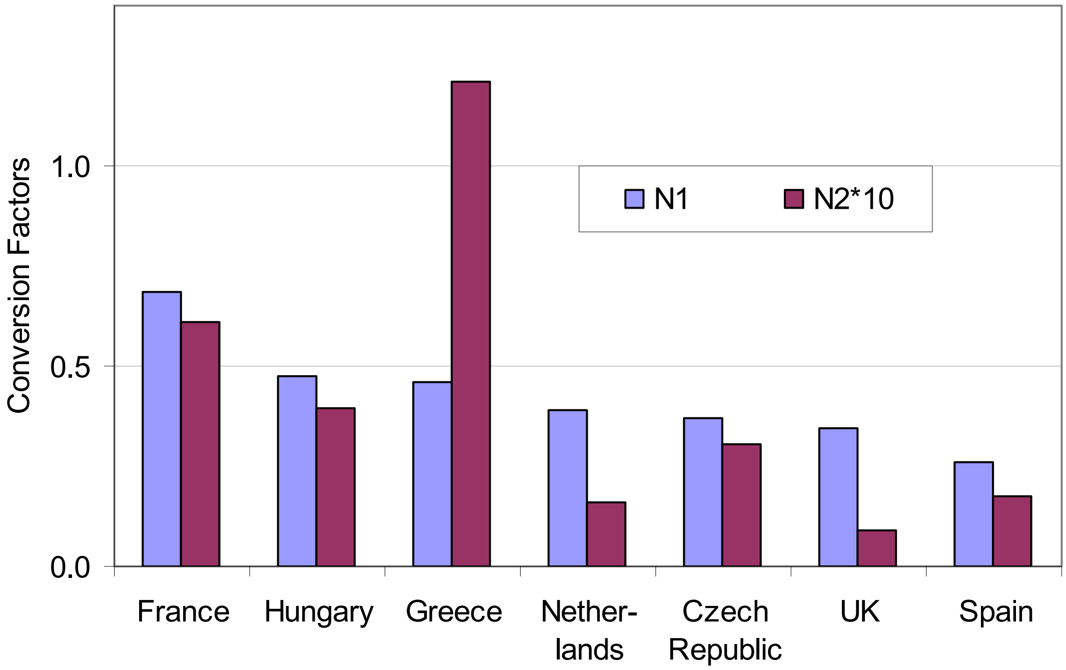
- Annual Statistical Report 2007
- Main Figures
- Children (Aged <16)
- Young People (Aged 16-24)
- The Elderly (Aged >64)
- Pedestrians
- Bicycles
- Motorcycles and Mopeds
- Car Occupants
- Heavy Goods Vehicles & Buses
- Motorways
- Junctions
- Urban Areas

Estimating of accident under-reporting levels in 6 countries

CARE data includes both fatal and non-fatally injured casualties, while there is an agreement over a standard 30 day period to define "fatal" there has been no equivalent definition of "serious" and it is therefore not possible to compare countries. SafetyNet developed a new definition of the "serious" category based on the Abbreviated Injury Scale 2005, an internationally accepted measure of injury severity. A "Serious" casualty is defined as any casualty with injuries classed as equal to, or greater than AIS 3. SafetyNet evaluated conversion factors in 6 countries to be used to estimate the numbers of these casualties. According to this definition the number of casualties C in a particular country is estimated as:

C = N1 * police reported serious casualties + N2 * police reported slight casualties

where N1 and N2 vary from country to country. The overall factors from 7 studies are shown below, N2 is considerably smaller than N1 and hence is multiplied by 10 in this figure.



Development of Common Accident Data Set

National accident data is collected differently in each European Country using different variables and values, this variation limits the efficiency of transformation rules and therefore the accuracy of analyses. SafetyNet has improved this position by developing a new Common Accident Data Set (CADaS) which lists standard specifications of the data. When a country wishes to enhance its national accident reporting system it has the option to review CADaS and to incorporate new fields using he standard definitions. It opens up the possibility for a convergent approach, over the long-term, for the national datasets.

13.1.2. Risk and exposure data

Measurements of risk support robust comparisons of the safety levels of different countries or under different conditions. There were no standard European specifications of exposure at the start of the SafetyNet project and a new set of definitions and further actions have been defined.

Development of standard protocols for exposure data

SafetyNet has defined a set of standard definitions for exposure data based on the categories

- Population
- Road length
- Vehicle fleet
- Driver population
- Vehicle kilometres
- Person kilometres
- Number of trips
- Time in traffic
- Fuel consumption

Review of data availability and usability

SafetyNet has examined the availability and compatibility of exposure data, according to the above categories, the five exposure indicators with the greatest levels of usability were

- Population
- Road length
- Vehicle fleet
- Driver population
- Vehicle kilometres

Recommendations for future collection of exposure data

SafetyNet has produced a series of recommendations to improve the harmonisation of exposure data including the steps necessary to gather the data.

Pilot studies for exposure data gathering in selected countries

SafetyNet has conducted pilot studies across 6 countries, Norway, France, Portugal, Czech Republic, Poland and Estonia to gather exposure data and analyse risks. The main conclusions were:-

- Some RED essential for pertinent comparison are missing (eg. number of veh km)
- The choice of a type of RED may change totally the conclusions of the analysis
- There is a balance to be made between the level of disaggregation, necessary for a more detailed approach, and the size of the sample and care is needed regarding interpretation of the results
- Only comparisons with RED will support conclusions regarding whether a given situation is due to local circumstances or general tendencies.

13.1.3. Safety Performance Indicators

Safety Performance Indicators are intermediate measures of the state of safety, they are directly related to both policy inputs and safety outputs but are more flexible and indicate responses to policy measures more readily than casualty outcomes.

Review of the State of the Art for SPIs

SafetyNet reviewed the state of the art definitions for key SPI areas with the following conclusions.

Safety area	Developed indicators
Alcohol and drugs	Alcohol percentage of fatalities resulting from crashes involving at least one *driver* impaired by alcohol Drugs percentage of fatalities resulting from crashes involving at least one *driver* impaired by drugs other than alcohol
Speed	The average speed either during daytime or during the night The percentage of speed limit offenders.
Protective systems	Daytime wearing rates of seatbelts in front seats (passenger cars + vans /under 3.5 tons) in rear seats (passenger cars + vans /under 3.5 tons) by children under 12 years old (restraint systems use in passenger cars) in front seats (HGV + coaches /above 3.5 tons) Daytime wearing rates of safety helmets by cyclists, moped riders and motorcyclists
DRL	DRL usage rate for all roads together, per road type, per vehicle type
Vehicles (passive safety)	Combined crashworthiness/ vehicle age measure of the passenger car fleet Measure for the safety of a vehicle fleet's composition due to incompatibility within the fleet
Roads	Road network percentage of appropriate current road category length per theoretical road category Road design EuroRAP Road Protection Scores
Trauma management	Availability of Emergency Medical Services (EMS) stations number of EMS stations per 10,000 citizens and per 100 km length of rural public roads Availability and composition of EMS medical staff percentage of physicians and paramedics out of the total number of EMS staff number of EMS staff per 10,000 citizens Availability and composition of EMS transportation units percentage of Basic Life Support Units, Mobile Intensive Care Units and helicopters/planes out of the total number of EMS transportation units number of EMS transportation units per 10,000 citizens number of EMS transportation units per 100 km of total road length Characteristics of the EMS response time demand for EMS response time (min) percentage of EMS responses meeting the demand

- average response time of EMS (min)

Availability of trauma beds in permanent medical facilities

- percentage of beds in trauma centres and trauma departments of hospitals out of the total trauma care beds
- total number of trauma care beds per 10,000 citizens

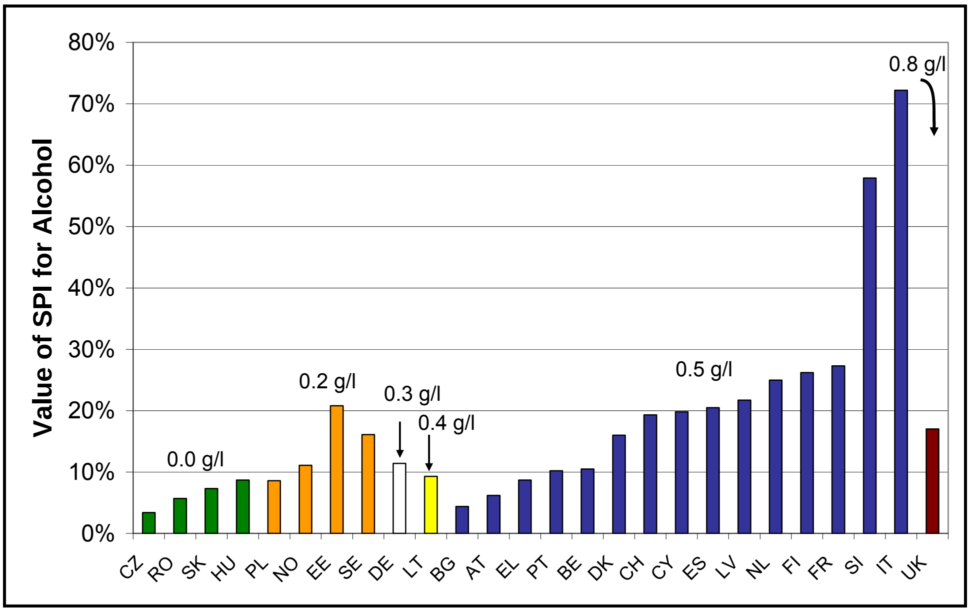
Furthermore, a combined indicator was developed to measure a country's overall performance for Trauma management.

Guidelines for gathering SPIs

The project reviewed current practise and derived new guidelines for methods to gather and record key Safety Performance Indicators.

Comparisons of countries based on selected SPIs

SafetyNet gathered available data from 29 European countries and used it to calculate SPIs and make comparisons. The example below shows the range of indicators for alcohol in reference to the national definition of alcohol limits.



Recommendations for future SPI collection

Finally the SafetyNet team produced a set of recommendations on the optimum manner to gather SPI data routinely and to incorporate it into the Observatory.

In-Depth data Recommendations for transparent and independent road accident investigation

SafetyNet contrasted the accident investigation approaches employed within each of the transport modes and identifies common factors. The key issues of independence and transparency of accident investigations are discussed and the SafetyNet recommendations for the key actions in implementing a pan-European accident investigation system for safety improvements are presented. The recommendations are in four groups:-

1. **Institutional**, referring to the structure and functioning of the body responsible for road safety investigations;
2. **Operational**, detailing how the body carries out investigations;

3. **Data**, addressing issues surrounding the storage, retrieval and analysis of data generated by investigations; and
4. **Development of Countermeasures**, dealing with how investigation conclusions should be presented, used and disseminated

A Fatal Accident Database comprising 1296 cases with fully developed protocols and analysis.

The CARE database is constrained by the data that is available in the national datasets and the capability to develop transformation rules. SafetyNet has developed a new Fatal Accident Database with a considerably level of detail and populated it with 1296 accident cases. This data has been analysed to demonstrate the level of enhancement over CARE.

An In-Depth Accident Causation Database comprising 1006 cases with fully developed protocols, a new accident causation classification system (DREAM 3.0) and an overview analysis of the data.

There is major gap in knowledge about the causes of crashes, particularly in the area of human error and systems failures. SafetyNet has developed a new protocol (DREAM 3.0) for deriving these factors on the basis of in-depth investigations and has applied it to a new database comprising 1006 accident cases. This data has been analysed to demonstrate the capability to identify new accident prevention opportunities.

13.1.4. Safety Information System

A website to provide access to data, knowledge and the SafetyNet project website including webtexts on 17 topical road safety subjects. At the end of the project the site was receiving over 7000 hits each month.

A website has been developed to provide access to the ERSO. There are four main areas

- Access to **safety data** reports including the Basic Factsheets and Annual Statistical Reports. Metadata is also available.
- A **knowledge base** comprising webtexts that have been subject to an intensive review procedure in order to ensure the highest quality. The topics are
    - eSafety
    - Alcohol
    - Novice drivers
    - Older Drivers
    - Cost-benefit analysis
    - Post Impact care
    - Road Safety Management
    - Roads
    - Safety Ratings
    - Speeding
    - Speed Enforcement
    - Pedestrians and Cyclists
    - Powered Two Wheelers
    - Vehicle Safety
    - Fatigue
    - Work-related road safety
    - Quantitative road safety targets

- **Links** to safety groups, safety project and other safety resources
- The **SafetyNet** project website

13.1.5. Data Analysis

Application of time-series analysis, multi-level models and other analysis tools to CARE, Fatal Accident and other data to demonstrate appropriate statistical approaches for comprehensive analyses.

Traditional analytic approaches applied to accident data, such as modelling or time series analysis, fail to take account of the dependencies within the data – there may be several casualties in a vehicle and several vehicles in an accident – and these approaches may inaccurately estimate the significance of causation factors. SafetyNet has investigated the use of multi-level methods and found that in some cases these offer a significant benefit over traditional approaches.