Road Safety Data, Collection, Transfer and Analysis

Deliverable 0.1
Final Project Report

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Background and purpose of DaCoTA

The European Road Safety Observatory was established European Commission and first announced in the 2001 Transport White Paper[1]. It was further developed in the 2003 Road Safety Action Plan [2] where the Commission announced it was to establish a new European Road Safety Observatory (ERSO) to "co-ordinate all Community activities in the fields of road accident and injury data collection and analysis". The framework of ERSO was established within the EU FP 6 funded project SafetyNet (2004 – 2008) which developed and validated standard protocols for core data and knowledge tools. At the completion of the project the data and knowledge developed by SafetyNet ERSO had been incorporated within the website of DG-MOVE. The DaCoTA project has been established with the support of DG-MOVE to further develop the content of the Observatory with additional data types and output tools. There are six areas of work which are summarised below.

Policy-making and safety management processes

Road safety management is the process by which road safety policies are generated, implemented and monitored. They include institutional actions, implementation of measures and monitoring of intermediate and final outcomes. The institutional structures involved include national and local government, infrastructure operators, vehicle regulators, traffic enforcement, training agencies and other stakeholders. There is a variation in approach across the EU 27 yet there is little information that characterises the key aspects of the approach not quantitative information linking these characteristics to road safety outcomes.

The DaCoTA team has systematically gathered information from a selection of 14 EU Member States using a specially designed questionnaire based on a model of road safety. Analysis of the results showed that there was no one single “good practise” model of road safety management that could be related to road safety outcomes. It was considered this was a result of the similarities between the countries evaluated and the comparison of the “snapshot” of the census and the decade of casualty reduction totals. It was however possible to identify a relationship between certain characteristics of road safety management and road safety performance indicators – the operational conditions of road safety. This is in accordance with the Sunflower model that assumes the policy context and input will first affect intermediate outcomes.

The evidence base is a key factor in ERSO and for road safety policymaking and the DaCoTA team also reviewed the data needs of key stakeholder groups. A web-based questionnaire was completed by over 500 road safety stakeholders who were asked to identify the nature and availability of the most important types of safety data. The highest priority data needs were:-

1. Information on crash causation factors (high priority for 67% of respondents)
2. Information on road users' behaviour and attitudes (63%),
3. A common definition of a fatality (60%),
4. Information on the costs and benefits of road safety measures (56%)
5. Serious injury counts, in addition to fatality counts (55%),

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[1] European Commission 2001, European transport policy for 2010: time to decide COM(2001) 370 final. Brussels, 12.9.2001

[2] European Commission 2003. European Road Safety Action Programme: Halving the number of road accident victims in the European Union by 2010: A shared responsibility. COM (2003) 311 final. Brussels, 2.6.2003

6. Methods to evaluate the safety impacts of road safety measures (54%)
7. Information on the safety impacts of combined measures (54%),
8. Common methods to perform evaluations of road safety measures (52%)

Pan-European in-depth accident investigation network

The review of policymakers data needs identified a major gap in availability of in-depth data that describes the causes of accidents and injuries. This data is typically gathered by attending the crash scene in time where specialist teams take measurements of the crash scene, interview participants and witnesses and inspect vehicles. Such data is heavily used by vehicle manufacturers, highway operators and increasingly the insurance industry. It directly impacts on automotive regulations and consumer rating systems such as EuroNCAP.

Each investigation may involve several thousand data items to be completed and so the numbers of cases gathered are considerably fewer than in national accident databases. In-depth data is gathered by a small group of countries including the UK, Germany and Sweden however the data gathered even by only these three countries is incompatible and does not reflect the EU situation. Two main barriers to representative data concern the lack of a harmonised protocol and the absence of suitable crash investigation teams.

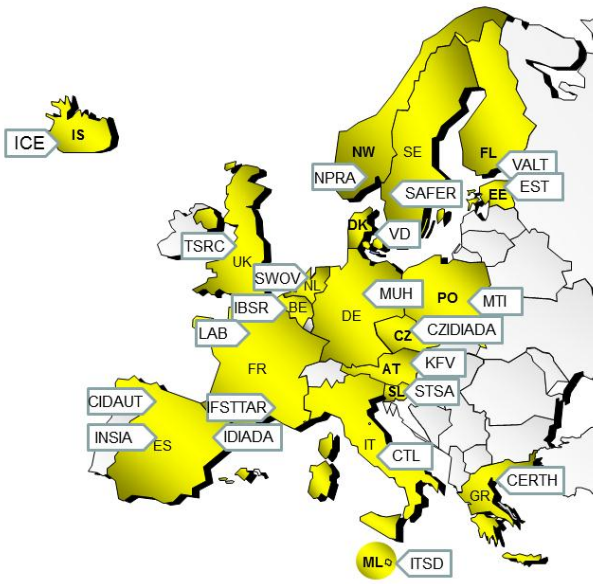
The DaCoTA team has addressed these obstacles and Europe is now ready to conduct systematic in-depth investigations of accident and injury causation. The main outputs are listed below.

1. A validated protocol covering all aspects of data collection including data specifications, case sampling and crash investigation methods. This includes the definitions of over 1,500 variables that can be completed for each crash.

2. A Wiki-based glossary of the data openly available at http://dacota-investigation-manual.eu/

3. An open-access database system to the data protocol ready for users to populate with their own data.

4. A network of teams in 19 EU Member States, each trained and having implemented the local infrastructure necessary for pilot investigations. Many of these teams have national support for future data gathering.



5. A set of pilot cases gathered by the teams to demonstrate the capability to investigate collisions.

The next step to initiate investigations of accident and injury causation at European-scale is to identify a suitable funding mechanism from a routine or research budget to support the teams.

Data Warehouse

A validated set of data protocols for accident data (CARE database), exposure data and safety performance indicators has been established in the previous SafetyNet project. Nevertheless there is still an absence of data in an available structured manner that needs to be urgently addressed. Furthermore there are other types of data that have not been previously addressed including health indicators, accident causation data, and information such as programmes, measures, legislation etc. The Data Warehouse has therefore been developed to structure these data into a format permitting regular access through a dedicated website (http://safetyknowsys.swov.nl/). With the support of the European Commission and the Member States through the CARE experts group this wide range of data has been gathered together in the form of Master Data Tables and used to develop a series of road safety analyses and syntheses.

The Master Tables contain the following data:

1. Road accident data derived from the CARE database covering 73 road accident elements from all EU countries
2. Risk exposure data comprising 97 elements for EU countries
3. Safety Performance Indicators for
   - Alcohol and drugs
   - Speed
   - Protection systems
   - Daytime running lights
   - Vehicle safety
   - Enforcement outputs
   - Accident causation
   - Health data
4. Under-reporting of crashes
5. Country characteristics
6. Traffic rules
7. Road safety programmes
8. Road safety measures
9. Road safety management
10. Road user behaviour

This data was used to develop a series of outputs continuing and extending Annual Statistical Reports, a road safety management profile for each country and Basic Factsheets covering

- Main figures
- Children (aged<15)
- Young people (aged 18-24)
- The Elderly (aged>64)
- Pedestrians
- Cyclists
- Motorcycles & mopeds
- Car occupants
- Heavy Goods Vehicles and Buses
- Motorways
- Junctions
- Urban areas
- Youngsters (age 15-17)
- Roads outside urban areas
- Seasonality
- Single vehicle accidents
- Gender
- Accident Causation

Decision support

The DaCoTA project aimed at providing policy makers with adequate data, information and tools for performing evidence-based policy making. In earlier and current EU projects, a rich variety of data, information and methods has been gathered and will continue to be gathered. In this context, the goal of Work Package the Decision Support Work Package was to make this stock of knowledge accessible and directly useable for the development of road safety policy and decision making. Decision Support therefore: (1) exploited the data available for analysis by providing forecast of the road safety situation in the different member states and (2) worked on the development of ready-to-use instruments. Tools that were well-appreciated in the past, such as overview fact sheets, or web-texts were up-dated and standardised. The use of standard methods was complemented by research activities to generate new tools like the national forecasts or the composite road safety index. All these activities were conducted in close communication with the user-group itself, the policy makers or those who directly support them.

An extensive range of outputs was generated following a detailed consultation and evaluation of policymakers needs and based on the data gathered in the Data Warehouse

1. Forecasts of traffic fatalities for each EU Member State for the period to 2020 based on advanced statistical procedures. Summary sheets and full reports were produced for each country.

2. State of the art reviews on key road safety topics were written by expert authors under the supervision of a peer group to ensure quality. Previous reviews developed within the SafetyNet project were updated and new reviews produced. The topics that are covered by the web texts are:

   Age groups
   - Children
   - Novice drivers
   - Older drivers

   Road users
   - Pedestrians and cyclists
   - Powered two wheelers

   Hazardous behaviour
   - Driver distraction
   - Cell phone use while driving
   - Fatigue
   - Alcohol/drugs
   - Speed and speed management
   - Work-related road safety

   Post-crash
   - Post impact care
   - E-safety

   Road safety measures
   - Roads
   - Speed enforcement
   - Vehicle safety

   Policy issues
   - Quantitative targets
   - Cost-benefit analysis
   - Safety ratings
   - Road safety management
   - Integration of Road Safety in other policy areas

3. Country overviews of road safety presenting the key characteristics of road safety in each of the 27 Member States in considerable detail including structure and culture, safety measures and programmes, safety performance indicators, final outcomes and social costs.
4. Research was conducted to develop a single composite performance index that would characterise road safety in each country, a partial success was achieved in the face of considerable methodological challenges.

Safety and eSafety

The rapid development of new sensing, communications and on-vehicle processing capabilities is opening up a host of new opportunities to improve casualty reduction. Technologies such as enhanced braking, stability control, lane keeping, driver status and others offer the capability to prevent or mitigate collisions. New autonomous systems, such as emergency braking are considered to have a great potential to improve casualty reduction. Nevertheless the capabilities to quantatively assess the benefits of the new systems has not yet matched the technological progress in the development of the systems. Furthermore it is not always clear how the functionality of the systems corresponds to the priorities for crash avoidance or mitigation or that the systems are addressing a key shortfall of drivers. The challenges for technology developers are to develop methods to predict the impact of a safety system before it is in widespread use, methods to measure the impact once it is in widespread use, methods to identify the major driver deficiencies that the technologies are to address.

In support of these objectives the DaCoTA team has developed new resources that can assist the identification of key functionalities and also propose suitable methods both to assess the safety impact of a system both in advance and when in production.

A general framework of assessment is presented that seeks to combine the assessment process within the wider context of evaluating and developing road safety. This framework addresses:-

- data collection methods
- data analysis methods
- socio-economic methods
- pitfalls and difficulties.

An analysis of drivers needs based on 445 in-depth accident cases has been used to assess the functionality of active safety systems against the errors made by the drivers. Conclusions are given on the appropriateness of individual safety measures to address the needs.

An evaluation of the key factors involved in deriving new vehicle test procedures to evaluate the performance and outcomes of new safety systems. One limiting condition is the lack of a central resource that defines the specific safety systems found on each car involved in a collision. The proposed modification of the Periodic testing (Directive 2009/40/EC) to include the assessment of the continued function of electronic safety systems is considered to possibly be a mechanism to develop such a centralised resource.

The future development of active, integrated and cooperative safety systems relies on the availability at European level of suitable detailed data on the causes of accidents.

Driver behaviour monitoring through naturalistic observations

The advent of low-cost data collection system that can be fitted to a vehicle and will record details of the vehicle usage now presents a new opportunity for driver behaviour data with greater detail and precision than has previously been available. By equipping cars with suitable instrumentation it is possible to continuously monitor how the vehicle is used and therefore certain aspects of the driver behaviour. Such equipment can measure location, speed, braking and the operation of vehicle systems through the CANBUS. More advanced equipment with video recording can record a continuous visual image of the driver and the external traffic environment. The 100 car study, conducted by the Virginia Tech Transport Institute has shown the power of such data in improving the understanding of the role and nuances of driver behaviour in respect of driving performance. The key characteristics of these so-called naturalistic driving observations is that the data should represent the true driving behaviour by being conducted in an unobtrusive manner so that behaviour is unaffected by measurement.

The DaCoTA team have evaluated the potential of naturalistic driving data to derive new measurements of exposure and safety performance indicators that would reinforce the data available from other survey methods.

The use of video, while very valuable at a research level, was considered not to be appropriate for the measurement of exposure or safety indicators since due to the major analytic effort required to review and code the video data. Furthermore to represent the spectrum of behaviours in a country it would be necessary to conduct large-scale studies where the costs of analysis of video data would be prohibitive. The team concluded that valuable low-level data could be gathered by a data acquisition system (DAS) comprising

GPS, accelerometers, and potentially further CANBUS data. Further context data describing the driver characteristics would be gathered by questionnaires.

The team prepared a specification of the requirements for a future large-scale naturalistic driving study that comprised instrumentation, study design, the risk-exposure and performance indicators that would be derived, the analytic methods and the manner of meeting legal and ethical requirements. The methods were validated using a series of small-scale naturalistic driving pilot studies conducted in Israel and Austria.

The outcomes of the work were a detailed specification of the requirements for a future large-scale naturalistic driving study.

RECOMMENDATIONS

DaCoTA recommendations for the transition of ERSO to become a fully functioning Observatory

The preparation and development work conducted by the DaCoTA team and the safetynet team before it have put in place the essential data specifications, collection methods, protocols and analysis methods to support a fully functioning ERSO. All of the methodologies have been validated through stakeholder consultations and pilot studies. While there are some types of data where further research is needed there are many that are now capable of being routinely implemented at EU level. Many of the data and policymaking tools developed in the two projects are now mature and are ready to form part of ERSO. To achieve this a number of key steps need to be taken to obtain the full value from the investment in previous accident data research studies, these steps are in respect of the institutional organisation of ERSO, implementation of routine data functions and integration with future EU road safety research. The priority data gap concerns the lack of European in-depth accident data which can be addressed by the structure put in place by DaCoTA in 18 countries.

The DaCoTA team makes the following recommendations.

Recommendations for Institutional arrangements for ERSO

1. **Establish terms of reference for the operation and future development of ERSO**

   These will ensure clarity over the objectives of ERSO and the manner in which it operates within the Commission and with external stakeholders. They will detail the participation of the Directorates-General of the EC, Member States, industry stakeholders and others and will embed the operational parameters of the Observatory.

2. **Establish an advisory body**

   The Observatory will rely on knowledge and data from Member States and other stakeholders to be fully effective. However it is also a service for road safety policymakers and it must continue to meet their needs. The Member States particularly are more than data providers and should have the opportunity to guide the future operation and development of ERSO.

   An advisory body is needed that will represent the body of stakeholders, it should include the Member States, perhaps with a link to the High Level Group on road safety, as well as industry and other stakeholders.

3. **Establish a funding stream for routine data collection**

   A routine funding stream is necessary for the future operation of ERSO, this will cover the costs of gathering and processing data, any special surveys that may be required, updating of the data tools and knowledge and maintaining the ERSO infrastructure. Precise costs have not been estimated since they depend heavily on the exact content of the Observatory but a similar activity in the US is budgeted at over $34m annually.

Priority data gap – in-depth accident data

4. The lack of European in-depth accident data is a major obstacle to a detailed understanding of the causes of accidents and injuries. A large-scale pilot study is now needed to implement regular collection of in-depth data across the EU, the teams established by DaCoTA in 18 countries provides the best platform available to achieve this.

Recommendations for implementation of routine data functions

5. Establish a procedure whereby the following data types and tools are updated annually and made available on ERSO
    - Exposure data – gathered by Eurostat + special surveys
    - Safety Performance Indicators – gathered by special surveys
    - Medium depth data on fatal accidents – gathered by enhancing national data
    - Basic fact sheets
    - Annual statistical report
    - Country overviews
    - Website – annual enhancement and updating
6. Establish a procedure whereby the following data types and tools are updated periodically and made available on ERSO
    - State of the art reviews – update and enhance every two years
    - Country forecasts – update every three years
7. Establish a road safety policy support structure to enable ERSO data to be presented in the most efficient and accessible form for policy-makers

Recommendations for integration with future safety research programmes

8. Establish a formal relationship between ERSO and the road safety research programme under H2020 to ensure the research programme to 2020 incorporates the needs of the developing Observatory.
9. Define a research programme in relation to ERSO to further develop road safety data tools and knowledge. Priority areas include
    a. The causes of accidents and injuries in the EU to car occupant casualties
    b. The causes of accidents and injuries to vulnerable road users in the EU
    c. The causes of accidents involving specific target groups (eg children, level-crossings, older road users, new model cars etc.)
    d. Data methods to assess the causes and social impacts of serious injuries
    e. Real-world evaluation of performance of new safety systems
    f. Impact of different road safety management strategies on casualty outcomes
    g. Driving culture and safety
    h. Development and implementation of a policy support framework for routine impact assessments
    i. Development and implementation of a policy support framework for routine cost benefit evaluations of measures
    j. Methodological improvements in naturalistic driving/riding (ND/NR) studies and FOTs
    k. Naturalistic studies & FOTs for VRUs
    l. Safety assessment of road infrastructures based on accident data

10. Ensure that results, reports, data and syntheses of <u>all</u> relevant H2020 research projects are made available in a suitable format to be incorporated within ERSO.

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1. INTRODUCTION

1.1. Background

In 2008 over 39,000 people were killed on the roads of the European Union with at least 1,000,000 people injured. In addition to the impact of human pain and suffering the economic impact of these fatalities is also considerable, having been estimated at €160,000 million for EU-15. The reduction of fatalities and injuries is now a priority for national and EU policy makers and the European Commission has adopted a target to reduce fatalities by 50% by the year 2010 compared to the year 2000 baseline.

In pursuit of this casualty reduction objective a wide range of vehicle and road safety policy measures are developed and implemented both at EU and Member State levels. These measures may address “traditional” road safety problems such as excess alcohol and speed and non-use of seatbelts, these are typically national level issues although there may be added value from coordinated EU action. Other measures are largely determined at EU level such as technical standards for vehicles and road infrastructure and cross-border enforcement issues. Increasingly the application of intelligent systems to road and vehicle safety is moving from the research domain to the market and there is now a recognised need for the evaluation of the safety impact of new systems. The European Commission and Member States hold responsibility for many aspects of policy-making but there are many other stakeholder groups including:-

- Automotive industry
- Insurance industry
- Road operators
- Fleet operators
- Police and emergency services
- Citizens groups
- Local and regional administrations
- Non-governmental organisations

Each of these groups is concerned with the implementation and outcomes of road and vehicle safety measures and has a stake in the development, implementation and outcomes of safety policies.

1.1.1. Evidenced based road safety policy making

Historically many of the decisions concerning road safety policy were made on an ad-hoc basis. However it is increasingly recognised that there is a need for a structured, evidence based approach to road and vehicle safety policy making. A successful road safety management process will require quantitative evidence to set casualty reduction targets based on specific measures and the reduction attainable from each. It will utilise accident data to identify road safety priority areas and to formulate appropriate measures to address the specific needs of the target populations and the circumstances of the problem. Safety indicators are used to identify the links between the implementation of measures and casualty reductions. There is a considerable level of transferability of road safety measures so benchmarking performance enables countries to learn from others and measures of risk facilitate this comparison. An essential part of any road safety policy-measure is an assessment of the effectiveness of measures in order to provide feedback and accident and safety data is needed to measure the outcomes. Technical measures such as road or vehicle performance requirements as well as education, training and enforcement measures all require assessment and feedback. Finally many aspects of road and vehicle safety involve the evaluation of technical measures - such as vehicle or infrastructure based systems, and the introduction of intelligent systems is of major interest. Both macroscopic and in-depth accident data is needed to support these assessments.

The SUNflower pyramid (Koornstra et al., 2002[3], Wegman et al. 2005[4]), describes a hierarchy of five levels of road safety components that can be used to describe a country's road safety performance (Figure 1).

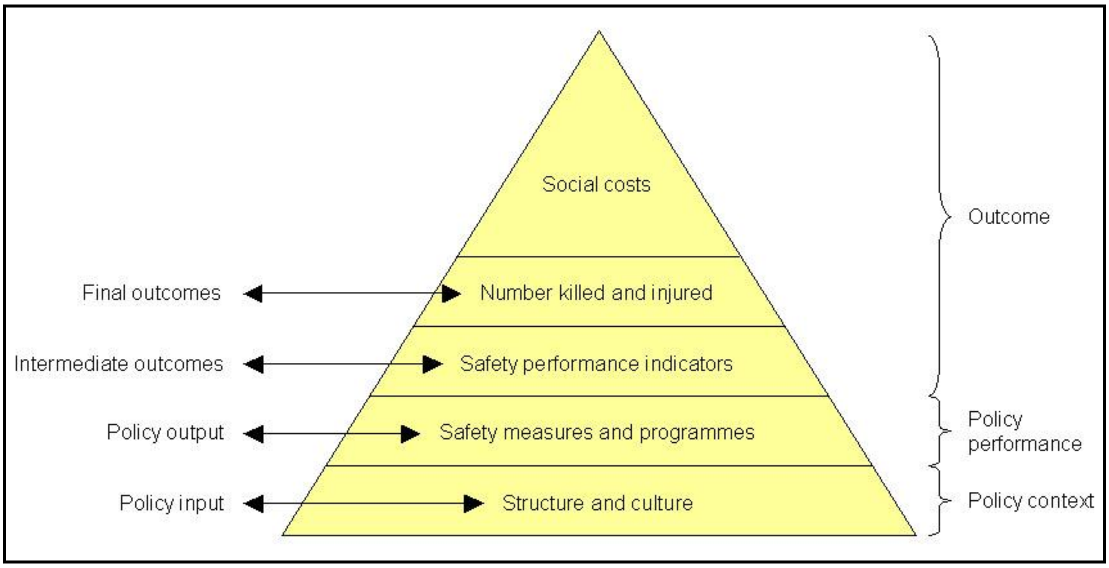

Figure 1: A target hierarchy for road safety (Koornstra et al., 2002[5]; LTSA, 2000[6])

The lower layers of the pyramid influence those above as follows:

- The road safety performance of a country is related to structural and cultural characteristics (i.e. policy input) at the bottom level.
- It is consequently related to common practice (i.e. safety measures and programs - policy output), resulting from the structural and cultural characteristics, at level 2.
- To link these first two layers to the actual road accident outcomes an intermediate layer specifies the operational level of road safety in the country, containing road safety performance indicators (RSPI) on issues like speeding, drinking and driving, as well as a concise depiction of the road network and the main features of the vehicle fleet.

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[3] Koornstra, M., Lynam, D., Nilsson, G., Noordzij, P., Pettersson, H-E., Wegman, F. & Wouters, P. (2002). SUNflower: a comparative study of the development of road safety in Sweden, the United Kingdom, and the Netherlands. SWOV Institute for Road Safety Research, Leidschendam

[4] Wegman, F., Eksler, V., Hayes, S., Lynam, D., Morsink, P. and Oppe, S. (2005). SUNflower: A comparative study of the development of road safety in the SUNflower+6 countries: Final Report. SWOV Institute for Road Safety Research, Leidschendam, the Netherlands.

[5] Koornstra, M., Lynam, D., Nilsson, G., Noordzij, P., Pettersson, H-E., Wegman, F. & Wouters, P. (2002). SUNflower: a comparative study of the development of road safety in Sweden, the United Kingdom, and the Netherlands. SWOV Institute for Road Safety Research, Leidschendam

[6] LTSA (2000). Road safety strategy 2010. A consultation document. National Road Safety Committee. Land Transport Safety Authority, Wellington

- Final outcomes expressed in terms of road casualties are then necessary to understand the scale of the problem. This type of information is found at level 4, and consists of different types of road risk indicators.
- The top of the pyramid includes a sound estimate of the total social costs of road crashes.

Data to describe and tools to estimate the characteristics of each pyramid component are necessary to assess road safety performance and for effective evidence based policy making.

All EU member states gather accident data in order to provide basic information on the national road safety population; this data is recorded both in national databases and in the EC CARE database. Some Member States gather additional information about the causation of accidents and injuries while others may record other safety information to support the interpretation of the evolution of road safety measures. Countries with an established road and vehicle safety information system include the UK, Sweden, Germany and the Netherlands; however there are no countries that systematically gather safety data in a comprehensive and coordinated manner. The lack of uniform safety data provision is greatest at EU level where the only consistent data is available within CARE and EUROSTAT, which does record some basic measures of exposure.

1.2. The European Road Safety Observatory

The need for European accident and safety data was recognised as a limitation on the implementation of effective road safety strategies and measures and in the 2003 Road Safety Action Plan, the European Commission announced the decision to establish the European Road Safety Observatory (ERSO). The ERSO brings together a range of data and knowledge sources to support safety policy making at both EU and national level.

The 6FP project SafetyNet constructed the basic framework of the Observatory and started to populate it with several levels of data. It has also put in place a number of the key processes concerning routine collection of the data. In general SafetyNet developed new data methodologies, validated them and presented results. Key achievements of SafetyNet include:-

- Extension of CARE database to incorporate the data from 27 EU Member States
- Recommendation for more comparable accident reporting
- Recommendation for comparable injury severity and coefficient for underreporting of severe injuries
- Developed protocol for defining exposure data for evaluation of accident risks
- Developed and validated a protocol for Safety Performance Indicators and applied it to EU Member States
- Developed a protocol for transparent and independent accident investigation
- Developed and validated a protocol used to gather in-depth accident causation data which was subsequently analysed
- Developed the ERSO website to provide access to all project results and to be the source of high quality road safety information
- Developed and applied a series of analytic approaches to analyse complex data structures, namely multi-level and time series data

In some cases (e.g. CARE data) the data gathering is already sufficiently well developed to be a routine EU-level activity. In other cases (e.g. exposure data, performance indicators) the capability of Member States to gather data in a harmonised manner is more varied and structures have to be developed at national level before data can be routinely updated. Finally there are areas (e.g. in-depth data) where the infrastructure only exists in a limited number of countries and new teams and infrastructure have to be put in place.

ERSO has been launched publicly and the European Commission has presented a vision for the further development of ERSO which maps out a path to a fully implemented Observatory incorporating a wide variety of data and knowledge from all EU Member States. The vision for the European Road Safety Observatory is that it should become an institutional data and knowledge system that will bring together a range of data relating to accidents (macroscopic and in-depth), the transport conditions (exposure, infrastructure), road user behaviour (attitudes and driving actions) and road safety management (policies, effectiveness, enforcement). The data will be gathered on an institutional basis and will be routinely updated depending on the speed of change. In principle the Observatory will consist of two parts, the web-based side to provide access to the data and information, and the procedures behind it to systematically gather, structure and analyse the data.

In this way ERSO can provide data, tools and information that are relevant to all components of the SUNflower Pyramid and therefore necessary to support effective evidence based policy making.

While SafetyNet has provided the structure and basic framework there were several additional areas of data and knowledge that require further development before the Observatory could be considered a mature resource. There was also a need to enrich the range of information gathered and to improve the structure and focus on supporting safety policy. ERSO would then be able to support routine activities with organised structures to provide regularly updated data and information in a systematic way as well as providing a platform for specific research activities that can address needs for data, tools and other information as they arise.

1.3. Project aims

The DaCoTA project aimed to further extend and develop the ERSO by developing and implementing new approaches to gather, structure and apply policy-related safety data that can be incorporated within the Observatory.

The six key areas of road safety data that were focused upon were

- Road safety policy and management
- In-depth safety related accident data
- Collecting and structuring data
- Accident forecasting
- eSafety
- Normal driving behaviour

Developments in road safety management are discussed in chapter 2 *Policy-making and Safety Management Processes*. The aims of this work area were to build a new linkage between policy making and evidenced based approaches by conducting a broad consultation with national level and other stakeholders and to review the road safety management approaches adopted in target Member States.

Chapter 3 *Pan-European In-Depth Accident Investigation Network* addresses the area of In-depth safety related accident data, and aimed to build a large-scale accident investigation infrastructure that will be capable of gathering in-depth safety related accident data concerning crashes across the EU. A review of existing in-depth investigation protocols was conducted and the most effective approaches were identified in order to produce a manual for conducting in-depth investigations.

The area of collecting and structuring data is considered in chapter 4 *Data Warehouse,* which describes the development of a road safety data warehouse as a comprehensive and integrated system with aggregate data and information necessary for decision making support. This work area aimed to continue the efforts made in previous projects by gathering, consolidating and standardising the available road safety data and information, through the exploitation of all available sources, in a systematic and comprehensive way.

Chapter 5 *Decision Support* addresses the development of tools useful for accident forecasting and other areas of knowledge based decision making. The main goal of this area was to bridge the gap between research and policy by bringing together policy makers' needs and tangible tools. Consultations were conducted with stakeholders, including Member States, to develop and implement models to forecast trends to assist in the identification of future road safety targets.

eSafety is the topic of chapter 6 *Safety and e-Safety.* This work area aimed to develop methodologies and approaches that will enable future evaluation of the safety impact of emerging intelligent technologies. It also builds on previous EU projects – such as Trace and eIMPACT to utilise available safety data and guide new technology development to address the principle safety requirements of vehicles and roads

Chapter 7 *Driver Behaviour Monitoring through Naturalistic Driving Observations* deals with normal driving behaviour. The aim was to set up of a methodology for continuous monitoring of normal driver behaviour that is comparable between countries, within the framework of the European Road Safety Observatory (ERSO). The methodology describes the necessary framework to gather, record and analyse naturalistic driving behaviour to inform safety policies and the development of new safety approaches.

Although dealing with separate topics, relationships between the work areas were established during the course of the DaCoTA project with knowledge about policy makers' needs for data and tools being passed from the road safety management work area to the decision support area. In addition, all appropriate knowledge, data and tools outputs were included in the Data Warehouse. The work in each area has also resulted in data, knowledge and/or tools that can be incorporated into ERSO.

2. POLICY-MAKING AND SAFETY MANAGEMENT PROCESSES

Chapter authors: Muhlrad, N. IFSTTAR; Papadimitriou, E., Yannis, G. NTUA

See also Deliverable 1.6: Final Report of WP1 – Road Safety Policy

2.1. Objectives

In the DaCoTA project, research on road safety policy had two purposes:

1. Identifying the needs for data and decision-support tools of road safety decision-makers, managers and other key stakeholders in order to develop the European Road safety Observatory, ERSO, and make it as relevant as possible for all the tasks involved in policy-making.

2. Developing knowledge on road safety management systems at the national level, both from a theoretical and logical point of view (defining “good practice” criteria and testing them) and from a practical point of view (describing and assessing existing road safety management systems in European countries, collecting practical ways to achieve elements of “good practice” and laying the grounds for a European observatory of road safety management to be integrated into ERSO).

As development of a “data warehouse”, of in-depth accident data collection processes, and of decision-support tools were other objectives of DaCoTA, some results addressing the first objective had to be obtained rapidly so as to be put into use immediately as a framework for the other research efforts.

2.2. Methodologies

Both quantitative and qualitative methodologies, most of them new, were designed to reach the objectives. The following figure provides an overview of the methodological developments and application.

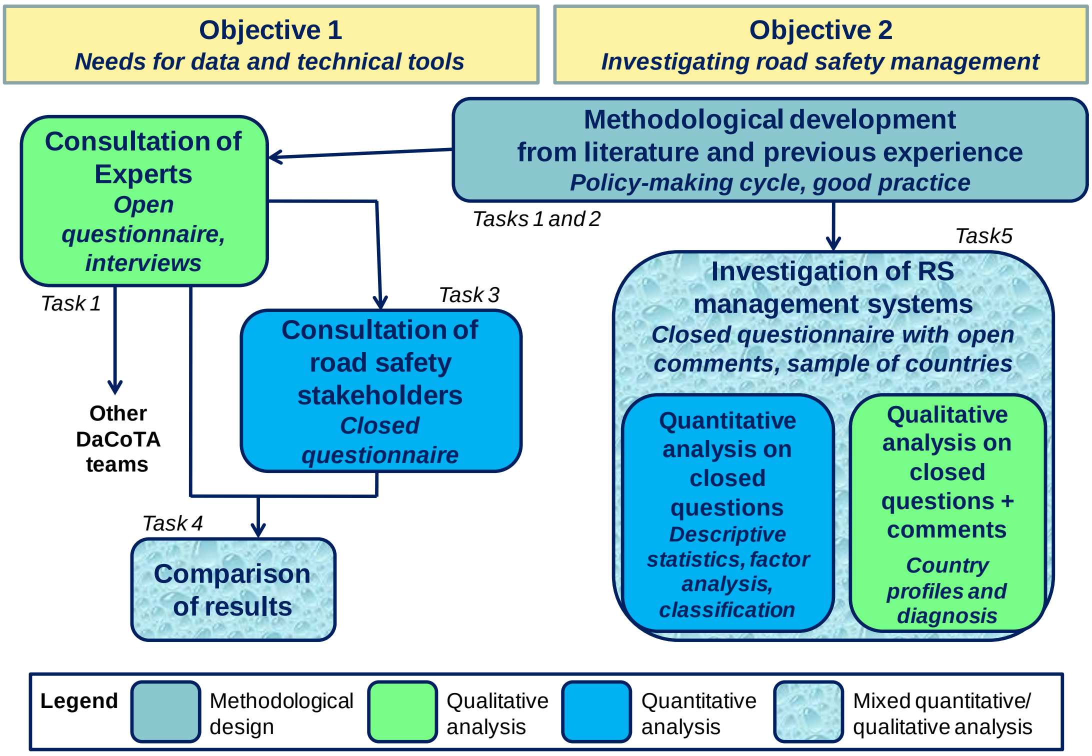

Figure 2: Overview of methodologies

2.2.1. Consultation of a panel of experts

Scientific support is necessary for road safety management to produce optimal results as only road safety interventions based on facts and knowledge can succeed in efficiently reducing the number of road casualties. However, road safety management is a complex process involving numerous steps, some of which may not be obvious to the scientific community. A description of the key tasks involved in this process was therefore needed to investigate the needs for scientific input felt by those working at the interface of road safety research and management.

As results on the actual needs for data and decision-support tools were expected at an early stage of the DaCoTA project to support new developments of ERSO, a consultation of a panel of experts was organized. The experts were to have in-depth knowledge of road safety management processes and needs in their country and to be, either directly involved in decision making, or working closely with decision makers as advisors. The National Expert Group of the European Commission, that represents all EU member states as well as non-member Schengen countries (Norway, Switzerland, Iceland), formed the core of the panel; a number of other qualified experts suggested by some of the EU experts and by DaCoTA team members were added to enlarge it.

Two parallel consultation methods were implemented: semi-directive interviews were carried out by members of the DaCoTA WP1 partners (mainly with panel members from their own countries) while a request for written contributions was sent through the EC to all panel experts. Three open questions were formulated, allowing the experts to describe their own experience, views and messages and to put emphasis on the issues they considered most important.

As a support to interviews and written opinions, a two-dimensional matrix was built up, describing some key steps of policy-making in which knowledge is crucial (fact finding, programme development, preparing implementation, monitoring and evaluation) and cross-tabulating them with the needs for scientific information (data, technical tools for data treatment, other decision-support tools, training tools). The matrix was also used as guideline for the text analysis of the information gathered.

More details can be found in Muhlrad, N, Dupont, E (Eds.) (2010): Consultation of a panel of experts on the needs for data and technical tools in road safety policy-making, Deliverable 1.1/4.1 of the EC FP7 project DaCoTA.

2.2.2. Consultation of road safety stakeholders

Experience and findings from the consultation of the panel of experts was used as a basis to perform a broader-scale consultation of road safety stakeholders including decision-makers, managers and other road safety professionals as well as researchers and representatives of the private sector and the civil society (businesses, non-governmental organizations). The aim of the consultation was both to validate the results obtained on the needs for data and decision-support tools and to assess priorities. The availability of the data and tools which were found useful or necessary was also investigated.

In view of the large number of stakeholders to be approached, it was decided to set up an on-line questionnaire and to make use of a standard survey tool. The bulk of the multiple-answer questionnaire was developed from the synthesis of the assessments provided by the panel of experts and structured according to the matrix crossing policy-making tasks and needs for scientific support. This core was complemented by questions such as country of origin of the stakeholder, field of work or previous experiences with national/international data or information sources. The questionnaire was tested by working colleagues of the research team who had no previous knowledge of its aim or contents, and all remarks from this pilot study were taken into account to prepare the final online version.

Circa 3150 stakeholder contacts from European and other OECD countries were collected from the European Commission, from the ETSC (European Transport Safety Council) as well as its PIN Panel members, and from FERSI (Forum of European Road Safety Research Institutes). The European Commission, DG MOVE, sent a cover letter to all respondents by e-mail, introducing the questionnaire and providing a web link to the survey. The survey was open for a month and a reminder was sent by the European Commission halfway through. Undelivered messages were excluded from the original list of recipients and the final answering rate was 16%, which is satisfactory for this kind of survey method.

Results of the survey were analysed through basic statistical methods to identify priorities and find out how stakeholders viewed the availability of the data and technical tools they wished to use. Furthermore, Principal Component analyses and Cluster analyses were performed on two sets of information (data needs, data availability) in order to identify groups of stakeholders sharing both similar priorities and similar problems as regards data and tools for knowledge-based policy-making.

For more details on the questionnaire survey, see: Machata, K, Barnes, J, Jahi, H (Eds.) (2011): Stakeholder's contribution, Deliverable 1.3 of the EC FP7 project DaCoTA.

2.2.3. Investigation of road safety management systems in European countries

The methodology was designed in four steps.

a) *Development of a road safety management investigation model*

An extensive review of the literature was performed, which showed that, although very little research had been carried out on road safety management systems, there was a consensus of experts as to what such a system should be for “good practice”. However, there was no indication that the consensus model was actually implemented in European countries. The qualitative investigation model developed in DaCoTA thus aimed both at describing in a consistent way what road safety management systems are in the field and at defining criteria of “good practice” to assess their good points and their negative aspects.

The structure of the model and the “good practice” criteria were based on literature and on the research and practical experience of the DaCoTA team members. To describe road safety management systems, a policy-making cycle (from agenda setting to policy implementation and evaluation) and the tasks to perform in order to get the desired policy outputs (including those in the matrix previously used) were defined as well as some transversal processes which were found essential to the performance of these tasks (such as inter-sectoral coordination, monitoring, or consultation of stakeholders). The “good practice” criteria were identified at each step of the policy-making cycle and for each transversal process (Figure 3). It was assumed that “good practice” implies knowledge-based policy-making.

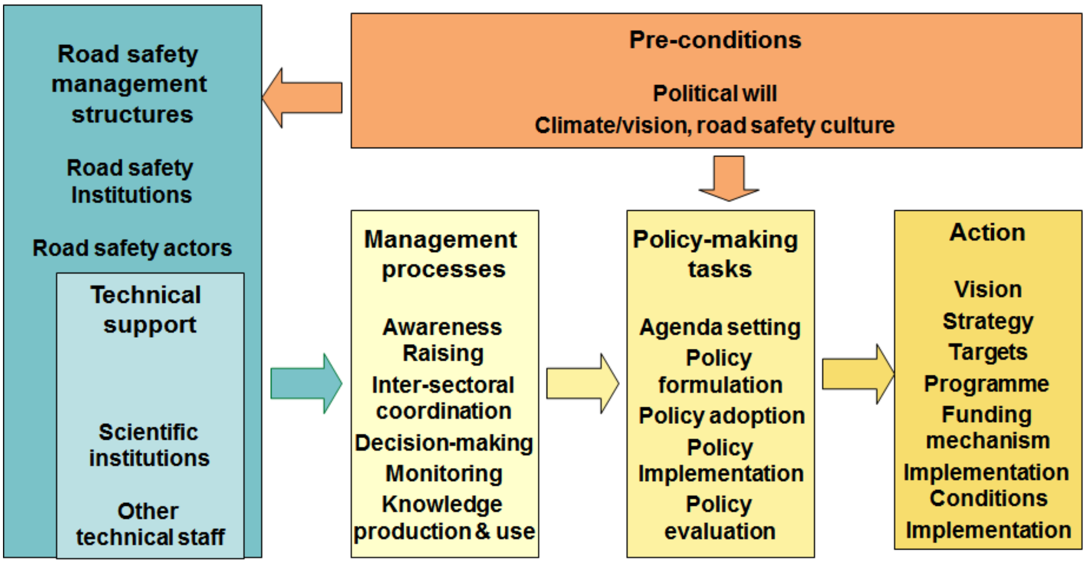

Figure 3: The components of the road safety management investigation model

b) *Development of a questionnaire and an investigation process*

Fact-finding on road safety management systems is not an easy task as few persons are fully familiar with the complex organization of road safety in their own country. It was found that the desired information could only be obtained from road safety experts. As in the panel consulted earlier, experts were defined as professionals with long experience and in-depth knowledge of road safety management processes in their country; they were divided into two categories: managers (directly involved in policy-making), and scientific experts (senior researchers or technical specialists having worked closely with managers). At least one manager and one scientific expert were identified in each country investigated.

Based on the investigation model, a detailed questionnaire was built up, including fifty questions structured in four parts (institutional organization, policy formulation and adoption, policy implementation and funding, monitoring and evaluation, scientific support and capacity building). As both quantitative and qualitative analysis of the information was to be performed, each question was divided in sub-questions calling for yes/no answers, but open comments were encouraged to qualify the answers given. As the vocabulary used in road safety to define policy-making tasks and processes has never been standardized, a glossary of terms was provided. However, as the questionnaire had to be prepared in the language used by the multi-national research team (English), it was feared that misunderstandings would perhaps occur if experts were not entirely fluent in this language: the questionnaires were thus filled in by each expert during a face-to-face or a telephone interview with one of the team members speaking the same mother tongue and translating when necessary. This unfortunately limited the sample of countries that could be investigated in the time span and with the resources of the DaCoTA project.

c) *Development of a storage facility for road safety management data*

The combination of yes/no data and of comments in open text required a specific tool for data storing and data treatment. A data storage facility with a friendly interface was thus designed and put on line, enabling the team members to enter each of the questionnaires filled in by the experts they interviewed and providing access to all information for all team members. The information entered was double-checked to identify missing data, inconsistencies or possible misunderstanding of a question and the final “cleaned” data set was made available under Excel format for quantitative analysis.

c) Development of methods for data analysis

A first step of qualitative analysis was performed in order to provide a full description of the road safety management systems in each country investigated and an assessment as objective as possible of the fulfilment of “good practice” criteria. To this purpose, full use was made of the open comments provided by the experts to qualify the yes/no answers. Both the questionnaires filled in by managers and scientific experts were included in the analysis as they were found to complement each other: a more comprehensive viewpoint usually came from the managers while the scientists were often more critical. The analysis provided individual country profiles for road safety management as well as “good practice” diagnoses, performed by comparing each country to the profile of a “reference” country that would fulfil all “good practice” criteria (Figure 4).

A second step of qualitative analysis was performed on a sub-sample of key questions with the purpose to compare European countries and get a more in-depth understanding of how they handle their road safety management systems. The analysis was also meant to check whether the model developed under DaCoTA can serve as a useful tool for comparing different national solutions.

For these purposes, the data gathered in the DaCoTA investigation was complemented with data from a PIN survey carried out by ETSC (Jost G. et al.:2012[7]) which did not cover all issues of road safety management considered in DaCoTA but included all countries from the European Union. Information was cross-checked as much as possible through international and national reports (in spite of a language problem as most of the latter are not translated

[7] Jost G.; Allsop R., Steriu M. (2012): A Challenging Start towards the EU 2020 Road Safety Target. 6th Road Safety PIN Report. ETSC Brussels.

into English). The areas of road safety management analysed included key policy-making tasks and management processes such as institutional organization, inter-sectoral coordination, stakeholders' involvement, policy formulation and adoption, implementation and funding, monitoring and evaluation. A detailed overview of how countries fared in each of these areas was produced, and a critical analysis of the situation in Europe and of the information available to describe it was performed.

Although it has been widely assumed that effective road safety management systems are a pre-condition to road safety action and therefore to road safety improvement at country level, this has never been scientifically proven. For the first time, quantitative analyses of issues related to road safety management systems were carried out, based on the answers provided by the country experts in the DaCoTA investigation. Different sets of analyses were aimed at identifying groups of countries sharing similar road safety management components, exploring the statistical link between road safety management clusters and fatality rates, and linking road safety management and road safety performance in terms of outputs (road fatalities) and of intermediate indicators.

A lot of effort was devoted to finding the most appropriate statistical methods to treat the data collected, as the relatively small sample of countries investigated coupled with the large amount of variables documented raised some technical problems. Road safety management data was separated into four sub-samples according to the structure of the questionnaire and the non-discriminatory variables were set aside. In the analysis of the relationship between road safety management and road safety performance, the answers to common questions in the PIN survey and in the DaCoTA questionnaire were used to increase the sample size. Different statistical tools were tested and the battery of statistical methods finally applied included factor analyses (Common Factor analysis, Principal Component analysis, Categorical Principal Component Analysis), cluster methods (Hierarchical, Ward and k-means), Spearman's rank correlation, Pearson correlation, Poisson and other Generalized Linear Models, and Beta regression models.

The intermediate and final road safety outcome indicators selected were those developed by the decision-support research group in DaCoTA WP4 (Road Safety Management Indicator, Road Safety Performance Indicator, Road Safety composite indicator) with reference to the SUNflower model.

It is to be noted that the two sets of information provided by the questionnaires filled in by managers and by scientists somewhat differed as the road safety management situation was viewed from different vantage points. As a result, they had to be separated for quantitative analysis. In the final outcome, particular attention was given to the managers' point of view as a matter of principle.

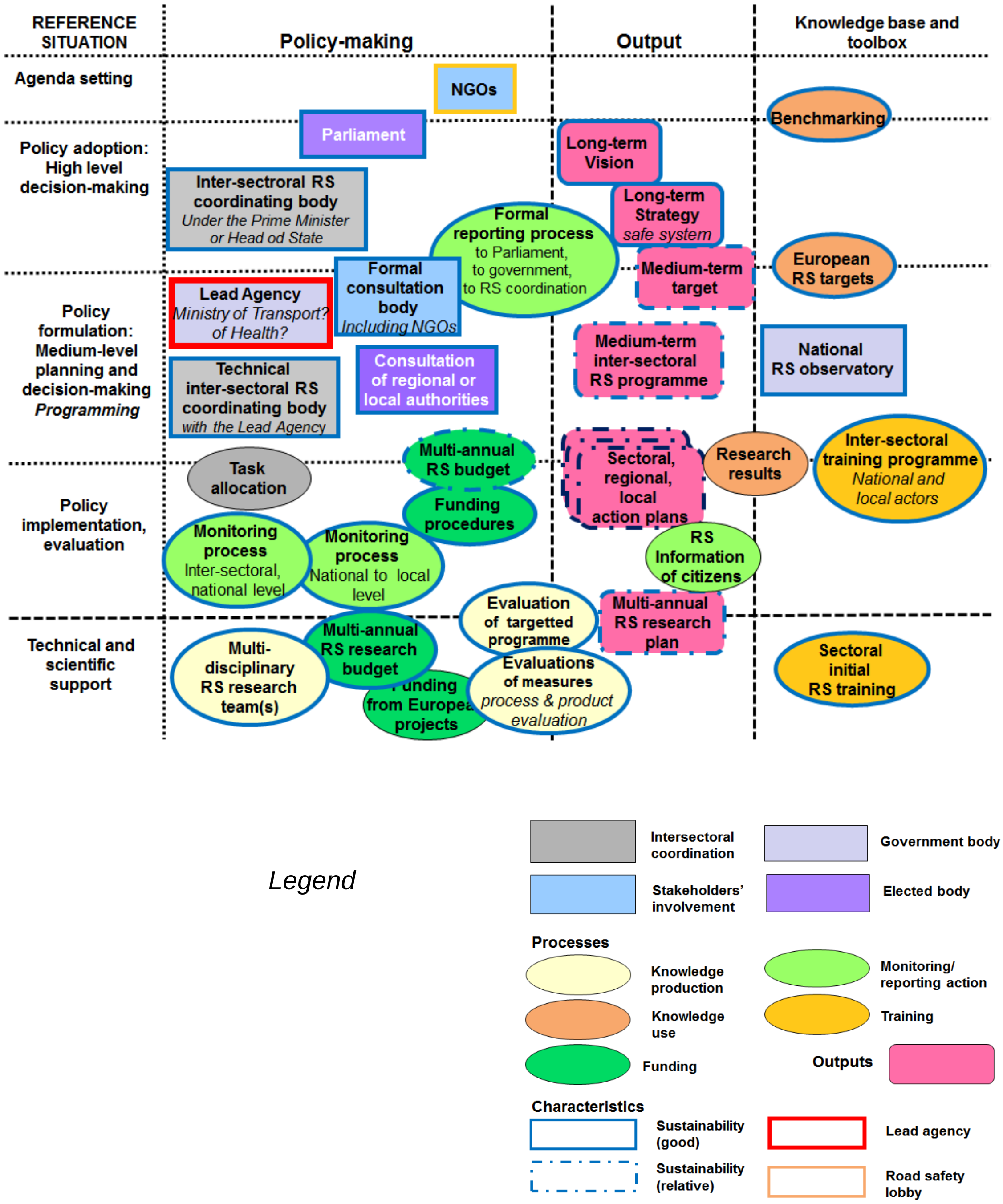

Figure 4: Profile of a "reference" country for road safety management

For more details on the road safety investigation model and questionnaire, see [Muhlrad, N., Butler, I., Gitelman, V. (Ed) (2011): Road safety management investigation model and questionnaire, Deliverable 1.2 of the EC FP7 project DaCoTA.](#) For detailed information on quantitative and qualitative analysis methods, see Papadimitriou, E., Yannis G., Muhlrad N., Gitelman V., Butler I., Dupont E. (Eds) (2012): Analysis of road safety management in the European countries, Deliverable 1.5 Vol.II of the EC FP7 project DaCoTA.

2.3. Main results

Over the three years of the DaCoTA project, a wealth of research results on road safety policy was obtained. Only a summary is provided below.

2.3.1. Needs for data and decision-support tools for knowledge-based road safety policy-making

Following the preliminary consultation of a panel of experts, an extensive survey was carried out through an online questionnaire among more than 3000 road safety stakeholders in Europe and beyond. Over 500 responses were obtained, including 394 from the European region. Most responses were received from the United Kingdom, Belgium, Germany and Spain. Response rates were specifically high for national statistics bureaus, research institutes and consultancies. The health sector, NGOs and European (umbrella) organizations also responded at rates above the average. Response rates were on the contrary particularly low for Public Enterprises, the European Commission and the European Parliament. From more than 120 questionnaires that were personally sent to representatives in the European Parliament only one response was received.

Stakeholders expressed high demand for data and knowledge in road safety related decision making. They also expressed discontent about the current poor availability of such information.

2.3.1.1. Priority rankings

The following issues scored highest with regard to priority for road safety work:

a) *Fact finding and diagnosis*

Information on crash causation factors (high priority for 67% of respondents), information on road users' behaviour and attitudes (63%), a common definition of a fatality (60%), exposure data (53%), crash databases that link police and hospital data (52%), Information on the under-reporting of road traffic crashes (49%).

b) *Development of safety programmes*

Information on the costs and benefits of road safety measures (56%), information on the safety impacts of combined measures (54%), common methods to perform evaluations of road safety measures (52%), a “good practice” catalogue of measures (50%), information on the public acceptance of specific road safety measures (45%).

c) *Implementation*

A common methodology for identifying high risk sites (46%), a “good practice” collection on implementation (43%), digital road maps for mapping crashes (41%), detailed information from road safety audits and road safety inspections (39%), a common methodology for in-depth crash analysis (38%).

d) *Monitoring and evaluation*

Serious injury counts, in addition to fatality counts (55%), methods to evaluate the safety impacts of road safety measures (54%), a common methodology for the evaluation of costs and benefits of road safety measures (44%), statistical methods for following trends (39%), a comprehensive monitoring of implemented measures across Europe (32%).

2.3.1.2. Misjudgement about availability

Most of the data and decision-support tools emerging as priorities are currently poorly available. It must be noted, however, that comparatively low availability scores were reported even for items which are already available - such as definitions of a fatalities or severe injuries for national statistics. Improving knowledge about the steadily growing portfolio of available data should therefore be one of the prime concerns of future public relations work in relation with ERSO.

2.3.1.3. Low scores but high stakes

Other technical tools such as in-depth investigations, naturalistic driving and simulator studies reached low priority scores but will be at the heart of European research for the coming years. Research thus anticipates on future needs, which is one of its functions, but the needs will be felt only if road safety stakeholders are made aware of the meaning and usefulness of the knowledge developed. Hence, one of the future functions of ERSO should be to present stakeholders with updated results from recent European research.

2.3.1.4. Components of priority and availability

Further statistical analysis was carried out in order to group the elements of the stakeholders' survey (more than 50 items of data and tools) into 'factors' or components, bringing together elements with similar priority and availability level. Table 1 summarises the results of principal component analysis and factor analysis that was carried out for three cases:

- Priority ratings
- Availability ratings
- Combined priority and availability ratings: in this case, a new composite scale was created, in which elements of highest priority but lowest availability were assigned the highest importance, while elements of low priority but high availability were assigned the lowest importance.

	PCA : Priority ratings	*PCA : Availability ratings*	*FA : Combined priority and availability ratings*
Component/Factor 1	"Implementation of measures"	"Costs and safety impacts of measures"	"Implementation of measures"
Component/Factor 2	"Statistical models"	"Statistical models"	"Accident and infrastructure analysis for the implementation of measures"
Component/Factor 3	"Costs and safety impacts of measures"	"Implementation of measures"	"Statistical models"
Component/Factor 4	"Road infrastructure and accident analysis"	"Road infrastructure and accident analysis"	"Exploring implementation frameworks"
Component/Factor 5	"Common definitions and under-reporting"	"Exposure and behaviour"	"Crash causation"
Component/Factor 6	"Crash causation"	"Policies, rules and regulations"	"Evaluation of measures"

Component/Factor 7	“Advanced research methods”	-	“Common definitions”
Component/Factor 8	-		“Information on safety impacts”
Component/Factor 9	-		“Improving data collection”

Table 1: Overview of the components/factors selected on the basis of the separate and combined analysis of priority and availability ratings

It observed that, working with priority ratings exclusively, with availability ratings exclusively, or with a combination of the two ratings, resulted for a large part in the identification of “similar” components. Some dimensions, on the other hand, seem to emerge more specifically when analysing availability ratings or the scale combining priority and availability ratings. This is the case, for example, for “Exposure and behaviour data”, and “Road safety policies, rules and regulations”.

2.3.1.5. Grouping stakeholders

The components shown in Table 1 were used to identify “groups” (clusters) among the stakeholders, sharing common priorities in terms of data and tools, and common data availability concerns. In this case as well, three analyses were carried out:

- Grouping stakeholders on the basis of priority ratings
- Grouping stakeholders on the basis of availability ratings
- Grouping stakeholders on the basis of the combined priority and availability ratings

Working exclusively on the priority ratings, 4 different clusters (groups) of stakeholders were identified:

- Cluster 1: stakeholders with “low priority for everything”;
- Cluster 2: stakeholders considering that data and models are specifically important,
- Cluster 3: stakeholders that tend to assign “high priority for everything, but especially implementation”,
- Cluster 4: stakeholders assigning high priority to in-depth data mostly

On the basis of availability ratings, 3 clusters of stakeholders were identified:

- Cluster 1: stakeholders who declare that information on costs and benefits of measures are available, but that models are not.
- Cluster 2: stakeholders declaring that models are available, but that data and definitions are needed.
- Cluster 3: stakeholders who lack information about the costs and benefits of measures.

Finally, when working with the combined scale of priority and availability, 6 clusters of stakeholders are identified:

- Cluster 1 “needs for most items, especially accident and infrastructure analysis”;
- Cluster 2 “moderate needs for all”,
- Cluster 3 “High needs for models, moderate needs in other, implementation unimportant”,
- Cluster 4 “No needs for models, moderate needs in implementation”
- Cluster 5 “Low importance of implementation and models, moderate needs in crash causation”

- Cluster 6 “High needs for implementation but no use of accident and infrastructure analyses

The investigation of background characteristics of the stakeholders in the various clusters reveals little association with the countries the stakeholders work in, but a stronger relationship with the type of organisation they work for. Interestingly, researchers and policy makers are equally represented in clusters, indicating that they have similar needs and priorities, although the opposite is often assumed in road safety analyses.

2.3.1.6. A particular sub-group of road safety stakeholders: the policy-makers

A sub-sample of 150 policy-makers was identified in the sample of respondents to the stakeholders’ survey. Belgium and the UK were over-represented in this Policy-Makers’ Group, which can be partly explained by the number of European organizations based in Belgium and the original survey only being in English. The majority of Policy Makers had worked in Road Safety for many years. 57% had worked 11 years or more in Road Safety with only 18% having worked less than 5 years.

Over 50% of Policy Makers stated that 13 data/tool items were of high priority: A common definition of a serious injury, information on crash causation factors, a common definition of a fatality, information on road user behaviour and attitudes, exposure data, statistical methods for priority setting, crash databases that link police and hospital data, information on the costs and benefits of road safety measures, information on the safety impacts of combined road safety measures, “good practice” catalogue of measures - including implementation conditions, standardised procedures and methods for carrying out evaluations of road safety measures, focusing on seriously injured counts in addition to fatality counts, and methods for evaluating the safety impacts of road safety measures.

However only 2 of these, “*A common definition of a serious injury*” and “*A common definition of a fatality*” were stated as having both high priority and high availability. The remainder of items were found as having low priority and low availability.

The results suggest that Policy Makers particularly focus on information related to the efficiency of road safety programmes and, in other words, on evidence guiding the choice of appropriate measures. Another group of tools emphasised by the Policy Makers concerned more detailed and comprehensive information on accident data and characteristics such as information on crash causation factors, on frequent crash scenarios and patterns, on road user behaviour and attitudes, as well as a need for crash databases that link police and hospital data. Policy Makers’ responses clearly demonstrated insufficient availability of the majority of tools needed at various levels of decision-making.

As the Policy Makers included in the sample are from a diverse range of organizations and from many different European countries, it was thought that the data/tools priorities and availability may differ between subgroups. Thus, two comparative analyses were carried out.

When examining the difference in priorities and availability of data and tools between the Policy Makers who feel that they are influential of the National Government and the Local/regional government, only small differences could be identified. One of the bigger differences in priorities related to “*Good practice collection on how countries have implemented specific road safety measures*”. Those who claimed to influence the National Government assigned a higher priority to this (58%) than those who influenced local/regional government (38%). A probable explanation for this is that National Governments are more likely to compare themselves to other countries while Local/regional governments focus instead on Road Safety measures adopted by other localities or regions within the country.

The priorities and availability of data and tools stated by those influential of the European Commission were also examined; however very small numbers reduced the reliability of the comparisons. What may be noteworthy is that the Policy Makers who regard themselves as influential of the European Commission, rank "*Results from naturalistic driving studies"* as a high priority whereas very few Policy Makers of the overall Group were of that opinion.

The needs for road safety data and tools expressed in high and low performing countries differed. In general, the high priority items as selected by the high performing countries were considered to have a greater availability than those assigned high priority by the low performing countries. For some items there were relatively large differences in priorities assigned between the high and low performing groups. "*Information on road user behaviour and attitudes*" and "*Exposure data*" were considered to be a high priority by the Policy Makers from high performing countries (75% and 76% respectively), whereas fewer Policy Makers from low performing countries consider these items to be high priority (19% and 28% respectively). In contrast, "*Comparisons of safety rules and regulations*" and "*Detailed road databases providing descriptions of road layouts, signing and marking, etc.*" were assigned the lowest priority by the high performing countries (14% and 17% respectively) but were considered high priority by the low performing countries (70% and 55% respectively).

This finding may reflect the evolution in road safety management thinking: at an early stage of dealing with road safety problems, priority is given to more common and immediate interventions, such as those related to road safety regulations or infrastructure inventory, whereas later, at a more advanced stage, a need for deeper understanding of factors and processes leading to road accidents becomes more of a priority. This reflected, for example, in the introduction of the notion of road safety performance indicators to measure current safety conditions of the transport system (ETSC, 2001; OECD, 2008).

2.3.1.7. Some conclusions

The results of the stakeholder survey should serve as a basis for forming a common picture of the demands of stakeholders (policy-making as well as non-policy-making) for data and knowledge in road safety. The specific analysis performed on the Policy-makers' Group is useful to identify both where there are gaps in data and tools and where there is a need for greater publicity so that Policy Makers know where to find the data/tools which they require. The development of data and tools for supporting road safety management tasks should take the differences in priorities found for various groups of policy-makers into account, i.e. such a development should not be general but certain policy-maker group oriented.

2.3.1.8. Current and future role of ERSO

Knowledge and use of the European Road Safety Observatory (ERSO, www.erso.eu) was found unequally distributed between countries and across categories of road safety stakeholders. Values for new Member States of the EU were generally higher than for EU15.

With regard to type of organization, road safety organisations and research institutes or universities reported the highest use rates. Lowest rates were observed for representatives of automotive and supplier industries as well as for national and regional administrations. Care should therefore be taken to make ERSO the standard tool suitable for a majority of road safety stakeholders across EU countries and across all road safety related professions.

On the basis of the analysis of the stakeholders' priorities, and the related availability of data and tools, a comprehensive set of recommendations for the enhancement of the ERSO is outlined, including short-term improvements (e.g. inclusion of additional existing data sources and tools) as well as medium-term actions for eventually addressing all the needs expressed by the stakeholders.

More information on the results of the stakeholders' survey can be found in Machata, K, Barnes, J, Jahi, H (Eds.) (2011): Stakeholder's contribution, Deliverable 1.3 of the EC FP7 project DaCoTA.
For details on the statistical analysis and grouping of stakeholders, as well as detailed recommendations for the enhancement of the ERSO, see Papadimitriou, E, Yannis, G. Gitelman V., Doveh, E., and Dupont, E., (Eds.) Analysis of the stakeholder survey: perceived priority and availability of data and tools and relation to the stakeholders' characteristics. Deliverable 1.5 (Vol. 1) of the EC FP7 project DaCoTA.
For details of the analysis performed on the Policy-Makers' Group, see Talbot, R., Dupont, E., Gitelman, V., Thomas, P. (2012): An investigation of Policy Makers' priorities for data and tools and their availability, Deliverable 1.4 of the EC FP7 project DaCoTA.

2.3.2. Description and assessment of road safety management systems in European countries

2.3.2.1. Road safety management systems in Europe: patterns and particularities

a) *Institutional organization, coordination and stakeholders' involvement*

Most road safety management elements related to institutional organization and coordination had a medium level of availability across the 14 countries investigated, revealing a large variation in the structures and processes at the higher level of road safety management.

Although it is widely acknowledged that effective road safety management can be achieved with lead agencies of various structural and procedural forms (Bliss & Breen, 2009), the results of DaCoTA suggest that road safety management systems based on strong departments of ministries, or on government agencies specifically established for this purpose, with clear responsibility for the government's road safety policy, are the most effective.

On the other hand, when road safety is oriented or represented by bodies such as inter-ministerial committees or road safety councils, the effectiveness is more likely to suffer. A possible reason for this is that their roles and relationship are not always clear, creating uncertainty and or overlaps in responsibilities and procedures. Another reason appears to be that inter-ministerial committees and road safety councils are typically assigned a coordination mission, and are seldom involved in implementation, while a strong, governmental Lead Agency will be responsible for both. Furthermore, no matter what type of Lead agency is established, the lack of dedicated budget observed in most countries is a major limitation.

The effectiveness of road safety management systems can also be largely affected by the degree to which regional authorities, NGOs, businesses or the public at large are involved via systematic consultation at all stages of the policy making process. Very few countries demonstrate such routine and fruitful consultation processes.

It is finally underlined that the currently changing economic environment is leading to modifications and even to a down-grading of the road safety management system in several countries. This makes it difficult to evaluate the effectiveness of structures as the present road safety performances are related to the previous higher involvement level of the national authorities.

b) *Policy formulation and adoption*

Road safety policy formulation showed the largest degree of “consensus” between countries, especially as regards the presence of a road safety strategy with specific quantitative targets for fatality reduction. Nevertheless, some differences and uncertainties are involved in the adoption of road safety programmes and the participation or consultation of regional and local authorities.

Road safety visions and targets appear to be strongly influenced by either European Union proposals or road safety “leader” countries in Europe. The vast majority of countries have adopted the EU target for 2020, as they had also adopted the previous one of 2010. “Vision Zero”, “Sustainable Safety” and “Safe Systems” are the main visions endorsed by several countries.

Almost all European countries have road safety strategies and programmes. However, there is no unique procedure for preparing them. For instance, the drafting of a programme may be coordinated by inter-ministerial committees, or by road safety councils, and the degree of involvement of the scientific communities varies. It is not always clear why a country adopted a specific orientation or how the measures included in the road safety programme have been selected, how the implementation was prepared, and how the various responsibilities for the implementation have been assigned to different bodies or organizations. As a result, there is a lot of inconsistency in the design of the programmes and the setting of priorities and of the implementation schedule. In such conditions, it is quite unlikely that all programmes and strategies will perform to the same high level.

Proposals coming from regional or local authorities are hardly ever integrated into national road safety programmes – with the possible exception of urban programmes in the large metropolitan areas. The same goes for the allocation of resources, so that the regional or local budgets are seldom adequately allocated or even defined at all.

Information is particularly scarce concerning the finalisation of the programmes in the ministries and in the government. This process typically consists of changes in some proposals, in the priorities and in the implementation plan, for political or other reasons, and these are in most cases unknown. Finally, the procedure followed for formal adoption of road safety strategies and programmes differs according to countries; in several of them, the last programme designed has remained pending and, either has been ignored, or serves as informal guidelines for day-to-day road safety work.

c) *Policy implementation and funding*

In general, implementation of programmes and measures appears to be the weakest component of road safety management systems in Europe.

Compared to other road safety management components, policy implementation and funding had consistently lower scores in the examined European countries, especially as regards the establishment of formal resource allocation procedures, the allocation of funding to evaluation, the sufficiency of funds and human resources and the drafting of plans to support implementation.

The problem of providing stable economic foundations for implementing and managing road safety programmes is the key to improved effectiveness and efficiency of road safety work. First of all, the budget needed to move towards a long-term vision is not estimated in most countries. In addition, a decision is seldom taken to ensure the availability of a budget for road safety activities from the national budget. Finally, the lack of information on implementation costs at the national and international levels, combined with a lack of knowledge on the methods appropriate to calculate these costs, makes for unreliable estimates of implementation costs. As a consequence, even if a provisional budget has been established to implement a road safety programme, the funding actually allocated is usually lower.

Moreover, formal procedures for budget allocation to the various actors are seldom in place. As a consequence, the agency responsible for implementation as well as all other stakeholders involved (regional/local authorities, NGOs) have to rely on their own current budget, for which road safety competes with other policy issues.

Only few countries have an efficient coordination structure and procedures to implement their programmes. In most countries, implementation is still dispatched between government sectors without any further control to ensure the consistency of interventions with the original programme. A lack of coordination at the operational level is clearly identifiable, resulting in some sectors being more efficient than others in performing the road safety interventions they have been assigned.

d) *Monitoring and evaluation*

In most countries, sustainable systems to collect and manage data on road accidents, fatalities and injuries are in place. A satisfactory level of availability was identified with respect to "benchmarking" for monitoring progress in the road safety situation in relation to other countries, and to the collection of behavioural data (typically through a national Observatory centralizing the data systems for road safety).

Nevertheless, most elements related to monitoring and evaluation had a medium or lower level of availability across the countries. In the majority of cases, monitoring is limited to collecting information when a programme ends; only a couple of countries monitor programmes while they are still in progress. Moreover, it is never quite clear what the scope of the monitoring is and how the results of the monitoring are exploited.

Only in few countries, evaluation of safety measures is part of the culture and a routine within the road safety programme, with a dedicated budget. In several countries, evaluation is very rare and adjusted to the available budget. Even when evaluation is consistently performed, it is usually limited to infrastructure and enforcement measures, or to specific behaviours targeted by specific measures. Formal efficiency assessment techniques are not always implemented.

As regards the evaluation of the overall road safety programme, it is mostly limited to a “checklist” of the specific measures foreseen, rather than an actual evaluation. Only one country has been systematically evaluating its entire programme.

e) *Scientific support, information and capacity building*

In most countries, a higher than medium level of availability is observed for a number of elements related to scientific support and information, such as the use of research results for formulating road safety policies, the systematic information of citizens on the national road safety policy and interventions and their effects, and the presence of articles or programmes in the media which review, criticize or challenge current road safety policies. Moreover, in most countries, there is at least one research institute or university department performing multi-disciplinary road safety research, although sustainability of national funding for research is currently highly questioned. Thus in some countries, survival and development of the research teams has been made possible only through their participation in European projects.

It is interesting to note that, while national road safety observatories exist in most countries, there is great variation in their type, role and operation. In a few countries, road safety observatories are part of the lead agency, while in most cases, road safety data collection and storing is taken over by research centres, statistical offices or the police.

Capacity building and training of road safety actors is seldom a systematic procedure with a dedicated budget, and very little is known about the amount of training actually performed, the content of the training courses or the degree to which graduates are later involved in practical or scientific work to improve road safety. Multi-disciplinary courses on road safety at university level are scarce.

Overall, it can be said that the scientific potential is there and may support road safety policies in the future. Currently, however, there appears to be a lack of cooperation or coordination between research and policy making, especially as regards the formulation of road safety programmes and the methods of monitoring and evaluation and interpretation of results. Making better use of the existing scientific capacity appears to be one of the major challenges for knowledge-based road safety policy making in the European countries.

2.3.2.2. Can countries be ranked on the basis of road safety management?

According to our investigation model, we can expect that countries meeting more “good practice” criteria in their road safety management system will be found in the group of good performing countries in terms of road safety outcomes. Similarly, one may assume that countries meeting fewer “good practice” criteria will be consistently found in the group of poorly performing countries. However, the qualitative analyses, confirmed by the cluster analysis, showed the complexity and variability of road safety management systems, so that the task of ranking the countries in terms of road safety management was bound to be very demanding.

Cluster analysis proved countries to be completely different when road safety management systems were considered as a whole, so that overall ranking was impossible; so ranking had to be tried for each of the five components of the road safety management systems as defined in the structure of the questionnaire. In doing this, however, no two countries were found to belong to the exact same ranking for all components. Across all the analyses, a number of countries with a consistently higher level of availability of some road safety management components could be identified, and others with a consistently lower level of the same features.

Interestingly, the countries that were ranked systematically at the top of road safety management components were not always those known as the best road safety performing countries (such as the Netherlands and the U.K.). Moreover, for the countries' group with seemingly higher overall (i.e. average) level of availability of the road safety management components corresponding to “good practice” criteria, the availability level was not consistently the best across all specific analyses. In fact, a similar overall ‘score’ on a part of the road safety management system (e.g. monitoring and evaluation) could be obtained with different scores on the individual “good practice” elements concerning that part of the system.

On the other hand, the countries that were consistently ranked at the lower end of the scale were also the countries with the lowest performances in terms of fatality rates.

Overall, the rankings carried out for the five distinct parts of the questionnaire were quite – although not fully – consistent, especially as regards the “best” and “worst” performing countries according to the DaCoTA “good practice” criteria. However, the inconsistencies that emerged when comparing the rankings of road safety management with road safety performance, especially for the “good” performing countries, brought forward the need for a dedicated analysis on the potential links between these two.

2.3.2.3. Is road safety management linked with road safety performance?

The dedicated analysis of road safety management and road safety performance was based on the SUNflower pyramid, tackling the entire hierarchy from structure and culture, to programmes and measures, to safety performance indicators (intermediate outcomes), and to road safety final outcomes (i.e. fatalities and injuries). Due to the complexity of road safety management systems, this analysis was based on a shorter version of the questionnaire, namely the common DaCoTA/ETSC-PIN questions.

The results suggested no direct relationship between road safety management and the final outcomes of the RS systems (be it mortality rate, fatality rate, the evolution of the number of fatalities between 2001 and 2010 or a composite index combining these indicators with others, such as the proportion of vulnerable road users in the total number of fatalities). However, they did suggest a relationship between road safety management and road safety performance indicators (composite index combining variables such as the number of annual alcohol checks per 1000 inhabitants, the rate of renewal of the car fleet, and more). This is in accordance with the SUNflower model which assumes that the policy context and input will first affect the intermediate outcomes, i.e. the operational level of road safety, which corresponds to the level of road infrastructure, the maturity of road user behaviour, the protection offered by vehicles etc. These operational conditions are thought to be the result of policies and interventions, and the final outcomes result from these operational conditions. The findings of DaCoTA thus confirmed that the effect of road safety management on road safety performance is indirect, and conditional to the operational level of road safety.

Of course, the fact that European countries constitute a small sample, does not allow for the identification of strong relationships, but rather for the indication of the presence of relationships. Moreover, some confounding factors could not be accounted for, such as mobility, economy developments, weather, long traditions etc.

Two additional reasons for the difficulty of linking road safety management with road safety performance have to be considered. First, the DaCoTA analyses concerned a “snapshot” of the road safety management systems in 2011 which did not account for their evolutions or, in several cases, was even biased by recent changes. The evolution of road safety management may be a strong determinant of the evolution of road safety performance. The DaCoTA investigation should thus be repeated at intervals to update the information and make it possible to introduce the time dimension in the analyses.

Second, it should be acknowledged that European countries have an overall good level of road safety performance and an overall good level of road safety management compared, for instance, to emerging countries, which makes it difficult to establish a relationship between these two parameters within their relatively narrow scales. It is also possible that managers in better performing countries are more ‘strict’ on providing information, which may lead to underestimating the level of their road safety management.

2.3.2.4. Some conclusions

The results of the DaCoTA analyses on road safety management systems suggests that, although a number of “good practice” elements can be established as regards road safety management structures, processes and outputs, it is not possible to identify one single “good practice” model at the national level. Best performing countries, are not always ranked best in terms of road safety management components and there is strong indication that economic and cultural elements may be key determinants of both road safety management and road safety performance, and of the link between those two. However, the proposed “good practice” criteria seem to work as regards the worst performing countries. One clear finding is that similar performance in road safety management can be achieved by means of differing structures and implementation processes.

Despite the differences in European road safety management systems, several elements have emerged as critical “good practice” criteria, such as the presence of a strong lead agency, the efficiency of the implementation – monitoring – evaluation part of the policy making cycle, the embedding of programmes in sustainable and results-focused structures and processes, and the distribution and coordination of responsibilities between national (or federal), regional and local levels. Especially the implementation, funding, monitoring and evaluation elements showed the lowest level of availability and appear to be the most problematic sections of the road safety management systems in European countries. The scientific potential present in each country was also found to be generally under-used for policy-making.

The DaCoTA results confirm the fact that the existence of an organisation or function does not necessarily imply that it works well; indeed, several countries have structures, lead agencies, strategies and plans, which are very partially if at all implemented, mainly due to lack of political will and motivation, lack of funding and coordination, lack of clarity in roles and responsibilities etc. This is often the case for poor performing countries, which scored high on institutional organisation and policy formulation, but very low on policy adoption, implementation, funding, monitoring and evaluation.

Little or no direct relationships between road safety management features and road safety performance was identified, and background indicators (GDP, level of motorisation) were dominant over road safety management effects. However, road safety management was found to be associated with intermediate safety performance indicators reflecting the operational level of road safety in each country. The weak relationship between road safety management and road safety performance was attributed to the fact that the European countries do not exhibit big differences in road safety performance, and that a minimum acceptable level of road safety management exists almost everywhere. Moreover, the time dimension could not be introduced retrospectively in the DaCoTA investigation, so that, in some countries, road safety management components were so recent that they hadn’t yet had the time to deploy their full potential, while in others, they may have been around for such a long time that their impact had already gradually fading away.

From a methodological point of view, differences were observed between scientific experts’ and managers’ responses, the latter tending to be more positive, especially as regards the role of the parliament, the availability of programmes, the resources and funding processes, the reporting procedures, the information of citizens etc. It was concluded that experts’ responses may reflect an independent and more objective view while managers are in a better position to provide up-to-date information. However, it is likely that neither the scientific experts nor the governmental managers could provide the complete picture of road safety management, which may explain some of the discrepancies in the quantitative analyses.

Overall, it can be said that the extent to which the road safety management “good practice” criteria are met is a pertinent measure for identifying a country’s road safety management profile and peculiarities. The extent and level of detail of the DaCoTA questionnaire was proved necessary for capturing the many important differences between countries, as well as the more subtle ones, and allowed for the magnitude and complexity of road safety management systems to be revealed.

Qualitative and quantitative analysis of this large amount of detailed data allowed for several conclusions to be drawn, and also for revisiting the original criteria in order to identify those elements which appear to be more crucial.

Detailed results can be found in Papadimitriou, E., Yannis G., Muhlrad N., Gitelman V., Butler I., Dupont E. (Eds) (2012): Analysis of road safety management in the European countries, Deliverable 1.5 Vol.II of the EC FP7 project DaCoTA.

2.3.2.5. Recommendations

On the basis of the results of the analysis carried out within DaCoTA WP1, a number of key messages and recommendations can be outlined for the improvement of road safety management systems in Europe:

- **Recommendations at national and local level**
    - Develop objective knowledge of RSM within countries
    - Decentralisation with care
    - Establishment of an Independent Lead Agency
    - Inter-sectoral and vertical coordination
    - Continuous stakeholders consultation
    - Vision and strategy is crucial for creating a road safety culture, but implementation is the critical step towards road safety improvement
    - Strengthen the link from policy formulation to policy adoption
    - Regular monitoring and evaluation
    - Resources and funding
    - Knowledge-based policies
    - Capacity building & training
    - Handle road safety management in times of recession
- **Recommendations at European level**
    - Adopting the safe systems approach
    - Exploiting the synergies of road safety and environmental policies
    - Adoption of serious injury reduction targets
    - Focusing on the essentials, leaving the details to the individual countries
    - Strengthening the role of ERSO
    - Publication of a Road Safety Management Good Practice Manual
    - Building on the existing framework and improving where necessary
    - Political will and commitment from all stakeholders

Detailed recommendations for practice and for future research can be found in Papadimitriou, E., Yannis G., Muhlrad N., Gitelman V., Butler I., Dupont E. (Eds) (2012): Analysis of road safety management in the European countries, Deliverable 1.5 Vol.II of the EC FP7 project DaCoTA.

2.4. The research team

Although task leaders coordinated the different research tasks, the methodological developments and the results obtained were very much collective work and all team members were involved in all steps of work.

Task leaders were Nicole Muhlrad, Ifsttar, France (general coordination, consultation of experts, methodological development), Emmanuelle Dupont, IBSR, Belgium (consultation of experts), Klaus Machata, KfV, Austria (consultation of stakeholders), Rachel Talbot, University of Loughborough, U.K. (road safety management data collection), Gabriele Giustiniani, University of Roma, CTL, Italy (road safety management data storing facility), and Eleonora Papadimitriou, NTUA, Greece (road safety management data analysis and synthesis of results).

Report editors and co-authors were Ilona Butler, ITS, Poland, Victoria Gitelman, Technion, Israel, Heikki Jähi, Ifsttar, France and George Yannis, NTUA, Greece. Other active team members were Charlotte Bax, SWOV, the Netherlands, Heike Martensen, IBSR, Belgium, Pete Thomas and Jo Barnes, University of Loughborough, UK. and Gilles Vallet, Ifsttar, France.

3. PAN-EUROPEAN IN-DEPTH ACCIDENT INVESTIGATION NETWORK

Chapter authors: Aldah, M., Talbot, R., Hill, J., TSRC; Giustiniani, G., CTL; Fagerlind, H., SAFER; Jänsch, M. MUH

See also Deliverable 2.5 Final Report on the Pan-European In-Depth Accident Investigation Network

3.1. Introduction

Crash investigation has been established for some time as a method for gaining an understanding of the causes and consequences of crashes. In-depth accident investigations aim to reveal detailed and factual information from an independent perspective on what happens in a crash. This information is useful to all the stakeholders in the Public and Private sector including vehicle manufacturers; road and enforcement authorities; insurance and certification bodies; as well as legislators and policymakers. These investigations are conducted by trained experts from multiple disciplines to collect as much useful information as possible, to be of maximum benefit in answering current research questions and any that may arise in the future.

Figure 5 Examples of crash investigation in progress

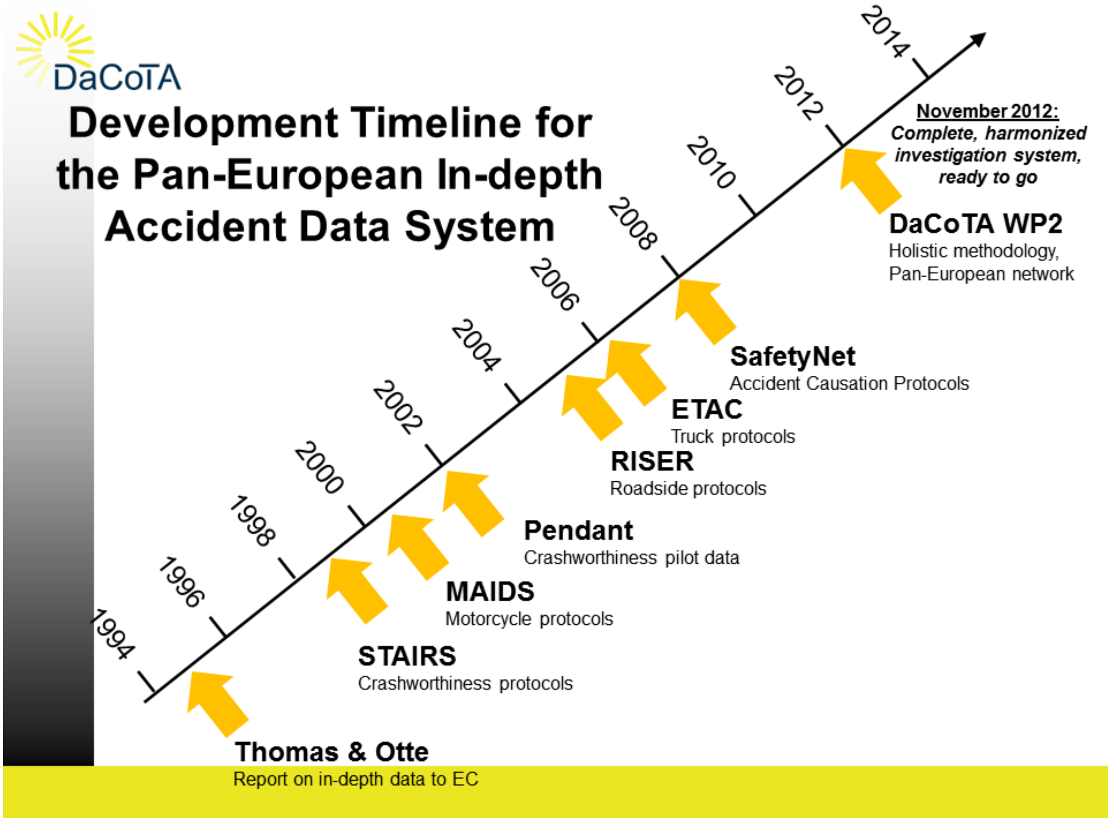

Figure 6 Key EU projects relating to in-depth data collection

This DaCoTA Work Package was tasked with formulating a common methodology for research accident investigation and identifying and training new research teams across Europe. The main goal for was to harmonize in-depth crash investigation protocols and, at an EU level, identify and train crash investigation teams who will prepare for investigations according to these harmonized protocols. The DaCoTA project is a culmination of many EU projects on in-depth accident investigation methods and databases over the years. In particular, the projects STAIRS, Pendant and SafetyNet had the greatest contribution to the development of DaCoTA. A timeline of some key EU projects related to these developments is listed in figure 2. This list is by no means exhaustive but it merely serves to illustrate how long this research area has been the subject of project work, and what some of the key projects were.

Setting up the network; training the teams within the network to a similar standard; and developing an appropriate methodology for data collection and entry – including conducting a pilot study – were all requirements of this project. These are described in more detail in the following chapters. The full details are available online on the project website: http://www.dacota-project.eu/.

3.2. The Need for In-Depth Data

3.2.1. European commitment to improving road safety

The European Commission have continued their commitment to reducing road casualties by renewing the target of reducing fatalities on European Union roads by 50% between 2011 and 2022[8]. Real world accident data will be required to provide evidence based information in support of achieving this new EU safety target as outlined in the Road Safety Action Programme[9] (RSAP).

Macroscopic accident data provided by national accident reporting systems and collated on a European level in databases such as the CARE database[10] have large accident numbers at a general level of detail, which can indicate problem areas. However this cannot address the detailed circumstances of accidents. Therefore there is a need for more detailed data that can assist in evidence-based policy making by providing the necessary information for the generation of countermeasures as shown in Figure 7 below.

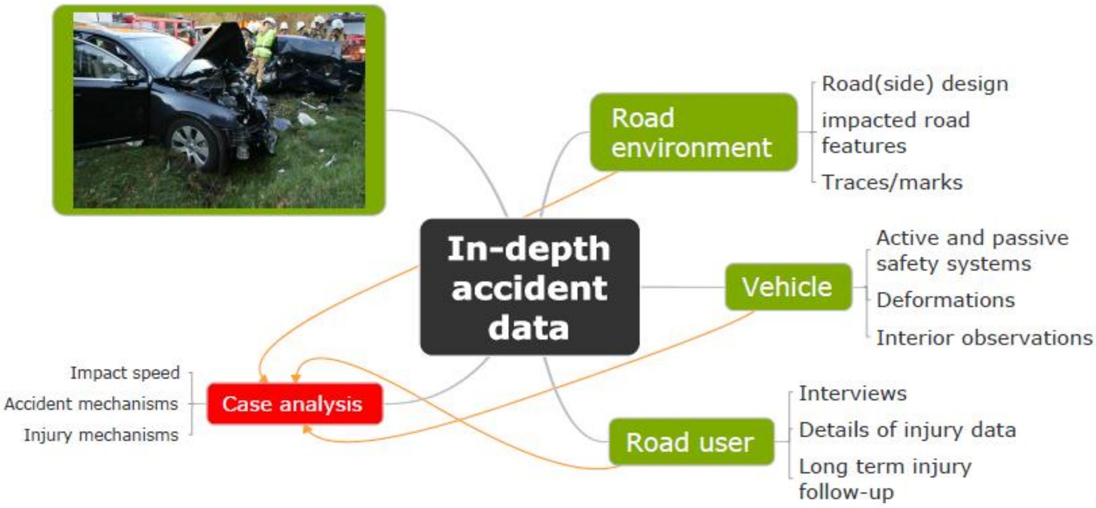

Figure 7: In-depth accident data uses

In-depth accident data provides detailed information on all aspects of the accident:

- the road environment e.g. road features involved in the collision and traces/marks;
- the vehicle e.g. deformation, safety system performance;
- the road user e.g. interviews and detailed injury data.

In addition the data collected for each accident is analysed to calculate factors such as impact speed, injury mechanisms and causation information.

In depth accident data has been and continues to be used in a variety of different ways, for example for policy making; monitoring; consumer testing; setting standards; and research and development. More specifically, in depth accident data has been utilised in research focused on accident prevention as, for example, it allows the factors contributing to an accident to be identified as well as providing real world input to driving simulator studies. In

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[8] EUROPEAN COMMISSION, 2010. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Towards a European road safety area: policy orientations on road safety 2011-2020.

[9] EUROPEAN COMMISSION, 2003. *Saving 20 000 lives on our roads – A shared responsibility*. [online]. Office for Official Publications of the European Communities, London. [viewed 7/12/2012]. ISBN 92-894-5893-3. Available from: http://ec.europa.eu/transport/road_safety/observatory/doc/rsap_en.pdf

[10] EUROPEAN COMMISSION, 2011. *EU – Road safety – Statistics- accidents data*. [online]. European Commission [viewed 7/12/2012]. Available from: http://ec.europa.eu/transport/road_safety/specialist/statistics/index_en.htm

addition, research into injury prevention relies on in-depth data to identify injury outcomes in different impact scenarios, including vulnerable road users, and how the interaction between different vehicle types affects injury outcome. Data from in-depth accident investigations has also been utilised in the area of development as a tool to identify ideas for new products and to evaluate the expected effectiveness of new safety systems.

3.2.2. Data Requirements by Stakeholders

A number of consultations with key stakeholders (European Community, industry, national administrations and the research community) were conducted to understand current and future data needs. The aim of this activity was to ensure the proposed methodology would be of use to the stakeholders for research purposes, policy formulation and improving road safety. This provided input on what should be the minimum requirement for a case, the disciplines required as part of the investigation and the basic skill-set required by an investigation team.

The consultation with the stakeholders provided support for continued in-depth data collection and its requirement for the future. A number of key research areas were identified covering driver behaviour, driving under the influence of alcohol or substances, intelligent vehicle technologies and road infrastructure design. Identifying causes of accidents especially focussing on countries with high road fatality rates and comparing them with other countries for ways to improve road safety was a common theme in the consultations. The consultation with the national administrations reported a strong willingness to work with the DaCoTA project to establish new teams across Europe in the different member states.

A matrix of research questions that were rated due to their complexity and the type of data required to answer was produced. These were then prioritised into questions of current and future interest, giving a list of 30 research questions/topics of which 80% could be answered with robust conclusion by in-depth data. The remaining 20% of the questions could mainly be answered by in-depth data but to achieve robust conclusions a multifaceted approach would be needed, for example including laboratory testing to verify results from real world data with repeatable tests. For

This work has identified a number of benefits that in-depth investigations provide such as an increased knowledge of the causes of accidents, injury prevention and countermeasure evaluation to name a few. This type of data has been invaluable to many member states across Europe for the past few decades and to open this market to the wider European member states will only increase the knowledge base and transfer between EU countries. This will help facilitate the development of effective countermeasures and help to make Europe a competitive force on a global level for industry and road safety strategies.

The work package partners were also questioned about their top research priorities in the Pilot Study. Many of these priorities were common between partners and were also to be found in the consultations with stakeholders conducted earlier. Key research priorities include Vulnerable Road Users; Accident Causation – Mechanisms and Analysis; and evaluating the effectiveness of new safety systems.

By establishing the level of data required to answer current and future research questions the partnership is recommending that all teams follow an on-scene data collection methodology, attending the scene soon after the accident but certainly within 1 hour of its occurrence. Although new teams will be able to follow a retrospective methodology whilst training to build the desired skill set for the investigators and to overcome any obstacles. This will ensure the network as a whole will be collecting data to a similar advanced level within a short time of beginning operations.

For further information please see Deliverable 2.1, Report on purpose of in-depth data and the shape of the new EU-infrastructure.

3.3. The New Investigation Network

The Pan-European In-depth Accident Investigation Network (the "Network") is made up of investigating teams who are all based in a number of different European countries. Some teams have many years' experience in in depth accident investigations, some have only been established for a short while so are still developing their skills and some are new teams that were created as part of the DaCoTA project. Each investigating team has a Team Leader and investigators. The DaCoTA network, methodology development and training were organised by the core Teams who are the partners in DaCoTA Work Package 2. Core Team member organisations also investigate accidents in their local areas and assisted less experienced (new and developing) teams in their activities through a pairing process. A list of the teams and a map of most of the participating teams are provided below.

Austria (KFV)	Denmark (VD)	France (IFSTTAR, LAB)	Iceland (ICE)	The Netherlands (SWOV)	Slovenia (STSA)	United Kingdom (TSRC)
Belgium (IBSR)	Estonia (EST)	Germany (MUH)	Italy (CTL)	Norway (NPRA)	Spain (CIDAUT, INSIA, IDIADA)	
Czech Republic (CZIDIADA)	Finland (VALT)	Greece (CERTH)	Malta (ITSD)	Poland (MTI)	Sweden (SAFER)	

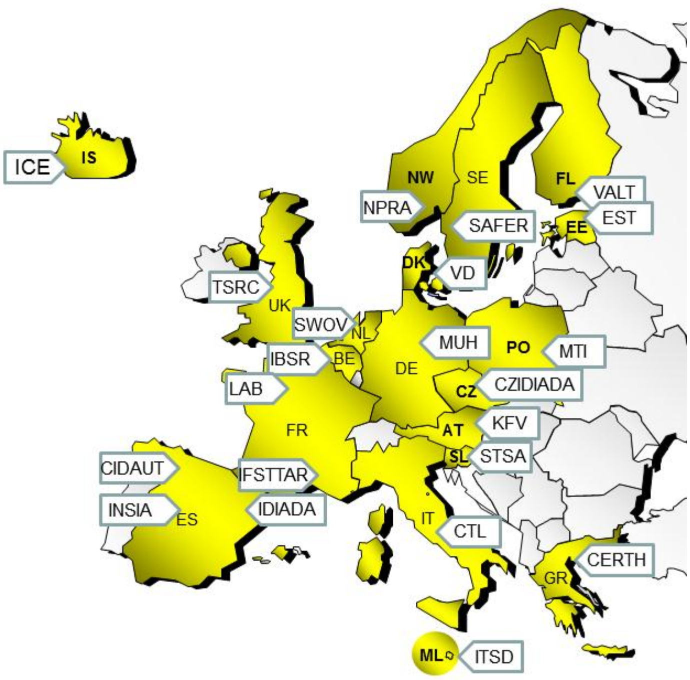

Figure 8 Map of participating team locations

Each Network team was asked to investigate 5 road accidents according to the DaCoTA methodology as part of a pilot study. The in-depth accident investigation process first requires investigators to make observations and gather information before going on to analyse the information to understand what happened and why. The methodology therefore covers both the collection of data and case analyses. Data collection involves a wide range of activities such as making notes, measurements, interviewing people, collecting injury details from hospitals, taking photographs and possibly making video recordings.

Case analysis includes identifying and coding how and why events such as collisions between road users or injuries to road users occurred, and more specific analyses are involved, for example, to calculate vehicle speeds.

As part of the Pilot Study, teams uploaded the data, photographs and analysis results into the DaCoTA online database system. The system provides approximately 1500 variables (or fields) for data entry per case. However, it must be noted that only a sub-set of available fields is relevant to any individual case (for example, variables defined for trucks will not be needed when there are only passenger cars involved in an accident). As an approximate guide, normally around 200 variables are need to be collected to describe the overall accident and road characteristics. In addition, around 200 to 300 variables are completed for each vehicle involved. When it comes to the humans involved, a further 100 to 200 variables are required.

Figure 9 Teams undergoing training in Spain

The teams attended a week long training course held at the IDIADA complex in Santa Oliva (Spain) between 12th-16th March 2012. Both practical and theory sessions were used to train teams to conduct in depth accident investigations according to the DaCoTA methodology and to use the DaCoTA database as the data entry tool (see Chapter 3.4). For training materials see Deliverable 2.3, Training package

The teams were questioned about their current in-depth investigation activities and sources of funding, as well as their ability to continue with investigations after the DaCoTA project. The partners were asked before and after the Pilot Study and the results were very encouraging. The responses given before the Pilot Study are shown in Figure 6 below, while the results from after the Pilot Study are illustrated in Figure 11 and Figure 12.

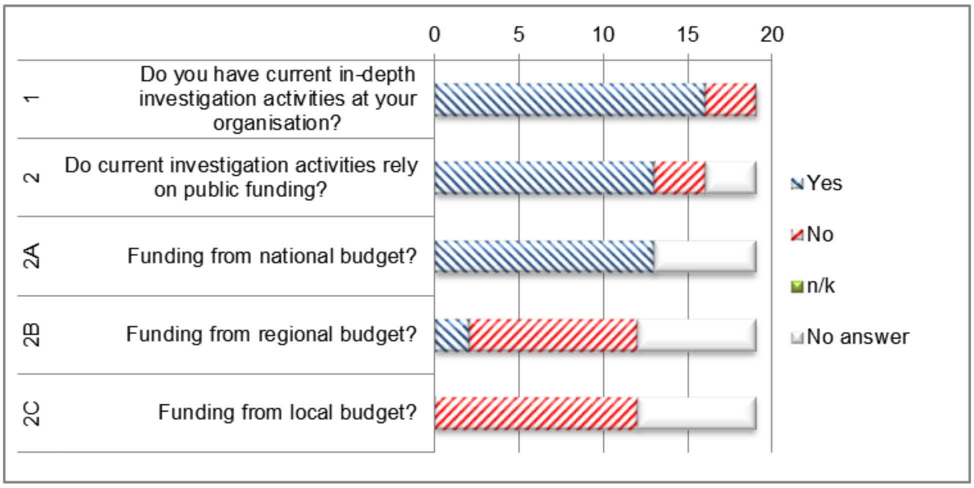

Figure 10 Responses to current budget and investigation activities from teams before the Pilot study

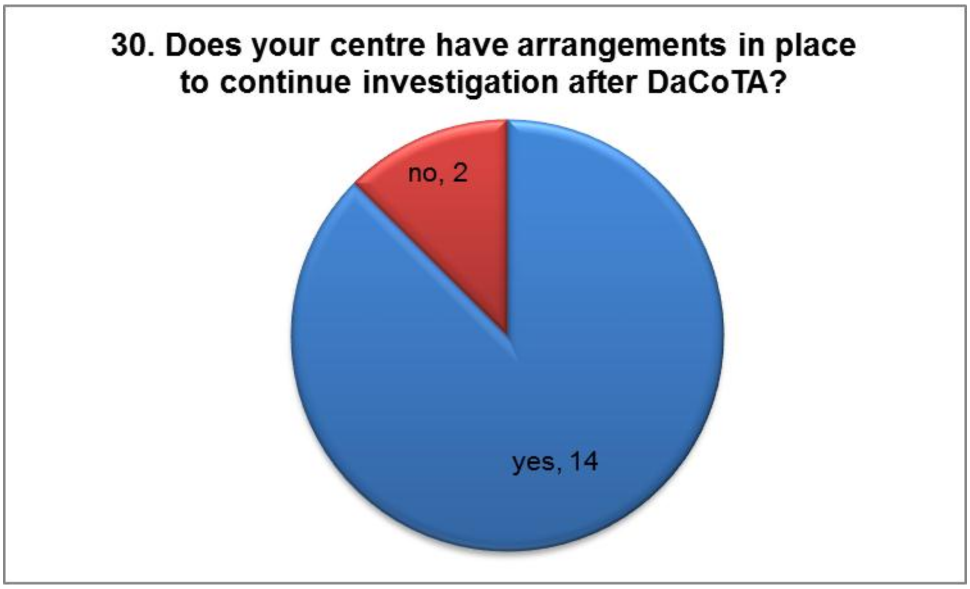

Figure 11 The number of respondents able to continue investigations after DaCoTA

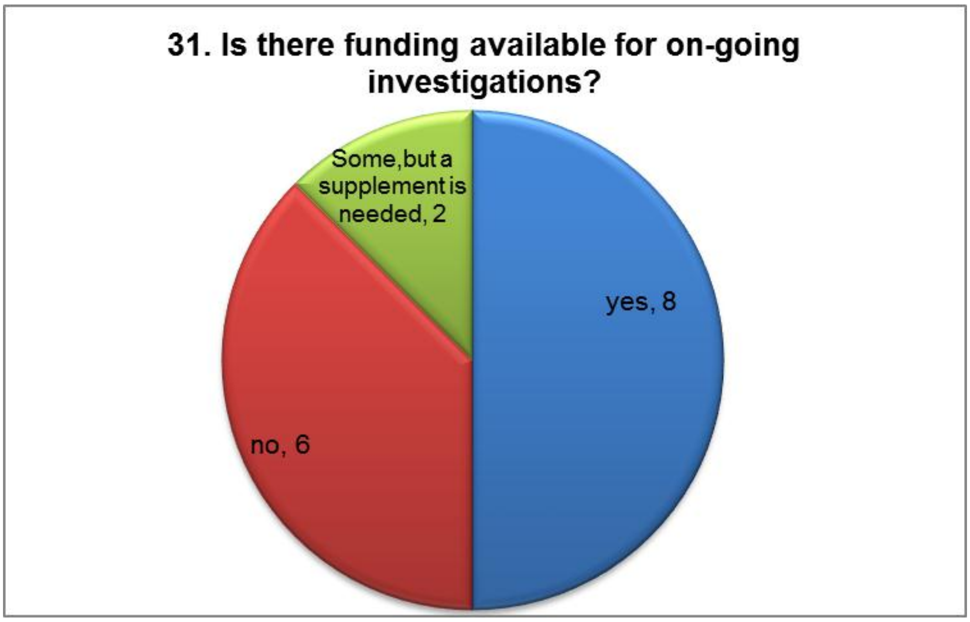

Figure 12 Availability of funding for on-going investigations

A majority of the partners had existing in-depth investigation activities with some public funding in place before the Pilot Study. After the Pilot Study, most of the teams had the arrangements and infrastructure in place to continue investigations after the end of DaCoTA, which was very promising for the future of in-depth data collection in Europe.

3.4. The DaCoTA System

3.4.1. Introduction

The components that make up the DaCoTA system are described briefly in this chapter. The DaCoTA system was developed starting from the System developed by the SAFER consortium for the Swedish in-depth investigation activities. The SAFER consortium made available its system for free. The System was then updated by CTL (University of Rome) and improved according to the DaCoTA needs and indications. The design of the system is such that it may be deployed and housed centrally with all the data entry and retrieval being performed over the internet, or a local database or hub can be installed if it is important to keep the data locally. This local hub can also interface with a central server if required.

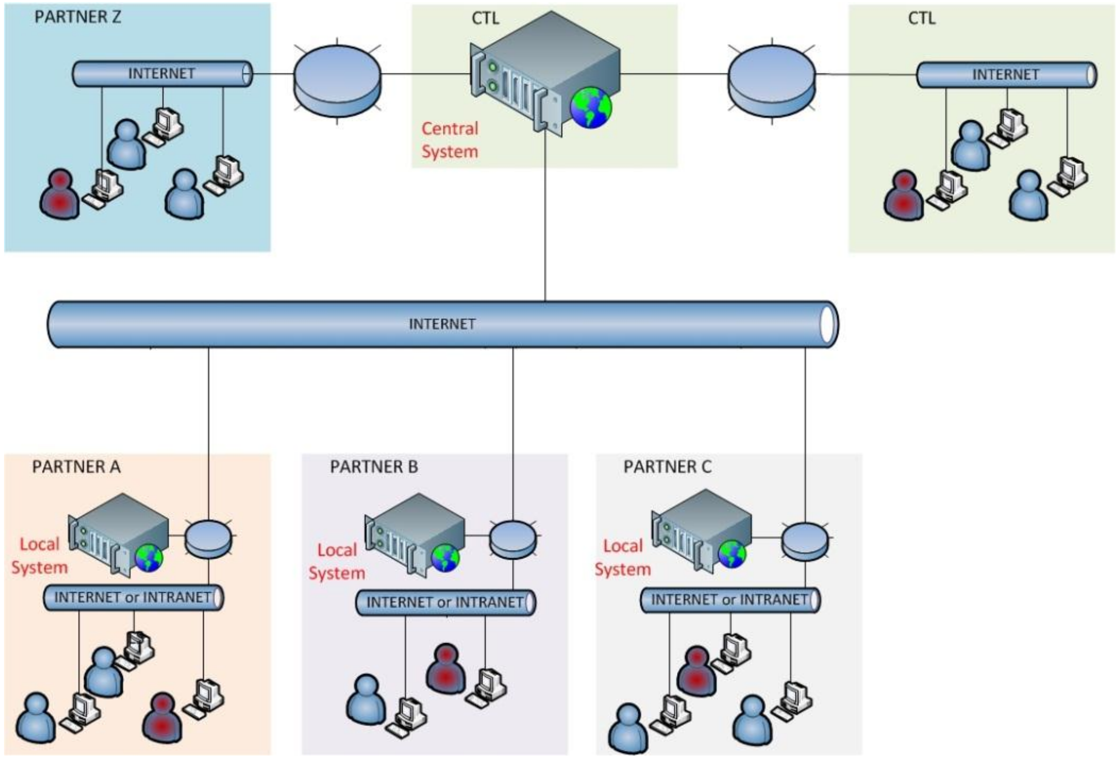

Figure 13 Diagram showing the two different methods of setting up and accessing the system

3.4.2. The Database and Online Manual

One of the tools provided to the Pan-European In-depth Accident Investigation Network teams is the DaCoTA crash investigation system. The DaCoTA crash investigation system is composed of two components:

- The database web application;
- The online manual.

The database web application has been developed in order to:

- Store in a harmonized way in-depth accident data;
- Analyse and filter the accidents collected;
- Secure exchange of the data collected and the analysis results among the partners involved.

Each team has been provided with one or more logins to the database and is able to insert data related to the accident investigated according to the DaCoTA protocol. For each accident the database also allows the insertion of pictures, files and movies and to store the results of analysis on accident causation using DREAM[11] methodology, accident reconstruction and injury mechanisms.

The data of the accident are organized in four different levels. Accident level refers to general data about the accident including the accident summary. All the data about infrastructure conditions and geometry are stored in the road environment level. Element

[11] H. WALLÉN WARNER, M. LJUNG AUST, J. SANDIN, E. JOHANSSON & G. BJÖRKLUND, 2010. *Manual for DREAM 3.0*. [online]. Chalmers University of Technology, Gothenburg. [viewed 11/12/2012] Available from: http://www.dreamwiki.eu/

level refers to the different vehicles involved in the accident (pedestrians included) and road user's level is where data about road users involved, including consequences of the accident, are stored. For each accident the database allows storage of up to 1,500 variables. For each level it is also possible to store in an organised way pictures, movies and files. Finally the database also allows the results of the case analysis for each accident to be stored. An overview of the database data structure is reported in the figure below.

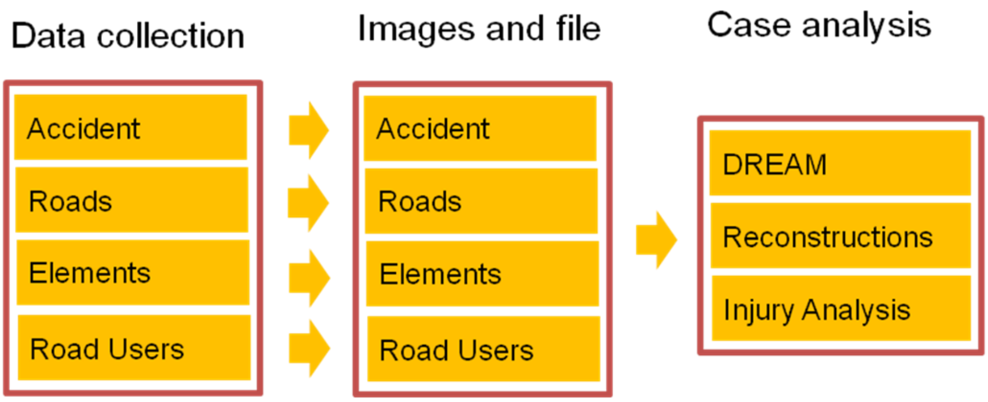

Figure 14 The database data structure

The database is not a simple application but it is a Rich Internet Application (RIA) and needs the use of the right set of technologies to provide the service (for more details see [DaCoTA Deliverable 2.2, Specification of Data system](). The main characteristics of the database are:

- Accessible over the internet;
- All frameworks and tools are open source;
- Server cross-platform architecture: Windows, Linux, Unix;
- Client interface is any web browser that supports Adobe Flash and runs on any Operating System with internet access.
- Central or local housing of the data is possible depending on the requirements

From the design point of view the database has been implemented to be as user friendly as possible, intuitive and easy to use (a snapshot of a database screen shot is shown in the figure below).

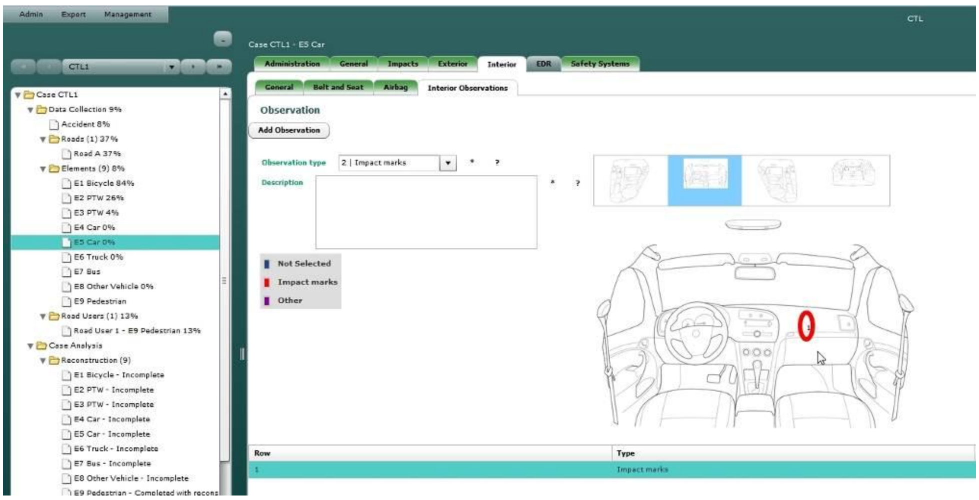

Figure 15 A view of the database

In the database, there is a direct link between each variable and the online manual in order to get more information about the variable, how to measure it in the field and how to code it in the database.

The online manual (see Figure 12), the other component of the DaCoTA Crash Investigation System, has been developed with the aims of:

- Providing a location for the DaCoTA in-depth road accident investigation methodology.
- Informing the scope, characteristics and practical requirements of the methodology.

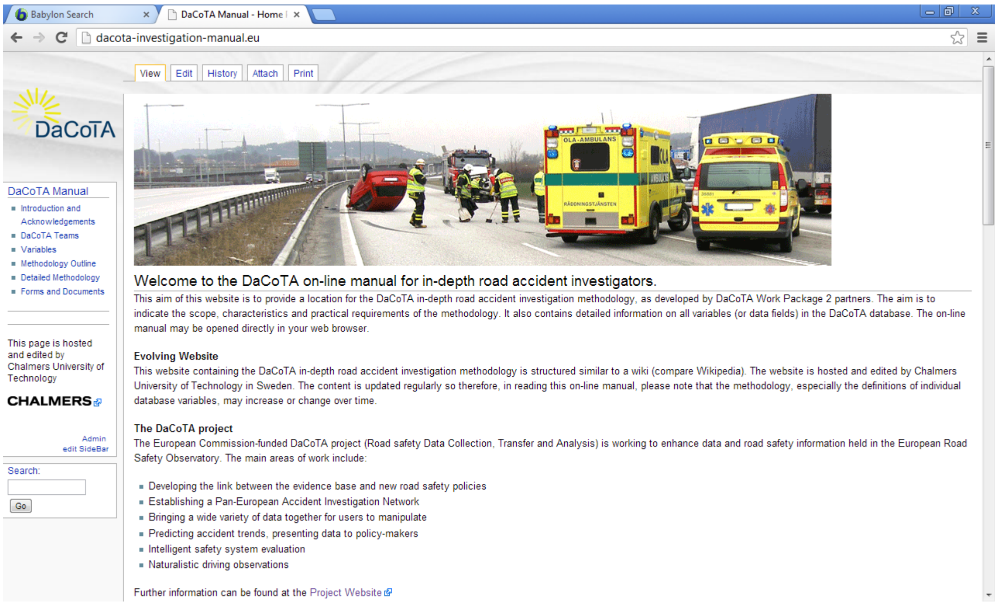

Figure 16 The first page of the online manual

Beside the information about the variables the online manual provides an overview of the DaCoTA methodology, information on secure and safe data collection in the field and forms and documents for data collection. The contents of the online manual are divided into six parts:

- Introduction and Acknowledgments
- DaCoTA teams
- Methodology outline
- Variables
- Detailed methodology
- Forms and documents.

The online manual is publically available online at http://dacota-investigation-manual.eu. Also see Deliverable D2.4, Final updated protocol with updates from Pilot review.

3.4.3. Selection of Accident Causation Method

One of the key tasks in developing the European method for accident investigations was to choose a method for accident causation analysis. The methods Driving Reliability and Error Analysis Method (DREAM), Accident Causation Analysis System (ACAS) and Human Functional Failure (HFF) are used by the partners in other projects and were the possible candidates. A list of important considerations for the selection of a method was set up and is presented in the list below. The HFF manual was translated from French into English.

- Good inter-coder reliability
- Possibility to make single case analyses and automated aggregated analyses
- Have a theoretically established background
- The method should contain enough and relevant causation factors
- Clearly describe contribution factors/causes
- A manual should exist and include examples and recommended applications
- It is desirable that the method has a clear start and end
- Identify the users of the data
- Be able to use the result to suggest countermeasures
- The method should be possible to implement into a database
- The method should consider all involved road users
- It is desirable that the method includes some kind of time sequence

During a period of about six month the WP2 partners compared the methodologies by:

1. Coding five example cases: Most partners had previous experience from using at least one of the methods. To get familiar with the other methods and be able to code the cases a coding exercise was set up.
2. Filling in questionnaire: After completing the exercise each coder was asked to respond to a questionnaire evaluating their experience of each method.
3. Voting: After presentation and discussion of the results of the coding and questionnaire all partners were asked to rank the coding systems according to which they would preferred to be used in DaCoTA. It was also possible to suggest changes to the preferred method.

All three steps in the process showed a small advantage for the DREAM method. Considering that DREAM was developed in SafetyNet and is supported as the European method by the Commission and that DREAM is already built into the existing database meant that DREAM was chosen for DaCoTA.

3.4.3.1. Compatibility of DREAM with the ACAS method

However as it is important for a pan European Database to allow for the possibility to transfer data to and from other (existing) databases, an additional study was conducted to evaluate the transferability of causation data from DaCoTA with the DREAM method to one of the other systems used in Europe: ACAS, as used in the GIDAS project in Germany[12].

In summary the analysis of the available causation data in the DaCoTA WP2 Database has shown that it is possible to conduct an analysis of the causes of traffic accidents based on the ACAS accident causation methodology. DaCoTA is able to provide comprehensive details on human behaviour and failures together with information on contributing influence factors. The principle source of causation information is the data recorded by the DREAM method. While in most cases it was possible to convert the causation information directly from DREAM to ACAS, in some cases a sharp and distinct conversion was difficult and extra information from pictures or other sources of information (e.g. the accident type) was used. Even though the cases that were collected from various different partners with different levels of experience in the DaCoTA database are far from being representative of anything, the distribution of causation factors for example over the main categories of human failures showed a realistic characteristic. The most failures were related to human failures like

[12] More information can be found at the study website: http://www.gidas.org

problems with seeing or identifying the available relevant information, only little errors occur when it comes to operating the vehicle.

The full compatibility report and ACAS methodology are available upon request[13]

3.4.4. Training

Figure 17 Teams undergoing training in Spain

A training package was created by the DaCoTA partners to facilitate the training of investigation teams who are members of the Pan-European In-depth Accident Investigation Network. This training package was initially delivered during the DaCoTA training week that was held in March 2012 in Santa Oliva, Spain. The following topics were included in the training:

- Preparing an Investigation Team
- Scene Examination and recording visual evidence about the crash scene
- Vehicle Examination
- Vulnerable Road Users
- Collecting Road User Data
- Medical information
- Case Analysis

A copy of the materials used in the training can be found in the document *DaCoTA training manual and draft protocols for in-depth road accident investigations in Europe* [14] These training materials can be used in the training of any future teams in the area of in depth accident data collection alongside the online manual.

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[13] Please see the internal report for DaCoTA Work Package 2, available from Jaensch.Michael@mh-hannover.de or j.r.hill@lboro.ac.uk

[14] Available from the project website: http://www.dacota-project.eu/ (Deliverable 2.3)

3.5. The Pilot Study & Review

This chapter describes a pioneering Europe-wide In-Depth Pilot Study that primarily ran during the second half of 2012 and the feedback from that study. This was the first time that 22 partners from 19 European countries collaborated on such a scale. There is no in-depth data available to describe the causes of accidents and injuries for Europe as a whole although earlier studies have conducted pilot investigations to develop protocols. DaCoTA has built upon previous work that identified teams and their research priorities to establish the infrastructure for a future investigation system that can be deployed beyond the completion of the project.

Every team in the network was tasked to investigate five accident cases and enter the data on these cases into the database. The review process that followed was divided into two parts: a case review performed by the core experienced teams and a questionnaire to collect feedback from the teams after using the system.

The results of this Pilot Study were used to further refine and improve the data collection methodology. Some of the results are presented here in brief while the majority of the recommendations are detailed in Chapter 6.

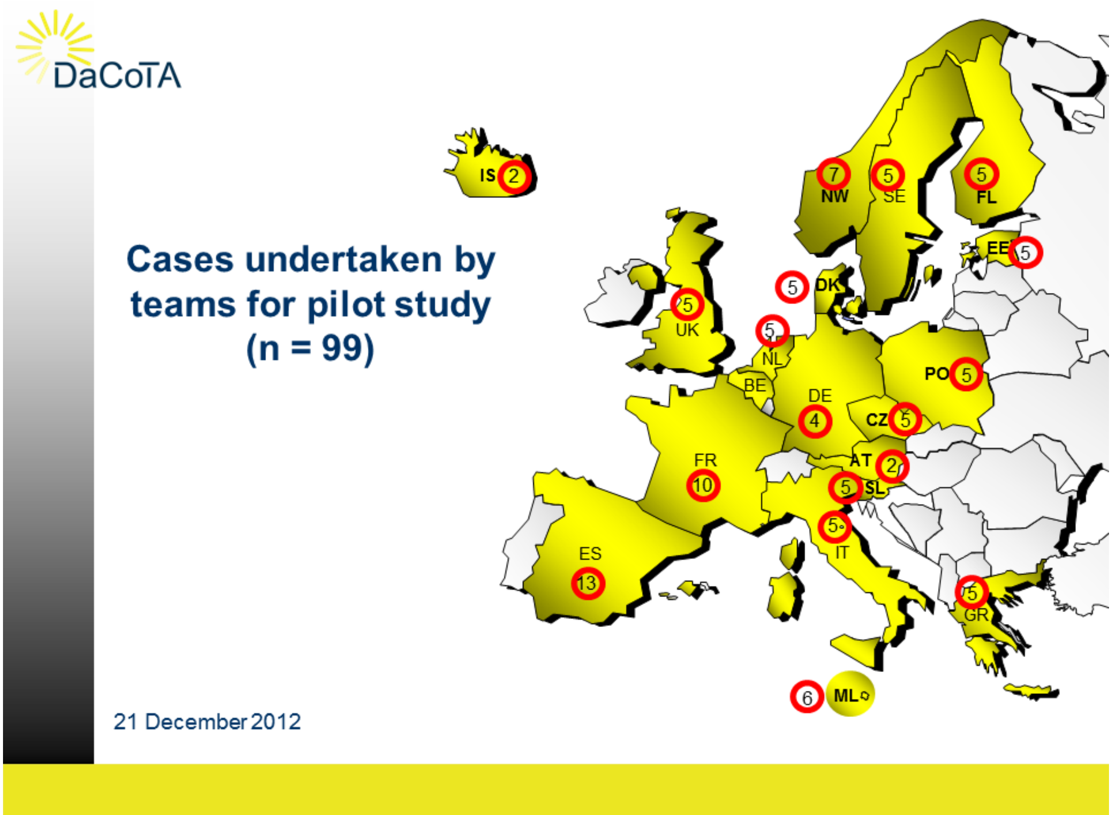


Figure 18 Cases collected by teams during the Pilot Study

In total, 99 cases were investigated by the teams across Europe as shown in the map above. Of these cases, 77 were entered into the database. On-scene investigations made up the majority of cases entered (46) while a smaller number of cases were investigated retrospectively (31).

The feedback obtained from the participating teams was encouraging and a testament to the viability of the methods developed in this project. Some challenges were still evident but these were common to work conducted in the area of safety. As shown below, the majority of teams in the Pilot Study were self-funded governmental and non-governmental organisations. A minority of organisations relied on DaCoTA (EU Project) funding, while some combined their resources with DaCoTA resources. Only 1 participating team was funded by the automotive industry.

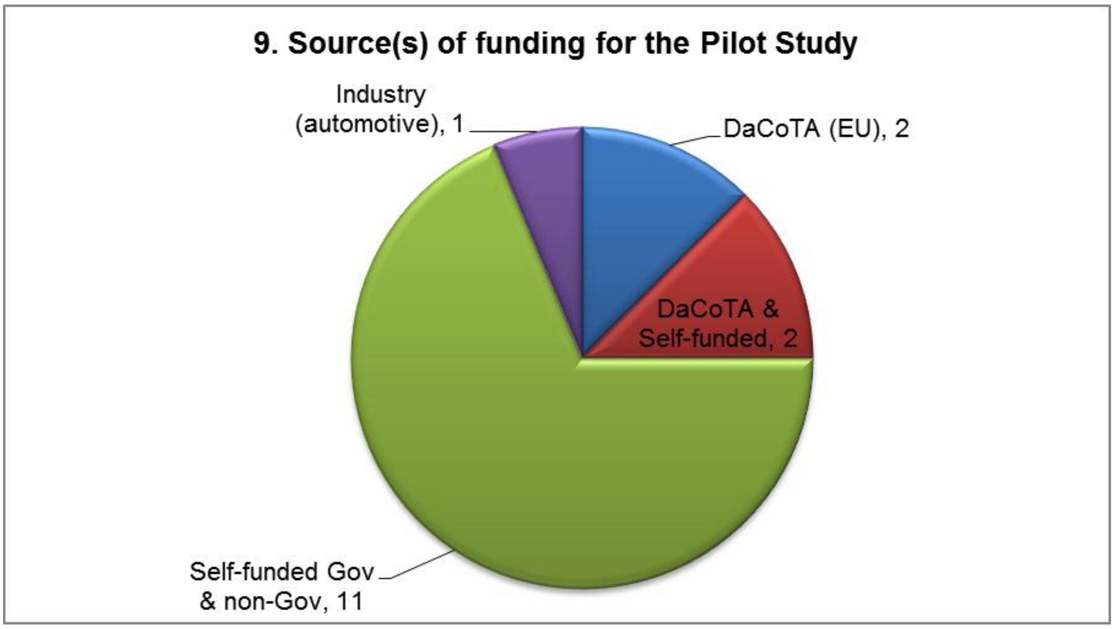


Figure 19 Sources of funding for the Pilot Study (n=16)

When asked whether they found difficulty in obtaining funding, 12 of 15 respondents indicated they found no difficulty, with only 3 partners finding difficulty in obtaining funding for this activity.

When it came to Case Analysis, about two thirds of the respondents were successful in completing the accident reconstruction section for their cases, but only about half were successful in completing accident causation and DREAM coding. It is worth noting that the difficulties encountered were rarely attributed to the DaCoTA system. Some of the perceived difficulty with the causation section was a result of the unfamiliarity of some teams with the process or the lack of appropriate software to assist in this task. Injury analysis was attempted and completed successfully by approximately a third of the teams (6/16), mainly due to a lack of access to medical data or experts in this area who can code it correctly.

In conclusion, a comprehensive, in-depth accident investigation methodology has been developed and tested as part of a full system ready for Europe-wide implementation. The participation and successful entry of cases by most of the team members is very encouraging for a future expanded network, especially after the feedback from this exercise was incorporated into the system.

3.6. Recommendations and Conclusions

DaCoTA Work Package 2's final product was to harmonize in-depth crash investigation protocols and develop tools to support the identified Pan-European Network of crash investigation teams who would prepare for investigations according to these harmonized protocols.

To achieve this a number of steps were taken. Research priorities and investigation teams cross Europe were identified as described in Chapters 2 and 3. The protocols were harmonised and presented as a methodology in an online manual [http://dacota-investigation-manual.eu]. A computer web application for input, storage and export of data was developed[15]. The online manual containing the methodology and the web application were linked and integrated into the “DaCoTA Crash Investigation System”. A training package was developed and the Pan European Network met for a week of training in order to harmonize procedures. The procedures were tested during a pilot data collection where each team investigated five accidents. The final part of the work was to review the results from the pilot study in order to find topics for further improvement.

The review was comprised of a case review by the core teams and a questionnaire concerning the experience all teams had during the pilot study. The results from the review and questionnaire were analysed and many issues were resolved within the project. Some issues are still open though and are presented below in brief.

3.6.1. General Recommendations

During the development of the Pan-European network, training week and pilot study important issues were noted.

- The support organisation around the methodology and the web application was very much appreciated and is essential to enhance data quality, receive case feed-back and act on it.
- The evaluation of the training package was well received with a mixture of theory and practice.
- New/inexperienced teams would benefit from training sessions provided by experienced teams.
- More exercises were required in drawing a scaled sketch of the crash. The information from the sketch is very important information when analysing the crash and for subsequent analysis.
- More focus should be directed to collecting human behavioural data.
- The link between the web-application and the online manual (where each variable has a direct link to the manual) has speeded up data entry considerably.
- Lengthy process to obtain medical and injury information – this should be anticipated for future studies.
- Not many teams have the ability to retrieve information on long term injury consequences but it will remain as an optional part in the methodology.
- Data protection is a delicate issue and it should be highlighted in the planning of any new activity. How data can be provided and distributed from all teams/countries should be clear. Many solutions exist to this problem and can be applied.
  - Date: only code year and season (e.g. Dec-Feb, Mar-May, Jun-Aug, Sep-Nov)
  - Time: only code intervals (e.g. 06-09, 09-12, 12-15, 15-18, etc.)
  - Geographical area: avoid use of city/area names or GPS coordinates.
  - Road environment: Never use any road names or numbers
- A thorough identification of priorities from research, policy and industry is important before data collection begins based on the identified priorities.
- Even if a joint data collection activity in Europe is not running it has proven important to continue the collaboration between the investigation teams. All teams learn from each other and the data ultimately improves.

[15] Full description available from the project website: http://www.dacota-project.eu/ (Deliverable 2.2)

3.6.2. Essential Improvements

Essential improvements include issues that need to be resolved before any new data collection activity based on this methodology starts. These issues were identified during the development and/or during the review but have not been resolved within the timeframe and/or resources of the project.

3.6.2.1. Methodology and Online Manual

- The online manual needs streamlining to ensure data quality.
- Road area: how to interpret and code the road area needs further development.
- Event type: the explanation in the manual needs to be extended to include which event should be coded and in which order.
- Core variables (those that need to be filled by all teams) need to be reviewed and fitted to the purpose of any new study.
- DREAM (see section 3.4.3): The web application needs to be updated to DREAM 3.2. The method for coding contributing factors to the crash was updated to version DREAM 3.2 during the project. The updated version was not implemented into the web application therefore DREAM 3.0 was used during the pilot.
- AIS injury coding: It is important for all teams to have trained personnel that use the same version of the AIS codebook (here AIS 2005).

3.6.2.2. Variables

- There are a number of variables options that are missing and need reviewing.
- Accident summary: all teams need to follow instructions on how to write informative summaries. The summary together with the sketch are two of the most important variables to quickly get an understanding of the crash.
- Some values available in the web application and the definition in the manual are not the same

3.6.2.3. Web Application

- Generally there were some issues in the application concerning the response from the server and the system was slow. During the pilot some parts of the application were still under construction and therefore slower than expected. When starting a data collection activity it is recommended that the storage system is thoroughly tested for best results.
- Guidance in the web-application: the web-application either need its own instructions on how to fill in specific variables e.g. “right click to add element” or requires a section in the online manual.
- Powered Two Wheelers: add option to input impacts
- Graphical User Interface (GUI): The “grids” (tables) that are built up in the web application when adding impacts, road components etc. should either be at the top of the page or the first row must always be automatically selected for viewing.
- Images and files: need to improve the access speed and incorporate the ability to view and download separate files.

3.6.3. Further Improvements

Desirable improvements are issues that would improve the DaCoTA Crash Investigation System but are not essential to use the tools developed.

3.6.3.1. Methodology and Online Manual

- Exterior images of the vehicle: It must be clearer which images (in which order) are essential for a case.
- Reconstruction: include guidance to use kinematic reconstruction and option in the coding of the crash.
- Vehicle crash profile measurements for calculating crash energy and speed change at impact (“C1-C6 measures”): suggest more detailed guidance on how to measure different deformation patterns.
- A draft telephone interview script was developed as part of the project but this requires optimisation.

3.6.3.2. Variables

- To explain how to code certain variables, examples may be added in the manual.
- It is worth considering if more variables could be automatically filled in due to another response of a previous variable to increase the automatic consistency checks for data quality.
- Date and time: due to data protection the exact date and time can be changed to seasons during the year instead and intervals during the day. Hours and minutes should be separated in the system to allow “unknown” to be coded.
- Traffic flow at accident time: Suggest changing the input from a numerical field to a list of choices that can be estimated at the scene (such as no traffic, moderate, heavy, saturated, unknown)
- Child Restraint Systems: should be automatically disabled in case of an adult person.
- More values should be added (such as novel vehicles), if needed, in the Sections “Vehicle type”, “Other vehicle.

3.6.3.3. Web Application

- Add percentage of progress indicator.
- Drop down lists: Should consider if the whole row of the short description needs to be available when viewing a case.
- Adding a spell checking facility to text fields could improve readability
- Adding a text search option would be useful to analysts.
- Sketching tool: an improved application can be sought and implemented (as long as it is open source software in keeping with the rest of the program).
- Text clarity: once a case is published, greyed-out text in some fields becomes hard to read.
- Length of text entries: some selected options are very long and cannot be viewed without referring to the online manual.

3.6.4. Conclusions

All the basic components for setting up the Pan-European Accident Investigation Network have been described in this document and a large scale trial of the system was presented along with the results of that trial and the positive feedback from participants. Beyond this project, a vision for the whole network has developed with the following:

- Common methodology (achieved)
- Investigating team network (achieved)
- Key operational requirements (achieved)
- Business model (still pending)

- Up to date research objectives (on-going)

Once the business model is in place this will enable the continued collection of in-depth data that can answer key research questions for all stakeholders and help Europe maintain a lead in road transport safety.

3.7. Acknowledgements

Special thanks go to the many individuals in addition to those named as authors who have contributed to this work from the following institutions:

- Belgium: Belgian Road Safety Institute (IBSR)
- Germany: Medical University of Hannover (MUH)
- Greece: National Technical University of Athens (NTUA), Hellenic Institute of Transport (HIT)
- Spain: Jefatura Central de Tráfico (DGT), Institute f. automobile Research (INSIA), Applus IDIADA, Foundation for Transport and Energy Research and Development (CIDAUT)
- France: French Institute of science and technology for transport, development and networks (IFSTTAR), Laboratoire d'Accidentologie (GIE RE PR)
- The Netherlands: Institute for Road Safety Research (SWOV)
- Sweden: Vehicle and Traffic Safety Centre (SAFER)
- United Kingdom: Transport Safety Research Centre (TSRC)

We are very grateful to all organizations who contributed to the pilot study during 2012. The core project partners were joined by other organizations to form the Pan-European In-Depth Accident Investigation Network. The partnership would like to extend our sincere thanks to colleagues from the following organizations for all their help and hard work:

- Austrian Road Safety Board
- Austrian Institute of Technology
- Technical University of Graz, Austria
- IDIADA Czech Republic
- Danish Road Traffic Accident Investigation Board
- Estonian Investigation Team
- Estonian Road Administration
- Finnish Motor Insurers` Centre
- Icelandic Road Accident Investigation Team
- Transport Malta
- Motor Transport Institute, Poland
- Norwegian Accident Investigation Board
- Norwegian Public Roads Administration
- Slovenian Traffic Safety Agency
- Volvo Car Corporation

The DaCoTA partnership would like to acknowledge the contribution of SAFER who developed the predecessor to the online manual. This system was given to DaCoTA for modification and use in its in-depth investigation activities.

4. DATA WAREHOUSE

Chapter authors: Yannis, G., Evgenikos, P. (NTUA)

For a more detailed report of Data Warehouse, see Deliverable D3.8 Data Warehouse – Final Report

4.1. Introduction

During the last two decades, the systematic efforts for gathering and harmonising road accident data at the European level have led to a significant upgrade and enhancement of the CARE database. Moreover, important data collection and harmonization efforts have provided very useful results as regards exposure data and safety performance indicators; however, the **availability, completeness and level of harmonization of this data varies significantly**.

At the same time, additional data and related information sources have been established at EU level, including in-depth data, behaviour / attitudes data, programmes and measures data, social cost data etc., mainly in the framework of European research projects. However, these data sources are still not of sufficient comparable quality, are still not sufficiently linked, and the aggregate data are not always accessible. Finally, an important amount of **national data remains unexploited** at European level.

And even though some European countries present a remarkable road safety level, being among the countries with the best road safety performance at global level, there are several constraints that do not allow for accurate road safety analyses at a European level. The lack of specific data and of related details (accidents, injuries, exposure, performance indicators, etc.), the data compatibility and comparability issues among the European countries and the low reliability of data in several cases are the most common problems that need to be confronted. Additionally, the **absence of standard methodologies** for data/information collection and analysis is observed, and through existing analyses correlations between various parameters are identified but not the causation of the accidents, thus analyses are not solution oriented.

On that purpose, **the necessity for systematic collection of road safety data and knowledge through a comprehensive tool is more urgent than ever**.

The expected outcome of DaCoTA WP3 was the establishment of a **solid but easily accessible, integrated road safety system** that will allow for road safety policy and decision making at all levels, to use a complete set of aggregate road safety related data (road accident data, risk exposure data, safety performance indicators, in-depth data, health indicators/data) and information (programmes, measures, legislation, social cost, behaviours/attitudes, regulations), supplemented by methodologies, analyses and benchmarking tools.

A **three-step methodology** was adopted for the development of this road safety data and knowledge tool:

1. Data and information assembly
2. Development of key road safety analyses and syntheses
3. Development of the Integrated Road Safety Knowledge System

4.2. Data and information assembly

As a first step existing road safety **data and information was gathered** from various national and international sources, initially directly from the sources and at a second phase through national Experts of the CARE/RSPI Experts Groups. On that purpose appropriate Master Tables were developed and were gradually filled-in for each European country.

4.2.1. Assembly of data

Road safety data gathered concerned: Road accident data from CARE, Risk-exposure data from EUROSTAT, IRTAD and national sources, data on Safety Performance Indicators, Health data/indicators from EUROSTAT and EU Injury database and In-depth accident data/indicators from the Fatal Accident Database and the Accident Causation Database.

Regarding **road accident data**, as they are already harmonised at the European level through CARE, the Community database with road accident data at disaggregated level, a list of **73 road accident elements** (variables and values) collected from all EU countries using a uniform protocol was established. The main criteria for the selection of these basic figures were that the combined variables and values must be useful for macroscopic road accident analysis at EU level, but also that they are available and reliable in all EU countries. This set comprises of the following basic figures regarding number of persons killed: total figures, pedestrians killed, total vehicle occupants killed by vehicle age group, passenger car occupants killed by vehicle age group, motorcyclists killed by vehicle age group, moped riders killed, cyclists killed, buses or coaches occupants killed, lorries or trucks occupants killed, killed in accidents with HGV, females killed by age group, male killed by age group, young drivers killed (18-24), young riders killed (15-24), older drivers killed (65+), children killed (0-14), men drivers killed, women drivers killed, non-national drivers killed, non-national riders killed, inside built up areas, in junctions, outside built up areas, on motorways, when raining, during daylight, during night-time, killed in single vehicle accidents, killed in alcohol related accidents.

With reference to **risk exposure data**, a first assembly through EUROSTAT and IRTAD took place and a list of **97 risk-exposure elements** was developed and included in the Master Tables: Population by age group, vehicle fleet by vehicle type and vehicle age, person-kilometres by vehicle type, vehicle-kilometres by vehicle type, vehicle-kilometres by road class, ton-kilometres, road length by road type, traffic per road type, economic and social indicators such as GDP, unemployment rate, fuel and alcohol consumption, etc.

Furthermore, data on selected **Safety performance indicators (SPI)**, reflecting the operational conditions of the road traffic system which influence the system's safety performance, have been gathered through the outputs of the SafetyNet project but also through the National Experts using the Master Tables, on the following topics. Regarding **alcohol and drugs** the SPIs are: % of fatalities resulting from crashes involving at least one driver impaired by alcohol, % of drivers above legal limit for alcohol in roadside checks, amount of roadside checks by the police, % of drivers above legal limit for drugs in roadside checks and amount of roadside checks. Regarding **speed** the SPIs are: average speed (during day or night), % of speed limit offenders, % of vehicles over speed limit by road type, speed limit by road type and average speeds by road type. Regarding **protection systems** for seat belt wearing the SPIs concern: Passenger cars - front seat (separated by driver and front seat passenger if available), Passenger cars - rear seats, Passenger cars - correct protection of children < 12 years, Heavy vehicles - front seat, Coaches - passenger seats, Daytime seat belt wearing rates for drivers, Daytime seat belt wearing rate on front seats of passenger cars and vans under 3,5 tons, Daytime seat belt wearing rate on front passenger seats of passenger cars and vans under 3,5 tons, Daytime seat belt wearing rate on rear seats of passenger cars and vans under 3,5 tons, Daytime usage of child restraints by children <12 years old and % of children totally unrestrained in cars.

For helmet use the SPIs concern: Cyclist helmets, Moped helmets and Motorcycle helmets.

Regarding **daytime running lights (DRL)** the SPIs are: total usage of DRL, usage rate of DRL per road type, usage rate of DRL per vehicle type, DRL usage by road type and total DRL usage.

Regarding **vehicles** the SPIs are: Vehicle fleet distribution by age, % of vehicle fleet tested by EuroNCAP, average EuroNCAP score for the vehicle fleet, vehicle fleet composition by vehicle type, crash worthiness, fleet age (median age), vehicle fleet composition (% of passenger cars, % of motorcycles and mopeds, % of public transport, % of other vehicles such as heavy goods vehicles and lorries), average EuroNCAP score 1994, age of passenger cars, SPI (combined vehicle age/EuroNCAP indicator), average percentage score of occupant protection for new passenger cars sold in 2008, average percentage score of pedestrian protection for new passenger cars sold in 2008, child protection of new passenger cars sold in 2008 and annual renewal rate of passenger cars in 2007 (percentage of new cars among all registered passenger cars).

Regarding **enforcement** the SPIs are: number of speeding tickets by the Police, amount of alcohol tickets by the police, amount of seatbelt wearing tickers by the police and amount of helmet use tickets by the police.

Moreover, harmonised data and information regarding **causation**, across a number of European countries, was used exploiting the in-depth SafetyNet Accident Causation Database. Data from 6 countries were collected in the SafetyNet project following a common methodology and, importantly, a detailed process for recording causation called the SafetyNet Accident Causation System (SNACS). This resource includes 1.006 cases split between Germany, Italy, The Netherlands, Finland, Sweden and the UK and was used to supplement the Basic Fact Sheets (BFS) with some basic causation data that can provide a top level overview of the topic being examined in the BFS. In the 2010 and 2011 editions, ten fact sheets had causation data added. To reflect the nature of the basic fact sheets, each causation section was limited to two pages with interesting points emerging for each topic. The causation section in each fact sheet started with a short introduction to the database, to make each fact sheets 'stand- alone'. For the 2012 edition a separate Basic Fact Sheet on Causation was prepared presenting basic information about the causes of accidents. It differs from other Basic Fact Sheets as the data is not currently expected to be updated, unlike the CARE database, so it provides a snapshot of accident causation factors. Nevertheless it illustrates some of the value that can be gained from the collection and analysis of in-depth accident data.

As combining road accident data with data on road accidents derived from the health sector can provide a better insight on the severity of the road accidents, but also on the identification of the appropriate measures to mitigate the impact of the road accidents, an assembly of **health data** took place in order to identify any indicators that could be incorporated into the DaCoTA system. Information on medical environment from EUROSTAT was exploited and the following health indicators were defined: Heath personnel by the type of personnel, hospital facilities and main causes of deaths. Additionally, in the 2011 edition of the Basic Fact Sheets a section 'Road Accident Health Indicators' was added to the Main Figures Basic Fact Sheet based on analyses of data from the EU Injury Database and in the 2012 edition, health indicator sections based on analyses of the EU Injury Database were added to nine of the Basic Fact Sheets.

Additionally, several other data useful for road safety analyses were gathered through the Master Tables. More specifically, data on **Underreporting** of casualties and data on **Country characteristics** (Area - km^2, amount of unused land - % of total area, average winter temperature of the capital city, average summer temperature of the capital city, annual precipitation level for the capital city (mm), population density and population living in urban areas.

4.2.2. Assembly of information

Road safety knowledge gathered for 27 European countries concerned: Road safety programmes in 30 European countries, 655 road safety measures identified for 34 different sub-categories (grouped in 4 main categories), with an exhaustive description and related information, 54 different traffic rules into 4 main groups (drivers, pedestrians, vehicles, emergency phone number), issues related to behaviour (self-reported) on Speeding, Drink driving, Protective systems usage, Overtaking, Driving through amber light, Giving way to pedestrians, Tailgating and attitudes towards risk taking regarding Alcohol and drugs, Speeding, Protective system usage. Finally, a review of road accident cost data and calculation methodologies.

For the selection of the information, the Basic Principles for the DaCoTA Data Warehouse were applied, namely:

- **Quality:** Data and information are made public only after thorough quality control (availability, reliability, comparability, etc.),
- **Transparency:** All data and information available to everybody, accompanied with the related meta-data (sources, definitions, etc.),
- **Independence**: Data, information and especially analysis results should be checked for their consistency and any bias should be properly highlighted,
- **Usability and Accessibility**: An advanced user interface should guarantee easy access to all data and information.

Appropriate templates were developed as checklists for every type of information to be collected and the data collection was carried out in three levels. Firstly, all international and National sources, research projects and any other available sources and links identified were explored and exploited. Secondly, the CARE/RSPI experts were consulted to validate and add any further information. Finally, in some cases missing information was collected through direct contact with national contacts.

Data on basic **road safety programmes** in 29 European countries were gathered and examined, and several elements such as the existence of a broad national road safety strategy with measurable targets, a specific national road safety plan with quantitative goals, the progress achieved, the responsible organization for implementing the safety strategy plans, etc. are considered. Additionally, information on Road Safety Management for the various countries was gathered through the Master Tables. More specifically, **27 relevant elements** were gathered regarding Key functions in road safety policy making, Road safety strategy or vision of the country, National plans and targets, availability of Road Safety Management components, Enforcement and Remarkable road safety policy issues.

Moreover, data on **road safety measures** in European and other countries were gathered and organised in respective categories, covering different road safety areas and geographical levels. Various data sources were used concerning mainly results from research projects (PROMISING, ROSEBUD, SUPREME, RIPCORD-ISEREST) and final reports/studies of CEDR, COWI and IRTAD. These measures were categorised into 4 main categories concerning Road User Behaviour, Road Environment, Vehicle and Road Safety Management consisting of the following sub-categories:

<u>1. Road user behaviour:</u>

Speeding, Alcohol, Seat belt, Helmet, Cell phone, Licensing, Physical examination of drivers, Child restraints, Pedestrian/ Cyclists, Education, Campaigns, Enforcement.

2. Road Environment

Traffic calming, Roadside treatments, Roadside guard rails, Junction layout, Junction traffic control, Signs, Road lighting, Infrastructure interventions, Maintenance, Infrastructure safety management.

3. Vehicle

Safety equipment (for motorcycles), Vehicle safety equipment, ITS, Trucks

4. Road Safety Management

Policy, Legislation, Road safety assessment, Road Safety Audits, Road safety inspection, Management of hazardous locations, Data Analysis, Post impact care, Trauma management

In total, **655 safety measures** were identified for the 34 different sub-categories and for each of them an exhaustive description and related information were recorded.

Information about **Traffic Rules** in the EU Member States was also gathered. Several rules were examined and a list of the most appropriate in terms of importance and EU availability was selected. In accordance with those arrangements, the data was divided into 4 groups: drivers, pedestrians, vehicles, emergency phone number. The scope of data collection was defined for each group and overall for the 4 categories 54 variables were defined and gathered for 27 Member States and Switzerland in an appropriate Table.

Several websites were reviewed (95) to find out the necessary information, such as the European Commission (DG MOVE), World Health Organization, International organizations (e.g. ETSC - European Transport Safety Council, International Transport Forum), Research Institutes, National sources as Ministry or road safety organizations. Each source and its data were evaluated and from each one the most reliable data were selected.

As information on how road users perceive rules, measures and behaviour in traffic can give additional insight in the public support for certain measures taken or to be taken and the self-reported behaviour also gives some additional insight in road user behaviour, related **data on road user attitude and behaviour** were selected and gathered. The SARTRE studies provided a good starting point for this information. The studies span a number of years (1996, 1999, 2003, 2011), the data are harmonised between European countries, and are updated.

From the SARTRE studies, the following issues were selected because they are relevant for road safety:

- Driver behaviour (self-reported);
- Attitudes towards risk taking.

4.2.2.1. Driver behaviour:

- Speeding frequency by road network type
- Drink driving frequency during last week (over the legal limit and driving with some alcohol)
- Protective system usage frequency by area type and road network type
- Red light (amber) running frequency
- Overtaking frequency in situations where it can just be made
- Tailgating frequency of too close following of the vehicle in front
- Giving way to pedestrians frequency

4.2.2.2. Attitudes towards risk taking:

- Alcohol and drugs information: a) agreement on freedom for people to decide for themselves how much they can drink and drive and b) agreement on more severe penalties for drink-driving offences. This information is also available by age group and gender.

- Speeding: agreement on more severe penalties for speeding. Information is also available by age group and gender.

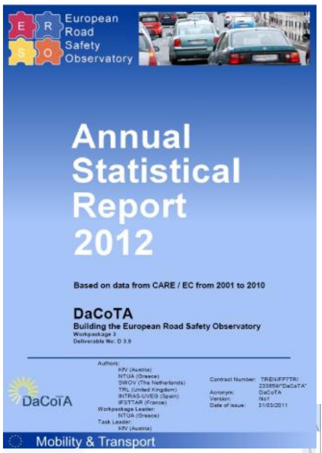
- Protective system usage: a) feeling of comfort when not wearing a seat belt and b) attitude towards the need of wearing a safety belt.

Moreover, as the costing of road accidents can also be envisaged as a tool of improvement of decision-making and a mean of classifying the politics, the projects, and the research regarding road safety, several existing studies and reports on **accident costs** calculation were reviewed and a synthesis report has been prepared, providing also recommendations for the harmonization of the calculation methodology between the countries.

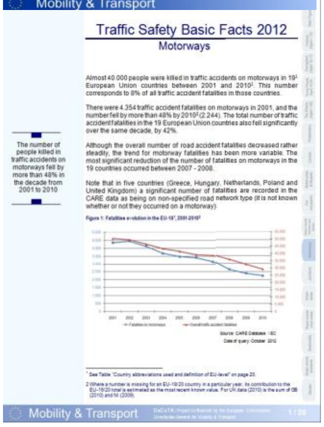
4.3. Road Safety Analyses and Syntheses

As a second step, **key road safety analyses and syntheses** were developed on the basis of the data/information gathered. Basic statistical outputs (Statistical Reports, Basic Fact Sheets) already developed using CARE accident data were prepared to be further used and disseminated together with the other DaCoTA results. These statistical outputs were gradually enhanced with additional non-CARE data that were gathered and included in the DaCoTA system (in-depth accident data, exposure data) and additionally, more Fact Sheets on new road safety related topics were developed. Other DaCoTA WP outputs (WP1 and WP4) were also included in the DaCoTA System, adding significant value to the “Countries”” section.

Three editions of the **Annual Statistical Report** were delivered (2010, 2011 and 2012) with 52 Tables and 26 Figures with the most interesting combination of selected road accident data related to: Person class, Person killed, Area type e, Motorway, Junction type, Weather conditions, Modes of transport, Month, Day of the week, Hour of day, from 27 European countries for a decade. The older Annual Statistical Report 2008 was used as the basis, but more recent road accident data from the CARE database, for more countries, were used in each edition. The last edition of the Annual Statistical Report 2012 provides the basic characteristics of road accidents for the period 2001-2010, on the basis of data collected and processed in the CARE database. The period 2001-2010 has been used in order to maximize the sample of data.



As access to the CARE database is only permitted to a restricted range of users, it has been important to develop a comprehensive range of publications based on these data that are accessible to the general public. The concept of the **Basic Fact Sheet** (BFS) with disaggregated road accident data for a decade on selected road safety topics, with worth-noticing comments outlined in the “highlight boxes” was developed, and progressively more Basic Fact Sheets are prepared and published annually. Within the framework of DaCoTA, three new editions were developed. The edition of the twelve (12) Basic Fact Sheets 2008 was used as the basis, but more recent road



accident data from the CARE database, for more countries, were used and also new content was gradually added. For the 2010 and 2011 editions five (5) new Fact Sheets have been developed, whereas in the 2012 edition another Basic Fact Sheet on Causation was included. The set of eighteen Fact Sheets is listed in the Table below. One part of the development has comprised adding details of accident causation to Fact Sheets where appropriate, based on in-depth accident data collected during the SafetyNet project, health indicators by the EU Injury Database, but also maps on specific road safety topics derived from the CARE system.

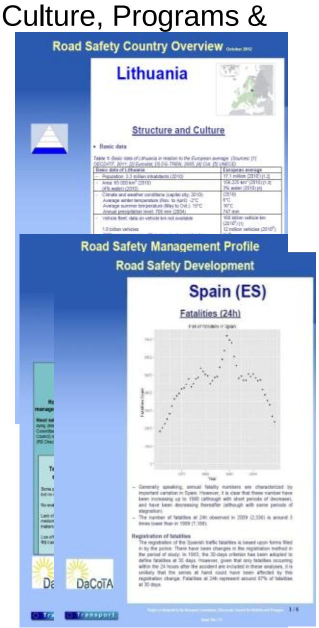
Titles of 2012 Basic Fact Sheets

	Basic Fact Sheet	Health indicators section	Causation section
Update and expansion of existing BFS	Main figures	Yes	No
	Children (aged<15)	Yes	No
	Young people (aged 18-24)	No	Yes
	The Elderly (aged>64)	Yes	Yes
	Pedestrians	No	Yes
	Cyclists	Yes	Yes
	Motorcycles & mopeds	No	Yes
	Car occupants	Yes	Yes
	Heavy Goods Vehicles and Buses	No	Yes
	Motorways	No	No
	Junctions	No	Yes
	Urban areas	No	No
New BFS	Youngsters (age 15-17)	Yes	No
	Roads outside urban areas	No	No
	Seasonality	No	No
	Single vehicle accidents	No	Yes
	Gender	Yes	Yes
	Accident Causation	No	-

Additionally, during the preparation of the Basic Fact Sheets (BFS) and the Annual Statistical Reports (ASR) a short document was prepared by one of the partners (TRL) setting out guidelines (**design principles**) that are to be followed when a Basic Fact Sheet is drafted or redrafted in the future, as more uniform style was desirable. Some of these issues also arise with the Annual Statistical Report. The guidelines are based as far as possible on scientific principles. In order to achieve consistency, however, it has been necessary to make rather arbitrary choices in some cases.

In order to facilitate road safety level comparisons between countries, **Country Overviews** were developed in DaCoTA Decision Support (Chapter 5) for each country, in which all layers of the Road Safety Pyramid are covered, related to: Structure & Culture, Programs & measures, Road Safety Performance, Indicators, Road Safety Outcomes, Social Cost. There is also a synthesis section where the safety position of the country is recorded, the scope of the main problem is noted and any recent progress and any remarkable road safety policy issues are presented.

Additionally, the data and information gathered allowed for the preparation of the **Road Safety Management Profile** for each European country within the framework of DaCoTA Policy-making and Safety Management Processes (Chapter 2). ‘Snapshot’ of the country’s road safety management system are included, based also



on coded answers to questionnaire and comments of governmental and independent Experts, interviewed in the first quarter of 2012. An overview of road safety management good practice elements is presented, structures, processes & outputs are described according to the policy-making cycle and various Notes & Observations are recorded regarding policy orientation, medium-level intersectoral coordination, stakeholders' consultation, funding, monitoring and reporting, relations between national/regional level and knowledge production & use.

Moreover, data and information gathered was exploited by DaCoTA Decision Support for the estimation of road traffic fatalities based on time-series analysis, as it is important to know in what direction the annual casualties are developing, and how fast this development is expected to go. In the **Country Forecast Fact Sheets** the road traffic fatalities, the traffic volume and the fatality risks are forecasted to 2020 and also forecasts according to mobility scenarios are carried out for all 30 European countries, with exposure as most important explaining variable. Forecasts of the road safety situation in every country include a description of the method adopted to produce these forecasts.

Finally, syntheses on key road safety issues were prepared in the form of **22 web texts**, containing high quality information on important road safety topics. The information is scientifically founded, easy to read and ready to use and for each of the subject treated, the information consists of an overview of the magnitude of the problem, prevalence and countermeasures. The subjects are broadly related to: Age groups, Road users, Hazardous behaviour, Post-crash, Road safety measures and Policy issues. All these web texts were initially developed in SafetyNet and updated in DaCoTA, under supervision of an editorial group (SafetyNet) and editorial board (DaCoTA), both consisting of international road safety experts, who were responsible for producing the information about a specific road safety subject. Both editions of the web texts (SafetyNet and DaCoTA) are included in the DaCoTA System.

4.4. Integrated Road Safety Knowledge System

At the last, third step, an **Integrated Road Safety Knowledge System** was developed as a comprehensive and integrated road safety information system with aggregate data and information consolidating, organising and making available existing data and information, necessary for the support of road safety decision making in Europe (see Figure 20 below).

Figure 20: Integrated Road Safety Knowledge System

The purpose of this DaCoTA System is to provide a web-based system containing in a structured way specific outputs of DaCoTA (statistics, interactive data, knowledge and tools), which will be gradually transferred into the European Road Safety Observatory (ERSO) of the European Commission (EC). It is a pilot system, in which different types of road safety data and knowledge were included and respective structures were tested, allowing their future exploitation into the EC ERSO system by giving easy access to data, information and tools, and thus supporting the road safety policy making in Europe.

The DaCoTA system is meant to serve any person who is interested in the data, information and tools that are made available. More specifically, persons using the system will be those interested in road safety related issues, in conducting their own analysis on basis of this data, or in comparing the performance of countries to determine what can be done to improve road safety. For those users who want to do their own analysis, it means that a certain level of knowledge of the quality and analyses of road safety data and tools is required. It is therefore expected that the users of the DaCoTA system will consist of policy makers, researchers and press. Based on the stated objectives and the target groups, the DaCoTA system was designed to meet certain specifications: the data should be easily accessible and also be as interactive as possible.

In terms of content, the DaCoTA System contains the following:

- Safety issues
- Countries
- Statistics
- Methods
- Links

The **safety issues** part is the knowledge base meant for the European Road Safety Observatory of the European Commission, where the user can find high quality information on important road safety issues in the form of web texts. The information is scientifically founded, easy to read and ready to use. For each of the subject treated, the information consists of an overview of the magnitude of the problem, prevalence and countermeasures. The subjects are broadly related to Age groups, Road users, Hazardous behaviour, Post-crash, Road safety measures and Policy issues.

Moreover, in order to help policy makers and researchers to have a good view of the road safety state of European countries, a number of **country tools** have been developed within DaCoTA. More information about the road safety state of a country, including costs, SPI's, measures, culture and context can be found in the Country Overviews. Furthermore, Forecasts for each European country and for Europe as a whole were developed and included in the DaCoTA System, indicating in what direction the annual casualties are developing, and how fast this development is expected to go. Forecasts of the road safety situation are made for all 30 European countries, with exposure as most important explaining variable in every country, including a description of the method adopted to produce these forecasts.

The **statistics** part contains road safety related data and important information on what to do with crash data. The data is organised either as part of an interactive data browsing tool (e.g. crash and exposure data) or as static data (ASR BFS, data about Safety Performance Indicators and driver behaviour/attitude).

Interactive data browsing tool contains for the time being crash data and exposure data, while **static data** contain:

- Annual statistical reports
- Basic fact sheets
- Data about performance indicators
- Data about Attitudes and self-reported behaviour

To get high quality data, information and well-structured tools, for each road safety product included in the DaCoTA pilot System a respective **methodology** has been developed and is described. The procedures of gathering safety issues and collecting information for the country tools are presented, as well as the procedure for collecting statistics and the related information (meta-data) and in-depth accident investigation.

Additionally, a complete set of **links to external files** is developed, gathering, linking and standardising road safety data as well as other sources, by providing reciprocal web links. The type of information that can be disclosed includes National data files, International data files, Research project links and Stakeholder links. The list includes the link to the website, a brief description of the organisation, project or database. Also the country and the type of link are specified and can be used to search. In total, more than 400 links are organised in several user-friendly ways, allowing the users to search for the information/data they need by Alphabetic order, Country, Focus (each divided by sub-categories) and Organisation.

Regarding the **functional specifications** of the System, these have been defined within WP4, in consultation with the CARE Experts Group. The Cognos PowerPlay was used as software allowing the development of a full-fledged data browser tool within the budget and the time available in the project. The Cognos PowerPlay software was used only in the framework of the DaCoTA project for the development of the DaCoTA pilot system and consequently the European Road Safety Observatory (ERSO) will on one hand exploit the experience of the development of this pilot system (structure, features, etc.) and on the other hand will acquire all data and knowledge contained in this pilot system to be incorporated at the ERSO under the ERSO structure and functionalities (web intelligence).

The delivered DaCoTA System is operational since mid-2012 (http://safetyknowsys.swov.nl) and can now be used as a point for discussing the usefulness of such tool and the wish to have it elaborated further into a full-grown ERSO-tool with the EC. The further development of the system can take place at a later stage, outside the DaCoTA project life-cycle.

For further information please see D3.7 Design and development of the road safety data warehouse – Final Report.

4.5. Next steps

The proposed DaCoTA pilot system can serve as example for the further **enhancement of the European Road Safety Observatory** (ERSO), as new structures and features were tested during the development procedure and new data, knowledge and analyses outputs have been assembled and have become available for incorporation into the existing ERSO.

Next steps for the improvement of this road safety data and knowledge tool concern carrying out more surveys for collection of exposure data, development of additional performance indicators and detailed recording of driver behaviour. These should be supplemented by more large scale experiments on in-depth accident investigation, naturalistic driving and driving simulator, **more research and analyses**, enabling the identification of more solutions to real life problems, thus leading to a more rigid European Road Safety Observatory.

Decision making of national and international Authorities and Stakeholders will benefit a lot from the operation of a powerful European Road Safety Observatory making available complete data sets and targeted road safety analyses and syntheses. More data and more knowledge widely available will progressively lead to the continuing reduction of casualties at the European roads.

5. DECISION SUPPORT

Chapter authors: Martensen, H. (IBSR), Dupont, E. (IBSR), Aarts, L. (SWOV), Bax, C. (SWOV), Twisk, D. (SWOV)

See also Martensen, H. & Dupont, E., (2012) Final report Work Package 4, Deliverable 4.10 of the EC FP7 project DaCoTA

5.1. Introduction and Objectives

The DaCoTA project aimed at providing policy makers with adequate data, information and tools for performing evidence-based policy making. In earlier and current EU projects, a rich variety of data, information and methods has been gathered and will continue to be gathered. In this context, the goal of Work Package the Decision Support Work Package was to make this stock of knowledge accessible and directly useable for the development of road safety policy and decision making. Decision Support therefore: (1) exploited the data available for analysis by providing forecast of the road safety situation in the different member states and (2) worked on the development of ready-to-use instruments. Tools that were well-appreciated in the past, such as overview fact sheets, or web-texts were up-dated and standardised. The use of standard methods was complemented by research activities to generate new tools like the national forecasts or the composite road safety index. All these activities were conducted in close communication with the user-group itself, the policy makers or those who directly support them.

Three general activities were undertaken: (1) contacts with the target group - decision makers and other actors directly supporting road-safety decision making - for input and feedback about the products developed, (2) the analysis of new data collected in the Data Warehouse, more specifically for the forecasting of fatality numbers in the different member states, and (3) the collection of existing knowledge to form tools for policy support. In the following sections, we will give a detailed description of these activities.

5.2. Decision support feedback group

To ensure the usability of tools that are designed to help policy makers in a knowledge-based decision process, it is essential to carefully register the needs of the target group and to re-check the usability of the emerging products. The design of the tools therefore took place in constant interaction with potential users of these products.

5.2.1. Evaluation of available panel

The European Road Safety Observatory is closely linked with a panel of road safety experts that is entertained by the European Commission. For each country, there are two types of experts: an expert on the road safety statistics and an expert on the safety performance of the country in question. This group has been established to build up the CARE database in which all fatal road crashes in Europe since 1991 are registered. Due to the theoretical work in EC projects like SUNflower and SafetyNet, it was recognized that more knowledge is needed on countries´ road safety performance (e.g., the amount of speeding, drunk driving, seat belt usage, etc.) to take a more proactive position. The original group of “CARE experts” was therefore extended to experts on road safety performance indicators and is therefore called the “CARE/RSPI” group.

At the beginning of the DaCoTA project, it became clear that an additional step was necessary to gain knowledge about the type of scientific information and tools needed in road safety policy making. This is essential for the Work Package on road safety policy making, but also for the work of Decision Support to design the tools that should serve policy makers in the most accessible way.

The first step was therefore to map the expertise of the CARE/RSPI group and to evaluate to which extent they would be able to answer questions about policy makers and policy making. On the basis of a questionnaire, it was investigated who would be the suitable target group for questions about policy making (if not the CARE experts themselves, they indicated another person better suited). On the basis of the results, a panel composed – for each country - of a road-safety expert and of an expert involved in decision-making processes was set up.

5.2.2. Registration of policy makers needs

A consultation was launched for the preliminary assessment of knowledge, data and analysis needs within road safety management for evidence-based road safety decision making in the European countries. The results identified specific needs for knowledge, data and tools, which will be taken into account for the creation of useful and relevant road safety decision support tools (Decision Support) and the development of a knowledge system (Data Warehouse)[16].

Two parallel consultation methods were implemented; the first concerned semi-directive interviews carried out by partners from the Policy-making and Safety Management Processes and Decision Support work areas with members of the panel mainly from their own countries. The second concerned a request for written contributions (procedure adopted in case of language or time constraints). Particular emphasis was given to the open nature of the questions, both within the interviews and the written contributions, allowing the experts to describe their own experiences, views and messages and to put emphasis on the issues they consider themselves important, without being "directed" by a detailed questionnaire to specific judgments.

The consultation provided a wealth of information on all aspects of road safety management in the European countries. A synthesis of the results of this open consultation was carried out by means of a predefined matrix. In this matrix, the basic road safety management tasks (fact finding, program development, implementation, monitoring, evaluation, etc.) cross-tabulated with distinct categories of needs (knowledge needs, data needs, methodological needs, tools needs etc.), allowed to link specific aspects of road safety policy making to specific benefits from using the necessary knowledge, data, methods and tools.

First of all, the need for setting ambitious yet realistic targets for the improvement of road safety was confirmed. As regards the development of road safety programmes and the selection of measures, a need for methodological advances was identified, including the improvement of cost-benefit and cost-effectiveness analyses, so that they can serve both for setting priorities and for assessing the combined effects of road safety measures. Moreover, the creation of handbooks and databases with accumulated international experience on the evaluation of measures was proposed, with emphasis on the country-specific conditions necessary to take into account in order to reach the maximum benefit of each measure.

With respect to the planning and implementation of road safety programmes and measures, the need to gather the available information from the international experience of measures implementation was frequently expressed. In particular, the information and data on the

[16] Moreover, this preliminary consultation of the Experts Panel served as a first step towards the full assessment of current practices and future needs of knowledge-based road safety management, that was to be carried out later on by means of a broader consultation of stakeholders (Policy-making and Safety Management Processes area))

procedures, the conditions, the time frame and the costs for implementing the measures need to be made available at European level.

Furthermore, the monitoring and evaluation task is considered to be most essential, not only for assessing the effectiveness of road safety measures, but also for identifying needs for further improvement. Several methodological needs were also mentioned, including the need for standardized assessment tools (statistical models, analysis techniques etc.), that will allow for the identification of the reasons and mechanisms leading to the observed safety effect of the measures.

Finally, a number of issues concerning the availability and quality of data for knowledge-based road safety management were outlined. They include the need to address the injury under-reporting problem at European level, the need for improved methods for determining accident locations by means of GIS technologies and tools, the need for improved exposure data, for increasingly reliable behavioural data and the need to promote the collection and use of in-depth accident investigation data. The Experts also stressed the need for road safety databases of different types (accident data, health data, exposure data etc.) to be linked and to be made more accessible.

For more details on the policy makers´ needs investigation, see

Muhlrad, N, Dupont, E (Eds.) (2010): Consultation of a panel of experts on the needs for data and technical tools in road safety policy-making, Deliverable 1.1/4.1 of the EC FP7 project DaCoTA.

5.2.3. User-based revision of tools

All output generated in Decision Support was constantly monitored by the road-safety experts of the CARE/RSPI groups. The members were involved in the whole production process. They were regularly consulted at all stages of the production process, and asked to comments on draft versions of tools produced for the different member states (forecast factsheets, country overviews…). Due to this, the CARE-RSPI experts strongly contributed to the design, the content, and the final appearance of all products.

5.3. Analysis and forecasting

The frequency of accidents and the number of fatalities evolve over time. In fact, the number of fatalities has decreased in most European countries in recent years. It is important to monitor these developments, focusing on a number of key questions

Has there been a continuous, smooth development or were there abrupt changes?

If there have been changes, are they to be attributed to changes in the actual risk of having (fatal) accidents, or rather to changes in traffic volume?

Where does the present development get us (if continued)?

The yearly number of road traffic fatalities in the different European countries is available in the CARE database. Road safety fatalities – although by no means the only interesting measure – are the key measurement to analyse and compare the development of road safety across countries, because they are less susceptible to underreporting than other measures.

5.3.1. The forecasting model

For the work done in this task, **fatality risk** is a key concept that is assumed to underlie the observed fatalities. Generally speaking, risk is defined as the occurrence of an unwanted event (here dying in a road crash) considered relative to the *exposure* to this risk (here the mobility in a country, usually measured by vehicle kilometres). It is important to consider the risk trend, because it shows to what extent the rises and falls in the development of road traffic fatalities are to be considered a “simple” consequence of the changes in mobility, and to what extent they have to be attributed to changes in the fatality risk.

The Latent Risk Time-series model is an advanced statistical model that allows monitoring the fatality risk. The forecasts of these models are in fact a combination of forecasts of the fatality risk and forecasts of the mobility. This statistical model is tailored to the evaluation of road safety developments, but had not been implemented as a modelling software so far. The first step was consequently to implement the model in the framework of a free statistical software package (R), and to make it available to other interested researchers by the same token. The underlying theory, the guide through the software, a step by step instruction to conduct the analysis, and a number of exemplary analyses are available in

Martensen & Dupont (Eds.) 2010. Forecasting road traffic fatalities in European countries: model and first results. Deliverable 4.2 of the EC FP7 project DaCoTA.

5.3.2. Forecasting fatalities in European countries

Once the method and software to analyse the development of fatality risk were available, a number of important decisions had to be made before producing the forecasts for the different countries.

5.3.2.1. Choosing the right model

The quality of the estimation of the fatality *risk* depends crucially on the quality of the mobility estimator. If the chosen mobility indicator does not accurately reflect mobility, the estimation becomes flawed. The danger is then that changes in the number of fatality (e.g. a drop in fatalities) would be confidently attributed to changes in the fatality risk (i.e. safer roads), while in fact they may only be a consequence of a reduced mobility. We had some indication that this could be a problem for several countries. The question therefore was: “How to evaluate the quality of a mobility indicator?”

The method to test this was to evaluate whether changes in mobility could actually be traced in the development of the fatalities. Although there can be other factors that affect the number of fatalities (i.e. a change in risk), a sudden decrease or increase in mobility should be seen in the development of the number of fatalities. The procedure and results for testing whether this is the case are described in Dupont, E. & Martensen, H. (Eds.) 2012. Forecasting road traffic fatalities in European countries. Deliverable 4.4 of the EC FP7 project DaCoTA.

It turned out that in 14 of the 30 countries, no influence of mobility could be observed, and consequently it was decided to analyse the development of the road fatalities without including an exposure indicator in the model.

5.3.2.2. What to do about the recession?

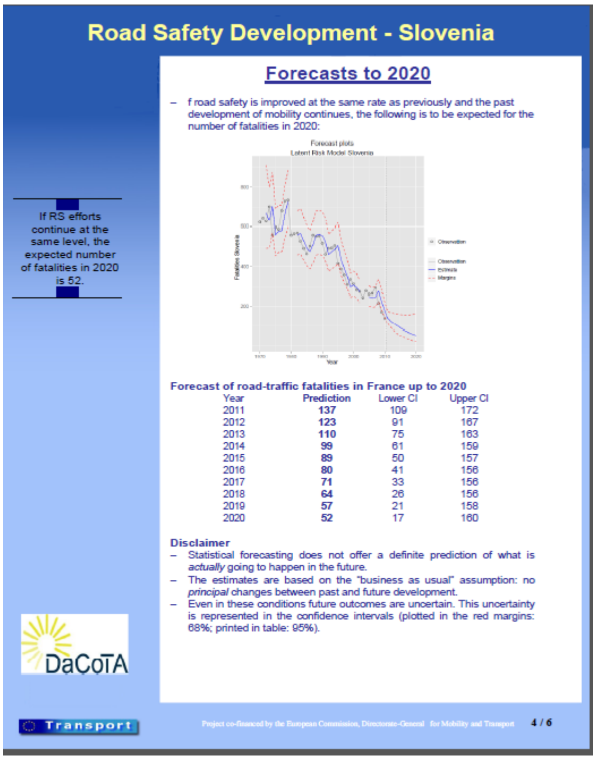
The most recent figures for most countries concerned the year 2010. For many countries there had been a sharp drop in fatalities since the year 2008 and there is reason to suspect a relation with the economic recession that started in the end of 2007. The investigation of similar phenomena in the past indicated that it is unlikely that these drops will continue as steeply in the future. There are different techniques to deal with this (described in D4.4) but it comes down to the choice between two evils: (1) being very conservative and therefore running in danger to ignore some real progress that has been made in road safety in the recent years or (2) to come up with overconfident forecasts that assume a continuation of the most recent trends that is probably unrealistic. Generally, we opted for the more conservative approach, however, for 7 countries (AT, IT, RO, ES, UK, CZ, LT) this was not possible and the forecasts for these countries must be considered very optimistic.

5.3.2.3. Presenting the forecasts

The methods applied to achieve the forecasts are sophisticated statistical tools, not easily understood by non-experts. The forecasting results however, are of direct interest for road safety practitioners with all levels of statistical expertise. We therefore decided to have two different types of report for each country:

The *full report* is a technical description of the forecasting model and of the process that lead to its selection. These detailed country reports are written for experts with an understanding of the statistical principles underlying latent state modelling (see D4.2).

The *forecast factsheets* are meant to give a relatively non-technical description of the past development of the fatalities (and of the exposure if available). If known, the (possible) reasons for the developments are shortly described. The forecasts of the fatality numbers up to 2020 (assuming the continuation of the past development!) are also provided. Whenever an exposure measure of the necessary quality was available, an estimation of the fatality risk is presented along with three scenarios based on different assumptions for the development of mobility in the next 20 years.



Road Safety Development - Slovenia

Forecasts to 2020

If RS efforts continue at the same level, the expected number of fatalities in 2020 is 52.

– f road safety is improved at the same rate as previously and the past development of mobility continues, the following is to be expected for the number of fatalities in 2020:

Forecast of road-traffic fatalities in France up to 2020

Year	Prediction	Lower CI	Upper CI
2011	**137**	109	172
2012	**123**	91	167
2013	**110**	75	163
2014	**99**	61	159
2015	**89**	50	157
2016	**80**	41	156
2017	**71**	33	156
2018	**64**	26	156
2019	**57**	21	158
2020	**52**	17	160

Disclaimer

– Statistical forecasting does not offer a definite prediction of what is *actually* going to happen in the future.
– The estimates are based on the "business as usual" assumption: no *principal* changes between past and future development.
– Even in these conditions future outcomes are uncertain. This uncertainty is represented in the confidence intervals (plotted in the red margins: 68%; printed in table: 95%).

Transport

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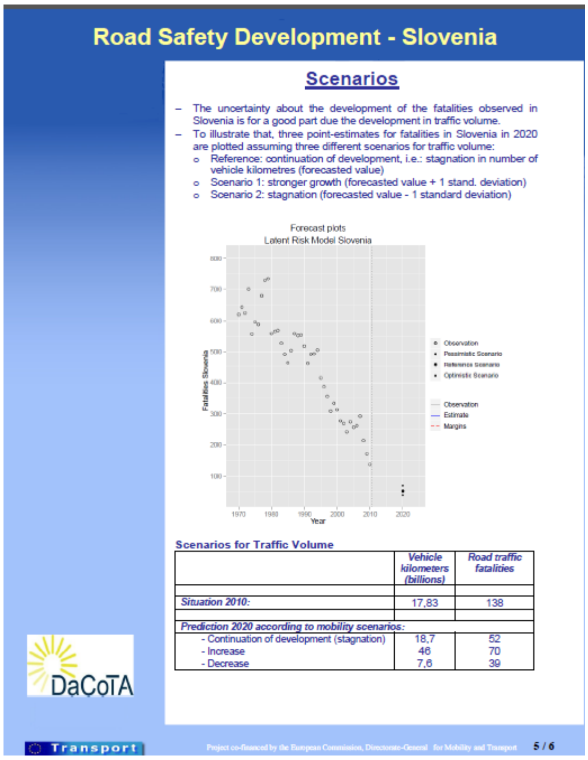

Road Safety Development - Slovenia

Scenarios

– The uncertainty about the development of the fatalities observed in Slovenia is for a good part due the development in traffic volume.
– To illustrate that, three point-estimates for fatalities in Slovenia in 2020 are plotted assuming three different scenarios for traffic volume:
  - Reference: continuation of development, i.e.: stagnation in number of vehicle kilometres (forecasted value)
  - Scenario 1: stronger growth (forecasted value + 1 stand. deviation)
  - Scenario 2: stagnation (forecasted value - 1 standard deviation)

Scenarios for Traffic Volume

	Vehicle kilometers (billions)	*Road traffic fatalities*
Situation 2010:	17,83	138
Prediction 2020 according to mobility scenarios:		
- Continuation of development (stagnation)	18,7	52
- Increase	46	70
- Decrease	7,6	39

Transport

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5.3.3. Towards an European forecasting model

The example of the recession had shown us that it is very important to look at the development of the number of road traffic fatalities (or other outcomes) in the European countries in parallel. After the recession had started, we saw a drop in fatalities that occurred in different countries in a similar way. This example shows that it is interesting to look for certain prototypical developments that were shared to varying extent by several countries. In

D4.7, we explored the possibility to formalize this approach and to express the development in different countries each as the sum of the *same underlying prototypical developments*. For each country, the prototypes would be weighted in a different way, which leads to the different developments that we actually observe. The technique proposed is based on macro panel analysis methods and is situated in the front-line of research concerning the analysis of data that is simultaneously related over time and across units (e.g., countries).

5.4. Tools for policy support

A lot of information has been collected within DaCoTA and other European projects. This ranges from databases to analysis results, best practices and software. The aim of this task is to take the necessary steps to make this information accessible to policy makers.

The focus of the products in this task is the presentation of knowledge in topical form, on the one hand, and on using the data collected from WP3 (data warehouse) on the other hand. All information and tools are meant to be included in the European Road Safety Observatory.

5.4.1. Updating and adding web texts

One of the valuable products that were initialised in SafetyNet, are the web texts on a number of relevant road safety issues. Within DaCoTA, these web texts have been updated and also a few issues have been added. Another aim regarding the web texts was to organise them better in order to prevent problems when they are transferred to ERSO.

The information in the web texts 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.

In order to guarantee the quality of the web texts and the state-of-the-art of the updates, a sound production and controlling procedure has been set up. In this procedure, experts were asked to write or update the text, and this was done under supervision and responsibility of an editorial board.

In DaCoTA, the following highly esteemed experts were member of the DaCoTA Editorial Board, which was chaired by Divera Twisk (SWOV Institute for Road Safety Research):

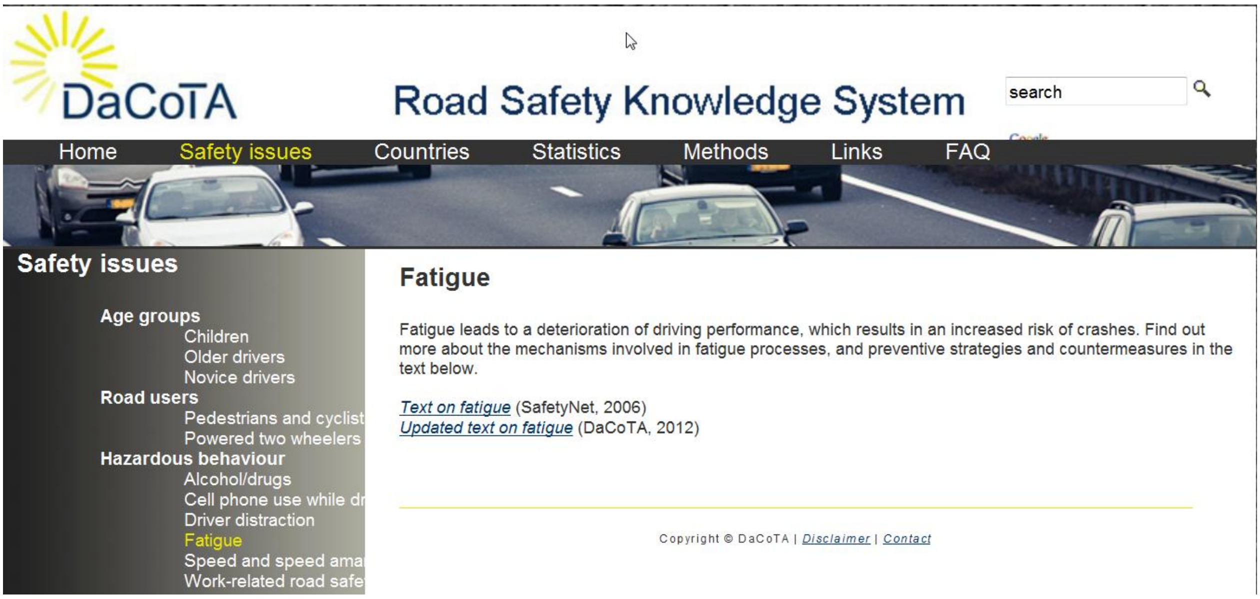
- Rune Elvik, TOI, Norway
- David Lynam, TRL, UK
- Ralf Risser, Factum, Austria
- Claes Tingvall, Swedish Road Administration, Sweden
- Pete Thomas, TSRC Loughborough university, UK

The topics that are covered by the web texts are:

- Age groups
    - Children
    - Novice drivers
    - Older drivers
- Road users
    - Pedestrians and cyclists
    - Powered two wheelers
- Hazardous behaviour
    - Driver distraction

- Cell phone use while driving
    - Fatigue
    - Alcohol/drugs
    - Speed and speed management
    - Work-related road safety
- Post-crash
    - Post impact care
    - E-safety
- Road safety measures
    - Roads
    - Speed enforcement
    - Vehicle safety
- Policy issues
    - Quantitative targets
    - Cost-benefit analysis
    - Safety ratings
    - Road safety management
    - Integration of Road Safety in other policy areas
    -

The organisation of the web texts in relation to ERSO has been tackled by transferring the original web text format into an interactive pdf-format. This enables users still to navigate within the text, but also to use the texts as print-out for other uses. A short introduction of the problem has been added in the website to attract the attention of the user to the text and to indicate the relevance of the issue at hand.



5.4.2. Functional specification and evaluation of browsing tool for data-warehouse

Within DaCoTA, a data-warehouse (Chapter 4) has been set up in which products of Decision Support and other Work Packages have got their place in a user friendly environment. In this subtask of Decision Support, the aim was to define functional specifications that could be used as guidelines by producing a data browsing tool (DBT).

In the functional specifications of the DBT, user groups as well as types of data have been defined. Also the importance on information on the data at hand has been emphasised:

meta-data. Finally, functional aims have been defined: data should be easily accessible and interactive and meta-data should be visible as well. In the final data-warehouse that has been built within DaCoTA (the Safety Knowledge System), these functional specifications were met as far as possible. For some data that was available, there was no use in making them interactive. These data are then presented in fixed format. Also, a few examples of meta-data have been implemented.

5.4.3. Specification and implementation of country overviews

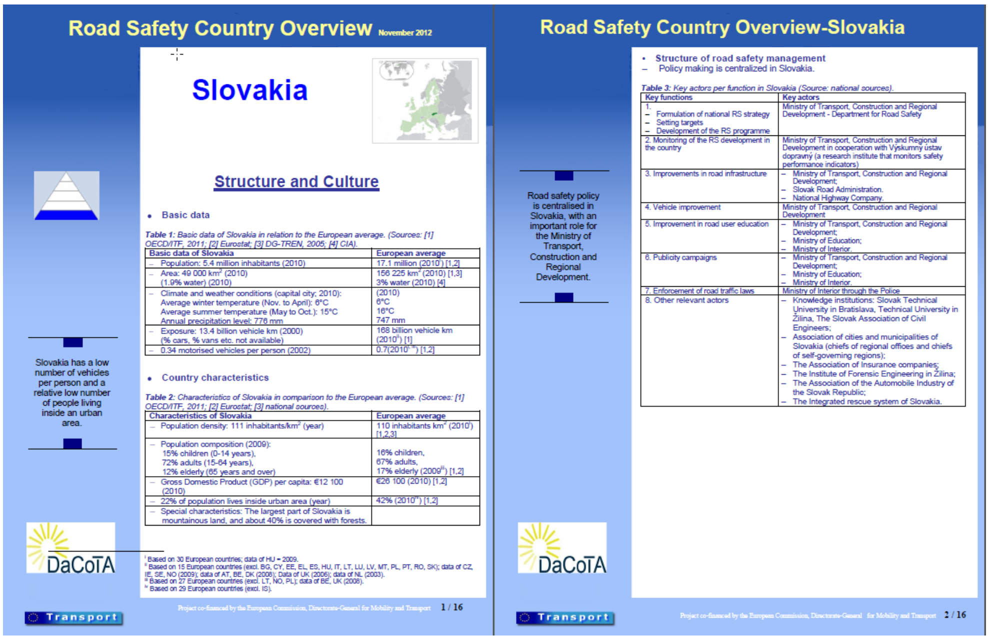
To help policy makers and researchers to have a good view of the road safety state of European countries, country overviews of all 30 European countries have been developed. Furthermore, a meta-document has been produced to give some background information on definitions and calculations used.

The country overviews not only present the current state of road safety in terms of annual number of crashes or traffic victims, it also contains information on precursors for crashes, such as behaviour and policy in a country. This information is organised by using the road safety pyramid as theoretical framework:

The overviews start with a presentation of basic facts of a country, the organisation in relation to road safety and attitudes of the drivers, presenting the structure and culture layer. Next, the road safety goals, vision, actions and programmes are mentioned following a fixed format. The data for each country are provided along with a European reference (European average or mode) whenever the information is available. Road-user behaviour and other system-quality characteristics of the country are described in the safety performance indicators part. It contains information on speed, drink driving, vehicle safety, and use of protective systems. The next part contains a description of the annual number of road deaths and their characteristics, such as road transport mode, age and gender, location, lighting and weather conditions, and crash type. Numbers are provided for 2001 and the last year available (2009, 2010 or 2011). The average annual change and the share of the number or fatalities in the last year available are also provided. Furthermore, some risk figures can be found, as well as information on under registration of fatalities and severely injured road users. The country overview proceeds with information on road safety costs, which constitute the top layer of the road safety pyramid. The most prominent characteristics of the country in relation to road safety are finally summarised in a synthesis.

Country overviews are available for the following countries:

- Austria
- Belgium
- Bulgaria
- Cyprus
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Iceland
- Ireland
- Italy
- Latvia
- Lithuania
- Luxemburg
- Malta
- Netherlands
- Norway
- Poland
- Portugal
- Romania
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- United Kingdom



5.4.4. Advancing road safety performance index

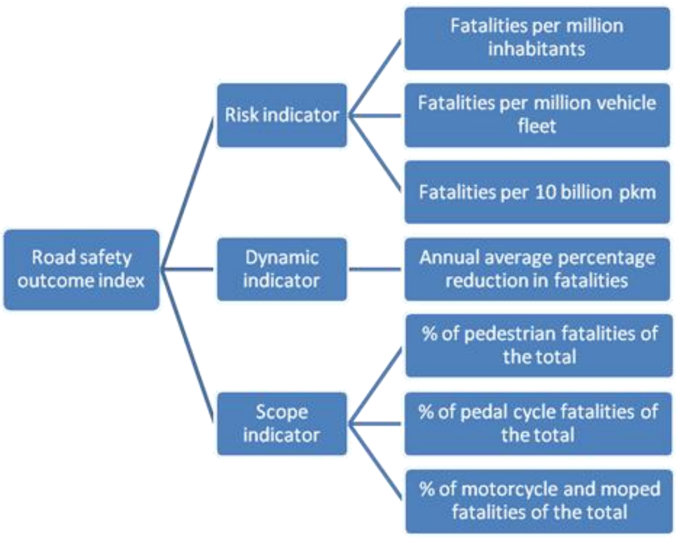
In this study, it was investigated whether it is possible to develop a Road Safety Index. The Road Safety Index is a so-called Composite Index: an index composed of several indicators which each separately and all together measure a specific field, in this case road safety. Such an instrument is used in various policy fields. Examples of composite indexes in other fields are the Sustainable Development Index, the Innovation Index and the Human Development Index. A composite index is an instrument to benchmark performances between countries, in this case road safety performances. This enables countries to compare themselves to others, it stimulates positive competition and shows specific improvement possibilities. Composing various indicators into one figure prevents policymakers and politicians from having to construct a complete picture out of a large number of indicators themselves. Despite the added value, there are specific features that a composite index does not offer. For example, it does not explain the differences between countries. Countries have to use the detailed figures from which it is composed to clarify their own scores. Furthermore, the Road Safety Index is not a prediction of road safety in the future and due to lack of (reliable and recent) data, the indicators used to compose the index cannot explain all variance between the countries.

Like the road-safety country overviews, the road safety index uses the road safety pyramid as a theoretical basis for benchmarking. The Road Safety Index however, uses only four layers of the pyramid:

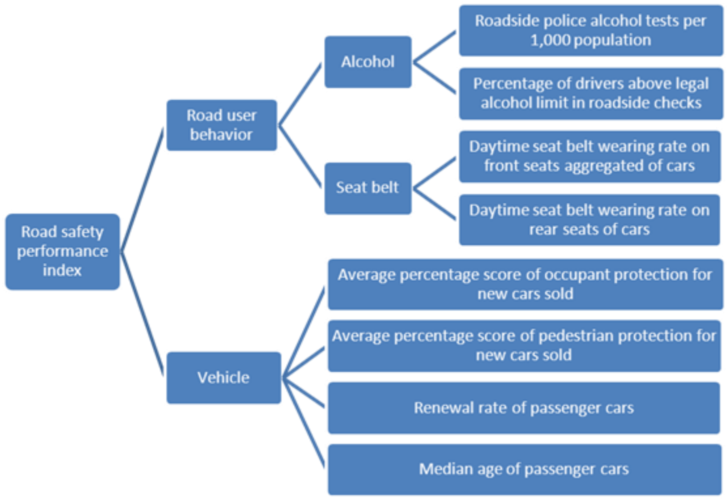
1. The Outcome layer, containing the number killed and injured
2. The layer of the Safety Performance Indicators
3. The Policy Indicators layer
4. The Structure and Culture layer, to group countries into two groups with more or less comparable characteristics

The Index does not use the Social Costs layer, because all available indicators for social costs are directly based on the outcome layer. On the one hand, the choice of variables or indicators within these layers is based on the theoretical framework developed in the SUNflower project and extended in the SafetyNet project (SUNflowerNext report). On the other hand, the indicators included were determined on the basis of data availability. We used various data sources for the index, such as IRTAD/OECD, CARE, UNECE, Eurostat, ETSC. The data of the 27 EU countries plus Norway, Iceland and Switzerland are used in the Index.

The indicators used to measure the outcome layer (number of killed and injured) are shown in the figure below. These are indicators such as fatalities per million inhabitants, but also more specific indicators such as percentage of cycle fatalities, or the annual average percentage of reduction in fatalities.

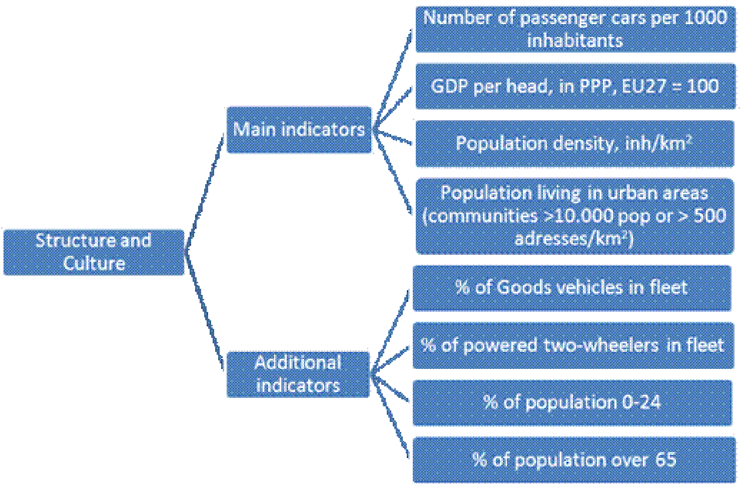


We also decided on indicators to measure the safety performance of countries, focussing on indicators for alcohol, seat belt wearing and car safety. Of course there are many more equally important safety performance indicators. The limitations encountered in this case relate mainly to lack of reliable, complete and recent data. The figure below shows the indicators chosen for safety performance:



For the policy indicators layer, several theoretical frameworks are available, but there is not much empirical evidence for the effect of road safety management structures -- as measured by policy indicators -- on road safety. WP 1 has done an empirical study on this topic, and their work shows interesting preliminary results: some clusters of policy indicators are positively correlated with road safety outcome, and some individual indicators are positively correlated with safety performance indicators (see Deliverable 1.5 – Vol. II). However, all in all, the current knowledge available on this issue is insufficient for the formulation of policy indicators As a consequence, although a theoretical framework for organising the indicator for this layer has been developed in this Work Package, no index was actually calculated for this layer.

The last layer of the pyramid, the structure and culture layer is used to divide the countries into two groups with more or less comparable characteristics with respect to road safety. The indicators for this layer are represented in the figure below:



Within each layer, the indicators are composed into one figure, using the Data Envelopment Analysis method which is widely used for the construction of composite indexes. The result should of course be scientifically sound, but it is also important that the results are recognisable and understandable for policymakers. The structure and culture layer is used to form two groups with a maximum of comparability within the groups and a maximum of diversity between the groups. The first group includes 10 countries: RO, BG, HU, SK, LV, PL, EE, PT, CZ, LT, and, on average, is characterized by lower values of economic development. The second group includes the remaining 20 countries, that score generally higher, but also more diverse on the structure and culture characteristics.

In a composite index in the original sense of the word, the sub-indices on (1) outcomes, (2) road safety performance indicators (SPIs) would again be combined into a single figure to represent the road safety for each country by means of one single number. According to the methodology of composite indices, this would not be justified if these two indices would correlate so strong that they measure practically the same concept; in that case, a composite index would be superfluous. An investigation into the associations between the two indices revealed indeed a correlation between the SPI index and the final outcome index. But still, the index scores differ in so many instances that a composite index would make sense provided that corrections are made for the correlations.

Ideally, an overall Road Safety Index (the RSI) would provide an unambiguous ranking of all countries, taking into account all indicators of safety outcomes. However, we came across some serious theoretical and practical problems when developing such RSI. It can be concluded that further research with respect to the weighting of layer- indexes is needed In this study, we opted to visualize the two constructed layer- indices in a graph (with four quadrants) in order to enable a country to compare itself with the 'best of class'. This will be illustrated for the two groups of countries. For each group, a graph with two dimensions is composed, representing the score of each country on both composite indices. The dotted green lines indicate the boundaries of "moderately high" safety performance levels, according to the results of both analyses. Thus the countries in the 2nd green quadrant (positioned in the upper right corner) are considered to be the best of class.

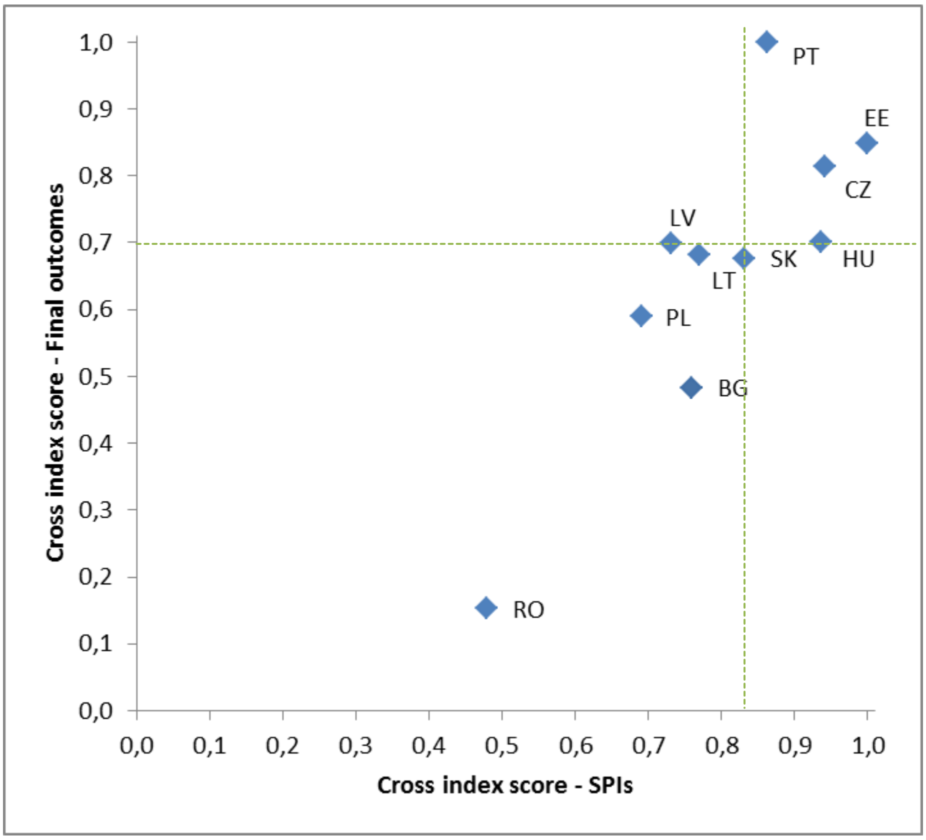


Figure Countries of group 1 plotted in accordance with their composite index scores.

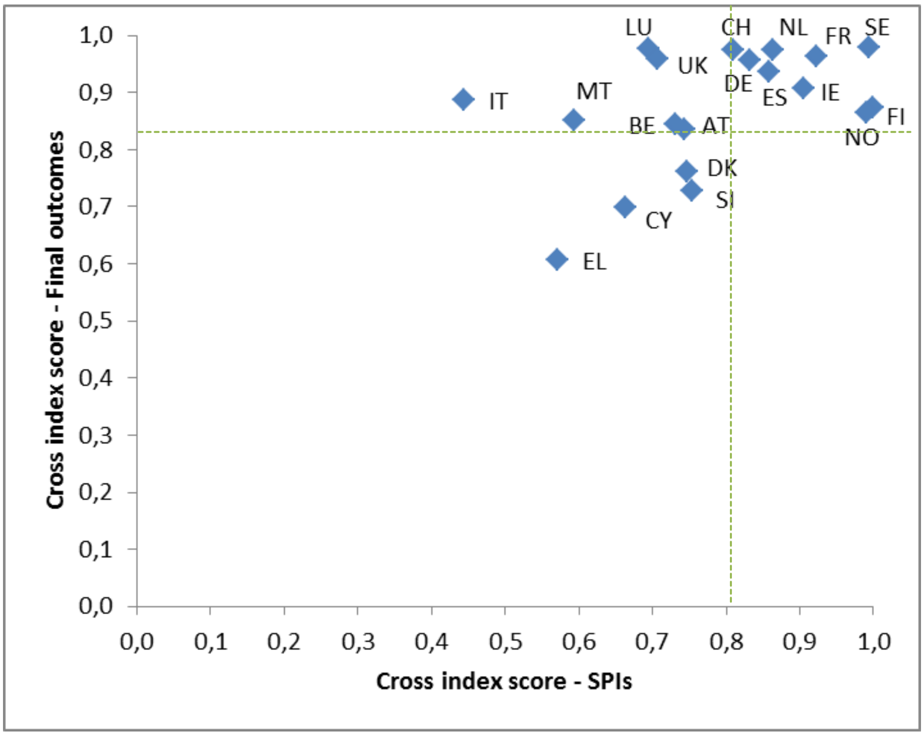


Figure Countries of group 2 plotted in accordance with their composite index scores.

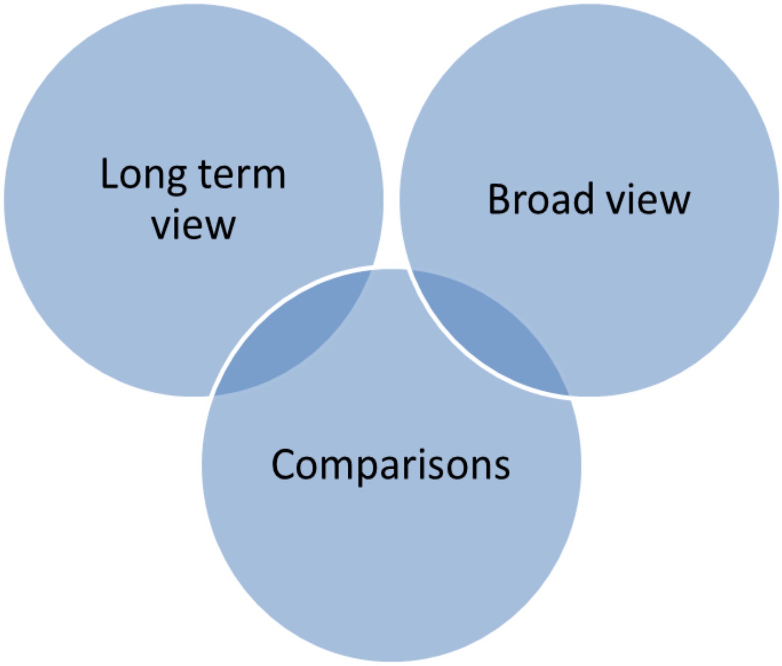
These figures enable any country outside the upper right corner to compare itself with the best performing countries. A better final outcomes and/or SPI index value would allow them to move to the best quadrant. Further comparisons of the indicators composing the relevant layer-index make clear on which SPI(s) and/or on which final outcome(s) indicator one should focus. This method does not offer the possibility to compare countries that are better on the one and worse on the other index. For such comparison, the relative weight of both indices need to be established.

To answer the research question of this study: is it possible to develop a composed Road Safety Index. The Road Safety Index that has been designed here can be further improved in the future. In the design process, it became clear that more reliable and comparable data on SPI's, as well as additional fundamental research on road safety management and on the relevant structure and culture indicators are needed. Also, research on the exact relationship between the various layers of the road safety pyramid is necessary. Finally, the aim for the future should be to improve and to update the Road Safety Index, to make sure that policymakers and politicians will use this instrument to improve road safety in their country.

For further information on country indices see: Bax, C., Wesemann, P., Gitelman, V., Shen, Y., Goldenbeld, C., Hermans, E., Doveh, E., Hakkert, S., Wegman, F., Aarts, L. (2012). Developing a Road Safety Index. Deliverable 4.9 of the EC FP7 project DaCoTA.

5.5. Conclusions

Decision Support Work Package integrated research results from other EU research projects (e.g. SUNflower, SUNflowerNext, SafetyNet, COST329, Rosebud, etc.) as well as data from other Work Packages of DaCoTA (WP3, WP1), and complemented it with own research to form ready-to- use products for road safety practitioners.



A large part of the information presented by WP4 focusses on the *countries* and enables a number of different views for each country:

- A *long term view* that allows to describe past road safety developments and to project them in the future so as to be able to evaluate actual future developments in the light of these projections.
- A *broad view*, enabling policy makers to see a complete picture of the road safety situation in a particular country. Instead of focussing on the outcomes, a broader array of aspects is considered that (might) determine the observed outcomes: structural and cultural characteristics of the country, its management structure, the measures taken to address road safety issues, various safety performance indicators concerning speed, alcohol, seat-belts, vehicles, enforcement, the social costs resulting from road traffic crashes in the country, and - last but not least - the fatality numbers and risk calculations for a wide range of different user groups and accident constellations.
- A *country comparison*, giving to composite scores for (1) road accident outcomes, and (2) road safety performance.

Next to the country information, WP4 also produced *topical information*. While the country information has mostly been gathered in this or previous EC projects, the topical information given in the web-texts summarizes research results from all over the world in an easily accessible text.

A good cooperation with the other Work Packages was essential for the functioning of Work Package 4. Together with Work Package 1, the needs of road safety policy makers were established that served as a guide for the present and future activities. There was a strong interaction between Work Package 3 and Work Package 4. Work Package 3 delivered the data necessary for the analyses in the present Work Package, while Work Package 4 delivered the specifications for the knowledge system and helped significantly filling it with its products.

An important principle in Work Package 4 was the continuous consultation of the potential users and other road safety experts. The on-going communication with the road-safety experts group entertained by the European Commission helped shaping the products eventually presented here. Four well-known road safety experts guided the production of the web-texts, and another group of road renowned experts reviewed the methodology of the composite road safety index. All these continuous interactions contributed to the production of tools that are both methodologically sound and accessible to road safety practitioners.

6. SAFETY AND E-SAFETY

Chapter author: Hermitte, T. GIE RE PR

6.1. Introduction

The overall objective of DaCoTA is to help develop knowledge-based road safety policies in European countries by continuing to develop a European Road Safety Observatory (ERSO) and providing methods to use ERSO data for policy development and implementation.

Road safety has been increasing in motorized countries now for 30 years and this increase shows that political willingness and efficient countermeasures can actually produce positive results. The last couple of decades have seen a promising increase in e-safety systems directly linked to technological progress. These systems are complementary to traditional safety countermeasures (regulation, education, enforcement, advertising and information campaign, car crashworthiness, infrastructure improvements, etc.) E-safety systems address accident prevention (preventive safety), accident avoidance (active safety), injury mitigation (passive safety) and rescue and health care improvement. These systems are intended to assist, inform or alert the driver by addressing one or several driving tasks (e.g. a navigation system helps the driver in his search for the right direction), by amplifying driver actions (e.g. the emergency brake assist reduces the time necessary to reach ABS regulation), by correcting a problem (i.e. ESC recovers loss of control), by preparing and providing car occupant or external user protection in the case of a crash (e.g. seat belts, airbags and pre-crash systems), or even by relieving the driver of certain tasks (e.g. Intelligent Speed Adaptation systems can, to a certain extent, replace the driver for speed regulation). And of course some other systems are protecting the car occupants in combination with a stiffer and enhanced car structure (seat belts, load limiters, pretensioners, airbags, etc.)

eSafety is often regarded in its very limited viewpoint which is concerning only stand-alone car technologies. It is, however, actually embracing much more: road infrastructure safety, traffic, car-to-car communication, also car-to-car or user-to-user communication or any kind of countermeasures linked with the availability of new technology. To a certain extent, automatic speed cameras and automatic penalties can also be considered as e-safety systems.

The integrated safety program (FP6), the e-safety forum, the cars 21 initiative and other actions since the nineties have demonstrated that, as far as research or deployment issues are concerned, the automotive industry, the road building industry and the public authorities have increasingly paid attention to the potential of technology to save lives and reduce harm on European roads. Considerable investments and expectations have been put in technology as a promising way for crash and injury prevention.

A European Road Safety Observatory must then take the broad and extended e-safety issues into consideration by analysing what types of safety problems are addressed by technologies, and, if and how technologies are effectively and efficiently addressing these problems.

The consideration of e-safety as a potential means for accident and injury prevention encompasses four main aspects, in sequential order:

- The determination and/or the updating of accident and injury causation issues
- The identification and the update of the road users' needs in terms of accident and injury risk reduction based of this prior knowledge about causation (if, for example, accident causation analysis reveals a problem in driver's perception of the pedestrian

in unlit urban areas, the driver need could be an enhanced vision in unlit urban areas).

- The determination of whether current or future technology can address these needs (for example, do the current night vision applications, and the technology behind, really target, in its complexity, the needs for a better detection of pedestrian in unlit urban areas)
- The assessment of all the potential benefits, and not exclusively the safety benefits

With the progress of the electronics, the evolution of safety systems always more sophisticated in the automotive industry tends to develop more and more. This Technology which was formerly reserved in “luxury” vehicle begins to become more democratic on more popular vehicle thanks to the costs which decrease. In front of this myriad of solutions it is important to be able to estimate the effectiveness of these systems to select the most relevant, be able to prioritize them, even propose them in the regulations. 3 main challenges have to be taken into account in an evolutionary context and multidisciplinary expectations to define relevant criteria;

- develop tools, strong methodologies to calculate these criteria;
- to have an effective and accessible common information system on the accidents in Europe

The basic research question of this Work Package is “How does technology contribute to road safety?” The objective is to develop methodologies and approaches that will enable future evaluation of the safety impact of emerging intelligent technologies. To answer to this question we propose in this report to develop the following aspects:

1. The methodological point of view: The objective is to develop methodologies and approaches that will enable future evaluation of the safety impact of emerging intelligent technologies. This is done by:
   - Identifying and updating the user’s needs in term of accident risk prevention and injury risk prevention
   - Identifying and updating how current technology can address these needs
   - Providing methodology on assessing the potential benefits of the relevant safety applications (not only the safety benefits).
2. The technological point of view : the objective is to show the limits and the future challenges related to the technology;
3. Tools/support point of view: Previous assessment methods need data to estimate effectiveness or performance of the technology. We propose here in the third part to make a specific step on this important aspect.

6.2. Assessment methods

In road safety, develop technology for the technology does not offer a great interest. This technology so innovative it is must serve first safety and bring a real added value to the driver in case of problem that he was not able to anticipate. The question is to know how to measure this contribution?

Thanks to the help of the mathematics and the statistics, assessment methods did not stop evolving to estimate the effectiveness of the systems to solve certain problems of road safety. In spite of the considerable progress which were realized, the complexity of the context, the sophistication and the increasing number of the “driving assistances”, the diversity of assessment methods and supports used to perform them (such injury accident databases) make that it is necessary to pursue the researches.

Regarding assessment methods, several issues have to be reached:

- The evolution of the road safety context. There are many years road safety was one a main concerns only in some countries (such as Sweden, UK or the Netherlands), while in other countries it stayed a target, without any real whish, ambitions or means to succeed, or for the most of states others priorities (economic or social) were more significant. The most important is not to be the best student with “good” results but that this road safety feeling is shared by everyone, that every citizen feels concerned. However if this awareness is not well anchored, they remain very fragile in particular in a difficult economic and social environment as today. In EU27, the last decade showed that with an attainable target and a real commitment of every actor, progress is possible. The road safety context evolves in space and time: problems are different according to regions (Industrialized countries and emerging countries), evolvement of the mobility (electric/hybrid vehicles, priority to soft modes, etc.), vehicles safer and safer for everybody, new regulations, improvement and development of consumerist test (EuroNCAP, LatinNCAP, JNCAP, etc.), bigger and bigger awareness by citizens, governments increasing the safety demand. All these components lead to changes in road safety context for which we have to be able to dread them. This can be done through a road safety observatory for example, allowing to update periodically the road safety diagnosis (in order to be able to have a statistical description of the road injury accidents, to handle evolution, the stakes, to define next priorities, to readjust road safety targets, to draw a realistic road map, to correct forecasting, etc.), or to update exposure data to know the change in the exposed population (travel patterns), to have a better idea of the new habits. A part of this issue has been developed in report D5.1 [1]
- The valuable notion: different values exist related to the human kind such as for example the health, eradication of starving, elimination of poverty, eradication of criminality, eradication of suicides, accident and injury prevention, ensure employment, avoidance of conflicts, wars, etc. and all of this for everyone, everywhere, now and in the future. For a long time, the road safety focused on the notion related to the Health and we mainly consider a road accident as an “illness”. In the road safety context, the question is what do we mean by illness healing? In other words, do we save lives? Do we mitigate injuries? Who takes benefits (what group) of the healing? Who pays and how much money do we save (e.g. in terms of price of life). Most of time we argue in terms of safety benefits and more precisely in terms of injury and fatality reduction. Others values exist depending on the domain of the stakeholder. Identity brand, consumerism rating, societal value, environmental value, economical value, ethics, client value, citizenship, technological value, etc.
- A general framework of the assessment activity is missing. Today the evaluation of safety systems is realized from well-known and basic methods but which base on no formalization. These methods rely essentially to know how of evaluators and the data which are available. The definition of a framework would allow to base these assessment tools, to identify the lacks or the areas of research to be developed (as well the methods as the data), to better formalize the requests to have more adapted results.
- The existence of several evaluations with different results. In the literature, it is not rare to find several articles dealing with the efficiency of the same safety system with sometimes different estimations. The great majority of these differences result either the working hypotheses, the used method, the interpretation made it or the used data. Rather than to choose to realize an additional evaluation, it would be necessary to develop the meta-analysis.
- The first role of active safety systems is to help us to manage (indeed to correct by itself in case of automatic system) critical situations and to avoid the accident. Most of the

evaluation studies are interested only for that purpose and forget other effects. Among these, there are the side effects (for example the system can also have an influence on other typologies of accident), the effects not planned (the driver can use the system for other thing of why it was designed), the indirect effects which can modify the behaviour of the driver (for example the driver can increase his risk taking believing that the system can compensate for his gap) or undesirable effects (for example the system can generate a new type of accident).

- The sophistication of the news and future technologies. For the last decades we got into a new area where the electronics rise sharply and became omnipresent. At first very expensive, its development and its advances made it gradually accessible and today every vehicles are equipped with. In a near future vehicles will be also communicating. They can so exchange information between them but also with the infrastructure and the environment. The evaluation of the effectiveness of this type of very sophisticated system (many interactions, exchanges, information to be sorted out and to rank, the diversity of the technologies of communication which can be used, the interferences, etc.) cannot be only made with the current assessment tools.
- The increasing number of safety device in vehicles. That they are dedicated to protect occupants in case of crash (passive safety systems) or to avoid the accident (active safety systems), safety systems are today more and more numerous in our vehicles. This proliferation of these helps or assistants and the heterogeneousness of "packages" makes harder and harder the studies of evaluation to be able to measure the effectiveness of such or such system (or group of systems) independently of the others.
- The driver's behaviour in the assessment loop. In regard to road safety, electronics allowed the development of ADAS (Advanced Driver Assistance Systems) allowing to provide a "personal" assistance to the driver in case of problem(s). If some of these helps are automatic, others ask for an interaction with the driver (through an HMI[17] for example) so that he can decide on an adapted corrective solution and execute it.

Only a part of these issues have been studied in the Work Package, and specific tasks were dedicated to the validation of the technology and the evaluation.

6.2.1. A general framework of the assessment activity

In order to improve the assessment activity we have to identify some issues that need to be handled. The current stakes of evaluation activity concern its objectives, the indicators, the tools/methods and the unpredictable changes.

Firstly, it is difficult for evaluators to identify what are the stakeholders' expectations concerning evaluation. The diversity of actors and their domain implies diversity in their needs; they do not all want the same things. Some of them focus on the economic side, other on the public health or technological sides. The main issue for evaluators (who design and perform evaluations) is that no method or tools that could help them in identifying needs are available.

Secondly, the major media used in evaluation to deliver the results is the "indicator". It is a mathematical object that gives factual information. Related to the first point, the conception of indicators is dependent of the expressed needs. Therefore, according to issues in identifying needs, evaluators have difficulties to offer relevant indicators. They mainly used indicators that they are in the habit to use and that they are able to calculate. Moreover, we do not identify methods/tools that allow designing new indicators.

[17] Human Machine Interface

Thirdly, evaluation is an activity that needs to be formalized in order to guide the evaluators' work. We only identify some operational methods and tools but we do not know how they were build and if they are relevant according to the needs. We do not find a general evaluation model that could handle its definition, its realization, its valorisation and its evolution.

Finally, the road system is a complex system that is usually represented by the triptych: vehicle, user and environment. One can understand its complexity by the unpredictable behaviour of each of its component. For the evaluators, who need to understand what they evaluate, complexity is an obstacle. They cannot foresee all the unpredictable changes that could affect performances of a safety strategy. For instance, the implementation of a system that automatically regulates speed of the vehicle could lead to the appearance of new drivers' behaviour that could be dangerous. They can take advantage of it to perform other task like phoning or reading. Complexity also implies a dynamic vision of the evaluation activity; this is not always the same. It evolves according the changes of its context. However, how evaluators can make evolve evaluations?

Following these observations, we proposed in the report D.5.4, Determination of a general evaluation model, a framework of the evaluation activity. This report introduces the representation of this framework through a systemic paradigm. Various functional and descriptive models are proposed. Evaluators used them as guidelines in order to model knowledge on study case and to design evaluations. This general framework takes into account the various viewpoints of stakeholders and evaluators. It allows performing evaluations that are relevant for all the various stakeholders and that aim to assess performances according to various viewpoints (aggregation of various performances from road safety fields – accidentology, economy, biomechanics, etc.).

This approach allows to define a comprehensive and helpful framework on the assessment activity.

6.2.2. Assessing and improving vehicle safety

As we identified previously, the progress regarding electronics and its progressive accessibility in terms of cost are going to allow the development of new more adapted safety systems and the resolution of problems up to now technically inaccessible.

So beautiful, perfect and innovative is, the safety system has first to answer to a real need and to solve as indicates its name a problem of safety.

For that purpose, it is important to have a solid core relying mainly on the following actions:

- The implementation of an information system on road accidents, common at European level (at world scale would be fantastic but not realistic) and to build it to last (this point has been tackled by Chapter 3, Pan-European In-Depth Accident Investigation Network);
- Improve the knowledge of the road accidents by updating periodically the road safety diagnosis for be able to describe the stakes and identify the priorities according to the problems (causes, factors, etc.) remaining to solve;
- Improve the assessment methods in order to progress and estimate better the "real" safety contribution of the systems, which means to be able to estimate their effectiveness with the help of relevant criteria, but also of identifying their potential limitations in real situations, from technical point of view, or due to exogenous or endogenous factors from the driver point of view.

Today most of the assessment methods on the effectiveness of safety systems consider the device as a black box (it is the case for a posteriori evaluations where only input and output are needed). We only look at the effects of the system. It is not need to know its features, only its domain of functioning that generally means one or several types of accidents which it is supposed to solve. On the other hand, the system has to be enough spread in the motor vehicle fleet to be found and that this sample has a significant size.

When it is not the case (for example for new systems) these classic methods cannot be used any more. Then, it is necessary to use a priori evaluation methods. The simulation tools with case by case analysis on relevant injury accidents still remains one of the methods usually used, but others exist. In this type of study, it is necessary to know a little more on the system, in particular some of their technical characteristics. It is what we called the white box (see figure below). This more thorough knowledge of the system can open on of wider studies. So, if some of technical characteristics are available on a set of systems, we are able to realize comparative studies (benchmark test) between these systems.

In the same way, the availability of technical data would allow to work on the optimization of the functioning of the system by finding the best compromise between the parameters to adapt itself to the real accidents life.

Also another possibility would be to participate to the design development by the definition of the specifications of the device built on the accidents data.

To improve the assessment studies, it is necessary to be able to take into account all effects and not those directly connected to the system itself. Until now, most of the proposed safety systems are activated in an automatic way (airbags, ESC[18] , etc.) or semiautomatic (need an activation by the driver such as ABS[19] or EBA[20]) and did not require an "interaction", an exchange with the driver.

The development of the new driving assistances (in particular alarm systems) are tending to attract more the driver through interface. Their effectiveness is going to depend not only on their functioning, but also on the one of the interface (HIM) and on the behaviour of the driver in the processing of the alert and the corrective action which he is going to undertake.

In other words, these systems cannot content themselves any more with an evaluation of the efficiency such as they were made up, and will have to take into account other aspects such as those connected to the human factor, which means to put the driver in the evaluation loop (Intelligent Box in Figure 21). Today this knowledge still very poor, but thanks to the naturalistic driving studies (see Chapter 7) and/or field operational test (FOT), this gap can be filled as one goes along.

[18] Electronic Stability Control

[19] Anti-blocking Braking System

[20] Emergency Braking Assist

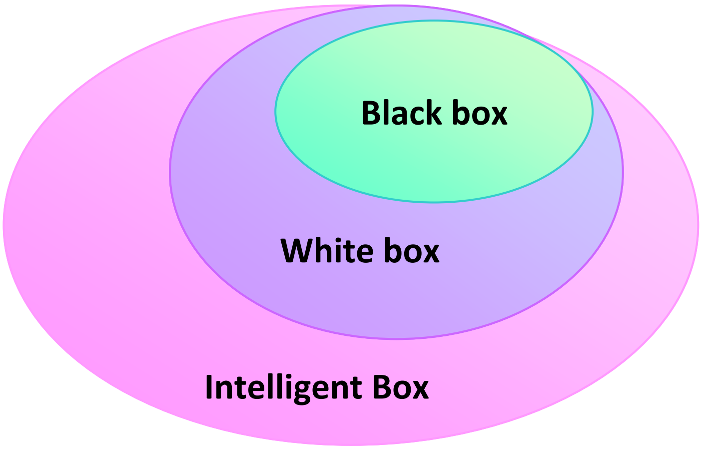


Figure 21: Global view of the assessment methods

6.2.2.1. Evaluation tools

The rapid growth of intelligent systems fitted to vehicles and the road infrastructure has raised the need to systematically evaluate the impact on safety and to give guidance on the most valuable functionalities of these systems.

Numerous assessment methods exist. They differ for most of them by the type of data that you have to have, by the scientific (mathematics) background that you need to perform them or also by the type of requests.

The safety benefits of systems can either be assessed on the basis of real-world accident data using epidemiological approaches or by a priori evaluation methods based on simulation tools or case-by-case analyses. The application of epidemiological methods necessitates that the system under investigation is on the market long enough to exert an influence visible in real-world accidents. Only then it is possible to gain information on its efficiency based on accident statistics. Many of these systems, however, take more than a decade to achieve a sufficient penetration rate. As a rule it is not possible to wait e.g. 10 years until the assessment of a system is feasible. Thus, the application of simulation tools can be a helpful instrument. Quite naturally these tools require detailed accident analyses and are based on certain assumptions, e.g. on the extent the system reduces impact speed. In order to verify these assumptions and the resulting predicted efficiency it could be beneficial to assess the outcomes of the tools by a posteriori methods as soon as the system shows a sufficient market penetration.

When using a posteriori or epidemiological methods it has to be determined if the evaluation is based on routine data or if a special survey should be conducted. Although the usage of routine data generally cause less costs it is often not possible to perform the evaluation on this basis since information on the equipment of vehicles with the safety system under investigation are not available in these data. Thus, in many cases the best way to perform an (a posteriori) evaluation of vehicle safety systems is to conduct a cohort study, possibly under application of a matched-pairs concept (pairing an equipped vehicle with a - similar but unequipped - reference vehicle). In any case the accumulation of safety systems has to be thoroughly looked at when the efficiency of a certain system is to be assessed.

If the evaluation results shall be expanded from one or a few countries to the EU-27 the iterative proportional fitting procedure can be applied as far as some basic auxiliary information at EU-27 level are available. This is especially relevant for results coming from an a priori evaluation because here for each case it can be determined whether or not the presence of the system would have avoided or mitigated the accident. Thus, the distributions (regarding e.g. injury severity, light conditions, etc.) of both the affected and unaffected accidents are known and can be expanded to a wider accident population. However, one should be cautious when interpreting the estimation outcomes since differences between countries e.g. regarding vehicle fleet may be a limiting factor for validity of the results.

Concerning socio-economic evaluation of systems, the application of a cost-benefit-analysis should be aimed at. In order to estimate the benefits (cost reduction due to the mitigation or prevention of accidents) standard accident cost schemes can be used.
All these concepts are detailed in deliverable D5.6. The objective of this report is to give an overview on the state of art of evaluation tools and by this providing some kind of reference book for the application of these tools.

6.2.2.2. Drivers' needs analysis

This type of analysis has been conducted in the frame of the task examining drivers' needs and the validation of technologies and constitutes a specific contribution to the studies dedicated to the evaluation of safety functions effectiveness. This contribution presents the specificity to be directed toward road user's needs, the particularity to be based on a methodology taking into account attested human safety difficulties (functional failures) an accident reality (context parameters).

Drivers' needs analysis allows to identify:

- Safety needs for different kinds of drivers, reflecting their accident-generating failures at the different stage of the process;
- The potential capacity of safety functions to meet these needs;
- The potential lacks in the functions efficiency.

Such results allow estimating the more or less appropriateness of the current safety systems, but also their weaknesses when considering real accident situations constraints. They also give some clues on the needs which are still not covered by the present devices. By such, these results can be considered as a contribution to the prospective ergonomics of safety systems, allowing their improvement for a better adequacy to the needs shown by drivers in accident situations and to the contextual constraints found in these situations.

Drivers' needs analysis is described in detail in the deliverable D5.5, Drivers' Needs and the Validation of Technologies with the objective to evaluate the capacity of safety functions to compensate for drivers' needs as they can be diagnosed thought in-depth accident analysis.

Two main criteria are used in this purpose: 1) the ability of each function to meet the needs of the drivers (e.g. if the driver shows a need in detection or diagnosis, is the system considered devoted to give the information or diagnosis needed?); 2) their capacity to cope with the parameters of the situations in which these needs were found (e.g. time/space constraints, trigger threshold of the system, physiological state of the driver, behavioural considerations, etc.).

The study has been conducted on a sample of 445 road traffic in-depth accident studies involving passenger cars, two-wheelers and pedestrians. It has been applied to the e-safety functions addressed in details within the technical DaCoTA Deliverable D5.2 ("Catalogue of the current safety systems") plus some e-safety functions dedicated to powered-two wheelers and also functions infrastructure-based.

The results present in detail for each accident configuration (car versus car, car versus PTW, car versus pedestrian, single vehicle accidents) and for each phase of the accident (approaching phase, rupture phase, emergency phase) the potential capacity of the safety functions to meet driver's needs. They also give a precise indication on all the parameters that could act as a potential limitation to the effectiveness of the systems.

Such results allow estimating the more or less appropriateness of the current safety systems, but also their weaknesses when considering real accident situations constraints. They also give some clues on the needs which are still not covered by the present devices. By such, these results can be considered as a contribution to the prospective ergonomics of safety systems, allowing their improvement for a better adequacy to the needs shown by drivers in accident situations and to the contextual constraints found in these situations.

Of course, the sample on which this study is based should be extended in order to gain in representativeness. This could be one of the interests of a European in-depth accident database as developed within the DaCoTA Project (See Chapter 3).

Other aspects are still to apprehend in further studies, notably dealing with the acceptance of safety systems and the capacity of their future users to master them appropriately.

6.2.2.3. Real world and Regulation

Another way of improving the vehicle safety can be realized through the regulations or the consumerist tests such as EuroNCAP.

These improvements not have to first objective to incite the creation of new innovative systems but aim mainly at establishing a minimum required level of safety for all vehicles.

The main difficulty bases on the definition of the configurations of tests approaching as much as possible real conditions of what we observe in the accidents, on the definition of relevant criteria, and on the definition of threshold or corridor in which the criterion must be established.

These points have been partly tackled in the task examining real world procedures and in deliverables D5.3 Review of the existing evaluation procedures related to safety systems and D5.6 Evaluation tools.

Regarding regulation or consumerist test, accident data still remains a big challenge. To establish criteria it is indispensable to have available accident data to be able to estimate the real effectiveness of a safety system. Today, even with the same method the results can differ according to the support used. In front of the diversity of road accident databases and the lack of having a consensus at the European level, the tendency of these institutions relies on the qualification of certain support and the recommendation to use them to realize assessments.

6.2.3. Future challenges

The work described here has been mainly oriented to assessment methods.

Among different issues picked out during the different studies carried out in the project, some challenges

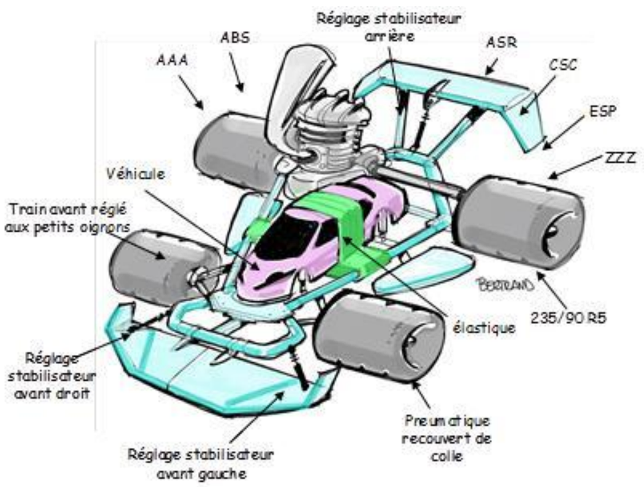
- We have to develop new criteria better adapted in new and future concerns. On one hand the gains in terms of human life will be more and more low because more we will get closer to the zero severe injuries or deaths on roads more this quest will be difficult, and on the other hand future safety systems will offer more than safety (example vehicle to vehicle communication) and these other values could be more significant in other future context (economic, societal, environmental, etc.).
- Assessment methods need to be improve to take into account the new challenge brought by future technology. These improvements will Identify the lacks of a methodological point of view and not content with making what we know how to make with the data that

we have. They will go through the development and the availability of accident data (today one of the weak points of the methods), by the consideration of the human factor in the evaluation loop and the development of the statistical tools.

- Today it is not rare to find several studies of evaluation of the same safety system with sometimes results which can to be different even contradictory. These differences are understandable most of the time by the taken hypotheses, the used method or the selected sample. The development of the meta-analysis would be interesting because it is a statistical approach combining the results of a series of independent studies on a given problem. Meta-analysis would allow a more precise analysis of the data by the increase of the number of studied cases and to draw a global conclusion. This approach widely used in medicine for the global interpretation of clinical trials. She would also allow to detect the biases of method of the analysed studies.

6.3. Technology

The main difficulty when we speak about "technology" it is that behind this generic word can hide other meanings. In the context of the road safety, technology can be interpreted as a safety system or to a component of this device. For example, if we want to identify the characteristics of functioning of a safety countermeasure, we realize that for the same service various safety systems can exist which can themselves be differentiated by the used technologies or its features.



Here we see appearing several concepts which we are going to define:

Safety Service: a service is a help or assistance supplied with the aim of answering a general road safety problem (example visibility enhancement, help of vehicle control, detection of the collision, etc.).

A ***Safety System*** is a component of a service, a tool of application allowing to solve a specific problem. For example, the system of detection of the blind spot is a system allowing to enhance the visibility for the driver (the safety service). A system can also be included in several services (example, the AEBS[21] is a system answering the services of detection of a collision or still a help of vehicle control in emergency situation by the contribution of an automatic braking).

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[21] Automatic Emergency Braking System : this system scan the road in front of the vehicle and in case of detection of an obstacle activate an emergency braking.

A ***Technology*** is a component of the safety system which assures a very precise function (for example acquisition, processing, execution, etc.). It refers to the technical aspect. A same technology can be used by various security systems.

Let us take an example: improvement of the braking efficiency.

The required service is to bring a solution which allows improving the performances of a braking in emergency situation.

Today, several safety systems answering this service exist (the following list is not exhaustive):

- ABS (Anti-Blocking System) which equips all the new vehicles and which avoids the blocking of wheels (loss of the efficiency of the friction) during a strong request of the braking by the driver.
- EBA (Emergency Braking Assist) which activates an optimal braking (ABS type) as soon as the driver requests an emergency braking. In fact the system is based either from an strong effort or a fast attack of the brake pedal.
- AEBS (Automatic Emergency Braking System) who activates an automatic braking as soon as an obstacle is identified in front of the trajectory of the vehicle.

Let us take now the example of the AEBS safety system and mainly those dedicated to the pedestrian. In this case, the system must be capable to detect a pedestrian in the trajectory of the vehicle and to stop the vehicle before the crash. Today, there are several technologies allowing to detect a pedestrian:

- The Radar: it is detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. The radar dish or antenna transmits pulses of radio waves or microwaves which bounce off any object in their path. The object returns a tiny part of the wave's energy to a dish or antenna which is usually located at the same site as the transmitter.
- Infrared Detector: it is a system allowing to detect the presence of a pedestrian from the thermal radiation of the object.
- The camera: the road scene in front of the vehicle is filmed by a camera most generally placed behind the rear-view mirror and a program is in charge of identifying the pedestrian(s) but also of being able to plan if this pedestrian will become a potential obstacle.

In this report when we speak about technology, we shall refer mainly to the notion of safety system.

In the task, Drivers' needs and the validation of technologies, we tried to draw up a list (not exhaustive) of available safety systems. 21 safety systems were selected for the vehicle. For each system, we created a specific card on which we find the following information (Deliverable D5.2 Catalogue of the current safety system):

- Its name
- A list of the problems solved by the service
- The covered features
- The identification of the phases of the accident where the service can intervene
- The different operating modes (Informative, alert, cooperative or automatic)
- The list of existing devices equipping vehicles and their main technical characteristics
- The associated evaluations of effectiveness which have been published.

These characteristics have been chosen in order to serve the drivers' need analysis

So beautiful and so successful is, a safety system have to be effective and to solve a real need or a safety problem.

There are 2 kinds to make:

- The first one is the one that we could denominate the "engineer's method" which consists in developing a safety system from a vague idea of a problem that he thinks of being important. Once the device created, and only after, an evaluation study is made. Here we design first a system and we check a posteriori that it corresponds to a real need.
- The second consists to start from a need and then to create the system the most adapted to the researched problem. Naturally, here also it is important to check its effectiveness once the system is developed because the technical constraints can reduce its functioning.

We see that in every case it is indispensable to have evaluation tools.

6.3.1. Main issues

Regarding the "Technology" point of view several issues have to be reach:

- Is the technology addressing the right problems? To answer this question, it is necessary to have available safety diagnosis (as up to date as possible) and a common methodology on accident causation to identify and quantify the stakes. It requires mainly the implementation of an information system on the successful and accessible road accidents for every member state but also at the European level.
- Is the technology correctly solving the problem? It is important to check that the final product, first correspond to the initial request and because some technical limitations exist, what is its real effectiveness.
- How much does it cost? The cost is not the same following who we talk about. Even if the economic balance advocates its use and its development, the distribution between profits and the costs cannot be allocated to the same group.
- What is the value for the client? As useful and effective is the safety system, is the customer will want to pay to have the system in his car, or he will consider that it is a due. Today, the automotive industry is able to make a high safety technological vehicle but unsalable. The economic crisis which affects Europe also risks to change our priorities. The craze for the low-cost cars shows well this tendency.
- Is it reliable? The challenge is to find the best compromise between the detection of all the aimed situations and the false alarms.
- Assume a safety integrated level. The complexity and the sophistication of the electronic systems increase more and more their vulnerability in the failures. The electronics and the embarked software have to lean on mechanisms of operating safety to protect itself against these risks of dysfunctions.
- To be effective certain safety systems must be very wide-spread (example communication car-to-car or car-to-infrastructure)
- To know the safety equipment in vehicles. Today it is very difficult to have an exhaustive list of the safety equipment of a vehicle. This information is spread and most of the time their access is limited. The diversity of the systems for a same safety service adds some confusion (c.f. Deliverable D5.2).

6.3.2. The limits

Today the perfect system does not exist. The best safety system still remains the human but he can have failures (cf. deliverable D5.5). The machine (device) is made for correct these failures, but it has some limits too:

- Limitations due to the technical possibilities;
- Limitations due to environmental requirements met in the accidents. The environmental conditions of a road accident are not controlled as well as in a test scenario.
- Limitations due to the driver himself. He can badly interpret an alert, either be unfit to react correctly or to be inattentive to his driving task.
- Limitations due to the way the system is used by the driver
- Limitations due to the costs of components or technical solutions.
- Humans have failure, the technology too

6.3.3. Future challenges

The safety systems of tomorrow will be more and more sophisticated. They will interface at first with the driver to become then autonomous and to manage at first very simple situations (car park manoeuvres, movement in mastered zone or driving on highway) then harder and harder to manage critical situations.

Regarding technology several challenges exist for the next years. Among them, the most important could be:

- Make ADA more accurate. Often the scope of the safety systems mounted on vehicles is limited. In these technological limitations, come to add limitations due to the environmental conditions (meteorological, traffic, surface, etc.) and sometimes also those relative to the state of the driver. The problem of the acceptability also rises (should not the help be too intrusive) but also the one related to the trust made by the driver for the system.
- Communication V2X: behind the technical problems connected to the communication protocol, to the standardization of exchange formats, to the selection of the relevant information to deliver to the driver, to the HIM, raises the problem of the evaluation of a system so complex;
- Automation: this step will represent a real jump forward and will imply numerous changes in our relation with the car. The autonomous vehicle which will circulate on any road is not for tomorrow because it will require at first the acquisition of knowledge related to the travel, to the traffic and to the road environment. The first vehicles will circulate in a restricted and controlled environment or will make simple manoeuver such as the car park for example.

6.4. Data support

The data are located at the heart of the process of information. They represent measures (observations), attributes or variables of social or economic nature. No matter the subject, the data play an important role in the understanding of what surrounds us.

In road safety, the knowledge on the accidents and their mechanisms requires the implementation of a dedicated information system. This information system articulates around 4 types of data:

1. The macroscopic accident data: they are based on aggregated information allowing to determine essentially stakes in terms of road safety or to make descriptive statistical analyses and only identify roughly the causes of accidents. Generally these databases

contain the exhaustiveness of the accidents but with a low level of details. They correspond to the national accident census collected most of time by the police. They are for example databases such as CARE[22] or IRTAD[23] at the European level or BAAC[24] in France.

2. The microscopic accident data: these collections are based on the constitution of a sample of accidents, analysed in detail and coded by experts. These analyses are going to allow to determine the accidental and injury mechanisms and to carry out studies on more complete and more adapted typologies of accidents. These analyses allow to determine the operational failures, in connection with the situational context of the driving (interaction between the drivers, infrastructure and the vehicle) and the context interns of the driving (status, intentions, motivations, etc.). This type of database includes generally a very big volume of information but about a number limited of cases. Unfortunately, these data collection are very expensive (experts team at full time) and ask a long time to have a consequent sample. One of their forces is to be able to adapt themself according to the new research questions. This type of data can be used for all type of evaluation, a priori evaluation too. Several such databases exist in Europe: EDA[25] in France or GIDAS[26] in Germany, CCIS[27] or OTS[28] in UK or INTACT[29] in Sweden.
3. The exposure data. This type of collection allowing to characterize a particular population (for example the young drivers or pedestrians) and so allow to give indicators connected to the notion of risk by the identification of the exposed population. This type of data are not so spread except for traditional census like vehicle fleet, average km driven, habitants, age pyramid, etc.
4. All the knowledge in road safety. This class gathers every tool and assessment methodologies as well as all the produced studies in road safety.

6.4.1. In-depth Accident databases

Since the mid 1990's a number of EU projects including STAIRS, PENDENT, RISER, MAIDS, EACS, ETAC and SafetyNet, have been commissioned to collect and devise methods to unify European data collection activities. This would then provide an in-depth database of comparable accidents allowing wide scale analysis and ultimately improving the understanding of the EU accident population.

In spite of these several attempts at European level, none has been perpetuated and there was no available common database structure which can be easily used by a new team wishing to go into this type of investigation.

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[22] Community Road Accident Database. CARE is the European centralised database on road accidents which result in death or injury across the EU. CARE provides Member States access to this central database which is hosted by the European Commission at the Luxembourg data centre.

[23] International Road Traffic and Accident Database. The IRTAD database includes accident and traffic data and other safety indicators for 29 OECD countries.

[24] Bulletin d'Analyse des Accident Corporels (France)

[25] Etudes Détaillées d'Accidents (France)

[26] German In-Depth Accident Study (Germany)

[27] Co-operative Crash Injury Study (UK)

[28] On The Spot (UK)

[29] Investigation Network and Traffic Accident Collection Techniques (Sweden)

However, some countries of the European Union (sometimes some private companies) developed their own in-depth accident database. It is the case of GIDAS in Germany, OTS in UK or the EDA in France, INTACT in Sweden for example.

If the strengths in terms of knowledge on the accidental and injury mechanisms brought by this type of investigation are not to be any more developed, there are numerous weaknesses which can slow down their development:

- The implementation of a specialised team at full-time remains very expensive, both at the level of the training and of the functioning;
- Need a long time to collect enough information to be correctly used;
- The necessary authorizations and the problems connected to the confidentiality of certain data (personal or medical) can be a real obstacle in certain countries;
- The harmonisation of variables is missing;
- The development of dedicate software to fill in information;
- No incitation from Europe to use a common dataset.

6.4.2. Vehicle safety equipment database

Information concerning vehicle safety equipment is more and more important especially for a posteriori evaluation. In order to be able to estimate the effectiveness of a device, we have to know which type of vehicles is equipped with.

Today the information on vehicles in terms of safety equipment can be obtained by various sources:

- Motor magazines or technical vehicle documentations. Most of these reviews give different type of information on vehicle such as technical characteristics or performance and today standard safety equipment. If documents are easily available, the implementation and the update of such a database can be time consuming and become quickly boring.
- The files of the registered vehicles. These files contain many information generally collected by a private company. Most of these files are not free and you have to pay to have it. The price depends on the requested information.
- Files manufacturers. These files are generally confidential and only the manufacturer can have access to the data.

6.4.3. Exposure data

There is no standard method for the collection of each exposure measure. In particular, different exposure measures may be derived from one collection method. For example, a travel survey may be used to collect vehicle kilometres, but may at the same time be used to obtain the number of trips, the time spent in traffic, vehicle ownership, or driver license holder ship. Accordingly, data collected by different methods may be used to produce an exposure estimate. For instance, passenger kilometres estimates may be obtained by using vehicle kilometres derived by traffic counts and vehicle occupancy rates obtained through surveys.

The usual exposure data that are most of time accessible are:

- Travel Surveys
- Traffic counts
- Vehicle fleet registers
- Driving licenses registers

- Road registers

However, the new technologies and the associated methods based on risk exposure ask to have information on specific target population such one linked to the driver behaviour depending on some context.

6.4.4. Challenges

Regarding road safety, the accident data are the weak link. Without these data there are no observations, no understanding of the problems, no stakes, no statistical description, no risk estimation, no identification of the priorities, etc.

If the data macroscopic accident data are available in most of the countries of the European Union, the data microscopic accident data are much less numerous and do not have often the same level of information what makes very complicated concatenations.

The main issues regarding in-depth accident data rely on the existence, the availability and the necessity to have a common core structure.

From the exposure point of view, some new improvements will be brought by the development and the spread of naturalistic driving or field operational tests studies.

6.5. Conclusion & perspectives

From evaluation point of view, the critical point still remains at European level where no common information system shared by all members states works.

Nevertheless the DaCoTA project showed that a common structure answering most of the researches questions could be organized at European level.

However without strong directive on behalf of Europe, the use of this structure is left free for each member states.

This lack of realization risks to be a brake for some countries to want to take a step forward and so to have “weapons” to fight better against the road insecurity and reach at the ambitious objectives fixed by Europe for 2020.

Certainly the question of the cost stays one of the main brakes because a complete information system on road accident must be carried out on the long term and needs experts. These Needs are not only for public institutions but are also shared by the industry.

The knowledge has to be shared and continuously improve in particular on the two following axes:

- Assessment tools and methodologies. The future security systems cannot be any more estimated correctly with the current methods. These will owe evolved to be more precise, quantify all the effects and take into account new concerns. Among the improvements which seem important to us today there are identification of new criteria (other been worth than injury reduction), the consideration of the human behaviour in evaluation loop and the development of the meta-analysis.
- Set up a common European information system. Whether it is for future decisions or orientations regarding road safety or for the identification of the priorities regarding development of the safety systems or anticipation of the future problems, the “sinews of war” will always be the accident data. If today in Europe most of the member states possess their own macroscopic accident data (more or less up to date), for example, the disaggregated accident data remain very scattered. From our point of view the future challenges as regards accident data will be:

- The development and the spread of in-depth accident data collection on the model brought by DaCoTA (see WP2);
- The implementation of a database gathering data regarding the list of the safety equipment by vehicle model;
- The development of exposure data such as the one those that could be extracted from naturalistic driving (ND) or field operational test (FOT) studies.

European commission, members states authority, automotive industry, road maker and all other actor in road safety have to work together in order to reach the 2020 target and to anticipate what will be tomorrow.

6.6. References

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7. DRIVER BEHAVIOUR MONITORING THROUGH NATURALISTIC DRIVING OBSERVATIONS

Chapter authors: Wegman, R. W. N and Bos, N.M. (SWOV).

See also Wegman, R.W.N., Bos, N.M. (2013) Naturalistic Driving for cross-national monitoring of SPIs and Exposure: An overview. Deliverable 6.5 of the EC FP7 project DaCoTA

7.1. Introduction

Driver Behaviour Monitoring through Naturalistic Driving, aims to develop an implementation plan for a large scale activity that uses Naturalistic Driving (ND) observations to continuously monitor relevant road safety data within the framework of ERSO.

7.1.1. List of Abbreviations

CAN	Controller Area Network
DAS	Data Acquisition System
ERSO	European Road Safety Observatory
EU	European Union
GPRS	General Packet Radio Service
GPS	Global Positioning System
ND	Naturalistic Driving
OBD	On-Board Diagnostics
RED	Risk Exposure Data
RFID	Radio-frequency identification
SD	Standard Deviation
SPI	Safety Performance Indicator

7.1.2. What is Naturalistic Driving observation

Naturalistic Driving methods are intended to gather data that represent the behaviour of the population of drivers in its basic state. Naturalistic Driving (ND) study can be defined as:

> *'A study undertaken to provide insight in driver behaviour during every day trips by recording details of the driver, the vehicle and the surroundings through unobtrusive data gathering equipment and without experimental control' (Van Schagen et al., 2011).*

Key features of ND studies include:

- Drivers use their own vehicles in their normal manner.
- The data gathered covers the driver, vehicle and surrounding road environment.
- The instrumentation is unobtrusive and drivers cease to be aware after a short period.
- There are no observers present in the vehicle.
- Data is recorded continuously during the driving process.

Ideally, a large-scale ND study includes a large number of fully equipped vehicles for a considerable period of time; the collected data being stored in a large database that subsequently is exploited to answer a wide variety of research questions.

The ND approach has become possible thanks to technological developments in data collection, data storage capacities, data-mining and image processing, with tools that become increasingly smaller, less obtrusive and less expensive.

Data collected through Naturalistic Driving observation has the potential to provide a high level of detail of (normal) driver behaviour in the pre-crash phase if a collision occurs and is thus a useful complement to traditional accidentology. In addition, it can provide important information on successful avoidance behaviour in near crash situations and it offers opportunities to quantify mobility (exposure to risk).

7.1.3. Naturalistic Driving observation and ERSO

Naturalistic Driving observation is commonly used for in depth study of specific road safety topics related to driver behaviour and driver condition. The objective of the DaCoTA Naturalistic Driving is **monitoring** the development of road safety by continuous data gathering in a harmonized way on a large scale (preferably all European countries, representative for each country and comparable between countries). It focuses on safety performance indicators (SPIs) and exposure to risk (RED) and on how often drivers routinely engage in certain behaviours that are considered to increase the risk of a crash. Obviously, monitoring road safety also allow countries to evaluate their own road safety policy and road safety targets. In this context Naturalistic Driving observation is for establishing trends in and between countries, which may be used for policy adjustments.

7.2. Relevant Data to be collected

For further details please see Talbot, R., Meesmann, U., Boets, S. and Welsh, R (2010). Naturalistic Driving Observations within ERSO, Deliverable 6.1 of the EC FP7 project DaCoTA.

7.2.1. Variables to monitor within ERSO

In task 6.1 an inventory of variables which would be relevant to be monitored within the frame of the European Road Safety Observatory was made (Talbot 2010).

Risk Exposure Data (RED):

- Vehicle mobility
- Fuel consumption
- Person mobility
- Number of trips
- Time in traffic

Safety Performance Indicators (SPIs), priority, indicated in a national experts' survey:

- Alcohol and drugs	High
- Speed	High
- Protective systems (use of seatbelts and child restraints)	High
- Daytime running lights (DRL)	Low

Additional SPIs from various sources:

- Fatigue	Medium
- Distraction/inattention	Medium
- Gap acceptance/headway	Low
- Near crashes	Low
- Accident causation	High
- Safety technology	Medium

The SafetyNet analysis on the current practices of monitoring RED and SPI topics showed that all these indicators lack availability and/or comparability across and within countries. Consequently, there is a need for improvement.

An additional level of disaggregate information on all topics is desired in order to do valid comparisons across the countries, see section 2.4.

Note that for a participant some variables are constant, such as his/her age, or the vehicle model. Others vary during the trip (e.g. road type, posted speed limit) and others are different each pass of the same road section, like the weather (transient).

7.2.2. Data collection through Naturalistic Driving observations

The next question is how the data on the topics identified can be collected through Naturalistic Driving observations and by what technical equipment.

It appears that the collection of a large number of these data depends on internal video, external video, or both, or on CAN data.

As the accumulation of video data takes large amounts of storage space and the analysis of these data is extremely time consuming, video is not suitable in a large scale activity: large numbers of cars, long continuous periods of data collection. Besides, willingness to participate and privacy issues may complicate such a study.

Considerations for meaningful data collection within reasonable limits of cost and complexity:

- a large number of cars have to be instrumented within the 27 EU countries, which necessitates a simple low cost device that is easy to fit;
- a large amount of data will be generated, so the data must be automatically processed and analysed, e.g. through the use of scripts;
- because extended periods of monitoring are expected, the equipment used should be unobtrusive and any methodologies adopted should require minimal input from the participants.

As a result, two scenarios are proposed. **Scenario 1** would be a basic low cost Data Acquisition System (DAS) using existing technology, which comprises a GPS logger and accelerometer. It would be necessary to identify who is driving the vehicle and to derive certain variables using map matching in order to collect meaningful data. The availability of map data is a potentially limiting factor here.

Scenario 2 would supplement the Scenario 1 DAS with extra sensors or capabilities - e.g. a connection to CAN data -, allowing the collection of additional variables that are important in the monitoring but cannot be measured using the Scenario 1 DAS. The availability of CAN data depends on the preparedness of car manufacturers to let these data be collected and interpreted by others than themselves.

Scenario 2 is more of a tool box approach, as certain additional sensors and connections can be arranged in the future.

Various topics are not or hardly suitable for inclusion in one of the above scenarios, as there is no reliable way of detection or they depend on driver input (alcohol, drugs, medicines) or on video data (child restraints, fatigue, distraction).

7.2.3. Data selection

Now that two scenarios have been formulated, we can look which RED, SPIs and additional topics can be collected and by what means.

On the basis of the possibility to collect the data by Naturalistic Driving (excluding video) and national experts' priority, the following topics are recommended:

By Scenario 1 DAS:

- Vehicle mobility
- Person mobility
- Number of trips
- Time in traffic
- Speed – excessive (i.e. exceeding the general or posted speed limit)
- Driving style - acceleration

Additional topics by scenario 2 DAS:

- Speed – inappropriate (i.e. faster than the prevailing conditions allow)
- Seatbelt use
- Headway
- Lane behaviour

- Driving style – braking, signal/light use

7.2.4. Context variables

In order to draw meaningful conclusions about data collected, it is necessary to collect information about the driving context.

After consideration of the practicality of collecting certain variables for a large scale activity, the following tables summarize the recommended and optional context variables to be collected.

Driver	**Vehicle**	**Network**	**Other (transient)**
Age	Make & Model	Road type (motorway, non-, motorway rural, urban,	Time (Day, Month, year, HH:MM: SS.FF)
Gender	Style (e.g. hatchback, SUV)	Area Type (rural, urban)	Distance travelled
Driving experience	Vehicle Age	Speed limit	Start & End of trip
Level of education	Vehicle Mass		Trip km (derived)
Occupation	Safety systems		Trip time (derived)

Table 7.1. Summary of recommended Scenario 1 context variables.

Driver	**Vehicle**	**Network**	**Other (transient)**
Personal characteristics (attitudes, offences, risk taking, perceptual skills etc.)	Model Variant	Road Class	Journey purpose (private/ professional)
	Engine Size	Junction type	Traffic flow
			Road conditions (icy, wet)
			Light conditions
			Weather conditions (precipitation, temperature)
			safety systems in use

Table 7.2. Summary of recommended additional Scenario 2 context variables

7.2.5. DAS specification/technical requirements

7.2.5.1. Scenario 1 DAS

DAS equipment

The requirements for a Scenario 1 DAS would be:

- Integrated system, individual components synchronized (common time stamp)
- GPS, EGNOS-compatible (viz. D6.1, section 2.6.2)
- Accelerometer
- Unobtrusive, In-car (participants may forget to install portable devices)
- Reliable power management
- Appropriate sampling rate (once per 1 to 10 seconds)

Data storage and transfer

In vehicle storage possibilities are USB drives and flash cards of sufficient capacity to avoid data loss. Data transfer to a central database can be done by exchange of USB/flash drives or uploading data through GPRS/UMTS/Wi-Fi. Driver involvement should be minimal, to avoid reluctance to participate and data loss.

The capacity requirements for data storage at country level depend on the period of data collection and the sampling rate.

The capacity and data protection issues for a central European database with aggregated data are much more limited.

Data analysis

There will be a need for data preparation before research questions can be answered. GPS data require matching to map data, to create many of the context variables. Map matching software can be purchased with the map data or a custom solution needs to be developed.

Any Naturalistic Driving Observation activity produces large volumes of data; therefore analysis software has to be capable of handling such quantities.

7.2.5.2. Scenario 2 DAS – additional requirements

The Scenario 2 DAS should be considered as a series of options that could be added to a Scenario 1 DAS to increase the number of topics that can be monitored in a large scale activity. These additions highly depend on available resources, which are influenced by technology development. From the start of the large scale activity an additional sensor could be added to collect additional data or additions could be made once the activity is established. Also such addition could initially be made in a subset of countries rather than all.

DAS equipment

To measure the proposed variables, additional sensors or access to the CAN is required. Any sampling rate used for a Scenario 1 DAS is also appropriate for recording temperature and the use of seatbelt, light and windscreen wiper.

Braking, signal use, headway, lane behaviour and activation of safety systems require a higher sampling rate, depending on the research question.

Data storage

The more variables are collected directly from the DAS and the higher the sample rate, the more data storage is needed in the car. It might also be necessary to upload data more often.

Of course the data storage needs for a central storage facility will also be greater, especially if many more derived variables are required.

Data analysis

If video is used to record driver ID there is a need to employ machine vision technology to automatically identify individual drivers so that analysis can take place.

7.3. Study design

The objective of is the Study design task is to specify the study design of a naturalistic driving study in the perspective of the European Road Safety Observatory.

The task deals with three main issues:

1) The experimental design, which focusses on how to sample the ‘population’ to get reliable estimates of the indicators to be measured.
2) The procedures to RED and SPI estimation, first it is described how current indicators (in ERSO) compare to the ones that can be derived from ND data. Then it is described how to filter data to receive new homogenous and comparable indicators from ND data.
3) Legal, ethical and privacy requirements.

For further information about the Study design see:
Bonnard, A., Brusque, C., Hugot, M., Commandeur, J. and Christoph, M. (2012). Study design of Naturalistic Driving observations within ERSO – Development of innovative indicators for exposure and safety performance measures, Deliverable 6.2A of the EC FP7 project DaCoTA.

7.3.1. Experimental design

Deliverable D6.2B discusses what sampling and estimation methods can be used to obtain population values of RED and SPI items based on a naturalistic driving study, see

Commandeur, J.J.F. (2012). Sampling techniques and naturalistic driving study designs, Deliverable 6.2B of the EC FP7 project DaCoTA.

Since it is impossible to study all car drivers of a country, a sample must be drawn. In order to decide what sampling and estimation method is most appropriate, we first have to consider the type of sampling frame(s) that are available, i.e. the source(s) from which a sample is drawn.

When the sampling frame contains information on all individual population elements, a **simple random sample** (all car drivers have an equal chance to find themselves in the sample) or a **systematic sample** may be considered.

When it is possible to define subgroups of car drivers that can be expected to be more homogeneous with respect to the RED and SPI variables, then **stratified random sampling** is recommended. This means that the car driver population is first divided into mutually exclusive and homogeneous subgroups (strata); subsequently within each stratum a random sample is drawn. This decreases the required sample size for the same precision of the estimates

If the individual values of an additional variable that is highly correlated with the RED/SPI variable of interest are known for all car drivers in the sample, then precision can be further increased by replacing the direct estimator with a **ratio or regression estimator**. However, this usually requires knowledge of the sum total of the additional variable in the population. Should the individual values of such an additional variable also be known for all car drivers in the population, then the selection procedure with **unequal probabilities** can be considered.

When the sampling frame happens to be decentralised (e.g., municipal), on the other hand, then the **two-stage sampling methods** can be used.

In all these cases, given an assumed homogeneity of the SPI/RED in the population and a pre-specified precision and probability it is possible to obtain estimates of the minimal required sample size. This number is usually quite independent of the size of the population of car drivers in a country. Only if the sample size is larger than 10% (of a stratum) of the population, a correction is applicable (Commandeur, 2012).

The practical implication of the chosen precision level is that only changes between two consecutive time points or periods larger than twice this precision level will be detected with the corresponding sample size.

As an illustration, consider a population of car drivers who on average drive 15,000 kilometres a year. Using a probability of 95%, the minimal required sample sizes obtained in a simple random sampling scheme in order to estimate the annual mobility of cars with precision levels of ±5%, and ±1%, and population standard deviations of SD=10,000, and SD=15,000 are given in Table **7.3** below. As the table indicates, sample size increases both when the required precision of the estimate increases, and when the variation of the variable of interest in the population is larger.

- With a population standard deviation of 10,000 km and a sample of around 700 car drivers, differences in the actual annual mileage up to 10% (plus or minus 5%) will remain undetected.
- With a population standard deviation of 10,000 km, and a sample of around 17,000 car drivers only differences up to 2% will remain undetected.
- If, however, the population standard deviation is 15,000, a sample of over 38,000 car drivers would be needed to reach the level of precision of ±1%.

SD = 10,000		SD = 15,000	
±5%	±1%	±5%	±1%
683	17,074	1,537	38,416

Table 7.3. Sample sizes required for estimating the mobility of cars in a country with a given standard deviation, precision level and 95% probability

The sample sizes in Table **7.3** are conservative in the sense that they are based on the direct estimator in simple random sampling, which have the largest standard errors. Other estimators and other sampling techniques will require smaller sample sizes. The other approaches require more information about the population by additional variables. Required sample sizes may be up to 70% smaller when stratified random sampling is used instead of simple random sampling.

In naturalistic driving study designs, the sampling technique of choice will depend on whether or not a centralized national sampling frame is available. In the Netherlands, for example, it seems obvious that the register containing all Dutch licensed vehicles is the most appropriate frame for sampling passenger cars. The database includes several technical specifications of each vehicle, being helpful additional variables for stratification. There is also a database containing all driver licences, including background of the drivers (age, gender). In the Dutch situation the available sampling frames imply that the units to be sampled should be the licensed drivers since they are the ones who give their consent to participate in the study.

If the sampling frame happens to be decentralised and municipal, for example, then a two-stage sampling design would be called for. An illustration of the latter approach is presented in Rofique et al (2010). The methodology of this survey covers and combines many of the aspects of sampling and it is worth to examine in more detail.

A number of specific conclusions and recommendations apply for the selection of a probabilistic sample of passenger cars in a naturalistic driving study design, see Commandeur (2012). The most important ones are:

1. All sample size estimation methods have in common that they require an a priori specified **degree of precisio**n and **probability**. The degree of precision simply specifies how close we want the sample estimate (of the mean, the total, or a proportion) to be to its actual population value; For sample size estimation we also have to specify how certain we want to be of obtaining the precision with a sample.
2. Some knowledge of the populations **variation of the variable(s) of interest** is required (in the population or in the different strata or the primary and secondary units of the sample).
3. When the objective is to measure changes over time, the required precision should consider the minimal difference in estimates between consecutive time points that we want to detect with certainty.
4. When information on additional variables in the population is available that are correlated with the variable of interest this opens up the possibility of improving the precision of the parameter estimates by using stratified random sampling.

5. When several items in the population need to be estimated, then this requires sample size estimations for each of these items separately.

6. Since ND monitoring is expected to cover multiple years, the best strategy for measuring change is to use a **rotating sample** where one part (50-80%) of the sample is retained and the remaining part of the sample is replaced.
The length of the **rotation period** should also take into consideration the costs and time required for the installation and de-installation of the ND device.
In order to control for seasonal fluctuations (e.g., holidays) it seems that a period of 1 year is ideal. This can be combined with the rotation procedure.

7. The continuous nature of the measurements implies that the ratio and/or regression estimators are well-suited candidates for improving the precision of the estimates: the observations from the previous period can be used to statistically increase the precision of the sample estimates.

8. The estimation of the required sample size should take the problem of **non-response** into account, and the sample size should be increased accordingly.

   In some countries at least, it should be possible to get information on the characteristics of the non-respondents by using the double sampling for non-response approach.

9. Selection **bias** as a result of non-response should be corrected for by post stratification based on 1) demographic information of the driver population; 2) technical characteristics of the vehicle fleet; and/or 3) odometer readings of cars as registered during roadworthiness checks. If available this last source of information is to be preferred since it is the best indicator of the actual distance travelled by cars.

7.3.2. RED and SPIs to be monitored

The objective is to find the best complementarity between the classical methods of RED and SPI estimation (as defined in SafetyNet) and the potential new ones.

Classical methods typically measure the behaviour of many vehicles or drivers at a specific location, e.g. speed loops.

When using naturalistic driving observations, it is harder to control the data collection as the drivers drive on any kind of road, in any kind of traffic and in any kind of weather. This makes it crucial to be able to identify all the variables and circumstances that might have an impact on the SPIs & RED, in order to compute meaningful SPIs & RED with a proper filtering and aggregation.

The indicators have to be relevant for both national and ERSO levels. It is crucial to guarantee the validity of the collected data and determine, for each country, how representative of the country they are and how they can be compared with other countries. It is also important to define the accuracy of the RED and SPI values and to provide a probability for each of them.

7.3.2.1. Helpful considerations and definitions

Data exploitation design

To process the RED and SPIs it is proposed that each country is in charge of the calculation of their respective indicators; only the ones necessary for the ERSO are shared; details are stored at national levels.

Near crashes

As has already been explained near crashes will not be studied in the scope of DaCoTA. However data about the dynamics of the vehicle will be considered as a source of information for the future, when knowledge on this matter will permit to define more accurately extreme events (such as very strong braking, safety systems use (ABS, ESC)).

Key concepts

While designing Risk Exposure Data or Safety Performance Indicators some principles should be kept in mind.

- The data sources' relevance, accuracy and availability have to be investigated in detail and taken into consideration
  - Definitions of context variables might be different between countries, especially when using a GIS (for example, the meaning of "urban" or "motorway" or the availability of legal speed limit…) or any third party database.
  - Measurements might be different if collected through sensor or through CAN bus (for example, vehicle speed…)
  - When comparing countries, it is critical to make sure that comparisons are done with similar base data.
- The time window, the filtering and the clustering should always be balanced with the accuracy of the indicator and it is important to be able to pass this information to the final data set used for the SPI calculation. This can be achieved by use of "Sub Sample Characteristics", or SPI SSC.
  - At the participant level, when selecting the time window (for example, during March 2011), when filtering (e.g. peak hours…) and a specific clustering (e.g. to compare motorway and urban situations), each SPI should be given with its SPI Sub Sample Characteristics that gives, for each driver, the amount of data that corresponds to the constraints (e.g., the time driven during March 2011, in peak hours, on motorways).
  - At the country level, when aggregating data from all the participants, the participant SSC should be carefully studied to determine if it is relevant to use the data for the country aggregate (for example, include a driver that spent 1 minute within the SPI-constraints?). Once aggregated at country level, the country SPI should also have a Sub Sample Characteristic that describes the number of participants finally used for the calculation and their total driving time.
- It is necessary to apply filters that guarantee that the data that remains after filtering is homogeneous. This can be used in two contexts:
  - When trying to obtain homogenous situations in terms of traffic density. The filters consist in removing all the data collected during daily peak hours, which are more prone to traffic jams. The filter can be 7h30-9h30 and 16h00-19h00.
  - When trying to obtain homogeneous "actually driving" situations. The filters remove all data with a vehicle speed below 5 km/h.

While fully aware that it is possible to create other indicators than the ones proposed by DaCoTA, it is strongly recommended to follow these 3 basic principles as they should guarantee the relevance of the newly designed SPIs.

Definition of Trips

Some calculations will need to consider the concept of trips. The authors propose to consider a trip to start/finish once the ignition is switched on/off. A trip can be prevented to be erroneously divided into several trips (by events like switch off while waiting in a queue), by joining two successive trips if the delay between the end of the former and the beginning of the latter is short (Wolf et al., 2004).

Definition of Day time and night time

Some calculations propose to compare day-time and night-time conditions and aim to differentiate situations in daylight and at night. As daylight periods vary during the year and also according to the latitude, harmonisation to obtain comparable and relevant “day” and “night” conditions is required.

The methodology proposed is to use a floating hour range, computed according to the time and position of the observation. This can be done by using a table giving for each latitude, longitude and day of the year, the time of sunrise and sunset, and to compute the daylight, night and twilight (2 hours in between) period.

Definition of Weather conditions

For homogeneity, some calculations need to filter out data during bad weather.

It is possible to use the sensors available in the vehicle (like the screen wipers activation, or the luminosity sensor used for automatic light activation) or to use third party databases, giving weather information for each various location.

Combining the two pieces of information will increase the accuracy of the weather information. It is proposed to focus on only 2 classes : “good” weather, which is when the weather report is set to “sunny” or “cloudy” and “bad” weather, which includes all other possible weather reports (for example, like rain, snow, fog…).

7.3.2.2. Procedure to RED estimation

Context and definition

Risk Exposure Data (RED) is used to calculate road safety risk indicators, which enable comparisons over time and countries relative to the amount of exposure. In other words, risk (road safety risk indicator) can be defined as a rate (SafetyNet, 2005):

$$\text{risk} = \frac{\text{road safety outcome}}{\text{amount of exposure}}$$

Figure 1 Road safety risk indicator equation

The EC project SafetyNet has identified 4 Risk Exposure Data of major interest for Road Safety (ERSO, 2010b)

1. Vehicle mobility of a country: “the total distance travelled within the borders of the country by road motor vehicles”. The according unit is vehicles x km.
2. Person mobility of a country: “the total distance travelled within the borders of the country by persons, regardless of their nationality”. The according unit is persons x km. This includes passengers.
3. Number of trips of a country: “the total number of trips made by persons, regardless of their nationality, in the country.” A return trip counts as two.
4. Time in traffic of a country: “the total time spent travelling by persons, regardless of their nationality or their mode of transport in the country”. The according unit is a unit of time (hours, minutes).

The SafetyNet project proposes to base RED estimation on a data collection framework including both travel surveys and traffic counts elements, each method presenting different features and advantages. Travel surveys have the major advantage of providing exposure data combined per person, vehicle and sometimes road characteristics. On the other hand, traffic count systems are the only method which can provide practically continuous exposure measurements over time.

Naturalistic driving studies consist in the observation of a sample of drivers. The vehicle of each driver is instrumented in order to record during his/her everyday mobility information on behaviour, vehicle position/dynamics and driving context.

So ND forces us to focus on the individual mobility as a motorist. In balance, ND gives us the opportunity to monitor the distance travelled and the time spent driving according to the driving context that can be described in terms of road type, period of the day/week/year, weather conditions, presence of passengers… We have also access to descriptive statistics of the trips, in terms of average number of trips by year, distribution of duration and length of a trips.

Using ND data to estimate RED assumes that both the driver sample and the instrumented vehicle sample can be weighed to obtain representative outcomes of the countries driver population and vehicle fleet.

The authors propose to calculate the five following RED from the ND data, all calculated over one year, within the country:

1. Mean distance driven by a passenger vehicle
2. Mean distance driven by a driver at the wheel of his/her main vehicle
3. Mean time spent by a driver at the wheel of his/her main vehicle
4. Mean number of trips made by a driver at the wheel of his/her main vehicle
5. Characteristics of trips made by a driver at the wheel of his/her main vehicle: distribution of length, duration and speed.

Multiplied (weighed) by the number of vehicles or drivers these values also describe the total mobility in a country.

Measuring requirements

The calculation of RED requires basically the continuous measuring of a set of data including date/time and GPS position. The difficulty raised by the estimation of the RED is that we need to be exhaustive in the recording of the trips made by the instrumented vehicle. This means that the data acquisition systems (DAS) must be always present in the vehicle.

This necessitates an on aboard system and not a mobile system, which may be forgotten at home. This also means that the DAS must be robust to limit the occurrence of breakdowns. The RED estimation is dependent on the GPS receiver that gives the position change of the vehicle. Unavailability and inaccuracy of GPS coordinates, will negatively impact their estimation.

The calculation of some RED needs to deal with the concept of trip (see 3.2.1).

Specific databases are necessary for the disaggregation or filtering of the RED according to the driving situation characteristics, like a geographic information system (GIS) (map GPS coordinates to infer the road type) and light condition and weather data bases (see 3.2.1).

The calculation of the RED needs to have an identification of the driver to keep only the trips where the ND participant is the driver. It will also be interesting to have an indication of the presence of passengers in the vehicle.

Lastly, the disaggregation per driver and per vehicle needs a set of data describing the participants sample in terms of driver characteristics and vehicle characteristics

Filtering of naturalistic data

Two filters have to be applied on the ND data for the calculation of RED.

The first filter concerns the identification of the driver. The four RED that describe the mobility (numbers 2-5, see above) keep only the trips where the vehicle is driven by the participant of the study. For the first RED only (total mobility of the vehicle), information is needed on the trips where the vehicle is driven by the secondary drivers of the car.

The second filter aims to select only the mobility within the borders of the country. The part of the trips outside the borders of the country needs to be removed. For the calculation of the trip number, the authors propose to exclude trips that cross the borders of the country.

Disaggregation of the RED

Apart from totals, also details on the mobility are needed. These details can be clustered into four areas according to the Driving situation, Trip characteristics, Vehicle characteristics and Driver characteristics.

Driving situation characteristics	• Road type (urban, outside urban area, motorway) • Hour and period of the day (dawn, daytime, dusk, night-time) • Day and period of the week (week day, week-end) • Month and period of the year (spring, summer, autumn, winter) • Weather condition (clement, adverse) • Presence of passengers
Trips characteristics	• Duration of the trip • Local or far distance mobility (around the participants home) • Regularity of the trip (done more than 10 times a year)
Vehicle characteristics	• Vehicle type • Vehicle age, engine size, mass
Driver characteristics	• Age ,Gender • Driving experience • Occupation[30] • Home location[31] • Country

Table 7.4. Clustering variables used for the disaggregation of RED

Aggregation of the RED at the level of the country

The values obtained for a given (stratified) sample of vehicles / persons need to be weighted to obtain a value describing the general exposure at the level of the whole fleet of motor vehicles or at the level of the whole population of the country.

7.3.2.3. Procedure to SPI estimation

It is possible to build 3 different types of SPIs.

- **Behavioural SPIs** refers to an indicator that describes drivers' behaviour toward a specific safety issue. The data may permit to identify some of its determinants (for example, speeding on motorways or seat belt use by age of the driver). Generally homogeneity filters are applied.
- **Descriptive SPIs** refers to an indicator that quantifies the occurrence of a phenomenon. This can be useful to assess if a safety policy is followed or not, but lacks the possibility to understand the causes (for example, time spent speeding or time spent without seat belt, the number of Left- or U- turns). Generally all data are to be used.
- **Situational SPIs** refers to an indicator that describes driver behaviour in very specific situations which are relevant in terms of road safety. They require an accurate assessment of the driving situation and manoeuvre (for example, adequate use of turning indicator when turning or overtaking). This will not be investigated in detail within the frame of DaCoTA.

The three families are complementary. The SPIs of these categories sometimes differ only by a filtering or a clustering.

[30] The occupation and more precisely the fact to be part of the working or non-working population, has a strong impact on mobility due to the part of professional trips, including commuting.

[31] The urban density of the home location has a strong impact on the motorization of a household and on the vehicle mileage and availability and use of public transport.

Table 7.5 shows an overview of the behavioural and descriptive SPIs to be monitored using Naturalistic Driving. Even if most of them are technically feasible without too many constraints, the limits of this feasibility are described in detail in the relevant chapters of D6.2A, as are their added value and the considerations to keep in mind when interpreting the results. For each SPI the process of data collection, filtering, clustering, processing and analysis is discussed.

	Behavioural SPIs	Descriptive SPIs
Excessive speed	-Mean speed and standard deviation of speed in free flowing traffic conditions -V85 in free flowing traffic conditions -Percentage of driving time over the legal speed limit in free flowing traffic conditions -Percentage of driving time 10 km/h over the legal speed limit in free flowing traffic conditions	-Percentage of driving time over the legal speed limit -Percentage of driving time 10 km/h over the legal speed limit
Seat belt use	-Percentage of trips by seat belt use (with, without, partial) -Systematic use of seat belt: percentage of trips with immediate seat belt fastening	-Percentage of driving time with seat belt fastened for drivers. -Possibly front passengers and rear passengers.
Daytime running light use	-Percentage of trips by DRL use (with, without, partial) during daytime and clement weather conditions -Systematic use of DRL: percentage of trips with immediate DRL switching on during daytime and clement weather conditions	-Percentage of driving time with DRL switched on during daytime. -Idem during clement weather conditions
Short headway	-15th percentile of the headway in vehicle following situations -Percentage of driving time by headway-class (>2 sec, 1–2 sec, 0.5–1 sec and <0.5 sec) in vehicle following situations -Frequency of occurrences of short headways periods (headway less than 0.5 second during at least 0.2 seconds) in vehicle following situations	-Percentage of driving time by headway class (>2 sec, 1–2 sec, 0.5–1 sec and < 0.5 sec) -Frequency of occurrences of short headways periods (headway less than 0.5 second during at least 0.2 seconds)
Strong deceleration	-15th and 85th percentile of the vehicle in deceleration situation -Percentage of deceleration time by deceleration class (>-0.25g, -0.25g – -0.50g and < -0.50g) in deceleration situations	-Frequency of strong decelerations (deceleration inferior to -0.5g during at least 0.2 seconds) by hours driven

Safety Systems use		-Frequency of safety system activation (Anti-lock braking system and Electronic stability control system…) by hours driven

Table 7.5. Overview of behavioural and descriptive SPIs

7.3.3. Legal and ethical issues

Data collection by Naturalistic Driving can give rise to legal and ethical issues. The overview in this section is based on the FESTA-Handbook on conducting Field Operational Tests and Naturalistic Driving trials (FESTA-consortium, 2011) and recent Naturalist Driving projects such as PROLOGUE and INTERACTION.

7.3.3.1. Legal requirements

At the European level there are at least two relevant directives. Directive 95/46/EC concerns the protection of individuals with regard to the processing of personal data and the free movement of such data. Directive 2002/58/EC concerns the processing of personal data and the protection of privacy in the electronic communications sector.

<u>Key issues raised by Directives 95/46/EC and 2002/58/EC</u>

- Personal data must be processed fairly and lawfully, and collected for specified, explicit and legitimate purposes, only after consent by the subject from whom data are collected. Objections are still possible afterwards;
- The controller must give information relating to the identity of the controller, the purposes of the processing, recipients of the data etc. He must implement measures to protect personal data against accidental or unlawful destruction or accidental loss, alteration, unauthorized disclosure or access;
- The controller must report the processing to a supervisory authority that keeps a register of reported processing operations.

In addition to the EU requirements, states often have relevant national Acts, Regulations, Directives and requirements when conducting a study using personal data.

7.3.3.2. Participants

Recruitment

In participant recruitment it is important to ensure that participants hold valid driving permits. The coverage of their insurance needs to be checked, in particular whether participating in the trial doesn’t invalidate the insurance.

Agreement

In the agreement all arrangements between participant and research organisation and the responsibilities of both parties are stipulated. There are a few topics that should at least be covered by the participation agreement:

- Costs; who is responsible for certain costs (e.g. vehicle maintenance, damage to vehicle, insurance excess, traffic penalties)
- Benefits; what is the allowance the participant will receive and are there possible other benefits (e.g. use of instrumented vehicle, fuel cost reimbursements)

- Risks; is the participant exposed to increased risks (involvement in crashes or theft of the vehicle or ND-device) and if so, what is done to minimise the risks?
- Withdrawal; is the participant free to withdraw his/her participation to the trial at any moment and how will this affect the agreed participation allowance.
- Confidentiality of recorded data; what will/won't be done with the data gathered? Which parties will own and have access to the data (during and after the trial)?
- Who is allowed to drive the vehicle, how will data recorded of non-participating drivers be dealt with?

7.3.3.3. Data protection and ownership, risk assessment

Data acquired by means of Naturalistic Driving will contain privacy sensitive data. It is important to determine what data is gathered and how this data will be protected.

Some personal data are needed to communicate with the participant and to describe the sample for stratification purposes. These should be stored separately. All other data gathered should be properly anonymised. Data that could lead to identification of the participant should never be released to other parties.

In the process of collecting data to building a database, several operations are required. In data transfer from the vehicle to the research institute it is important that access is regulated and data is stored secured in such a way that unauthorized access is impossible. This implies that in-vehicle stored data should be secured (or encrypted) to avoid unauthorized access (e.g. in case of burglary). Also data transfer should be a secured process and intermediate storage devices should be properly cleaned after use.

Also on the final storage device, data should be stored properly secured and access to the data should be regulated. All 'users' of the data should be briefed in case the data contains privacy sensitive information and confidentiality agreements should be signed.

Vehicle instrumentation and approval

Observation equipment shouldn't interfere with the normal functioning of the vehicle and its (safety) systems. Vehicles should be instrumented by professionals that are authorised to perform the installation and make the necessary adjustments, without invalidating the approval for on-road use of the vehicle.

Risk assessment

A comprehensive risk assessment plan should be prepared that demonstrates that the risks have been properly managed. The plan should contain all identified risks and describe how each specific risk is approached. A lawyer could be consulted to help identifying potential risks and advise on managing these risks.

7.4. Small Scale Naturalistic Driving Pilots

In task 6.3 two pilot studies have been done, in Austria and Israel. In Deliverable D6.3, Small Scale Naturalistic Driving Pilot, the pilots are described, one for each of the two DAS scenarios.

7.4.1. Austrian pilot (scenario 1)

For Scenario 1 an off-the-shelf system for Naturalistic Driving observation (pDrive lite®) was installed in 10 cars. It collected date/time, speed, acceleration and GPS positions. For the identification of the driver a video camera was used.

Data was collected on each vehicle for 4 months. During this time, all data except video were collected continuously.

The *pDrive lite* ® records data at 100 Hz and this was reduced to 10Hz for analysis, as such a high sampling rate is not necessary for Scenario 1 data collection. Data was manually transferred from the DAS to a SQL database approximately every 2 weeks. Map matching was then undertaken to identify the type of roads the participants used for each trip. Data was available for road type but not speed limits. Without headway measurement it appeared difficult to know whether the driver had a free choice of speed or that he/she was influenced by the vehicle in front.

At the beginning of the field trial people filled in a questionnaire on driver and vehicle characteristics. During the study, every participant was asked to fill in a travel diary for one week, which should provide information of every trip, e.g. the distance travelled, the number of trips as well as possible correlation of subjects' information and collected technical data. Once during and once after the field trial the participants were asked for their experiences with pDrive lite®, such as awareness of its presence, influence on their driving behaviour and difficulties with the system.

7.4.2. Israel pilot (scenario 2)

The Israeli study aimed to collect data according to Scenario 2. 7 participants were recruited. The DAS consisted of MobilEye, a system that measures headway and lane departure, and TrackTec, a system which acts as a data logger and records vehicle speed, acceleration and position. Can-Bus data was collected for 1 vehicle and a system which records fuel consumption was fitted to 4 vehicles. These systems were off-the-shelf technology. The connections between them were developed for the study. GIS software was used to perform map matching.

Data was collected on each vehicle for 6 months. A mixture of continuous and event-based methods was used to record data. Headway, acceleration, speed and GPS were measured continuously at a sample rate of 30 seconds. Event-based measurements were taken when a predefined event occurred, for example when the lane departure and collision warning thresholds were met.

3,459 trips were recorded for the participants during the 6 month data collection period. Analyses were possible with regard to road type, driver gender, weekday, time of day, length and duration of journey, speed and acceleration as well as headway and lane departure. Other Scenario 2 topics, which rely on Can-Bus data, were more problematic.

7.4.3. Conclusions from the pilots

For the results of the pilot studies in terms of data gathered we refer you to D6.3. Both studies demonstrated that it is possible to collect relevant data continuously over a period of time using relatively low cost and easy to install equipment. Different approaches used by the studies highlight the importance of defining sampling rate and trip definition precisely before data collection starts. Although different sampling rates and trip definitions do not impact the total distance and driving time, the trip definition does affect the number of trips recorded and results in different lengths and durations of single trips. The trip definition must be carefully defined as it may have implications for database structure and handling.

Regarding sampling rate a compromise must be found between huge amounts of data and the gain/loss of events missed by averaging the data over the sampling interval time.

The Austrian and Israeli studies lead to the following practical recommendations when implementing a ND study:

- A detailed planning and recruitment procedure in necessary. Besides that a ND study needs to be well structured and organised (support team). Continuous support allows errors/defects to be corrected as soon as possible (to prevent data losses).
- Relatively cheap, off-the-shelf devices can be sufficient for a ND study. It is essential to have a storage capacity that is big enough, as data can be lost when the storage device approaches its capacity. A buffer battery is very useful to guarantee a safe storage of the data.
- For a large scale activity it is recommended to stream data onto some form of solid state storage device, e.g. by transmitting the data automatically and to store it on a server.
- Numerous secondary variables or indicators can be calculated from the raw data. The problem is more how to define them and how to operationalize them. Depending on what conclusions need to be drawn, more or less additional information may be needed.

DaCoTA ND pilots demonstrated the capability and usefulness of collecting very detailed data on exposure, speed and associated characteristics. It shows that it is possible to obtain a very detailed account of exposure and safety related behaviour, which it is, so far, not possible to collect by other methods. The scenario 1 data are limited to exposure, speed and acceleration. Scenario 2 data covers a wider range of variables and would seem to have an added value to scenario 1.

7.5. ND for monitoring Performance and Exposure: considerations for implementation

I The final task was to take a broader look at the aspects to be taken into account when implementing ND research for monitoring purposes, based on and reviewing the findings of the preceding deliverables in this Work Package, and discussing a number of practical issues.

The final chapters of deliverable D6.4, Report on Implementation plan for Large Scale Naturalistic Driving research within ERSO ,contain a concise summary of the whole project and are therefore largely reproduced in the sections 7.5.4and 7.5.5.

7.5.1. Budget allocation and priorities

The available budget will be a decisive factor shaping details of the study. When implementing a naturalistic driving study, one should dimension carefully (at least) 3 major budget allocations:

- For the data collection systems,
- For the sample recruitment,
- For the development of SPIs & RED calculations and analysis.

The part of the budget of the study dedicated to data collection systems should be significant enough to permit the purchase of a device corresponding to the scenario 2 specifications.

The budget of the study dedicated to the sample should be spent by favouring the size of the sample over the number of countries that perform the study. This will make it possible to immediately obtain results that are meaningful for the country and that can be compared relevantly to the other countries' results. It will also decrease the time necessary to investigate in detail the legal and ethical requirements. Once the first countries are operational, it will be possible to extend the study to other new countries in a second step, which will also allow the use of the experience obtained during the first implementation.

The budget of the study dedicated to the SPIs & RED development should be spent by favouring the RED development and the SPIs linked to excessive speed, as they can be compared to classical SPIs and act as a way to evaluate the methodology and the results, and the SPIs that have a clear added value compared to classical methods (Short Headways, Strong deceleration and braking, Safety System use, …). Once the first SPIs are operational, it will be possible to extend the study in a second step to other SPIs.

7.5.2. A third scenario

Following the wish to monitor also other safety relevant SPIs, such as drug use, inattention, distraction, fatigue and near crashes, it is explored what would be the consequences if a part of the sample is equipped with video cameras. This leads to the introduction of a third scenario in addition to the two scenarios introduced in D6.1 (of which scenario 2 substantially depends on CAN data, which on the short and medium long term is hard or impossible to come by). With increasing complexity and costs, this will result in an increasing amount of information. The third scenario that is presented is monitoring near crashes by event-triggered video recordings. In combination with RED, near crashes can be a useful SPI to compare countries and developments over time.

Minimally this requires a video camera with a fairly wide-angled view, which permanently records the traffic situation ahead of the vehicle. To prevent unmanageable quantities of data the recordings are discarded after a short time, except data of periods immediately before, during and after events indicating a near accident, such as harsh braking, accelerating or steering movements (thresholds to be defined).

The events that trigger the video recording can be seen as near crashes, however, video data is necessary to judge the correctness and to minimise false positives. Thus a more reliable picture of the number of real near crashes can be drawn. In addition, the video data gives background information about the seriousness of the near-crash and the road and traffic circumstances. The video data can be used for research purposes as well, studying the circumstances of near crashes.

It must be noted, however, that an event-triggered video does not give the full picture; it does not provide information about near crashes that did not involve an action (braking, steering correction) of the driver, but where a crash was avoided by an action of another road user.

7.5.3. Towards a scenario 4?

So far, the scenarios presented have in common that SPIs and RED data is collected through equipment and sensors added to the vehicle. This has proven to be a feasible approach that can provide useful information. However, given that fairly large samples are needed, it is also a rather costly and labour intensive approach. In addition, the reliability of the data depends on the recruitment of a representative sample of the population, an effort that is not easy at all.

In theory there is a fourth scenario, that is not dependent on equipping cars nor on voluntary participants, but a scenario that extracts data directly from all cars based on CAN-data, OBD, and other trip and travel data collected automatically by the vehicle (e.g. trip recorder, event recorder, E-call-related data). This approach would result in more reliable data because it would include the complete passenger car fleet and other motor vehicles.

This option, however, is not something that can be realised overnight. One important aspect is that, currently, car manufacturers apply their own technical specifications for most of the CAN and OBD data and they are not very keen on sharing these with other car manufacturers or external parties. This means that this type of data is not widely accessible nor comparable between car makes and models.

Given the theoretically promising characteristics of this approach, it is time now to explore the feasibility and future options and the roles of the various parties involved. As a first step, the requirements for this data need to be elaborated:

This is a process that needs to take place in consultation with the car manufacturers. Timely involvement may help to realise their commitment and a positive attitude.

Furthermore, the European Commission can play an important role as well by promoting or maybe even regulating harmonisation of, and free access to the relevant data of the different European car makes. An important condition is that the access and use of the data do not conflict with European or national privacy legislation. Since, eventually, also non-European car makes and models would need to be included, this effort would also affect car manufacturers outside Europe, because it might result in specific requirements for non-European cars that are imported in the EU.

An important other aspect related to this approach would be the public support for transferring all sorts of privacy-sensitive data from their car to a central database. Even though subsequent data aggregation and data storage can be arranged so that information cannot be traced back to individual vehicles, it is not unlikely that a majority will develop strong anti-‘Big Brother’ sentiments. If this means that people have to give their informed consent for logging the data of their car, there is again the issue of a representative sample.

It will take a long time to make this approach work. But in the end, an approach that directly extracts the relevant information from the vehicle, seems to be a more solid and sustainable approach than monitoring through ND research. Therefore, it is recommended to start discussions now, trying as a first step to break the taboo of sharing some information between different car manufacturers.

7.5.4. Conclusions and Recommendations

The main conclusion of the project is that, in principle, the ND approach has substantial added value compared to more traditional data collection methods like crash registration and surveys, because ND ensures continuous, automatic and standardized data collection. This is true for both SPIs and RED. A prerequisite is that similar data acquisition systems and methods/definitions are applied. These systems as well as technology for data transfer and data storage is available and has proven to be operational. Though the current Deliverable is purely focused on road safety and exposure data, the collected data will also be useful for other transport areas, in particular eco-driving, traffic management and even road maintenance.

In order to get reliable information, a fairly large sample is needed. The exact size of the sample depends on the variation in behaviour in the population and the required level of precision of the results. Assuming that the sample is drawn in a cleverly stratified way, a sample of 10,000 drivers per country seems to be the absolute minimum for RED such as the annual mobility. Experiences in the USA show that it may require substantial effort to get sufficient participants with the required characteristics to allow for a good stratification.

With regard to data collection, based on cost considerations, three scenarios are distinguished. It is recommended to start off with Scenario 1: a low-cost simple, off-the-shelf simple data acquisition system (e.g. an OBD GPS tracker or a Smart Phone) and a limited number of additional sensors, measuring:

- Vehicle mobility
- Person mobility
- Number of trips
- Time in traffic
- Speed (excessive)
- Seat belt use
- Light use

In addition, the data acquisition system would need to register continuously the time, the date, and the location (GPS). In combination with a map matching tool, and an indication of the road class and the speed limit, this would allow comparisons of the mentioned RED and SPIs and would give an indication of the occurrence of excessive speed. For cross-national comparisons it is important to define a (limited) number of comparable road classes. Furthermore, as a relatively simple driver identification method, it is recommended to use a magnetic swipe card or an RFID tag.

At a later stage, additional SPIs and network characteristics could be added successively (Scenario 2), including:

- Time headway
- Acceleration
- Lane departures
- Inappropriate speed
- Signal use
- Junction type

A few SPIs are very relevant from a safety point of view, but with current techniques cannot be measured reliably in an unobtrusive way. This applies, in particular, to alcohol and drugs use.

In addition, SPIs that would need continuous video recordings do not seem to be feasible in the short term, because this results in huge amounts of data and extreme high costs for the related data transfer and data coding. That means that the SPIs fatigue, inattention, distraction and the (proper) use of child restraints cannot be monitored by means of Naturalistic Driving.

Furthermore, as Scenario 3, it is recommended to equip a limited number of cars also with an event-triggered video in order to monitor numbers of near crashes as yet another relevant SPI. As a very useful side product, this effort will provide data that can be used to further specify and refine the quantitative and qualitative relationship between near crashes and real crashes.

For all three scenarios very strict European and national legislation applies in relation to data protection and privacy, among others requiring all participants to sign an informed consent.

Though it is impossible to give a reliable estimate of the costs involved, the costs can be expected to be fairly high. Just assuming a simple OBD GPS tracker of €100 and a participant incentive at the value of €400 would add up to an annual 5 million euro per country assuming the recommended sample size of 10,000 drivers. And this amount does not include the costs of man power related to participant recruitment and contact, and the organisation and management of the data collection, transfer, storage and analysis.

In short:

- ND research can provide very useful information about several very relevant SPIs and RED for cross-national comparisons and comparisons over time.
- Technology for data collection, data transfer and data collection is available and has proven to be operational, at least on a small and medium scale.
- Bottlenecks in the successful implementation of ND research for monitoring may be:
    - Recruitment of sufficient participants
    - Harmonization of definitions of variables, disaggregation levels and analyses
    - Operation costs

Hence, in parallel, it is recommended to start exploring the possibility of a scenario 4 now, i.e. a scenario where relevant data is extracted directly from the vehicle via CAN-bus, OBD, and other data collected automatically by the vehicle. In theory, a lot of relevant information is already available with no or little additional costs; in practice, however, the information is not generally accessible nor comparable between car makes and models.

One of the first steps, in consultation with the car manufacturers, is an elaboration of the requirements for this data: what is available, needed, technically feasible. The European Commission can play an important role as well by promoting or maybe even regulating harmonisation of, and free access to the relevant data of the different car makes and models.

Whatever data is collected, whatever data acquisition system is applied, the ND approach for monitoring, as discussed in this report, is largely oriented towards passenger cars and their drivers; as a consequence, the resulting information about SPIs and RED is restricted to that user group.

The ND methodology can also be applied to other vehicles, but that will involve several additional organisational and technical requirements and related efforts. Current technology is not sufficiently robust and stable to apply to cyclists on a large scale, nor to pedestrians. This all means that getting an overall view of the safety related behaviour and the exposure to risk of *all* road users, requires more additional methods including the more traditional surveys, trip diaries, and observations.

7.5.5. A central role for Europe

Despite various bottlenecks and challenges, the potential of ND research for monitoring purposes is sufficiently large to start off with the implementation of Scenario 1. Since harmonisation and international comparability of data are the key reasons for this effort, there is a central role for the European Commission in initiating this task and taking the lead, most likely within the ERSO framework. A stepwise approach is recommended, including successively:

1. Creating support and finding budget by presenting the case to the relevant road safety bodies at European and Member State level, explaining the need for harmonised, comparable international data, the ND approach, and its added value.
2. Preparing a detailed description of all practical implementation aspects, including the functional specifications of data collection equipment, participant selection, data transfer and storage, definitions of variables, disaggregation levels and analyses.
3. Identifying the relevant national organisations, responsible for national data collection and pre-analyses, and fine-tuning data collection procedures (including legal aspects) and variable definitions in consultation with them.
4. Developing and equipping a database at EU level and defining the required data to be provided and the procedures and time schedule, in consultation with the relevant national organisations.
5. Setting up European-wide communication strategies to guarantee maximum dissemination and use of the collected data.
6. Setting up one year national pilots in at least four Member States.
7. Adapting procedures and definitions, based on the pilot experiences.
8. Successive implementation of Scenario 1 in additional Member States.

Parallel to steps 6 and 7, Scenario 2 (additional SPIs/RED) and 3 (monitoring near-crashes) can be elaborated, piloted and implemented, applying a similar stepwise process.

From the very beginning, the EC is advised to initiate discussions with the car manufacturers, using existing discussion platforms, with the aim to explore longer term possibilities of Scenario 4, i.e. the scenario where relevant data is extracted directly from the vehicle.

Finally, in order to elaborate these steps and to assist the EC in performing these steps, it is advised to compose a consortium of organisations. Possibly, this can be part of the future research agenda that is currently being prepared by the PROS consortium.

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9. RECOMMENDATIONS FOR FUTURE WORK/DEVELOPMENT OF ERSO

The European Road Safety Observatory was established European Commission and first announced in the 2001 Transport White Paper[32]. It was further developed in the 2003 Road Safety Action Plan [33] where the Commission announced it was to establish a new European Road Safety Observatory (ERSO) to "co-ordinate all Community activities in the fields of road accident and injury data collection and analysis". This vision for ERSO means that it should now become a routine activity of the European Commission supported by an organisational structure that facilitates the flow of data, the development of the knowledge base and ensures that ERSO is able to address future information needs for evidence based road safety policymaking.

A useful reference for the future development of the Observatory is the safety data system that has been established in the United States since the 1970s. An integrated set of datasets has been in continuous operation and provides a range of resources for national and state level policymaking. Table 9.1 below describes each data type. The US system operates with a total annual budget of over $34m (2006)[34] and this sets the level of investment that is required for a fully functioning data system. EU investment has not been at a similar level and it can be seen from Table 9.1 that in comparison Europe is weak in respect of accident data. Nevertheless the availability of exposure, safety performance and road safety management data means that Europe is strong in these areas. It is not suggested that the US approach should be copied and there are some types of data that would be handled more efficiently within the DaCoTA proposals however the comparison with the US establishes the magnitude of investment in road safety data made by comparable global entities.

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[33] European Commission 2003. European Road Safety Action Programme: Halving the number of road accident victims in the European Union by 2010: A shared responsibility. COM (2003) 311 final. Brussels, 2.6.2003

[34] Report to Congress NHTSA’s Crash Data Collection Programs. DOT HS 811 337 April 2010. http://www-nrd.nhtsa.dot.gov/Pubs/811337.pdf

Table 9.1: US Safety Data resources

Data	Purpose	Examples of use	2006 budget
Fatality Analysis Reporting System	Census of fatal traffic crashes in the United States. FARS is the sole source of national statistics on police-reported fatalities.	• Identify trends in highway safety problem areas • Provide basis for regulatory and consumer information initiatives • Evaluation of the decrease in the BAC limit from .10 to .08 • Evaluation of motorcycle helmet usage legislation • Evaluations of restraint usage laws	$6,992,000
NASS General Estimates System (GES)	A nationally representative probability-based sample collected at 410 police jurisdictions in 60 locations around the United States. The approximately 55,000 annual cases are statistically weighted to represent the 6.2 million police-reported crashes annually. The NASS GES is the sole source of national estimates statistics on police-reported injuries other than fatalities.	• Identify trends in highway safety problem areas • Provide basis for regulatory and consumer information initiatives • Provide basis for cost and benefit analyses of highway safety initiatives • Defect investigations	$1,500,000
NASS Crashworthiness Data System (CDS):	A nationally representative stratified in-depth sample collected in 27 locations across the United States. Approximately 4,500 annual cases are statistically weighted to represent the 6.2 million police-reported traffic crashes of the towed light passenger vehicle population annually.	• Vehicle safety standards • New Car Assessment Programmes • Future vehicle safety priorities • Evaluation of safety systems	$10,500,000
National Motor Vehicle Crash Causation Survey	A nationally representative probability-based sample collected in 24 randomly selected locations across the United States. In-depth investigations are conducted on scene. Approximately 3,000 cases are collected annually that are statistically weighted to represent the factors or events that led up to a crash for towed-vehicle population in the	• Government and auto manufacturers to evaluate crash avoidance performance • NHTSA rulemaking and programs • Data to support primary prevention of crashes • Evaluation and assessment of intelligent safety systems	$7,920,000

	6.2 million annual police-reported traffic crashes.		
Special Crash Investigations	An elite team of investigators that perform very detailed in-depth investigations on a limited number of crashes. SCI data are the sole source of detailed data on new and rapidly changing technologies.	• Primary data source for advanced air bag rule • Only source for air bag-related fatality investigations • Only source for school bus crashworthiness data • Defect investigations	$1,683,000
Crash Injury Research and Engineering Network	A network of trauma surgeons, epidemiologists, crash investigators, and engineers researching vehicle crashes resulting in serious and/or disabling injuries. Outcome data on occupants up to 12 months post-crash for research on long-term outcomes. Only NHTSA crash data system prospectively reviewed by medical doctors and bioengineers for NHTSA and academic research	• Lower extremity injury in offset frontal crashes • Thoracic and abdominal response in frontal, side, and oblique crashes • Contact and non-contact brain injuries • Current research on paediatric injury mechanisms and child safety seats • Data used for initiation of updated Field Triage Guidelines • Sole source of detailed injury mechanism field data for computer simulations	$3,800,000
State Data System	Computerized State crash data from 29 States.	• Support Defect Investigations • Research rollover propensity • Rulemaking • Occupant protection effectiveness	$500,000
Crash Outcome Data Evaluation System	Probabilistic linkage of crash data to EMS data in 30 participating States, to include emergency department, inpatient, and death certificate information. Some States also link to vehicle registration, driver licensing, other traffic records, and/or other injury records. CODES is the sole source of national estimate statistics on medical and financial outcome cost.	• Provides cost benefit analysis data to regulators • Motorcycle helmets • State laws • Rulemaking • Defect investigations	$1,500,000

The SafetyNet Integrated Project was funded under FP 6 to develop the methodological framework for ERSO, to establish a mechanism to gather and amalgamate comparable indicators, and to initiate the population of the Observatory with data and knowledge. The work of DaCoTA has enabled strong progress in development of ERSO and it is now ready to become a fully functioning Observatory.

The DaCoTA team have substantially developed the Observatory by extending and enriching the data content, producing new data tools and establishing new data gathering capabilities. The details are presented in this report and summarised below.

The increasing availability of knowledge and data has identified a strong need for road safety data across the community, since the road safety knowledge system website was opened in February 2012 it has attracted over 70,000 hits. There has been considerable interest in the data that has become available and clearly a strong unmet need. A major gap in available data concerns in-depth data and this need was very strongly voiced at the DaCoTA Conference in November 2012 which was attended by nearly 200 delegates.

Many of the data resources developed by the DaCoTA team for ERSO are now mature and can be directly implemented while the development of other types remains within the research domain. The knowledge base of state of the art reviews is considered to be a world leading resource on road safety and a major benefit to policymakers. The network and protocols established in 18 EU member States for in-depth data gathering are waiting for the next steps.

The further development of the European Road Safety Observatory can take place at three separate, but connected, areas - institutional organisation of ERSO, implementation of routine data functions and integration with future EU road safety research.

9.1. Institutional organisation of ERSO

The development of ERSO has largely taken place within the research domain, reflecting the need to establish a coherency and rigour of the combined data and knowledge resources. While some of the products of data and tools are already available on the DG-MOVE website there are many parts that do not. However the website is only the visible part of the underlying operation to gather and organise comparable data for the EU Member States. In order to make the transition from a series of research activities to become an institutional function there are a number of procedures that need to be established before the Observatory can be considered to be fully functioning. The DaCoTA team recommends that the following steps be taken by the European Commission.

Recommendations for Institutional arrangements for ERSO

1. **Establish terms of reference for the operation and future development of ERSO**
   These will ensure clarity over the objectives of ERSO and the manner in which it operates within the Commission and with external stakeholders. They will detail the participation of the Directorates-General of the EC, Member States, industry stakeholders and others and will embed the operational parameters of the Observatory.

2. **Establish an advisory body**
   The Observatory will rely on knowledge and data from Member States and other stakeholders to be fully effective. However it is also a service for road safety policymakers and it must continue to meet their needs. The Member States particularly are more than data providers and should have the opportunity to guide the future operation and development of ERSO.

   An advisory body is needed that will represent the body of stakeholders, it should include the Member States, perhaps with a link to the High Level Group on road safety, as well as industry and other stakeholders.

3. **Establish a funding stream for routine data collection**
   A routine funding stream is necessary for the future operation of ERSO, this will cover the costs of gathering and processing data, any special surveys that may be required, updating of the data tools and knowledge and maintaining the ERSO infrastructure. Precise costs have not been estimated since they depend heavily on the exact content of the Observatory but a similar activity in the US is budgeted at over $34m annually.

9.2. Implementation of routine data functions

The development of a routine data resource for policymaking purposes goes through a series of phase which are outlined in Figure 9.1 below.

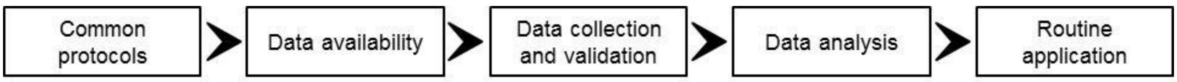

Figure 9.1: Data availability and harmonisation stages

In order that data is available for all EU Member States it is essential that a common protocol is used. This protocol can be utilised either at the data gathering stage, if the same procedures and coding formats are used in each country, or at the data processing stage where transformation rules can be applied.

Data also has to be available in principle in each country, if no data is gathered or the procedures are such that it is not representative it cannot be used for safety policymaking at the EU level. It can be gathered at an institutional level as part of a wider mobility survey or can be the subject of specific data gathering activities.

The task of gathering the safety data has to be undertaken on a routine basis. Depending on the rate of change of the data and its importance this may need annual data gathering as in the case of CARE data or less frequently as for the Sartre of attitudes to road safety.

The value of the data will only be obtained once it is available for analysis. This can be conducted centrally and some of the sensitivities surrounding the data may promote this however the most effective way is for data to be widely available for policymakers to conduct their own analyses. Some types of data may require specific types of agreement but in general publicly funded data should be widely available.

11. Data and knowledge content and status

The process of developing data resources outlined above has been followed for the data within the Observatory. Each data type has been evaluated and the necessary methods for implementation within ERSO are summarised below. Further information in the table shows the status of other key components.

Macroscopic accident data	**Status**
Project	SafetyNet and DaCoTA
Data protocols established?	In place for EU 27
Data collection method in place?	In place - gathered by national police forces
Data collection validated?	Yes
Data storage and access methods in place?	Yes - CARE database
Ready for routine data collection?	Yes - already in place
Next steps	Wider access for non-governmental users

Risk exposure data	**Status**
Project	SafetyNet and DaCoTA
Data protocols established?	Yes
Data collection method in place?	Partially through Eurostat, further specific surveys needed
Data collection validated?	Yes
Data storage and access methods in place?	Yes - Road safety knowledge system
Ready for routine data collection?	Yes
Next steps	put in place annual collection procedures for disaggregated exposure data for EU-27

Safety Performance indicators	**Status**
Project	SafetyNet and DaCoTA
Data protocols established?	In place for EU 27
Data collection method in place?	Specific surveys needed for most countries
Data collection validated?	Yes
Data storage and access methods in place?	Yes -Road safety knowledge system
Ready for routine data collection?	Yes
Next steps	Conduct periodic surveys

Medium depth fatal accident data	Status
Project	SafetyNet
Data protocols established?	Yes - for 8 pilot EU Member States
Data collection method in place?	Yes - for 8 pilot EU Member States
Data collection validated?	Yes
Data storage and access methods in place?	Yes - database structure available
Ready for routine data collection?	Yes
Next steps	Implement system in EU 27

In-depth accident and injury data	Status
Project	SafetyNet and DaCoTA
Data protocols established?	Yes
Data collection method in place?	Yes, special teams established in 18 EU MS
Data collection validated?	Yes
Data storage and access methods in place?	Yes - specialist database available
Ready for routine data collection?	Yes
Next steps	Use established teams to start routine data collection. Also available for special research studies

Road Safety Management data	Status
Project	DaCoTA
Data protocols established?	Experimental protocols available
Data collection method in place?	Yes
Data collection validated?	Yes
Data storage and access methods in place?	Yes - specialist data storage system available
Ready for routine data collection?	Further research needed
Next steps	Further development and evaluation of RSM data needed

Naturalistic driving data	Status
Project	DaCoTA
Data protocols established	Experimental protocols established
Data collection method in place	Yes
Data collection validated	Partially
Data storage and access methods in place?	No
Ready for routine data collection?	No - further research needed
Next steps	Conduct wider-scale naturalistic driving study, further evaluation of ND data

Knowledge	Status
Project Protocols established Data collection method in place Data collection validated Quality review Ready for routine data collection? Next steps	SafetyNet and DaCoTA 21 state of the art reviews of safety topics produced or updated Specialist authors produced each review Format trialled and modified following user review (SafetyNet) World-leading peer review committee responsible for quality and oversight Yes Incorporate reviews into ERSO, initiate updates every two years. Add further topics as required. Maintain peer review group

Data tools	Status
Basic Fact Sheets	17 annual data publications on selected topics produced annually. Incorporate into ERSO and continue with annual updates
Annual statistical report	Report produced annually. Incorporate into ERSO and continue with annual updates
Country Overviews	Overviews of road safety in EU27 now produced. Incorporate to ERSO and update annually
Country forecasts of accidents	Now available for EU 27. Incorporate to ERSO and update every three years
Road safety management profiles	Available for EU 14. Extend to EU 27, incorporate to ERSO, continue to develop structure and content of profiles
Composite index of road safety	Available for EU 27. Continue to develop index and strengthen link to outcomes

Website	Status
Availability Structure and framework Next steps	DaCoTA Road Safety Knowledge System available at safetyknowsys.swov.nl Validated in SafetyNet and DaCoTA Incorporate into ERSO

Most of the types of safety data that have been developed by DaCoTA are now ready for routine collection and priority data gap concerns the lack of European in-depth accident data which can be addressed by the structure put in place by DaCoTA in 18 countries. The DaCoTA team makes the following recommendations for their implementation.

Recommendations for implementation of routine data functions

1. Establish a procedure whereby the following data types and tools are updated annually and made available on ERSO
    - Exposure data – gathered by Eurostat + special surveys
    - Safety Performance Indicators – gathered by special surveys
    - Medium depth data on fatal accidents – gathered by enhancing national data
    - In-depth accident and injury data – gathered by DaCoTA teams
    - Basic fact sheets
    - Annual statistical report
    - Country overviews
    - Website – annual enhancement and updating
2. Establish a procedure whereby the following data types and tools are updated periodically and made available on ERSO
    - State of the art reviews – update and enhance every two years
    - Country forecasts – update every three years
3. Establish a road safety policy support structure to enable ERSO data to be presented in the most efficient and accessible form for policy-makers

Priority data gap – in-depth accident data

4. The lack of European in-depth accident data is a major obstacle to a detailed understanding of the causes of accidents and injuries. A large-scale pilot study is now needed to implement regular collection of in-depth data across the EU, the teams established by DaCoTA in 18 countries provides the best platform available to achieve this.

9.3. Integration with future EU road safety research programme

The road safety environment continues to change with new measures becoming available and new safety challenges emerging. While monitoring progress towards targets continues there are many demands for new evidence to support policymaking. In particular the rapid introduction of new intelligent technologies to vehicles, infrastructure or as nomadic systems is seen as having the potential to prevent or mitigate crashes and reduce fatalities. There are many research challenges concerning the functionality of the systems, the predicted or measured effectiveness, the behavioural changes of road users or the impact on specific groups. Related research was common under FP 7 and is expected to increase under H2020.

There is a considerable value in establishing a two-way engagement between the ERSO and the future H2020 safety research programme. There are many safety issues related to policymaking, product development or use of future transport systems that prompt research activities. Where these relate to safety data and knowledge they fall within the mandate of the Observatory to “coordinate all Community activities in the fields of road accident and injury data collection and analysis”. There may be a stimulus from ERSO to initiate specific research programmes or there may be a safety value in taking the public results of research and incorporating them into the Observatory. The following examples of relevant areas of research are just some extracted from a recent stakeholder review conducted under the PROS project (Priorities for Road Safety Research – FP 7).

- *Analysis of the relevance and root causes of single-bicycle/powered two-wheeler accidents*
- *Accident analysis of small overlap crashes*
- *In-depth investigations of crashes with new safety technologies*
- *Accident/incident research with the aim of better understanding the basic mechanisms whereby distraction, drowsiness, alcohol and drug intoxication cause crashes*
- *Causes of accidents and injuries to all road user types*
- *Analysing the root causes of night-time cycling accidents*
- *Identifying common crash scenarios for older road users to prioritise and identify key countermeasures for crash avoidance and injury mitigation*
- *Harmonisation of in-depth data collection methods (data sets and procedures) for accident and injury causation, taking into account the hierarchy of causes, extension of sources of information and data to be observed*
- *Method development for the analysis of disabling (long-term) injuries*
- *Calibration of international Crash Modification Factors (CMFs) to local conditions and validation of the developed standardisation methodology*
- *Improvement of data collection and analysis of work-related road accidents*
- *Naturalistic driving/riding studies (for all road users)*
- *Relationship between ND data and accident causation*
- *Effectiveness measures of safety systems (before and after introduction)*
- *Socio-economic aspects of road accidents incl. the evaluation of long-term injury consequences*
- *Analysis of the perceived risks of cycling versus actual risks taking into account health effects (physical safety)*
- *Analysis of the consequences of modal shift on road safety*
- *Verifying road safety ratings via independent crash data*
- *Cost benefit analyses of black spots: main investments where best benefit*
- *Measuring magnitude of the contribution of vehicle defects to accidents*
- *Economic, safety and environmental effects of longer semi-trailers for lorries*

The results of each of these studies would be relevant to policymakers and hence to ERSO. Equally it is anticipated that a stakeholder group advising the operation of ERSO would be recommending studies such as those above. The DaCoTA team makes the following recommendations:

Recommendations for integration with future safety research programmes

1. Establish a formal relationship between ERSO and the road safety research programme under H2020 to ensure the research programme to 2020 incorporates the needs of the developing Observatory.
2. Define a research programme in relation to ERSO to further develop road safety data tools and knowledge. Priority areas include
    a. The causes of accidents and injuries in the EU to car occupant casualties
    b. The causes of accidents and injuries to vulnerable road users in the EU
    c. The causes of accidents involving specific target groups (eg children, level-crossings, older road users, new model cars etc.)
    d. Data methods to assess the causes and social impacts of serious injuries
    e. Real-world evaluation of performance of new safety systems
    f. Impact of different road safety management strategies on casualty outcomes
    g. Driving culture and safety
    h. Development and implementation of a policy support framework for routine impact assessments
    i. Development and implementation of a policy support framework for routine cost benefit evaluations of measures
    j. Methodological improvements in naturalistic driving/riding (ND/NR) studies and FOTs
    k. Naturalistic studies & FOTs for VRUs
    l. Safety assessment of road infrastructures based on accident data
3. Ensure that results, reports, data and syntheses of all relevant H2020 research projects are made available in a suitable format to be incorporated within ERSO