SUNflower+6

A comparative study of the development of road safety in the SUNflower+6 countries:

Final report

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Project co-financed by the European Commission,
Directorate-General Energy and Transport

Editors:
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Foreword

The number of road traffic crashes, fatalities, and casualties is decreasing in all European countries, as it is in other high-income and highly motorized countries in the world. Despite an ongoing increase of motorization, we manage to reduce the numbers of deaths and (seriously) injured by investing in the safety quality of the road traffic system. However, the toll of crashes on our roads is still considered to be unacceptably high. Almost all European countries are working with road safety targets, expressing their intentions to improve road safety. The European Commission itself is very ambitious indeed: it aims at halving the number of fatalities in the first decade of the 21st century.

The SUNflower concept can be considered as an important contribution to the goal of reducing the road crash toll on our roads. It is based on comparing road safety policies, programmes and road safety performances in different European countries. Building upon a methodology developed in the original SUNflower project, the policies in different countries are compared and trends are identified. The results are of potential value for the countries involved, for other countries, and for the European Union. SUNflower offers the possibility for countries to learn from each other and by doing so, to speed up road safety improvements.

As road safety is a complex problem, we need to understand the past as thoroughly as possible in order to learn from it and to even change the future. All who are familiar with this problem know that fast and easy solutions cannot improve road safety in a sustained way. Understanding the past in order to learn lessons for the future is the essence of SUNflower. The SUNflower methodology is data driven and knowledge based. Comparing policies and trends in different countries is of a very complex nature, never being sure of not overlooking an important factor, or one or two underlying forces. But surprisingly enough, the results are always astonishing, sometimes they confirm prejudices, often they are eye-openers, and sometimes they are groundbreaking.

SUNflower started in 1999 and reported its first result with *SUNflower: a comparative study of the development of road safety in Sweden, the United Kingdom and the Netherlands in 2002.* Based on this, SUNflower is considered as a strong brand, appreciated and trusted. An honest and powerful methodology is now available.

It was decided to extend this first result and to expand it to SUNflower+6. In this study three groups of countries were formed: the original SUNcountries (Sweden, United Kingdom and the Netherlands), the Central group (the Czech Republic, Hungary and Slovenia) and the Southern group (Greece, Portugal, and Spain and Catalonia). In SUNflower+6, a first consideration is given to the impacts of regional road safety actions with the autonomous region of Catalonia being benchmarked alongside Spain and other countries.

A large number of researchers from different countries was involved: David Lynam, Barry Sexton (TRL, United Kingdom), Göran Nilsson (VTI, Sweden), Charles Goldenbeld, Peter Morsink, Siem Oppe, Martine Reurings, Divera Twisk, Willem Vlakveld (SWOV, the Netherlands), Vojtěch Eksler, Jaroslav Heinrich (CDV, Czech Republic), János Gyarmati, Peter Holló (KTI, Hungary), Bruno Bensa, Nina Bolko, David Krivec (OMEGAconsult, Slovenia), Simon Hayes, Susana Serrano (DSD, Catalonia/Spain), Laia Pages Giralt (SCT, Catalonia), Pilar Zori (DGT, Spain), Yannis Handanos, Dimitris Katsochis, Chryssanthi Lymperi (Trademco, Greece), António Lemonde de Macedo, João Lourenço Cardoso, Sandra Vieira Gomes (LNEC, Portugal).

The results are summarized in five documents:

- SUN *An extended study of the development of road safety in Sweden, the United Kingdom, and the Netherlands.*
- Central *A comparative study of the development of road safety in the Czech Republic, Hungary, and Slovenia.*
- Southern *A comparative study of the development of road safety in Greece, Portugal, Spain, and Catalonia.*
- Footprint study *Development and application of a footprint methodology for the SUNflower+6 countries.*
- Final report *A comparative study of the development of road safety in the SUNflower+6 countries: Final report.*

In the Foreword of the SUNflower report (2002), I expressed my wish that the study would be used as a model and would trigger off further comparable studies. We have gone from one study to five, in which nine countries and one autonomous region have participated. I am grateful for that result and I expect the same success as from the initial SUNflower study.

I would like to thank the whole SUNflower+6 team. Their task was a very challenging one and everybody worked hard to produce high-quality reports. I am grateful for the European Commission and all our other sponsors in the different participating countries to make this study possible. I do hope the results will find their way to further reduction of the number of casualties on our roads.

Fred Wegman

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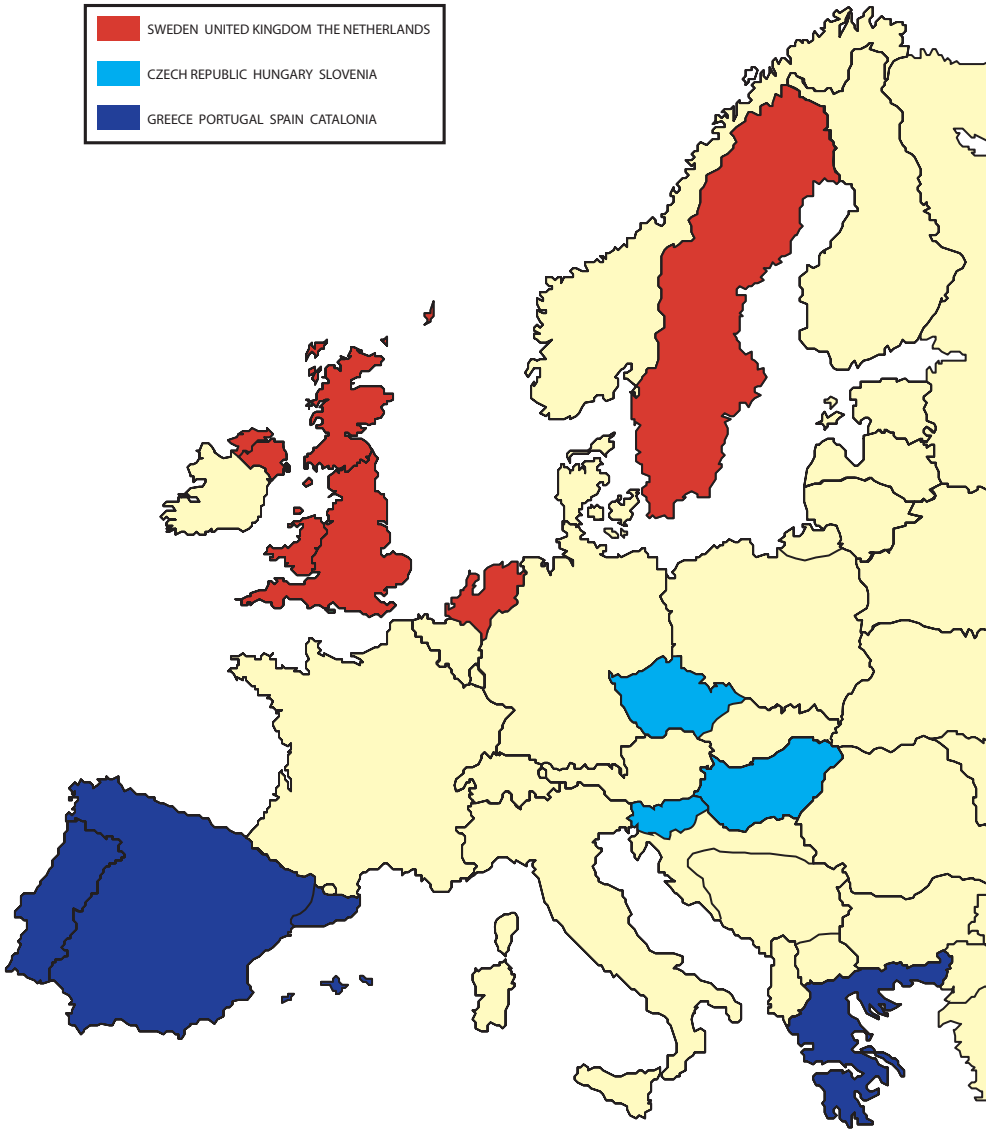
SWEDEN UNITED KINGDOM THE NETHERLANDS
CZECH REPUBLIC HUNGARY SLOVENIA
GREECE PORTUGAL SPAIN CATALONIA

Summary

This project has developed the SUNflower approach, originally used to assess Sweden, Great Britain and the Netherlands, for comparing safety programmes and records between countries. The approach has been applied to nine countries, adding three Central European countries (the Czech Republic, Hungary and Slovenia) and three Southern European countries (Portugal, Greece and Spain, and additional to this the autonomous region of Catalonia) to the three original SUN countries. The topics covered have been increased.

The SUNflower approach is a data-driven approach in which the safety status of a country (region) is described and compared (benchmarked) with other countries (regions), developments over time are understood in order to identify strong and weak points of a country (region) as a basis to learn from each other and to speed up road safety improvements.

Over the period from the early 1980s to the present, all countries in SUNflower+6 have improved in terms of mortality rate (fatalities per head of population), fatality rate (fatalities per number of motorized vehicles) and fatality risk (fatalities per number of kilometres travelled). For two countries the path to improvement involved an initial increase in mortality rate (the Czech Republic and Hungary). These occurred at times of political change and rapid increase in motorization. Improvements in all nine countries followed a trend of exponential improvement, that is to say a constant improvement rate (percentage). However, differences in improvement pace can be observed between the countries or between different time periods. In general, countries starting from higher levels of mortality and fatality rates have made more rapid progress in reducing these rates than the countries which already had lower rates at the beginning of the period. The nine countries are still separated by a factor of almost three in mortality rate and a factor of almost five in fatality rate. The general shape of the improvement curve is similar ('exponential'), but the ratio between personal safety (mortality rate) and traffic safety (fatality rate) is still quite different between the countries. Sweden, Britain and the Netherlands are virtually the same. If the group of countries that are currently worse than these three follow their most recent trend, their mortality rates will remain significantly higher if their fatality rates are similar to the current rate in the SUN countries. Further research is recommended to understand the factors influencing these developments.

The casualty toll observed in different countries differs fundamentally in the modal split, as individual modes have very different risk levels and the differences of road network design, as different road types have different risk levels. This results in significant differences in collision matrices between countries. It is not yet obvious whether all countries are lying on the same overall fatality rate curve over time but the observed differences suggest that countries follow their own improvement curve or learning curve.

A substantial part of the differences between countries in both fatality rates and fatality numbers may result from the size of the different road user groups in each country and their interactions with other traffic and with network configuration. Quantifying these effects is not easy. Estimates in the report suggest that they might explain, for example, up to half the difference in car occupant fatality rate between Sweden and Britain, and most of the difference in pedestrian fatality rates between the SUN countries. Further research is needed to explore this issue more fully.

On the basis of current trends the majority of the nine countries are unlikely to contribute their "share" of the European fatality reduction target for 2010. Despite encouraging reductions in 2004 in Sweden, Great Britain and the Netherlands, it is unclear whether these can be sustained over a long period. The contribution from the three Central countries is uncertain and may be small. The Southern countries of Greece, Portugal, and Spain (including Catalonia) are making progress towards this ambition, but more needs to be done to ensure that progress is sustained and that best practice is more widely adopted.

Comparing policies and performances in relation to specific safety topics the following results can be presented:

- Drinking and driving safety problems continue to cause concern, although all nine countries report good progress on this subject. A 'hard-core' problem still persists and requires additional policies. All nine countries have sound legislation, although different legal BAC levels are used. In all countries but one (the UK) random breath tests are carried out and the number of these tests increased considerably over the years. Significant differences between the countries can be observed when it comes to sanctions and punishments and rehabilitation of convicted drivers. BOB-campaigns (designated driver) are used broadly in SUNflower+6 countries. Discussions on the introduction of 'alcohol interlocks' are taking place in several countries, as is the topic of how to prevent driving after taking drugs and alcohol.

- Seatbelts are a very important way of reducing injuries and fatalities in crashes and legislation and enforcement are the key components to increase wearing of seatbelts by all car occupants. In all SUNflower+6 countries it is compulsory for drivers, front seat passengers and rear seat passengers to wear seatbelts, and also children to be restrained. Belt wearing increased over the last decades, but usage rates show that there is still room for improvement. All countries should formulate goals on seatbelt wearing close to 100% wearing rates.

- Speed management: all SUNflower+6 countries continue to experience serious problems of vehicles exceeding speed limits. In terms of fatalities this may well be of a similar magnitude to the drink-driving problem. Speed management requires a very integrated approach in which speed limit setting given the road and traffic conditions, good road design (design consistency and continuity), large scale enforcement, ITS application, raising public awareness and acceptance of measures are the central elements. Here lies a challenging task ahead for all SUNflower+6 countries.

- Pedestrians and cyclists: impressive reductions can be observed in the number of fatalities among pedestrians and cyclists in all SUNflower+6 countries during the last decades, although these categories still run a relatively high risk. The explanations for these improvements are not well documented and studied. Only some general indications can be given here: reduced exposure to risks, safer pedestrian and cyclist environment, better managed speeds, improved skills and behaviour etc.

- Powered two-wheelers run a relatively high risk, especially when young riders are involved. In most SUNflower+6 countries motorcyclists are the dominant factor here, in some other countries mopeds are also important. More powered two-wheelers on the road, so more exposure to risk, is the main driving force behind this growing problem. Improving helmet wearing is a simple and effective measure. But also attempts should be made to enable powered two-wheelers better share road space with other transport modes. Finally, more discipline is needed for those who violate legislation and police enforcement is instrumental in achieving this.

- Young drivers: all countries continue to have high proportions of young driver fatalities experiencing relatively high risks, and no measures appear to have been particularly effective in reducing them. This group appears to be affected less by general safety improvements than other groups. A coordinated approach is required involving education, training, licensing, enforcement, publicity, use of technology and other road safety measures.

- Implementation: effective and efficient safety policies need strong governmental support and clear guidelines set and budgets provided for local authorities.

Safety outcomes and performance indicators in the different countries are affected by many factors. The report explores ways of presenting this information to help understand how the interaction between these factors leads to the differences in outcomes. Simple one factor bar charts cannot be used to do this. We have developed an approach that seeks to define a "footprint" for each country, built around the different levels in the safety pyramid underpinning the SUNflower methodology.

Two levels of footprint schemes have been developed: a detailed footprint scheme and a summary footprint scheme. Examples are given of using this to compare a country against a reference safety level, comparing development over time within a country, and comparing performance in pairs of countries. A prototype expert system has been developed to enable users to carry out chosen comparisons. It is recommended that this tool should be further elaborated by applying it under practical conditions.

Specific recommendations are made for individual countries and for actions by the Commission. These are discussed in more detail in the reports on the three country groups.

1. Introduction

The first report of the SUNflower project (Koornstra et al., 2002) compared the safety strategies and programmes in Sweden, the United Kingdom and the Netherlands, looking both at forward strategies and the underlying reasons for the trends in traffic safety in each country in the last decades. Individual case studies were included on policies relating to some important road safety topics, such as drinking and driving, seatbelt wearing, low-cost infrastructure improvements, and inter-urban road networks. The report identified many general similarities in approach to road safety policy, but also identified differences in the way policies had been implemented.

The study has inspired researchers in many countries throughout Europe and finally became a basis for a new project - SUNflower+6 - which extends the scope of the original work, both in terms of more detailed analyses and in the geographical coverage.

In this new study nine countries were brought together: the original so-called SUN countries (Sweden, United Kingdom and the Netherlands), three countries from Central Europe (the Czech Republic, Hungary and Slovenia) and three Southern countries Greece, Portugal and Spain, and the autonomous Spanish region of Catalonia.

The SUNflower approach explores the question "What exactly makes a country improve road safety?". Which measures, interventions, developments are beneficial, which operational aspects or which underlying concepts can be determined and, a key-element in this approach, what is the possibility for transfer from one country to other countries? So, the core of the SUNflower approach is comparing safety practices of different countries based on a good insight into the relationship between the developments of road risks and road safety policies, programmes, and measures. This insight might conceivably identify key factors, which could further improve the current safety practice of a country.

Based on our experiences with comparing road safety between countries, we developed a road safety footprint, which is a representation of the road safety status and development over time in a country.

Moreover, the methodology and findings of such a comparative study might also offer guidance for remedial action in other countries (not involved in such a comparison) and for the European Commission, when defining policies to marshal efforts around the target of halving the number of road deaths over the period 2001-2010 (European Commission, 2001).

In summary, the three objectives of the SUNflower+6 study are:

- To compare road safety practices and developments in three groups of countries (SUN

countries, Central and Southern countries) identifying the strengths and weaknesses of each country through comparative benchmarking.
- To develop a knowledge-based framework for benchmarking road safety in a country.
- To present recommendations to improve road safety by non-SUNflower+6 countries and the European Commission.

This resulted in three reports that examine the road safety performance of the nine countries participating in the SUNflower+6 project. As said before, the three reports provide a benchmarking of road safety based upon (and extending) the original comparison of **S**weden, the **U**nited Kingdom and the **N**etherlands (SUN), the road safety situation of three Central European countries (the Czech Republic, Hungary and Slovenia) and three Southern countries of Greece, Portugal and Spain (including a separate analysis for the autonomous region of Catalonia). The possibility to incorporate Spain into this study emerged during the course of the study. On the one hand this enabled a larger dataset of evidence to be examined and, on the other hand, it enabled the project to address benchmarking of road safety at a national and regional level.

The basis of the SUNflower approach can be found in a road safety target hierarchy as developed by LTSA in New Zealand (LTSA, 2000) and further elaborated in the initial SUNflower study (Koornstra et al., 2002).

This target hierarchy, depicted in a pyramid-form in Figure 1.1, has five layers:
1. social costs (socio-economical costs associated with road crashes),
2. final outcomes (number of killed or injured in a road crash),
3. intermediate outcomes (safety performance indicators, SPIs),
4. safety measures and programmes,
5. 'structure and culture'.

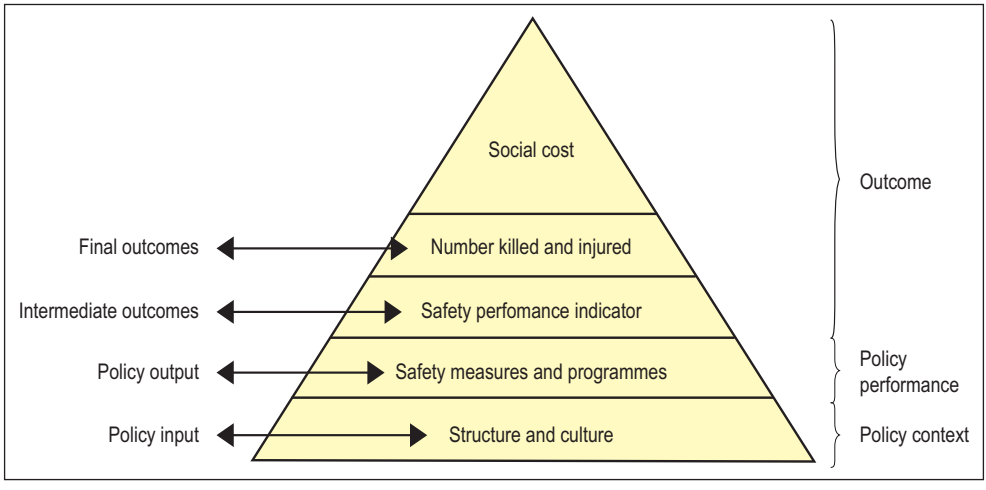

Figure 1.1. ***A target hierarchy for road safety (Koornstra et al., 2002, and LTSA, 2000).***

Comparing safety practices and developments between countries implies three-dimensional comparisons. Vertical comparison tries to understand the (causal) relationships between indicators on the different levels. Horizontally components in a country are compared, and also countries respectively jurisdictions. Finally, the third dimension is the time-dimension (not depicted in Figure 1.1).

The SUNflower approach does not include the valuation of crashes; the top of the pyramid are the final outcome indicators, mainly based on number of fatal crashes and number of fatalities. This restriction to fatal crashes and fatalities has been chosen to eliminate any problem related to biased under-reporting of crashes with less serious outcomes, such as injuries and material damage only and to get around considerable differences in the related definitions.

The vertical dimension (measures and programmes - performance indicators - number of killed/injured) has been dealt with by using case studies (e.g. drinking and driving, seatbelt wearing, speed). The horizontal component per country deals with specific transport modes, age groups and road types.

One of the key features of the SUN approach is the retrospective analysis of data on road crashes covering several decades. Ideally, these trends should be (chrono)logical effects of well-understood interventions (measures and programmes) and developments on safety performance indicators (SPIs). This requires high-quality and comparable data for the countries involved and over the period observed. The fact that this is not always the case emphasizes the permanent collection of high-quality data and moreover the necessity, in the interim, to be satisfied with surrogates and estimates.

To summarize: the aim of the study is to analyse retrospectively a series of indicators describing a particular case (policy action or problem) and to use benchmarking to identify those policies or actions that are found to be particularly effective in dealing with the road safety problem, and thereby to propose policy improvements most likely to produce casualty reductions in both the SUNflower+6 countries and other European countries.


ZONE
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SCAGE

2. Development of road safety over time

2.1. Personal safety and traffic safety

In international comparisons two (different) risk indicators are often used (Trinca et al., 1988): personal safety and traffic safety. Risk calculated as the number of fatalities in road crashes divided by the number of inhabitants can be considered as a measure of mortality, a mortality rate. It reflects the degree to which road crashes affect the safety of the population. It is a measure of *personal safety*. It is a well-known and often used measure in public health and allows for comparing different health threats.

Traffic safety can be understood as a measure of how safely the road transport function is performed. The nominator is commonly expressed by the number of fatalities on public roads as the outcome of a crash in a certain period of time (year). As indicated in the Introduction already, injuries are often not included in international comparisons due to different definitions and due to reporting problems. However, this does not reflect the importance of preventing crashes resulting in injuries.

The denominator of traffic safety should express the exposure to risk and is generally defined as some form of the amount of travel. It is commonly measured per million vehicle kilometres or passenger kilometres in international comparisons. For road safety purposes comprehensive measurements of traffic volumes should distinguish between different transport modes, road types, and age groups in order to make meaningful comparisons. However, it turns out to be quite difficult to estimate accurately these disaggregations. That is the reason why different 'surrogate measures' had to be developed and were developed over the years. In many countries more information is available for motorized travel only, and not for non-motorized travel. If data on kilometres travelled is not available, the number of vehicles can be used, or less completely, the number of motorized vehicles. In a country with very dominant motorized traffic, such a limitation does not greatly affect the accuracy of a fatality rate. However, in a country like the Netherlands, with 20% of the fatalities being cyclists, or if powered two-wheelers play a dominant role, incorrect results have to be accepted.

In the SUNflower approach the following rates are used:

- *Personal safety:* number of fatalities in a country divided by the number of inhabitants living in that country (per 100 000 inhabitants) - Mortality rate.

- *Traffic safety rates:* number of fatalities in a country divided by the number of motorized vehicles (per 10 000 vehicles) - Fatality rate.

- *Traffic safety risks:* number of fatalities in a country divided by the number of motorized vehicle kilometres (per 100 million vehicle kilometres) - Fatality risk.

If risk data are available, these are to be preferred above rate figures and they will be used.

In the Trinca report (Trinca et al., 1988) it is stated that the level of traffic safety and the level of personal safety are related to each other. However, not by a relative simple relationship such as a linear one: lowering traffic safety risks may not necessarily result in lower mortality rates. This is the case if exposure increase is greater than risk reductions. Personal safety and traffic safety are different indicators and are expressing different phenomena. It is recommended that both are used. The burden on a society can be expressed in terms of personal safety and the safety quality of the road system in terms of traffic safety rate or risk.

The relationship can be expressed in the following equation: personal safety = traffic safety x motorization. At low levels of motorization the traffic safety level is poor and the personal safety level relatively good. With a growing motorization a gradual decay of traffic safety can be observed. However, personal safety worsens initially followed by an improvement later. Countries with high motorization levels are characterized by improvements in both indicators. In this chapter both indicators are presented, accepting missing data on vehicle kilometres for Hungary and in the first period for Catalonia (see also Table 2.1). The values for Spain include those for Catalonia in all tables and figures of this report.

1981-1983	SE	UK	NL	CZ	HU	SI	EL	PT	ES	Cat
Population x10^6	8.32	54.81	14.28	10.31	10.71	1.93	9.79	9.47	38.03	5.98
Fatalities	774	5742	1758	1102	1581	554	1499	2498	6102	877
Vkms x10^9	51.93	283.14	76.01	23.40	-	5.22	33.35	21.15	130.48	-
Vehicles x10^6	3.49	18.96	4.85	2.75	1.93	0.54	1.62	2.24	11.16	2.35
1991-1993										
Population x10^6	8.64	55.96	15.13	10.33	10.34	1.99	10.36	9.38	39.11	6.09
Fatalities	712	4204	1273	1462	1966	482	1816	2631	7677	1153
Vkms x10^9	64.85	413.33	102.66	29.52	-	7.73	61.67	45.57	215.46	36.23
Vehicles x10^6	4.37	24.46	6.15	3.41	2.46	0.78	3.02	2.70	17.23	3.16
2001-2003										
Population x10^6	8.91	57.63	16.09	10.21	10.17	2.00	11.00	10.23	41.53	6.50
Fatalities	538	3463	1003	1404	1331	263	1706	1631	5421	798
Vkms x10^9	72.86	483.78	131.3	43.61	-	12.98	110.64	72.31	345.64	48.60
Vehicles x10^6	4.94	30.39	8.18	4.37	2.98	1.04	5.70	5.09	24.83	4.19

Table 2.1. ***Average yearly number of fatalities, population size, number of motor vehicles (mopeds excluded) and vehicle kilometres for the nine SUNflower+6 countries and Catalonia for three time periods.***

2.1.1. Personal safety over time

Personal safety has improved in all nine countries during the period 1970-2004 (see Figure 2.1). The poorest performing country in 1970 (Slovenia) had a mortality of about 35, all countries are below the 15-level in 2004. The best performing countries (SUN countries) reached almost the 5-level. The other countries are grouped in between 12 and 15. This means still a remarkable difference (a factor up to 3) between the SUN countries and the other six countries. Furthermore, Figure 2.1 depicts clearly that road safety improvements come gradually, and that a steady long-term trend is more desirable than short-term improvements, which quite often turned out to be (annual) fluctuations around a long-term trend. The improvement of the SUN countries is far smoother than that of the other six countries. Explanations for the departures from the long-term trends should be sought in the individual countries, and throughout this report some ideas are presented about these explanations.

Not all countries follow the same pace of gradual improvements over this period of time. A few countries had to face temporary deteriorations (for example the Czech Republic, Hungary, Portugal, and Spain) in the 1990s compared with the 1980s. But the general trend is a downward one.

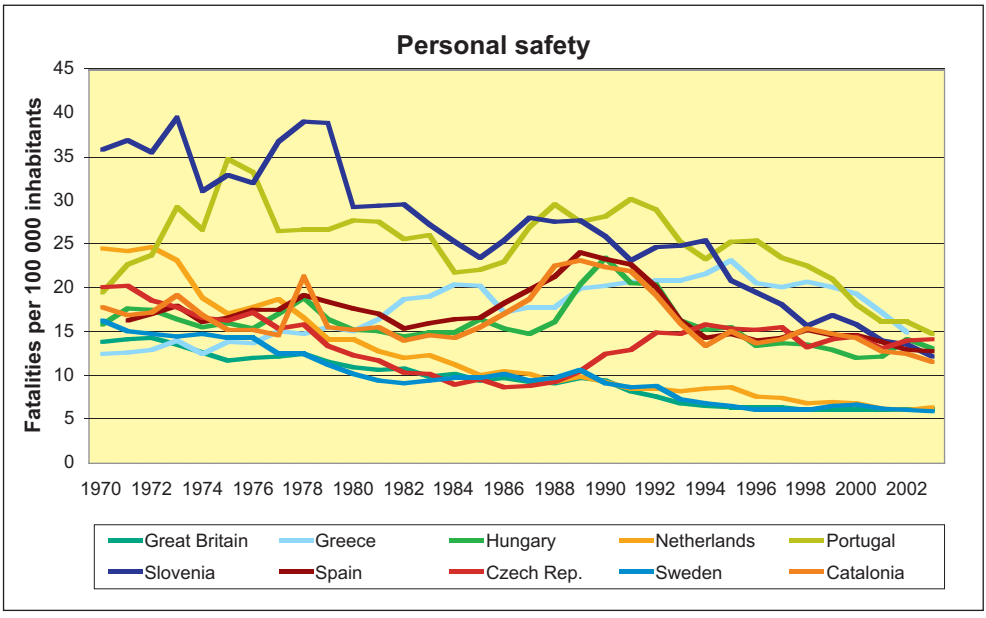


Figure 2.1. *Number of fatalities per 100 000 inhabitants from 1970-2003 for the SUNflower+6 countries.*

2.1.2. Traffic safety over time: fatality rates

Traffic safety rates have improved in all nine SUNflower+6 countries with different improvement rates (see Figure 2.2). Interestingly enough, countries from the three groups in this study (SUN, Central and Southern) are not placing themselves in the same reduction rate. Generally speaking we observe a downward trend and the country groups are coming closer together, although, as said before, not all individual countries from one group had performed better than all those from another group. Hungary remains having a relatively high fatality rate, which is most probably associated with the high severity of crashes, low motorization rate, and relatively high speeds on rural roads.

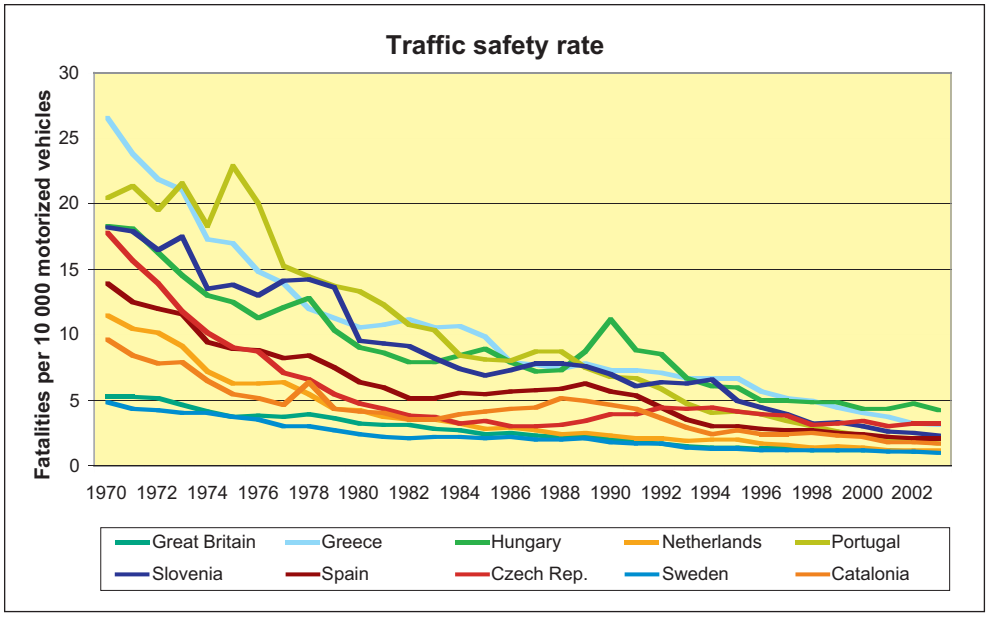


Figure 2.2. ***Number of fatalities per 10 000 motorized vehicles from 1970-2003 for the SUNflower+6 countries.***

2.1.3. Traffic safety over time: fatality risks

Seven countries have information on the number of kilometres travelled by motorized road users (no data are available on kilometres travelled in Hungary and Greece). Because data are missing for the period 1970-1980, the graph in Figure 2.3 starts with 1980.

Comparing Figure 2.3 with Figure 2.2, it can be seen that the fatality risk reduction is similar to fatality rate reduction. The reductions for Portugal and Slovenia are impressive.
From 1994 onwards the risk for the Czech Republic is falling faster than the fatality rate, but slower than in Portugal and Slovenia.

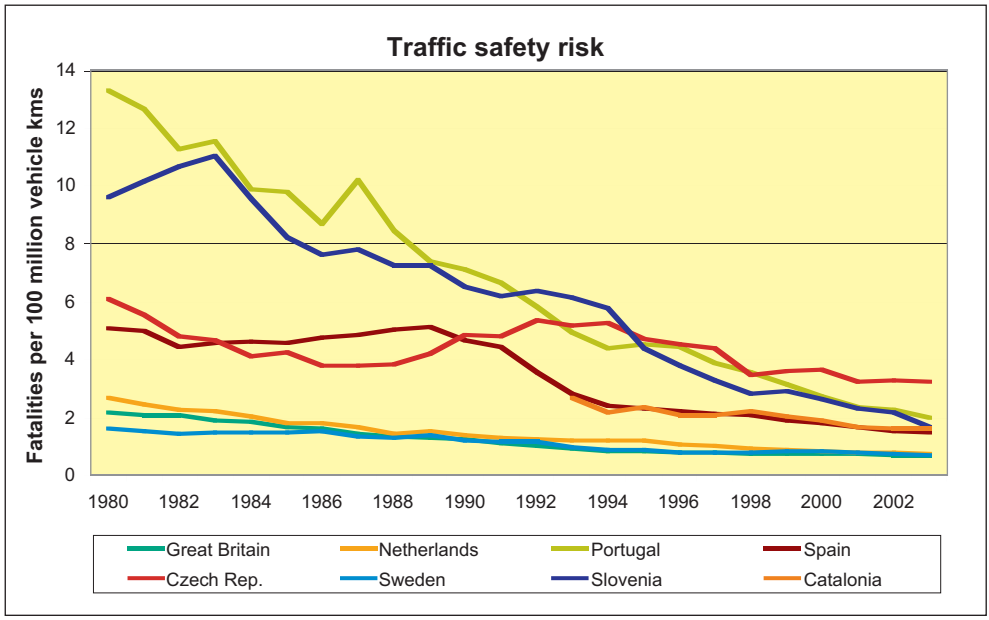


Figure 2.3. ***Number of fatalities per 100 million vehicle kilometres from 1980-2003 for seven countries and Catalonia.***

Further analyses of these trends use only fatality rates because the risk values were incomplete from 1970 onwards. Using a Singular Value Decomposition (SVD) technique (see Morsink et al., 2005) it became clear that the original nine series of fatality rates can be reduced to one general trend underlying all nine series. The trend given in Figure 2.4 shows a general exponential decay. It can be seen that from the mid-1970s to the 1980s the decay is better than exponential (almost linear) and from the mid-1980s to the mid-1990s worse (almost constant). The trend before the mid-1980s is steeper than in the periods after that. More in-depth analyses showed that in the middle period, a period of relatively modest improvements, especially the Central countries, and more specifically Hungary and the Czech Republic, did not show large improvements.

Deviations from this general trend can also be observed. Three countries can be mentioned in this respect. The decay in the Netherlands in the 1970s follows a higher improvement rate than Britain and Sweden, followed by a low rate from the end of the 1970s onwards, although overall these three countries follow a remarkably similar development.

For the Central countries, Slovenia follows the most stable improvement rate over the three decades (e.g. see Figure 2.2). After an initial improvement for the Czech Republic in the 1980s compared to the 1970s, a steep increase can be seen, which levels off from 1994 onwards. The trend is however steep, as is the case for Hungary in the same period. The period 1988-1994 for Hungary is very remarkable with a dramatic worsening (such a worsening was not

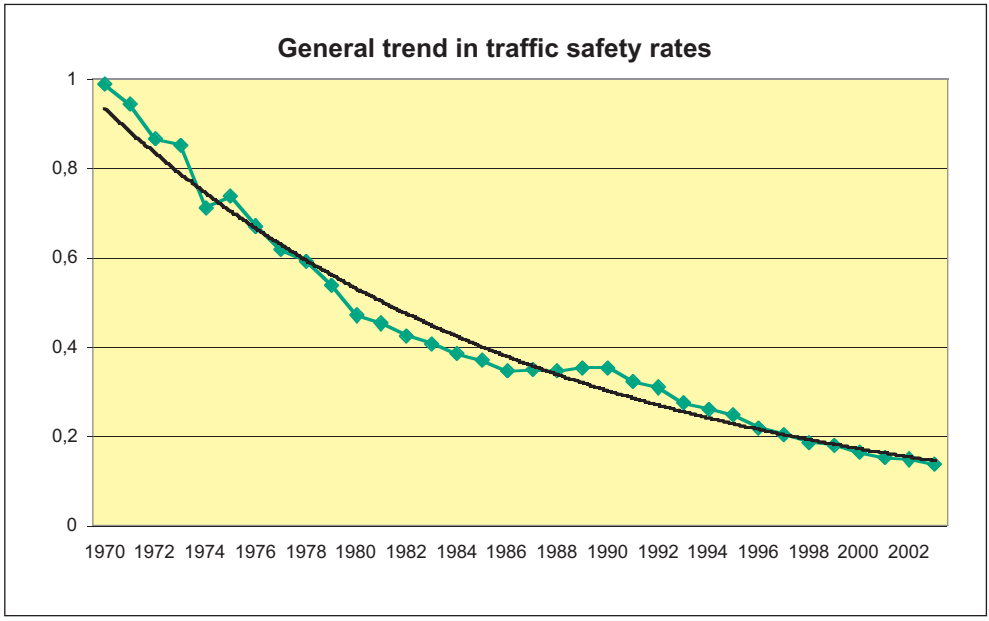


Figure 2.4. ***General trend in fatalities per number of motor vehicles for the SUNflower+6 countries, resulting from a SVD analysis together with the best fitting exponential trend.***

observed in the Czech Republic!). We are tempted to relate this development to the dramatic political changes in Hungary during that period.

Spain was not doing well during the 1980s, but improves at the same rate as the general trend in the 1990s. For Greece a mixed picture emerges with periods less good as the general trend in the early 1980s and 1990s, but performing relatively well at other times. During the last couple of years, both Greece and Spain follow the general trend line but Portugal does not. Portugal had a peak around 1974 (the Portuguese revolution) but has done better than the general trend form the beginning of the 1990s.

To summarize: all countries follow a general downward trend on fatality rates, and this trend can be described by an exponential curve (same reduction rate per year). However countries have a different reduction rate for different time periods in between 1970 and 2004, and moreover, differences in improvement pace can be observed between countries.

2.1.4. Personal safety versus traffic safety

In Figure 2.5 the most recent positions of all nine countries are depicted on the personal vs. traffic safety scale. This figure illustrates clearly the different positions of the SUN countries compared with the other six countries and Catalonia: on personal safety a difference up to a

factor 3, on traffic safety up to a factor of 5. The position of the three SUN countries is remarkably similar. Unexpectedly (compared with the situation in the SUN countries), the other six countries have substantially different positions, especially on the traffic safety scale. On the personal safety scale they range between 12 and 16 (30%). On the traffic safety scale the differences are more noticeable (between 2 and 4.5, a factor of more than two). This raises the question "How have the six countries reached their current position on this graph?" This is shown in the following section.

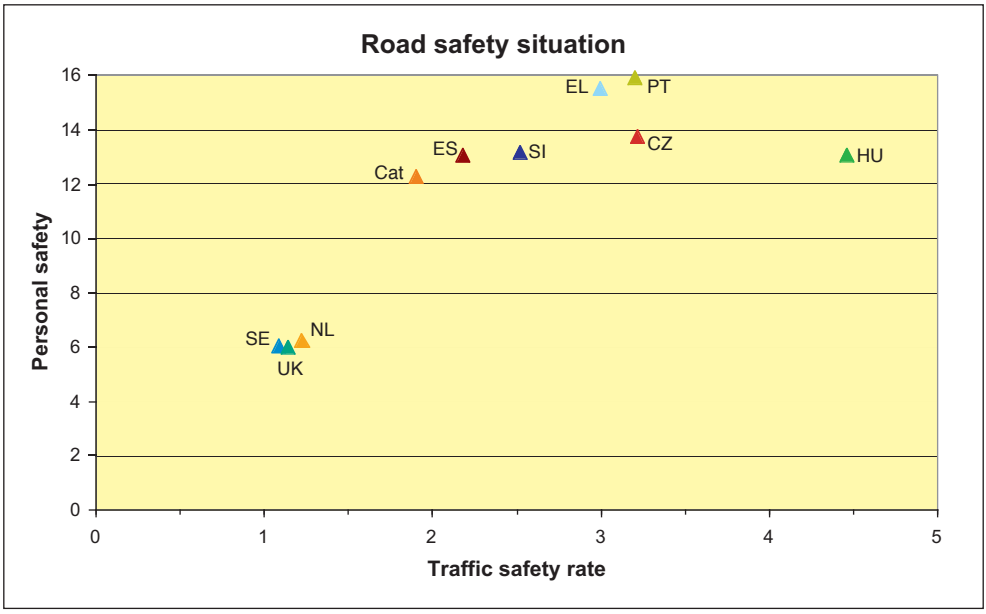


Figure 2.5. ***Road safety situations in SUNflower+6 countries for 2001-2003 (mean value) as personal safety (fatalities per 100 000 inhabitants) versus traffic safety rate (fatalities per 10 000 vehicles).***

2.1.5. Personal safety versus traffic safety over time

Figure 2.6 shows the position of each of the nine SUNflower+6 countries and Catalonia for the aggregated periods 1981-1983, 1991-1993 and 2001-2003. All countries experienced a motorization rate growth over the period. Two trends can be observed in this graph. First, all countries have improved their position both on the personal safety scale and on the traffic safety scale. But the speed of improvement is not the same. The most impressive improvements are shown by Slovenia and Portugal. The same 'direction' of improvement during the last decade (which seems to be identical for the SUN countries) can be observed by some of the other countries as well. The exceptions here are Greece and the Czech Republic. A last observation from this graph is the development in the period 1981-1983 and 1991-1993 in four countries: Spain (incl. Catalonia), Portugal, Hungary and the Czech Republic. In these three countries a very marginal decrease of traffic safety rate went together with an increase in personal safety.

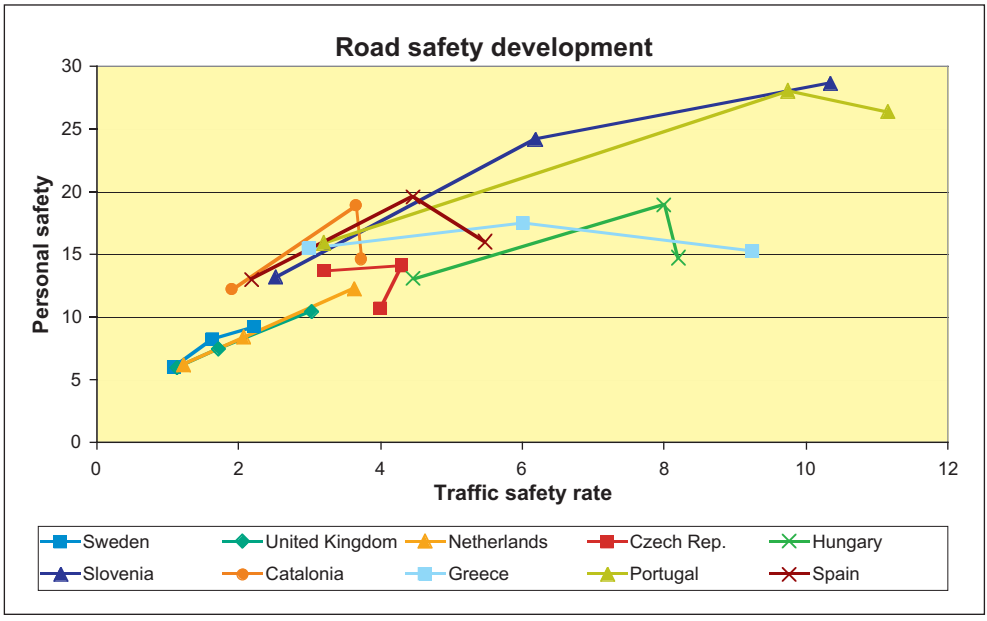


Figure 2.6. *Development of road safety in SUNflower+6 countries, visualized as personal safety (fatalities per 100 000 inhabitants) versus the traffic safety rate (fatalities per 10 000 vehicles). Time development from the 1981-1983 period for points at the right side of the graph, via 1991-1993 to 2001-2003 for points at the left side of the graph.*

Figure 2.6 clearly illustrates that the improvement pace of the nine countries differs. These improvements can be seen in Table 2.2 where values of rates and risk for the periods 1991-1993 and 2001-2003 are shown as percentages of the 1981-1983 values (100% = no change over the period considered).

1991-1993	SE	UK	NL	CZ	HU	SI	EL	PT	ES	Cat*
Mortality	88.6	71.7	68.3	132.3	128.8	84.3	114.4	106.3	122.3	129.1
Fatality rate	73.6	56.7	57.1	107.3	97.6	59.8	65.0	87.4	81.5	98.0
Fatality risk	73.7	50.2	53.6	105.2	-	58.8	65.5	48.9	76.2	-
2001-2003										
Mortality	65.0	57.4	50.6	128.5	88.7	46.0	101.3	60.4	81.3	83.7
Fatality rate	49.2	37.6	33.8	80.3	54.5	24.4	32.4	28.7	39.9	51.1
Fatality risk	49.6	35.3	33.0	68.4	-	19.1	34.3	19.1	33.5	61.5 *

* Catalonia: 2001-2003 compared with 1993.

Table 2.2. *Mortality, fatality rate and fatality risk for the periods 1991-1993 and 2001-2003 as a percentage of the values for 1981-1983.*

It can be seen that mortality increased considerably for the Czech Republic and Hungary during the 1980s and very early 1990s, and to a lesser extent for Greece, Portugal, and Spain. For the SUN countries and Slovenia there was a considerable decrease.
In 2001-2003 the mortality for the Czech Republic and Greece is lower than in 1991-1993, but still higher than in 1981-1983. Especially for Portugal, but also for Spain, the mortality is much lower. This is again also the case for the SUN countries and Slovenia.

Compared with 1981-1983, the averaged fatality rates are lower in 1991-1993 for all countries, except for the Czech Republic, and lower for all countries lower in 2001-2003. The reductions are most impressive for Portugal, Slovenia, Greece and the Netherlands. These figures show that the improvement in safety more than compensates for the growth in motorization.

The fatality risk figures show comparable differences to those for the fatality rates, except for Spain where the fatality risk is much lower in both periods and for Slovenia and the Czech Republic in the last period. For these two countries not only the number of vehicles, but also their use increased considerably.

The largest fatality risk reductions, of around 80%, are found for Slovenia, Portugal in 2001-2003 compared with 1981-1983. For the UK, the Netherlands, Spain and Greece, these reductions are around two thirds. Sweden (and Catalonia) follow with 50% and for the Czech Republic the reduction is about one third. For Hungary no risk data is available, but Hungary halved its fatality rate. These figures show that although the non-SUN countries have the largest reductions in absolute numbers, the proportional change for the SUN countries is equally impressive.

2.2. General developments

One factor fundamental to the casualty toll observed in different countries is the modal split, as individual modes have very different risk levels. A more complicated, but an equally important factor, is the interaction between the different modes, in relation to network configuration and traffic density. These interactions and their effects are more difficult to quantify than the differences in risk between the individual modes.

2.2.1. SUN countries

The overall safety performance, safety management systems, and safety cultures in the three SUN countries are fairly similar, but still individual risk differences have been observed (e.g. high risks for pedestrians and motorcyclists in Great Britain, for mopedists in the Netherlands, and to a lesser extent for car drivers in Sweden).

A substantial part of the differences between countries in both fatality rates and fatality numbers may result from the size of the different road user groups in each country and their interactions with other traffic and with network configuration. Thus, for example, a country such as Sweden, with low traffic densities and a heavy focus on rural car travel, should be expected to have a

higher car occupant fatality rate per vehicle kilometre than Britain which has a much higher traffic density, despite the same general safety culture and efficiency of safety management. Similarly, Great Britain, with a higher density of pedestrian movements interacting with a higher density of motorized traffic can be expected to have a substantially higher pedestrian crash rate unless it has implemented special measures to counter this situation.

Quantifying these effects is not easy. Estimates in the report suggest that they might explain up to half the difference in car occupant fatality rate between Sweden and Britain and most of the difference in pedestrian fatality rates. The comparison between Britain and the Netherlands is less clear, partly because of uncertainty about relative traffic flows. With the flows allowed for, the difference in pedestrian fatality largely disappears but the Dutch car occupant fatality rate appears to be higher than the British rate, once the benefits of the high usage of motorways in the Netherlands has been discounted. However, these analyses relate to 2003 fatality rates and the Dutch rates for 2004 appear substantially lower. But much more detailed data and analyses are required to properly explore these effects.

Countries can take action to mitigate such innate problems. In the Netherlands, a high level of bicycle activity is accommodated at relatively low risk. This appears to have been achieved partly by providing extensive facilities to separate cyclists from motorized traffic and partly by managing the motorized traffic on these roads so that they limit the conflicts that might lead to severe cyclist injuries. The same situation has not been achieved in the Netherlands for mopedists or in Britain for pedestrians. In a parallel context, Sweden, with long low volume rural routes, has been unable to discourage speeding among car drivers to the extent achieved in the other two countries.

2.2.2. Central countries

A fundamental factor influencing the casualty toll observed in the three Central countries over time has been a change in modal split, as individual modes have very different risk levels. A good example of the change in traffic composition is the increase of heavy goods vehicle traffic, which occurred in two waves. The first followed the change of political and social systems at the end of 1980s and the second following these countries joining the European Union in May 2004. There has been a shift from mopeds to motorcycles observed in terms of exposure data recorded in the early 1990s that led to the development of different fatal crash patterns for related two-wheelers. This trend, however, has consolidated over the last decade. In contrast, a continuous decrease in exposure of pedestrians and cyclists in traffic has not resulted in casualty reduction. Czech and Hungarian elderly pedestrians and cyclists have significantly higher risk in traffic than other age groups, while powered two-wheeler riders do not run significantly higher risk than other road users. The young drivers of passenger cars in all three countries need special attention as they have significantly higher risk than experienced drivers. The higher proportion of young drivers involved in fatal crashes in Slovenia is likely to be a result of higher exposure in traffic, and it is also necessary to note that there are far more licensed drivers among the younger population in Slovenia than in the Czech Republic and Hungary, and car ownership among young people is higher.

Car occupants become casualties of road crashes in more than 50% of all cases in all three countries, followed by pedestrians, cyclists, lorry occupants and motorized two-wheelers. In the Czech Republic 798 car occupants were killed in 2003, which is 55% of all fatalities. In Hungary 567 car occupants (50% of all fatalities) were killed, and in Slovenia 146 (60%). The different modal splits might be used to explain the minor differences among Central countries. The percentage of lorry occupants killed among all fatalities is very similar in all three countries representing 3% of all fatalities in the Czech Republic, 4% in Hungary and 2% in Slovenia. Powered two-wheelers represent 8% of all road fatalities in the Czech Republic, 6% in Hungary, but 12% in Slovenia. The majority of them are motorcyclists, as there are four times more motorcyclist fatalities than mopedists fatalities in all three countries. The divergence between the three countries is related to their different exposure of two-wheelers in traffic. There are only small differences in the proportion of bicycle fatalities among the three countries, which can be explained by different exposure of cyclists to risk due to different topographies and overall riding conditions resulting for example from different population density or living standards. Pedestrians represent between 16% and 23% of all road fatalities (Slovenia, Hungary) pointing to important differences among countries. Most of them died after a collision with a car.

2.2.3. Southern countries

The analysis of collision matrices shows that the percentage of car occupants involved in all fatalities varies from 47% for Greece to 61% for Portugal, and up to 65% for Spain (when vans are included with cars). The lower proportion of car fatalities for Greece is partly related to the lower level of car motorization, but also to the relatively high ownership of motorcycles; Greece has the highest proportions of motorcyclist, pedestrian and lorry occupant fatalities. Spain, Portugal and Catalonia have higher proportions of car occupant and mopedist fatalities. Combined, the fatalities of riders of powered two-wheelers (mopeds and motorcycles) account for between 15% (Spain) and 23% (Greece and Portugal) of all fatalities. One of the factors explaining the lower fatality rates for motorcyclists and mopedists in Spain and Catalonia (compared to Greece and Portugal) is the higher rate of helmet use. In Greece youngsters do not legally have access to a moped until a year later than Spain or Portugal; the consequent lower exposure probably contributes to the relatively low proportion of mopedist fatalities.

Current trends in all three countries (and in Catalonia) show a positive reduction in fatalities, but the trend has not been a steady overall progressive reduction (as in the SUN countries). In percentage terms, for the period 1999-2003, the reductions in mortality rates (fatalities per number of inhabitants) range from 17% for Greece to 41% in the case of Portugal (21% for Spain, 27% for Catalonia); for fatality rates (fatalities per number of motorized vehicles) from 40% for Spain to 64% for Portugal (44% for Catalonia, 53% for Greece); and for fatality risks (according to the vehicle kilometres estimates available) from 40% for Catalonia to 57% for Portugal (47% for Spain, 51% for Greece).
The last decade has seen an important development in roads infrastructure and in vehicle stock (especially cars and powered two-wheelers) in all three countries. On the one hand, the

varying trends and the changes in roads and vehicles make it difficult to quantify the impact of specific measures; on the other hand, there is a good basis for the comparison in so far as the Southern countries are seen to be facing similar changes and challenges.

Lorries, and particularly Heavy Goods Vehicles (HGVs), have an effect on fatality totals that is disproportionate to their relative proportion of the total vehicle fleet, as the probability of a fatality resulting from a collision involving an HGV can be four times higher that that from an average collision involving other vehicles. If possible therefore the fleet size and road usage of HGVs should also be included as an indicator of expected fatality total.

2.3. National policies and progress on casualty reduction

2.3.1. Sweden, United Kingdom and the Netherlands

The first report of the SUNflower project (Koornstra et al., 2002) compared the safety strategies and programmes in Sweden, Britain and the Netherlands in 2000, looking both at forward strategies and the underlying reasons for the trends in traffic safety in each country between 1980 and 2000. Individual case studies were included on policies relating to drinking and driving, seatbelt wearing, low-cost infrastructure improvements, and inter-urban road networks. The report identified many general similarities in approach to road safety policy but also identified differences in the way policies had been implemented. Koornstra et al. showed that although overall fatality rates in these countries were similar, the rates for individual modes were more varied.

The national target in *Sweden* in 1990 for the year 2000 was 600 fatalities. This target was reached in 1994 and the revised target was then 400 fatalities in the year 2000. Although this target was not met, a new target was presented for the year 2007 - half of the number of killed in 1996 or 270 fatalities in the year 2007. The traffic safety work in Sweden during the last decade is characterized by traditional road and vehicle improvements. The resulting traffic safety effect manages to balance the effect of the traffic and speed increase. A lot of traffic safety measures have been taken in the local areas each year during the period. The total effect of these measures was unfortunately not enough to produce a continuously decreasing trend in fatalities, although the results of the last few years are promising.

The main *British* target is in terms of numbers of killed and seriously injured (KSI) casualties combined. A review concluded that the KSI total is on a downward trend that is only 2.4% less than that needed to be on target. It was noted that motorcyclists continue to be disproportionately represented in casualty numbers. A secondary target is to reduce the number of child KSIs by 50%; progress on this is already two thirds towards the target, after only one third of the time period. Despite these apparent encouraging trends, serious concern was expressed at the levelling off in the previously reducing annual number of road crash fatalities. Analysis showed that this is mainly a result of the continuing high number of car occupant and motorcyclist fatalities.

In 2005 a new national traffic and transport plan has been accepted by the *Dutch* Parliament. Although road safety has not been positioned as the most challenging area, the objective is to achieve a continuous improvement of traffic safety in order to keep the Netherlands at the top of the EU safety ranking. Safety targets have been put to 900 fatalities (-15%) in 2010 and 580 (-45%) in 2020, compared with 2002 numbers. As part of the traffic and transport plan, ongoing work on traffic safety is proposed to influence driver behaviour, to change infrastructure, to use innovative technology and to apply (inter)national agreements. Consistent application of the principles of the Sustainable Safety concept in policy will be aimed at, since they have been credited for much of the safety increase of recent years. Implementation of policies have been decentralized to regional and local authorities as much as possible.

Between 2000 and 2003 progress in fatality reduction had stalled in Sweden and Britain. In Sweden this is likely to seriously compromise the achievement of their targets unless new initiatives can be found. Political will and funding does not seem to be at a level where it will encourage these to a sufficient extent. In Britain the continued downward trend suggests this target is more likely to be met. In the Netherlands there has been a continuing small downward trend in fatalities and this appears to have accelerated significantly in 2004 (19% reduction compared with 2003), although the reason for this is not yet understood. In Sweden and Britain results for 2004 also show a reduction in fatalities (8% for Britain and 9% for Sweden), although again not yet fully understood. Despite these more promising results, concern still exists about the lack of total reduction in fatalities since 2000, and the three countries are currently not contributing substantially to the European fatality reduction target.

The investigations that have so far been made in Britain into the difference between fatality trends and severe injury trends do not suggest that change in reporting practice (i.e. lower reporting of severe injuries) is a substantive factor in the difference. Rather there are many small factors which together are leading to a higher likelihood of a fatal outcome when crashes occur, including changes in driver behaviour and in the mix of the vehicle fleet. These may suggest that at the level of safety already achieved by the three SUN countries and others, a further change in safety culture is required both in management systems and in individual behaviour, before further larger reductions in fatalities can be achieved. Lack of reduction in the annual number of fatalities in Great Britain has also been affected by significant growth in motorcycling, which carries a relatively high risk of fatal crash involvement. It is important to observe a rather modest increase of traffic in Sweden during the last couple of years (1% per year) compared with 2-3% in the years before.

2.3.2. Czech Republic, Hungary and Slovenia

Analyzing the development of road safety since the year 1970, general improvements were observed in all three Central countries thanks to improved general conditions in the field of road transport. The fall of the Iron Curtain in the late 1980s, which was accompanied by a continuous and significant increase of traffic up to twice as large as in former EU15 countries, would normally be translated into a serious worsening of the road safety situation. Unfavourable factors were (partially) balanced by infrastructural improvements, modal split

changes, and modernization of the motor vehicle fleet. Although the three countries tried to tackle the problem of assuring traffic safety in this time in a similar way, through infrastructure improvements, new young driver education and changes in Highway Codes, the results were quite different because of the differences in national road safety management and enforcement strategies.

Thus the development of road safety in Central countries varied considerably. Due to the deficiencies in enforcement and other factors, there has been a serious worsening of road safety in the Czech Republic, which lasted until the second half of the 1990s, when the trend became neutral. In contrast, in Hungary and Slovenia, traffic safety was improving at this time, after negative development in the mid-1980s.

Road safety performance in the last ten years is rather similar in the three countries, as a continuous reduction in the number of road fatalities can be observed. This was very steep in Hungary, but it faded away during the last few years, while in Slovenia a continuous reduction in road fatalities has been observed. The trend in the Czech Republic has been almost neutral in the last decade. Relating these development trends to the exposure in traffic, significant improvements can be identified, but it is likely that the evolution of road safety in all three countries is very sensitive to the introduction of particular road safety related regulations (speed limits, daytime running lights, blood alcohol content limits, etc.) and the level of police enforcement. The improvement of traffic safety in Slovenia over the last decades was likely to have been a consequence of a) the early introduction of several road traffic regulations and their effective enforcement accompanied by extensive construction of new motorways and expressways, b) the considerable upgrading of the vehicle fleet, and c) the introduction of several traffic calming measures and general improvement of safety standards of roads. Slovenia is also likely to have benefited from more flexible and effective road safety policy at national and regional level, with defined targets and distributed responsibility among all stakeholders.

Infrastructural changes and improvements realized in the last decade played a substantive role in eliminating road crash consequences. These included both the extension of the motorway network realized in the 1990s in all three countries, causing a shift of traffic onto a relatively safer road type, and the wide implementation of low-cost safety measures in municipalities. Above all these were roundabouts and other traffic calming scheme elements, which led to the reduction of causalities in urban areas (the rate between urban roads and other roads fatalities changed from 3:2 in 1980 to 3:5 in 2003). It is however regrettable, that their implementation has solely been based on local decisions on cost-effective, or cost-benefit analysis with regard to road safety, and no specific programmes have been established at national level to promote the best practices. The only exception was Slovenia, which recently introduced a relevant programme at national level in 2002.

On the threshold of the 21st century, the Czech Republic, Hungary and Slovenia are moving in the same way towards casualty reduction, although many differences still remain. The progress of the three countries compared with the targets set, is rather slow and targets are out of reach without additional efforts, especially in case of the Czech Republic and Hungary.

However, there is a large room for improvements and the targets should be still perceived as achievable and challenging. The progress towards defined targets needs to be more closely monitored and critically evaluated, based not only on outcomes, but also on road safety performance indicators, which are scarcely available at this time. A broader application of scientific based knowledge and deeper cooperation between policy makers and road safety researchers is another challenging task for all three countries. Road safety needs to be declared as an important social and health topic by politicians and should become an integral part of education processes. Moreover, improvements in road safety organization, management and cooperation among all stakeholders, together with provision of sufficient resources, seem to be crucial for further development. Progress is not strictly related to the available resources for road safety improvements, but strongly depends on the efficiency of financing road traffic and road safety activities, e.g. road safety audits and cost-benefit and cost-effectiveness analysis ought to become an integral part of any future infrastructural improvements.

2.3.3. Greece, Portugal, Spain and Catalonia

During the last two decades, road crashes in Greece are the cause for death of almost 6 people per day. Every year more than 20,000 road crashes with casualties occur on Greek roads in which more than 2000 drivers, passengers and pedestrians are killed and about 30,000 are injured. The low level of road safety in Greece can be improved if Greek authorities exploit successful experience in other countries and abandon the approach of fragmentary actions and traditional separation of competencies among the authorities involved.
The necessary prerequisite for the improvement of road safety in Greece is the development and implementation of a strategic plan and the adoption of an integrated road safety policy. Within the above context, a research project was commissioned for the development of the first Strategic Plan for the Improvement of Road Safety in Greece, the implementation of which can lead to a decrease of 20% up to 2005 and 40% up to 2015 in the number killed in road crashes.

Traffic crashes in *Portugal* reached their highest peak during the 1970's (in 1975 the number of 2676 fatalities in road crashes was reported). Since then more attention has progressively been devoted to road safety issues, and a slow but almost constant decrease in crash and fatality rates has been achieved. At the same time, and especially after Portugal joined the EU in 1986, road transport has experienced a very substantial growth. Nevertheless in absolute terms, although the number of injury crashes has increased (by almost 50% from 1980 to 2000), the number of related fatalities has decreased (by almost 25% in that same period). But it was not until after 1970 that the most important measures specifically directed to road safety were taken, at various levels of intervention and at various stages.

The crash level in *Spain* rose sharply in the early 1980s having been stable at just over 60,000 personal injury crashes per year during the 1970s (amongst other things, the 1970s saw the introduction of the first alcohol and speed limits, and the obligatory use of helmet and lights for motorcyclists on interurban roads). The number of personal injury crashes peaked in 1989 at over 100,000 per year with 176,599 casualties when the Road Traffic Act was introduced,

The early 1990s saw a decline in crash levels; in addition to the new legislation this is possibly associated with major improvements in roads infrastructure and a growth in the vehicle fleet. From 1994, when the crash level was around 80,000 crashes and 120,000 casualties, up to the end of the 1990s the crash level worsened. Since 2000 the level has stabilized at around 100,000 personal injury crashes and 150,000 casualties per annum.
The manifesto of the national Government elected in 2004 sets out to reduce road fatalities by 40% by 2008, adopting 2003 as a reference year. This means saving 2160 lives in 2008 compared to the 5399 persons killed in 2003. This is the first time that a quantitative target has been set for reducing road fatalities in Spain.

The evolution of road safety for the autonomous region of *Catalonia* is generally similar to the overall trend in Spain. Following a continued rise in the numbers of all kinds of road crashes in the 1960s and early 1970s, a period of stabilization at around 19,000 personal injury crashes per annum is identified during the late 1970s and early 1980s. The mid 1990s show a moderate increase in personal injury crashes stabilizing at around 22,500 at the end of the century. The road safety level of the year 2000 has been adopted as a reference for the last two Catalan Road Safety Plans, each covering a three year period. The Catalan Road Safety Plan for 2005-2007 aims to achieve a 30% reduction in the 891 persons killed. This target is consistent with the target set by the European White paper of a halving of fatalities by 2010.

The last decade has seen an important development in roads infrastructure and in vehicle stock (especially cars and powered two-wheelers) in all three countries. On the one hand, the varying trends and the changes in roads and vehicles make it difficult to quantify the impact of specific measures; on the other hand, there is a good basis for the comparison in so far as the Southern countries are seen to be facing similar changes and challenges. Current trends in all three countries (and in Catalonia) show a reduction in fatalities, but the trend has not been a steady overall progressive reduction (as in the SUN countries). It has to be noted that, in absolute terms, the rates of the Southern countries at the start of the 21st century are not dissimilar to the rates of the SUN countries at the start of the 1980's.

All three countries (and the autonomous region of Catalonia) have published a plan covering a period of three or more years (including the year 2005) that sets quantified targets for a reduction in the number of road fatalities. Such progress in road safety planning is a relatively new aspect of road safety in the Southern countries studied. The targeted reductions for Portugal are even more ambitious than those of the EU White paper, proposing a halving of road deaths by 2010, whilst those for Spain and Catalonia are in line with the European overall projection and those for Greece are more modest.

The evolution of the legislative framework across the Southern countries contains more similarities (e.g. alcohol limit for general drivers, progressive introduction of mandatory use of protective systems), than differences. The organization of safety activities at central level shows a lead ministry engaged in both the development of policies across the territory as well as the coordination of activities across various ministries. In the case of Spain, the largest of the countries studied, some of the regions have assumed the lead for organizing some road safety matters - as is the case for Catalonia and Basque Country.

Generally, the vertical coordination of safety activities from central and regional to the local level is not well-developed. This can be at least partly explained by the efforts to improve police enforcement with respect to a common perception of problems concentrated on the inter-urban roads. Over the last decade, the transport systems have experienced increases in road networks (especially high-capacity roads) and in the numbers of vehicles and drivers. These changes have undoubtedly had impacts upon road safety performance, making it is quite difficult to identify the impact of key legislative developments.

2.3.4. Conclusions

It is illustrated well in this chapter that road safety improvements are not just happening by themselves, but are more the result of continuing efforts with the aim to improve road safety. We collected strong indications that, generally speaking an increase in the organization of activities and quality improvement of road safety programmes can be seen from 1985 onwards. This is primarily the case for the new SUNflower+6 countries. The SUN countries were already rather active before this year.

The specific measures reported show that from the 1970s onwards not only a large number but also a wide variety of measures, has been applied in the SUN countries. In later periods measures are more specific in these countries. This tendency of a wider variety of measures as the number of measures increases can be noticed for the other countries as well.

Economic growth and the corresponding rise of motorization in the SUN countries shortly after World War II resulted in a steep increase in road safety problems. A large number of safety initiatives and safety measures were taken on a great variety of safety aspects in the late 1960s and early 1970s. The effects of these efforts are mirrored in the decrease in the fatality rates and risks since the 1970s. Further improvements took place in later periods as well.

For the other countries (in Central and Southern Europe) these developments manifested themselves later. For some countries these changes were related to important political changes (e.g. Portugal, Hungary, and the Czech Republic). The same picture can be seen in these countries as for the SUN countries: an increase in motorized traffic resulting in a growing number of casualties. These growing numbers led to an increased attention for road safety, leading to new road safety policies and organizational measures and safety measures in the SUNflower+6 countries without any exception. These measures were of a similar nature, but addressed the specific nature of the road safety problem in a country. The pace of improvements differed for the countries.


MAN
DAF

3. Comparison of disaggregate safety outcomes within and between countries

The comparison of safety outcomes at a disaggregate level can be done in every conceivable way. We limit ourselves here to four main dimensions: transport mode, conflict partners, age, and road type. We are well aware that these are interrelated and cross-tabulations are possible, but for this first comparison this limitation seems to be satisfying.

3.1. Safety per transport mode

Figure 3.1 shows for the SUNflower+6 countries the distribution of fatalities per transport mode (in percentages). The dominant position of cars and lorries is beyond all doubt, especially in Sweden and Spain. Several clear differences can be observed when it comes to some other modes. It should be kept in mind that differences can be explained by differences in risks but also by differences in use and in exposure to risk. The percentages of pedestrians are relatively high in the United Kingdom, the Czech Republic and Hungary and low in Sweden and the Netherlands. The United Kingdom and Greece seem to have a problem with motorcyclists. The percentages of moped fatalities are relatively high in the Southern countries (except Greece) and the Netherlands, but cyclists are almost not present in the Southern countries. This leads to the conclusion that the percentages for pedestrians and cyclists (non-motorized traffic) are highest in the Central countries, more specifically in Hungary and the Czech Republic, followed by the SUN countries (more specifically the UK - pedestrians and the Netherlands - cyclists), and lowest in Sweden and the Southern countries (except Portugal).

A more detailed analysis, using Weighted Poisson Models (WPM) has been carried out on these data (see Morsink et al., 2005). Three main conclusions can be drawn from these analyses:

- Major differences can be observed between Central and Southern countries: less motorized fatalities in Central and less non-motorized fatalities in Southern countries.
- Countries in the Central group are rather similar, as are (to a somewhat lesser extent) the countries in the Southern group.
- The SUN countries are not comparable and different from the countries in both other groups.

Table 3.1 gives an overview of the percentage changes between 1993 and 2003. Here we see a growing dominating role of cars and lorries. For pedestrians we see a decrease for all countries, as is the case for cyclists in almost all countries. So, the share of non-motorized traffic in the

number of fatalities has gone down during the last decade in the SUNflower+6 countries. This will be caused by a combination of reduced exposure and reduced risks and it is interesting to explore this further.

The picture for powered two-wheelers is somewhat mixed: increases for motorcyclists in all countries except Spain and Catalonia. Mopeds give a rather mixed picture, however in all three Central countries the moped share is reduced and even more in two of the Southern countries.

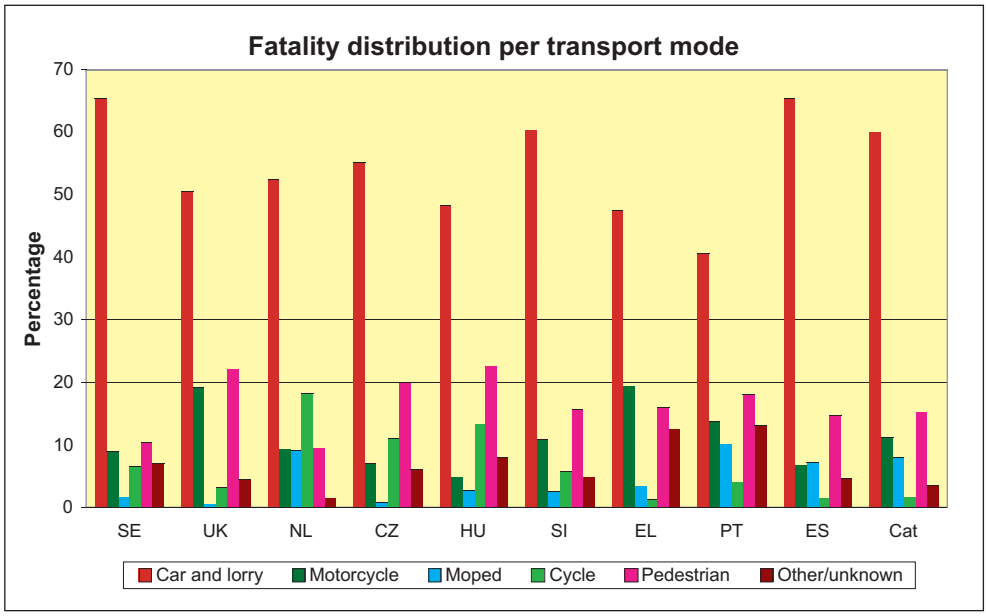


Figure 3.1. *Percentages of fatalities per transport mode in the SUNflower+6 countries and Catalonia in 2003.*

Transport mode	SE	UK	NL	CZ	HU	SI	EL	PT	ES	Cat
Car + lorry	6.3	9.3	1.9	4.7	10.3	4.7	27.8	15.2	5.1	4.4
Motorcycle	33.7	79.6	9.2	43.8	46.5	194.3	30.4	72.6	-26.1	-19.9
Moped	-23.2	18.6	24.4	-66.9	-22.8	-32.1	-66.2	-46.1	28.0	47.5
Cycle	-40.3	-33.4	-6.2	10.2	4.8	-22.9	-22.8	9.7	-36.5	-11.0
Pedestrian	-30.1	-32.2	-19.6	-23.8	-26.5	-30.9	-30.6	-30.0	-15.8	-14.5

Table 3.1. *Percentage change of the percentage of fatalities per transport mode between 1993 and 2003.*

3.2. Safety per transport mode for different crash opponents

Information on what is known as the crash opponent is very informative. The crash opponent is the other transport mode than that of the victim. Unfortunately, for two of the three Central countries this information is not available, as can be seen from the empty cells in Table 3.2. However it was decided to include these comparisons in this chapter, notwithstanding this lack of information for these countries.

Table 3.2 shows that in almost all countries one third of the fatalities results from a single vehicle crash (all transport modes), except the United Kingdom and Hungary (one quarter).
This lower percentage correlates with the high percentage of fatalities on urban roads in these two countries (see also Section 3.4). Furthermore, the dominant position of motorized vehicles as crash opponent is very obvious reading the passenger car and lorry rows of this table.
The percentage for lorry and bus together is particularly high (around 15%), compared with the percentage for cars (around 35%). The amount of vehicle kilometres per year for lorries and busses is about 5 times smaller than for cars. Lorries are somewhat overrepresented as crash opponent in Sweden, the moped in the Netherlands, and the motorcycle in Greece.

Crash opponent	SE	UK*	NL	CZ	HU	SI	EL	PT**	ES*	Cat*	Avg.
Single vehicle	35.0	24.4	34.9	36.1	23.1	35.1	36.0	33.6	36.0	30.8	32.7
Passenger car	38.9	40.0	39.4	-	-	41.3	28.7	40.3	38.0	41.3	38.1
Lorry	18.3	14.4	13.5	-	-	14.9	14.9	8.8	9.1	7.8	13.4
Bus	3.6	2.7	2.0	-	-	4.1	3.2	1.3	1.4	1.0	2.6
Motorcycle	0.6	1.3	1.0	-	-	0.8	4.0	1.2	0.6	0.9	1.4
Moped/Cycle	0.2	0.2	2.5	-	-	0.4	0.3	0.7	0.7	1.0	0.7
Other	3.4	17.0	6.6	63.9	76.9	3.3	12.9	14.1	14.3	17.1	22.9
Total	529	3507	1028	1447	1326	242	1605	859	5399	767	-

* 'Three vehicles' category included in 'other' for the UK, Spain and Catalonia, and also for Portugal.
** Values for Portuguese national roads only.

Table 3.2. ***Percentages of crash opponents involved in fatal crashes in the SUNflower+6 countries in 2003.***

More detailed analyses showed that motorized vehicles are more involved in single crashes than non-motorized traffic. This is perhaps not surprising, but also four-wheelers are more involved than powered two-wheelers, which is perhaps counter-intuitive.

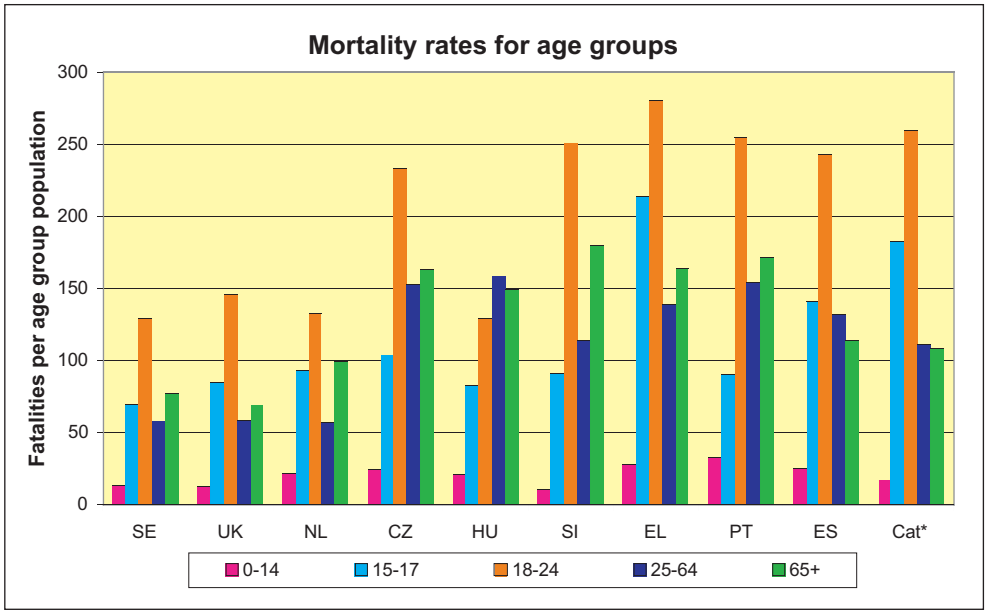
In order not to complicate matters too much, comparisons are made for SUN and Southern countries. This resulted in the following interesting results. Single sided moped and motorcycle crashes are lower in SUN countries than in the Southern countries. This can perhaps be explained by two different factors. First the high volumes/densities on British and Dutch roads making single vehicle crashes less likely and second differences in speed behaviour.

The proportion of motorcycle crashes in the Southern countries (with as crash opponent the other motorized transport modes) are equal to the proportion of moped crashes. In the SUN countries motorcyclists are far more involved than mopedists, although this pattern is heavily influenced by the high proportion of motorcycle crashes in the United Kingdom. There are relatively more lorries and buses involved in fatal crashes in SUN countries than in the Southern countries. Lorries and buses are more involved in crashes with cars than with non-motorized modes and powered two-wheelers. Most road users killed in lorries and buses are involved in single vehicle crashes.

Remarkable differences exist between Greece and Portugal and Spain. For Greece there are more fatalities with motorized crash opponents than with mopeds and bicycles. There are also significantly fewer motorcyclists than four-wheelers as crash opponents and less lorries+buses than cars as crash opponents.

3.3. Safety for different age groups

To compare safety of different age groups we recommend that the number of fatalities is related to the number of inhabitants in age groups. Further information on exposure would be welcomed, but is not broadly available. The results from 2003 for all nine countries (and Catalonia) are presented in Figure 3.2.



* Values for Catalonia from 2002.

Figure 3.2. *The number of fatalities divided by the population size of each group for five age groups in the SUNflower+6 countries and Catalonia in 2003.*

All countries show the same pattern. Except for Hungary the top bar represents the 18-24 group. The 15-17 group is relatively high in all countries. The rate for youngsters (0-14) is relatively low.

The overrepresentation of 15-24 group could be at least partly explained by the fact these groups start to use new transport modes (novice drivers), run a higher risk in general (see also Section 4.7) and use relatively high risk modes such as powered two-wheelers.

Table 3.3 summarizes the results of comparing mortality rates in 2003 with those in 1993. For almost all countries and all age groups an improvement can be observed (negative values, thus a mortality reduction). The best results are seen for the very young and for the elderly. Most probably this correlates with the improvements for non-motorized transport modes as reported in Section 3.1 and perhaps also with the reductions found on urban streets. Whether this is a result of exposure reduction and/or risk reduction is a subject for further research.

Age group	SE	UK	NL	CZ	HU	SI	EL	PT	ES	Cat
0-14	-16.3	-49.4	-32.6	-24.1	-52.3	-91.5	-14.0	-55.1	-37.7	-58.5
15-17	-22.9	0.3	-30.2	4.7	-32.6	-78.9	49.8	-60.9	3.6	-4.6
18-24	14.8	12.8	-5.9	-8.2	-43.2	-48.2	-15.6	-41.3	-19.2	-23.5
25-64	-13.8	-0.7	-13.8	-5.8	-12.5	-49.8	-22.2	-35.4	-23.9	-26.5
65+	-38.2	-36.3	-37.7	-14.1	-30.9	-38.6	-26.9	-48.2	-22.1	-23.2

Table 3.3. ***Percentage change of the mortality rates between 1993 and 2003.***

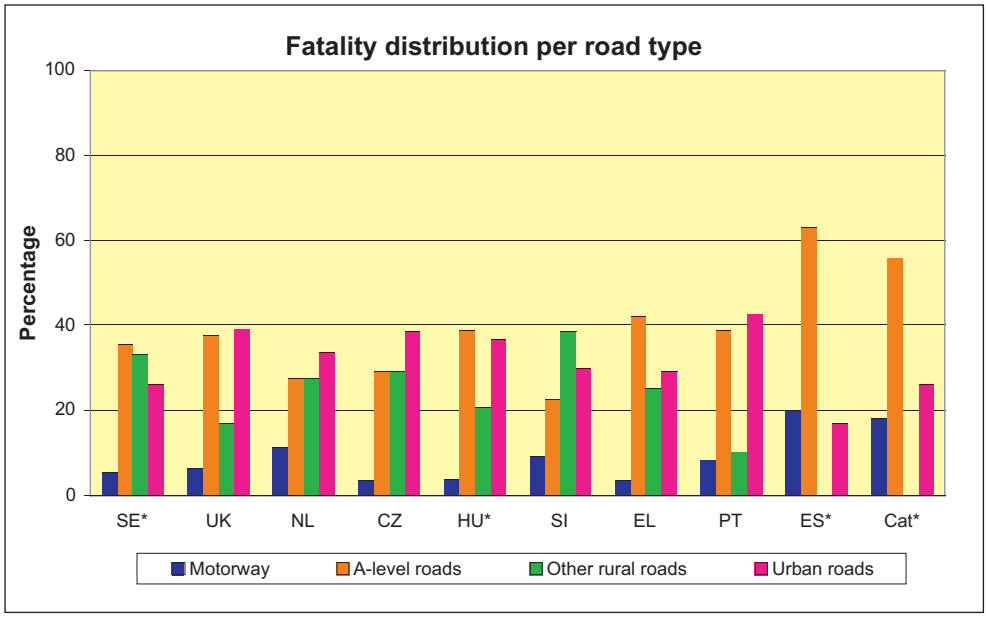
The figures for the 18-24 group give reason for concern in all three SUN countries, showing an increase in Sweden and the United Kingdom. For the 15-17 group we can see subtle increases in the Czech Republic and Spain, but a dramatic increase in Greece. The average reduction is largest for the 0-14 group, followed by the 65+ group.

3.4. Safety for different road types

We distinguish four road types, as can be seen in Figure 3.3. Motorways and urban streets are rather well-defined. The distinction between A-level roads (more important rural roads) and other rural roads (minor) is somewhat problematic due to differences in definitions. Most fatalities occur on A-level and other rural roads together. The proportion of fatalities on motorways lies in a range from a few percents to almost 20% in Spain. Of course this distribution is greatly determined by the road lengths in the different categories, and also by differences in the number of vehicle kilometres travelled on the different categories and the transport modes using the different road types.

Comparing changes over the last decade (see Table 3.4) a general decrease can be observed in the percentages for urban roads. This decrease is most noticeable for Greece and the

Czech Republic and least for the Netherlands, Portugal and Spain. Urban developments and changing travel patterns (more traffic outside urban areas) are key explanatory factors. The improvement in urban areas is in agreement with the reduction in mortality rates for the 0-14 and 65+ groups. For motorways an increase in the fatality percentage is seen for all countries. This is the result of the increased use of motorways, especially in Slovenia, Portugal, and Greece. For countries with available data a reduction of fatality risks can be observed. Special attention should be given to the 'higher speeds' roads (A-level and motorways) in Portugal, Greece, and to a lesser extent the Czech Republic, because their share is increasing. At the least, this indicates a reason for further research on quality of road design in relation to speed behaviour (and of course exposure).



* 'A-level' including 'other rural' roads for Spain and Catalonia. Data for Hungary from 2002. Data for Sweden from 2001.

Figure 3.3. *Percentage of fatalities for different road types in the SUNflower+6 countries and Catalonia in 2003.*

Road type	SE*	UK	NL	CZ	HU	SI	EL	PT	ES*	Cat
Motorway	3.4	17.4	18.7	5.3	-	187.5	69.6	140.2	8.1	-
A-level road	7.8	3.9	-15.1	29.6	-	-31.6	88.5	-6.4	-1.4	-
Other rural road	3.8	26.2	14.1	15.7	-	25.5	-28.1	1.0	-	-
Urban road	-16.4	-12.9	-0.9	-21.9	-	-9.9	-26.0	-4.9	-3.4	-10.8

* 'A-level' including 'other rural' roads for Sweden and Spain. Data for Sweden from 2001.

Table 3.4. *Percentage change of the percentage of fatalities per road type in 2003 compared with 1993.*

3.5. Conclusions

There are large differences in percentages of fatalities per transport mode for the nine countries. Their differences were less extreme in 2003 than in 1993. There seems to be a general tendency towards more equal percentages, in which the percentage of fatalities in cars and lorries tends to increase to a value of 50 tot 65% of all fatalities. The percentage of pedestrian fatalities is decreasing considerably in all countries, for cyclists in all countries except the Czech Republic, Hungary and Portugal, and for mopedists in all countries except the Netherlands, United Kingdom, Spain and Catalonia. The percentage of motorcyclist fatalities has increased in all the countries, except Spain (Catalonia included). This general trend is in agreement with the substantial decrease in the number of urban fatalities (in which non-motorized fatalities are higher than on rural roads).

The absolute number of fatalities for car, lorry and other vehicles decreased in all countries in the period studied except in the Czech Republic, notwithstanding the increase in share. However, the number of fatalities among motorcyclists increased in absolute numbers in all countries, except the Netherlands and Spain.

The comparison of mortality rates by age group shows that there is a considerable improvement of safety for all age groups in 2003 compared with 1993. The average improvement is highest for the 0-14 year group, followed by the 65+ group. The average reduction is smallest for the 18-24 group, followed by the 15-17 group. A possible explanation for this difference in effect for the age groups is the reduction in risks per transport mode. Furthermore, the effect is in agreement again with the general and substantial decrease of the number of fatalities on urban roads. Comparisons for other road types outside urban areas are difficult, because exposure data of good quality is often missing. Also major differences in classification and standards and geographical differences for these types of road types explain differences in risks between road types.

The percentage motorway fatalities of all fatalities is increasing in all countries, while the percentage of urban fatalities is decreasing. Changing traffic patterns and an expansion of motorway networks are related to these developments.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4. Case studies of specific topics

Case studies are a key component in the methodology of the SUNflower approach; they result in a better and more detailed understanding how the road system performs. Fundamentally, case studies try to represent the vertical and horizontal dimension in the pyramid (Figure 1.1). Through the different layers of the pyramid (vertical dimension), a case study follows a road safety topic such as drinking and driving, seatbelts and speed management. But moreover, case studies are carried out for components of the road safety problem such as different road user categories (pedestrians, cyclists, mopeds, motorcyclists, heavy goods vehicles, etc.) or road types (motorways, rural roads etc.). This is the horizontal component.

The three SUNflower+6 reports (Lynam et al., 2005; Eksler et al., 2005; Hayes et al., 2005) covered many case studies (see Table 4.1). These studies were chosen on three grounds: the case studies presented in the initial SUNflower study (Koornstra et al., 2002) and its recommendations for follow-ups, observed policy relevance for a country group and the availability of relevant high-quality data. The main findings of those case studies in which two or more country groups participated are presented and briefly discussed here.

Case studies	SUN countries	Central countries	Southern countries
Pedestrians	X	X	X
Cyclists	X	X	
Mopeds	X		X
Motorcycles	X		X
Young drivers	X	X	X
Heavy goods vehicles	X		
Speed management	X	X	X
Enforcement	X		
Implementation	X		
Drinking and driving	*	X	X
Seatbelts	*	X	X
Low-cost engineering	*	X	

* Carried out in the initial SUNflower study (Koornstra et al., 2002).

Table 4.1. ***Overview of the case studies in the three country groups.***

4.1. Drinking and driving

All three *SUN countries* have a good overall safety record on drinking and driving. Prevention of drinking and driving is based on legislation and enforcement. One function of the law is to show that drinking and driving is dangerous and not acceptable. The other function is to threaten potential drink-drivers with sanctions and to enable detection and conviction of drinking drivers. It seems that the problem of drinking and driving is the biggest in Britain and somewhat less in the Netherlands, but it is a much smaller problem in Sweden. Sweden has the most screening tests and moderately severe sanctions. Britain has the most severe sanctions but the least screening tests, while the Netherlands has more screening tests, but the mildest sanctions.

A very low limit such as in Sweden can be effective in reducing the number of crashes with drink-drivers, provided that it is appropriately enforced. The experience in Sweden and other countries where the limit was changed to a lower level shows that the effects depend more on the level of enforcement than on the actual value of the limit: Sweden has a general limit of 0.02%, Britain of 0.08%, and the Netherlands of 0.05%. Lowering the legal limit (Blood Alcohol Content BAC) to 0.05% has been discussed in Britain. The Netherlands introduced recently a 0.02% limit for novice drivers. Random breath testing has been found effective in reducing drinking and driving. The level of random breath testing in Sweden is double that in the Netherlands. Random breath testing is not allowed by law in the United Kingdom. The dominant aspect seems to be that intensified enforcement of the legal limits has contributed to the reduction of drink-driving fatalities. The effectiveness of publicity is not completely clear.

Enforcement of the (BAC) limits has been successful in the Czech Republic and Hungary, where the zero BAC limit together with rigid enforcement in the past proved its efficiency in the reduction of alcohol related crashes and its consequences. It is likely that, in both countries, a strong association between alcohol consumption and drinking and driving does not exist. However, the problem of driving while intoxicated by alcohol still remains. The prevalence of alcohol related road crashes in Slovenia is alarming and currently represents a major road safety problem. In addition, there is evidence of driving while intoxicated by drugs among young drivers in all three countries, but no data on this topic is currently available.

Drink-driving remains a serious problem for *Southern countries* with a total of between 1200 and 2000 persons killed in 2003. Greece and Spain (and Catalonia) have achieved good records of alcohol levels of killed drivers. The evolution of the legislative framework across the Southern countries is similar (all apply a general limit of 0.05%), but with some differences (Greece and Spain apply lower limits for young drivers; Greece and Portugal apply intermediate and higher limits). In addition, all three countries apply random breath tests and a substantial number of tests are carried out. For example in 2003, it was reported that some 1.3 million breath tests were performed in Greece (1 check per 3 cars, approaching the 1 per 2.5 cars target set by the European Commission), some 900,000 controls were made in Portugal (1 test per 5.5 cars) and over 2.5 million controls were realized in Spain (includes 400,000 tests in Catalonia, but excludes controls in the Basque Country and those by local urban police), amounting to around 1 test per 7 cars. The relatively good performance of Portugal is attributed to earlier lowering of the general limit and the strictest sanctions

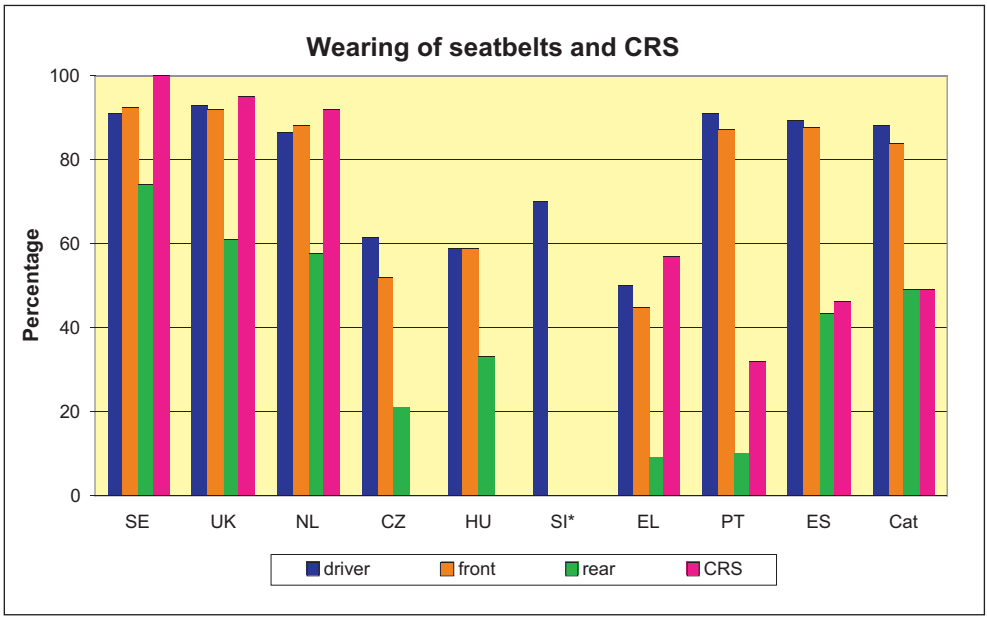
To summarize: safety problems with driving under the influence of alcohol continue to cause concern, although it seems to be problematic to use crash statistics to estimate the number of killed people in alcohol-crashes (not to speak of crashes involving drugs!). All nine countries report about good progress on this subject, although a 'hard-core' problem still persists and requires additional policies. All nine countries have sound legislation, although different legal levels are used (ranging from zero to 0.08%). The level which seems most strongly supported in Europe is 0.05%. However, the zero limit in the Czech Republic and Hungary, and the 0.02% in Sweden should not necessarily be harmonized and raised to 0.05%). In all countries but one (the UK) random breath tests are carried out and the number of these tests increased considerably over the years; in almost all countries millions of these tests are carried out annually. Significant differences between the countries can be observed when it comes to sanctions and punishments and rehabilitation of convicted drivers. BOB-campaigns (designated driver) are used broadly in SUNflower+6 countries. Discussions on the introduction of 'alcohol interlocks' are taking place in several countries, as is the topic of how to prevent driving after taking drugs and alcohol.

4.2. Seatbelts

International research and experience show that the use of occupant restraints is a highly effective way of reducing severe and fatal injuries to car occupants. Seatbelt legislation (on fitting belts in cars and on wearing belts) and enforcement are proven to be effective to improve seatbelt wearing and reduce the number of casualties. All SUNflower+6 countries have seatbelt legislation for front seat passengers, rear seat passengers, and for child restraints. Wearing rates differ, as can be seen in Figure 4.1 showing the rates based on roadside surveys. A goal for any country on seatbelt wearing should be almost 100%, and certainly higher than 90%. Rates in the Czech Republic, Hungary, Slovenia and Greece remain low. Additional work has to be done on rear seat wearing, on wearing during urban trips and on child restraint systems in all but the SUN countries.

Belt wearing in the front seats of passenger cars is high (above 90%) in all three *SUN countries.* Belt use in the rear seats is quite high (74%) in Sweden, but lower in Britain (about 61%) and in the Netherlands (58%). The use of child restraint systems is high (about 95%) in all three SUN countries. Not a lot of efforts are being made to accomplish a further increase. Recently, an integrated publicity campaign (combined with enforcement) in the Netherlands resulted in higher wearing rates. This campaign was focussed on children, but through them also on the other car occupants (their parents!).

Seatbelt wearing rates in the *Central countries* are relatively low compared with other European countries. An increase in seatbelt wearing in passenger cars to 90% would lead to up to 15% reduction in fatalities in all the Central countries. Major obstacles nowadays are the low awareness of risk, leading to misuse or omission, and the high price of appropriate systems. Therefore, governments should search for ways to ensure the widespread presence of belts in all family cars within the Central countries. Enforcement is among the weak points of the road system, especially in the Czech Republic and Hungary. Fines for not wearing seatbelts seem more or less symbolic when compared with the fines for other offences.



*) Estimate, see Eksler et al., 2005.

Figure 4.1. ***Average wearing percentages of seatbelts by drivers, front passengers and rear passengers, and of child restraint systems (CRS) in the SUNflower+6 countries for 2001-2003.***

Seatbelt wearing rates by Greek drivers are well below those of the other countries, and also below Spain and Portugal. With seatbelt use among those involved in KSI crashes at just over 40%, there is a great opportunity for saving more lives by improving seatbelt use by Greek drivers. The rates achieved in Spain and Portugal exceed 80%; in Portugal this may be at least partially attributed to suspension of those drivers repeatedly found not wearing a seatbelt; in Spain the programme of continued monitoring has facilitated targeting of publicity and enforcement by age, sex and location. Greece, Spain, and Catalonia show low belt wearing rates for rear seat occupants and on urban roads; Portugal does not have disaggregated information. Whilst part of the improvement in driver seatbelt wearing may be attributable to the improved safety features of new cars, it is evident that police enforcement has contributed to raising the belt wearing rates for all countries in recent years.

It is estimated that somewhere between two-thirds and three quarters of children in the Southern countries and region that were killed (in 2003) were not using the appropriate child restraint system. It is evident that the administrations have been making efforts to obtain information about this problem, but further efforts are required to ensure more complete recording (both of use levels in crashes and numbers of sanction penalty notices issued).

To summarize: use of seatbelts is a very important way of reducing injuries and fatalities in crashes and legislation and enforcement are the key components to increase wearing of seat-

belts by all car occupants. In all SUNflower+6 countries it is compulsory for drivers, front seat passengers and rear seat passengers to wear seatbelts, and also children to be restrained. Belt wearing has increased over the last decades, but use rates show that there is still room for improvement, especially with regard to rear seats and short trips (e.g. in urban areas). The Czech Republic, Hungary and Greece have still to take important steps for further improvements and better enforcement seems to be the key factor here. All countries should formulate goals on seatbelt wearing close to 100% wearing rates.

4.3. Speed management

Today all roads in SUNflower+6 countries have a maximum speed limit. These speed limits should comply with road layout and functionality. Speed limits have been more and more harmonized between different countries and the speed limit of 50 km/h is very common in urban areas, while the speed limit on rural motorways differs normally from 100-130 km/h. Speed limit systems in each country are somewhat complicated taking into account the different transport modes and road types. Although hard figures are lacking, it is thought that in about one third of all crashes speeding is an important factor.

Managing speed is good for road safety, although the precise relationship between speed and risk induces debate between road safety professionals.

A major problem for all SUNflower+6 countries lies in violating existing speed limits. This is true for all road types. Improved management of excessive speed is a key factor in bringing down the number of injuries and fatalities on our roads. For this a special emphasis should be placed on urban streets (in order to reduce consequences of crashes with vulnerable road users) and on rural roads (to deal with lower design standards).

The Netherlands has been particularly successful over the last two decades in improving the safety of vulnerable road users on the urban network both through physical treatment of 60 km/h roads and through extensive introduction of 30 km/h zones.

Greater variation in road network features and higher traffic levels have led to a less clearly defined speed management system in Great Britain than in the other two SUN countries. Changes to the rural single carriageway speed limit system in Britain are being considered, but a substantive change in planning speed management is only likely to result from a reduction in the overall speed limit together with the definition of a larger network of higher speed strategic roads of appropriate standard. In urban areas, implementation of lower speeds in residential areas is less well advanced in Britain partly because of pressure from the heavier traffic flows.

Speeding is most prominent on rural roads in Sweden, although high proportions of drivers exceed speed limits in urban areas in all three SUN countries. At the same time automatic speed enforcement methods are only just beginning to be implemented in Sweden. Automatic enforcement with fixed penalty fines is particularly widespread in the Netherlands; 70 speeding offences per 100 drivers were recorded in 2002. There are indications in Britain that extensive

use of automation may be undermining public confidence and not modifying behaviour in the way intended.

Speeding is a serious problem in all three *Central countries* and the major obstacles for its effective treatment are inappropriate road environment, legislative framework and inefficient enforcement by police forces, including their lack of capacity and equipment. The latter is only partly true in the case of Slovenia, where effective enforcement strategies have been applied in the last decade. Reductions of the speed limit in the past led to a decrease in speed related crashes, but it seems that it is not only the limit itself, but also the infrastructure modifications, which should be seen as an important factor leading to speed decrease on roads over time. At the same time, development in car design with generally higher engine performance should be viewed as an opposing factor. Common introduction of the 50 km/h speed limit in urban areas (instead of 60 km/h) in 1997 in the Czech Republic, 1993 in Hungary and 1998 in Slovenia was a success in all three countries leading to a reduction in fatalities of 26% in the Czech Republic and 14% in Hungary in urban areas. In contrast, an increase of speed limit on motorways realized in all three countries in the second half of the 1990s had only a minor negative effect on the road toll in the Czech Republic and Slovenia, although in Hungary the effect was more pronounced, perhaps due to the simultaneously applied speed limit increases on other road types outside built-up areas. Speed enforcement is well developed in Slovenia, while in the two other countries it fails due to the imperfect organization and legislation in the Czech Republic and due to the insufficient effectiveness of the controls in Hungary.

The only available means of comparing speed-related fatalities in the three *Southern countries* are the police crash reports and researchers are reluctant to use these reports for this purpose. However, these sources are sometimes used if no other data is available. Recent trends (based on polices reports) show fatality reductions for Portugal and Greece. In spite of the higher level of speed controls carried out in Spain, speed-related fatalities (according to police reports) remain almost unchanged. Catalonia is the first location of the Southern countries to implement automated camera systems to manage excessive speeding, and the first results show that this type of system is very effective in reducing speeds, infringements and crashes. A similar speed management system is being deployed across the rest of Spain during 2005 and 2006.

To summarize: we conclude that the SUNflower+6 countries continue to experience serious problems of vehicles exceeding speed limits. In terms of fatalities this may well be of a similar magnitude to the drink-driving problem. Speed management requires a very integrated approach in which good speed limit setting (given the road and traffic conditions), good road design (design consistency and continuity), large scale enforcement, ITS application, raising public awareness and acceptance of measures are the central elements. Here lies a challenging task ahead for all SUNflower+6 countries.

4.4. Case studies for different transport modes

Before presenting the results of the case studies on the different transport modes, it is helpful to give a rough picture of the shares of the modes. Table 4.2 presents the information for 1993 and 2003, and Table 4.3 summarizes the changes for the three country groups. As mentioned in Sections 3.1 and 3.2, motorized traffic is very dominant in road crashes: the largest number of people killed is driving in a motorized four-wheeled car and a large majority of crash opponents are motorized vehicles. In our case studies specific attention is paid to high-risk groups and vulnerable road users: pedestrians, cyclists, mopedists and motorcyclists. Furthermore, young drivers are running high risks. Finally, heavy goods vehicles have a disproportionally large influence on crash severity.

1993	SE	UK	NL	CZ	HU	SI	EL	PT	ES	Cat
Car + lorry	61.6	46.1	51.4	52.7	43.7	57.6	37.1	35.4	62.2	57.6
Motorcycle	6.6	10.6	8.5	4.9	3.4	3.7	14.8	8.0	9.2	14.2
Moped	2.2	0.6	7.3	2.3	3.5	3.7	9.8	18.8	5.7	5.5
Cycle	11.1	4.9	19.5	10.0	12.8	7.5	1.7	3.7	2.3	1.8
Pedestrian	14.9	32.5	11.7	26.3	30.7	22.7	23.1	25.9	17.3	18.0
Other/unknown	3.6	5.2	1.6	3.9	5.8	4.9	13.6	8.2	3.4	3.0
Total number	632	3814	1252	1524	1678	493	1830	2368	6378	967
2003										
Car + lorry	65.4	50.4	52.3	55.2	48.3	60.3	47.4	40.8	65.4	60.1
Motorcycle	8.9	19.1	9.2	7.0	5.0	10.7	19.3	13.8	6.8	11.3
Moped	1.7	0.7	9.1	0.8	2.7	2.5	3.3	10.2	7.2	8.1
Cycle	6.6	3.3	18.3	11.0	13.4	5.8	1.3	4.1	1.4	1.6
Pedestrian	10.4	22.1	9.4	20.0	22.5	15.7	16.0	18.1	14.6	15.4
Other/unknown	7.0	4.5	1.6	6.1	8.1	5.0	12.7	13.1	4.6	3.5
Total number	529	3508	1028	1447	1326	242	1605	1546	5399	767

Table 4.2. *Percentages of fatalities per transport mode and the total number of fatalities in the SUNflower+6 countries and Catalonia in 1993 and 2003.*

4.5. Pedestrian and cyclist safety

There appears to be less walking per person in the Netherlands than in Sweden and Britain; this is particularly so among older children and adults possibly because of the more extensive use of bicycles. Fatality risk per distance walked in Britain is about twice that in Sweden and 30% higher than that in the Netherlands. The network and traffic related explanations for these differences are supported by the similar inflated levels of risk across all age ranges. In most other ways, pedestrian activity in Britain is relatively similar to that in the other two countries,

1993	SUN countries	Central countries	Southern countries
Car + lorry	49.0	49.3	51.8
Motorcycle	9.7	4.0	9.9
Moped	2.2	3.0	9.3
Cycle	8.8	10.9	2.5
Pedestrian	26.0	27.8	20.2
Other/unknown	4.3	4.9	6.2
Total number	5698	3695	10576
2003			
Car + lorry	52.4	52.5	57.5
Motorcycle	16.0	6.4	10.4
Moped	2.5	1.8	7.0
Cycle	6.7	11.6	1.9
Pedestrian	18.3	20.8	15.5
Other/unknown	4.2	6.9	7.6
Total number	5065	3015	8550
Percentage change 1993-2003			
Car + lorry	6.9	6.6	11.0
Motorcycle	65.0	58.7	5.1
Moped	11.6	-42.0	-24.6
Cycle	-24.2	6.5	-24.1
Pedestrian	-29.7	-25.3	-23.4
Other/unknown	-2.3	40.2	22.9
Total	-11.1	-18.4	-19.2

Table 4.3. *Percentages of fatalities per transport mode and total number of fatalities, together with the percentage change from 1993 to 2003 for the transport modes in the three groups of countries.*

although there is a slightly higher proportion of pedestrian fatalities in Britain with high levels of alcohol in their blood. There is no evidence of less attention being given to pedestrian safety education and pedestrian training in Britain.

The same factors are likely to influence cyclist fatality risk in Britain, which is twice as high as in the other two countries. It is also clear that for many years in Sweden and the Netherlands the road environment has been planned with more consideration of bicycle use. Although Sweden has recently introduced a bicycle helmet wearing law for children, it has not had a major effect on the numbers of cyclist fatalities; deaths among elderly cyclists contribute the most of all age groups to the national fatality total.

Elderly pedestrians have higher risks than any other road user group in all three *Central countries.* The proportions of pedestrian fatalities (among all fatalities) are the highest for the Czech Republic, followed by Hungary and Slovenia. The considerably higher proportion of pedestrian fatalities occurring on pedestrian crossings observed in the Czech Republic and Slovenia indicates inappropriate speed of vehicles and a lack of discipline of both drivers and pedestrians.

Poor behaviour of pedestrians is behind the majority of their fatal crashes, mostly occurring when crossing roads away from the marked zebra crossings. Pedestrians' alcohol consumption is also one of the factors increasing pedestrian risk. The implementation, modernization, and proper arrangement (e.g. lighting) of pedestrian facilities in and outside of built-up areas, as well as the mandatory use of reflective objects and lights at times of low visibility, encouraged by promotion of effective education systems, would contribute to higher safety levels for pedestrians in all three countries. There is a strong need for additional infrastructure arrangements in many municipalities, which will ensure enough pedestrian facilities to allow safe crossing. The traffic organization of many other towns should be reconsidered in order to give higher priority to vulnerable road users and decrease their risk through infrastructure improvements (traffic calming).

The same factors are likely to influence the fatality risk of cyclists in the Central countries. Slovenia shows better performance (cyclist mortality) probably due to the lower exposure caused by the country's mountainous character and safer riding (infrastructure, bicycles, and helmets). Although the Czech Republic has recently introduced mandatory bicycle helmet wearing for children, it has not yet had a major effect on the number of cyclist fatalities; the deaths among elderly cyclists contribute the most of all age groups to the national fatality total.

Portugal presents, in general terms, the worst rates for pedestrian fatalities and injuries in the group of *Southern countries*. However, the trends point to a convergence towards current rates similar to those presented by the other two countries and the autonomous region, especially in the cases of killed and severely injured. These current rates, however, are still well above those for Sweden and the Netherlands. Generally, the age pattern of pedestrian fatalities for the Southern countries is similar to that for Sweden, with elderly pedestrians being a particularly vulnerable group for Greece.

To summarize: impressive reductions can be observed in the number of fatalities among pedestrians and cyclists in all SUNflower+6 countries during the last decades, although these categories still run a relatively high risk. The explanations for these improvements are not well documented and studied. Only some general indications can be given here: reduced exposure to risks, safer pedestrian and cyclist environment, better managed speeds, improved skills and behaviour etc. We strongly recommend further research on this.

4.6. Powered two-wheeler safety

In the Netherlands, the moped fatality proportion and mortality rate are much higher than in Sweden and the UK. In all three *SUN countries* fatalities among the 15-19 age group contribute a disproportionate amount of all moped fatalities. 15-17 year olds contribute a large share of the moped kilometres in both Sweden and the Netherlands. Dutch fatality rates per moped km are 1.6 times higher than the Swedish and 2 times higher than the British. In the 15-17 age group, Dutch fatality rates are 4 times higher than Swedish rates.

In Sweden, access is allowed to mopeds at the age of 15; in the Netherlands and Britain the access age is 16. In Sweden and the Netherlands, no moped licence exists and only minimal training applies. Britain requires basic training and the use of registration plates but numbers of mopedists are relatively small. The low general traffic rates in Sweden, compared with Britain and the Netherlands, and the low level of moped use during the winter may partly explain why this relatively easy younger access to mopeds does not produce the higher risk seen in the Netherlands. The general improvement in safety trends in the Netherlands over the last decade has not been mirrored by similar improvements in moped risk; the combination of vehicle and user characteristics and the lack of a dedicated infrastructure, as has been provided for cyclists, has hindered progress for this user group.

Britain has fewer motorcycles per head of the population, or motorcycles as a proportion of traffic flow per year, and has the highest number of kilometres travelled per motorcycle. Britain has a fatality rate per motorcycle kilometre which is 50% higher than that in the Netherlands and doubles that in Sweden. The high fatality rate among younger motorcyclists may be a factor in these differences, as this group potentially comprise a lower proportion of motorcyclists in the Netherlands due to high moped use. But the motorcyclist fatality rate for 25-49 year olds in Britain and the Netherlands is also substantially higher than that in Sweden. These age groups are more likely to be using larger motorbikes. The involvement of older motorcyclists on larger motorbikes is highest in Britain, although there is evidence that this group is also rising in Sweden and the Netherlands. The reason why this group should have such a low fatality rate in Sweden is not clear but it may be associated with the relatively sparser road network and lower traffic volume.

The scope of the powered two-wheeler safety problem in *Central countries is* marginal in comparison with Southern countries, as their share among all road fatalities is significantly lower in all three Central countries. Powered two-wheelers represent 8% of fatalities in the Czech Republic and Hungary, while their share is little higher in Slovenia at 10%. In Southern countries only moped fatalities share of all modes reaches such a proportion (e.g. 9% in Spain). From the trend of powered two-wheelers fatalities observed in the three Central countries, it is likely that the negative development observed since 1990 has reached its peak in the early 2000s. Since the early 1990s the proportion of killed mopedists and motorcyclists have changed significantly from 2:3 in 1990 to up to 1:10 in 2003 in the Czech Republic and from 2:3 to 1:2 in Hungary, where the rate was 3:2 in 1995. The current rate in Slovenia is around 1:5. This was a logical consequence of the shift from small powered two-wheelers to motorcycles after the market opened and the purchasing power and living standards of Central European countries increased.

Exposure data is partly available for the Czech Republic (since 1970) and Slovenia, where it covers the period of the last 10 years. There has been a stagnation of powered two-wheelers traffic performance in the Czech Republic, while the Slovenian motorcyclists run nowadays 2.5 times more kilometres than 10 years ago. However the average traffic performance per capita was fairly similar in 2000 for the both countries, but it should be mentioned that it has been substantially increasing in Slovenia in the last decade. The fatality rates per vehicle kilometre are fairly similar in the two countries as well. There has been a continuous decrease in powered two-wheeler ownership observed in the Czech Republic and Hungary, while the number of registered powered two-wheelers has been rather stable in Slovenia over the last couple of decades.

As the problem of powered two-wheelers is generally perceived as marginal in the Central countries, it is very difficult to find any two-wheelers orientated road safety initiatives. Helmet wearing rates are sufficiently high for motorcyclists, but significantly lower for mopedists.

The number of motorcycles in *Southern countries* is increasing, particularly in Greece and Portugal. Catalonia has a notably high stock of motorcycles (in 2003, almost a third of the Spanish total, almost half the stock of Greece). Motorcycle fatalities per capita show improvements for both Greece and Portugal, although by 2003 the former remains three times, and the latter two times the level of Spain. Similar improvements are seen for fatalities per motorcycle, although the rate for Portugal in 2003 is four times that of Greece and six times that of Spain/Catalonia. In 2003, for Greece, two out of every three motorcyclists killed were not wearing a helmet, compared with approximately one in seven of the motorcyclists killed in Spain, 1 in 10 for Portugal, and 1 in 25 for Catalonia. There are proportionately more young motorcyclists killed in Greece (half are aged 20-29) than in Spain (highest age group being 30-39) and Catalonia (highest age group is 40-49). Portugal appears to have a particular problem with motorcyclist fatalities driving off the road, especially on rural roads.

The number of mopeds is increasing in Spain and Catalonia, and is decreasing in Portugal, but recent data for Greece is not available. The trend in fatality rates per capita for mopeds shows great improvement for all counties but especially for Portugal. Nonetheless, for 2003, the rate for Portugal remains four times that of Greece, with Spain and Catalonia at almost twice the Greek figure. In terms of fatality rates per moped for 2003, the rate for Portugal is twice that of Spain/Catalonia, and almost ten times that of Greece. A major factor relating to the good performance of Greece concerns the higher minimum age (16) for obtaining a moped driving licence, as well as the higher test requirement.

To summarize: powered two-wheelers run a relatively high risk, especially when young riders are involved. In most SUNflower+6 countries motorcyclists are the dominant factor here, in some other countries mopeds are also important. More powered two-wheelers on the road, so more exposure to risk, are the main driving force behind this growing problem. Improving helmet wearing is the simplest contribution to the powered two-wheeled vehicle problem. But also attempts should be made to enable powered two-wheelers to share road space better with other transport modes. Finally, more discipline is needed for those who violate legislation and police enforcement is instrumental in achieving this.

4.7. Young drivers

Young drivers had an approximately 4 to 5 times higher crash involvement in fatal crashes. Young male drivers have a far higher risk than young female drivers. The improvement over time of novice and experienced female drivers is about the same. In comparison with the development over time of the safety of expert male drivers, the safety levels of young male drivers fall behind. Dominant characteristics are: single vehicle crashes, presence of passengers, exposure during weekend nights, and in many countries also alcohol. The close resemblance between SUNflower+6 countries suggests the universal nature of the problem of young drivers. It is not easy to relate policy interventions to changes in crashes at a macro level.

Young drivers in the Netherlands have the worst safety record of the three *SUN countries*. A possible explanation for their high crash risk is that, compared to Sweden and the UK, young drivers in the Netherlands have spent fewer hours behind the wheel before they do the driving test. The reason for this is that so far accompanied driving before the driving test has been legally forbidden in the Netherlands. The risk among male drivers is higher than for female drivers and is generally becoming worse, probably as a result of changes in lifestyle. Young male drivers are more likely to drive late at night and, although the use of alcohol hasn't increased in the past decade, the use of illicit party drugs has. From reported behaviour, speeding is more of a problem among younger drivers in the UK and the Netherlands than in Sweden. There is little evidence that any of the special measures aimed at novice drivers have had any substantial impact.

Slovenia has the highest proportion of young driver fatalities (18-24) compared with fatalities within the group of experienced drivers (30-59) in comparison with the Czech Republic and Hungary. But when exposure data featuring the number of licence holders in an age group is taken into account, higher risks for Slovenian drivers decrease substantially and the risk is actually lower than in the other Central countries. An explanation for the higher proportion of young driver fatalities in Slovenia compared to the Czech Republic and Hungary is that Slovenian young drivers start to drive their own car very soon after they acquire their driving licence. Young drivers in the Czech Republic and Slovenia are generally over-represented in alcohol and weekend night crashes compared to older drivers; there is no over-representation to be seen in Hungary. Recently, special attention has been given to young drivers, especially in Slovenia, where special provisions including additional training programs for novice drivers have been introduced. The results of the new provisions will be seen in the near future, however, at present it appears that none of the special measures aimed at young drivers have had any substantial impact, bearing in mind the situation in all three Central countries. In the future, more and more Czech and Hungarian young drivers will possess their own cars and will drive more, and for this reason the proportion of young driver fatalities will tend to increase. That is why the high risk of young/inexperienced drivers should be addressed today, before a real boom in car-ownership comes.

The relative risk ratio is the number of drivers in fatal crashes related to the population aged 18-25 years with those of the 30-59 age group. For all *Southern countries* for the most recent year (2003) the ratio is between 1.5 and 2.0, indicating that this is a common problem, of

similar magnitude. The trends show an improvement for Portugal (from over 2.0 in 2001) and a slight worsening for Greece and Spain (from 1.2 in 1997). Young Southern males are also five times more likely to be involved in fatal crashes than young females. Data for Spain indicates that, in terms of crashes per licence holder, the younger age group is three times more likely to be involved in road crashes than the older age group.
Considering the data for 2003, the types of crashes in which young drivers of Southern countries are over-represented are single vehicle crashes (especially Greece and Spain); crashes at weekends (particularly Portugal) and crashes with several passengers present (particularly Catalonia, Spain and Greece). The problem of dangerous driving by young drivers during the weekend nights is particularly severe in Southern countries due to the combination of a good climate and extensive late-night activities.

To summarize: young drivers' risks are relatively high in all countries. These high risks result from factors such as age and inexperience. Males run higher risks than females. The period immediately following licensing is particularly dangerous. Dominant crash characteristics are: single vehicle crashes, presence of passengers, weekend nights, and alcohol. But also the dominant patterns of experienced drivers are reflected in the dominant patterns of young and novice drivers, indicating that it is not just a young driver problem but also a safety problem in general. In the past this young group appeared to be affected less by general safety improvements than other age groups. A coordinated approach including education, training, licensing, publicity, and use of technology is required to reduce the high risks of young drivers. The goal should be to continually improve the overall road safety levels and reduce the differences in risk levels between young, novice drivers and more experienced drivers, especially with regard to young male drivers.

4.8. Implementation of low-cost infrastructure improvements

The focus of engineering programmes differs somewhat in the three *SUN countries*, as a result of the distribution of crashes and traffic within the road networks. The pattern of fatalities among road users also varies. To isolate the effects of (low-cost) engineering measures is difficult due to several programmes being implemented simultaneously.

Significantly more kilometres of 30 km/h roads have been introduced in the Netherlands than in the other two SUN countries. These were included in what is known as the *Start-up Programme on Sustainable Safety*, not only addressing the planning and design of road infrastructure, but strongly emphasizing this. These components were: functional road classification, 30 km/h zones and 60 km/h zones, safety of two-wheelers, and roundabouts. Evaluation studies suggest a 6% reduction in the number of fatalities and in-patients (Wegman et al., 2006). Moreover, the Netherlands has managed, relatively effectively, to improve safety of cyclists mainly through provision of additional facilities for them, both on and off the road.

Work on local road engineering programmes is managed differently in the three SUN countries. Britain has decentralized responsibility fully. In the Netherlands, the transfer of responsibility has been more gradual. In Sweden, although the urban communities are active in local road improvement, the main programmes have always been defined at the national level. Increased

funding for local safety schemes in Britain was a key element of the strategy to meet the casualty target for 2000. In the Netherlands, local activity has been encouraged through a series of incentive programmes. Remedial programmes directed towards high-risk sites and routes have been most evident in Britain. Programmes in Sweden and the Netherlands have mainly been junction improvements, and most recently these programmes have focussed on introducing roundabouts.

It is difficult to find any kind of a systematic engineering improvement programme realized in the *Central countries*, which promotes application of low-cost measures. Due to the limited state budget for road construction and maintenance, the municipalities financed this from their own budget, and realized most of the measures themselves, sometimes with a direct state financial contribution. There is a need to initiate and implement a systematic programme for infrastructure improvements at the regional level in all three countries. To enhance the effectiveness of investments better, vertical cooperation between local and state governmental levels is necessary. Regarding implementation of particular projects, technical guidelines provided by municipalities and designers with best practice examples are available.

The implementation of efficient and effective safety policies needs not only strong governmental support, but also clear guidelines set and budgets provided for the local authorities, which will deliver many of these policies. The role of research in delivering necessary knowledge to policy makers should not be neglected, since many decisions are nowadays taken without appropriate analysis of the problem to be solved. Road safety management at the local level should be developed especially in the Czech Republic and Hungary. In addition, policies need to be seen as fair and balanced and this is best achieved through citizen participation in the development of the policies. A local road safety expert should also be given enough room to propose new measures and policies. A communication strategy to encourage a constructive debate is important so that the policies can stand criticism from vocal minorities. Also, there is often no reliable information as to whether these measures had a positive influence on the level of road safety, therefore more attention should be given to the cost-benefit and cost-effectiveness analyses of the measure taken at both national and local levels.

All three Central countries have to deal with financial constraints on the implementation of road safety measures. Unfortunately, the state budget contains no special fund or grant system to finance road safety improvements. The model of shared responsibility is a cornerstone of effective road safety management; therefore private funding or investments should be enhanced at both regional and local levels.

To summarize: implementation of efficient and effective safety policies needs not only strong governmental support but clear guidelines set, and budgets provided for the local authorities which have to deliver many of these policies, particularly for low-cost infrastructure improvements. In addition, policies need to be seen as fair and balanced and this is best achieved through citizen participation in preparation of the policies. General treatment of urban streets with low-cost measures requires active support from local communities/municipalities, expertise to deal with limited budgets and an active supporting role, when it comes to co-financing, of the central government.

5. Footprints

5.1. Brief description of the footprint approach

One of the goals of the SUNflower+6 project is to develop a methodological framework for a country's road safety footprint. Such a footprint will help to identify strong and weak points, can direct further and more detailed analyses and can assist in showing ways to road safety improvements. At this stage, the proposed methodology is considered as a first step in the definition of an overall methodology, based on state-of-the-art knowledge and the information gathered in SUNflower+6. Eventually, it may grow into a widespread tool for benchmarking road safety.

A road safety footprint of a country can be described as a representation of the road safety status of a country. It is:

- a multiple score of standardized key indicators,
- that can be compared with meaningful references,
- expressed as a snapshot in time, and as a past picture over time.

It includes:

- a full picture of all impacts of road crashes,
- and their most relevant underlying elements and processes for which causal relationships are understood.

Ideally, the road safety footprint of a country is a composition of suitable indicators at all levels of the pyramid, and for all components of the traffic system (road user, transport mode, infrastructure). It cannot be restricted to only headline numbers, since countries that perform almost identical at a macroscopic level, can show a lot of difference in, for example, the implementation of measures and risks for individual modes. This was clearly indicated in the SUNflower study (Koornstra et al., 2002), in which a wide range of safety indicators was identified.

Continuing this approach, the comparative group studies in the SUNflower+6 project have addressed additional subjects and consequently introduced additional indicators (Lynam et al., 2005; Hayes et al., 2005; Eksler et al., 2005). Based on these reports, and other activities (ongoing, or finished), such as the SafetyNet project (http://safetynet.swov.nl/), an overview of possible safety indicators has been prepared. The aim is to let this set of indicators be a coherent footprint. For this reason, the causal relationships between the key safety topics at the different levels (transitions over pyramid levels) should be known and based on state-of-the-art knowledge.

The overview presented is based on state-of-the-art knowledge and current practices in the SUNflower+6 countries. We therefore consider it as the best that can be achieved at the moment, and it provides a robust starting point to be complemented with new knowledge or

better insights in due time. Due to its conceptual nature, the overview sometimes represents a rather ideal situation. It may not easily be achieved by many countries in the short term, but it gives a reasonable target for monitoring traffic safety performances. In some cases, substitutes for the ideal indicators have been identified.

Footprint based benchmarking is mainly meant to show how a country deviates from a reference. This especially concerns those deviations that indicate a worse performance than the reference. It is not meant to completely explain all observations regarding the road safety of a specific country, but it can highlight items that need improvement, and that should be investigated in more detail.

The type of reference that is interesting for benchmarking differs between countries and may change over time. Here some examples of meaningful references are presented.

References for individual countries:
- Other countries that perform better; incentive to approach 'the best in class'.
- The average of a wide range of countries: to put one's own situation into perspective, and determine one's position within a group of countries.
- Road safety targets; to provide insight for making the right choices to reach the targets.

References for the European Commission:
- Determine which countries trail with respect to the average, and on what topics.
- Determine which improvement efforts are efficient for reaching targets (for example the 2010 target).

Indicators can reflect the country's situation at a particular moment in time, but it should also monitor developments over time. This can be achieved in two complementary ways. First, footprint schemes can be designed for different time periods, giving a discrete representation of performance in each period. Alternatively, time trends will show continuous developments over time, for a limited number of general safety indicators.

It should in the end be possible to track a specific road safety aspect through all levels of the pyramid. For example it should be possible to track high social costs of a particular safety aspect down to casualty numbers, via operational conditions of traffic, to a measure that has or has not yet been taken, and the social, political and cultural environment that it originates from. The other way around is valid as well. For example, a country that has implemented many safety measures should perform relatively well on the safety aspects that are related to these measures. Or, if this is not the case, the reasons should be clear and also be reflected in the indicators. For example, it might be expected that in a country where a rather high BAC is permitted or where the police do not perform alcohol controls frequently, the percentage of drivers under influence of alcohol will be high, and associated with a high proportion of fatal crashes. The quality of the safety indicators and the quality (science based) of causal relationships between indicators at different pyramid layers are the success factors for this goal. Especially regarding these items, it is important to realize that the methodology development is an ongoing process that should adapt to new insights and new developments in road safety.

We propose to distinguish two components in this footprint approach:
- a detailed footprint scheme, and
- a summary footprint scheme.

The detailed footprint scheme is a fact sheet type of template, as depicted in Table 5.1. The topic *transport background* gives a first impression of the country's settings. Then successively *final outcomes, safety performance indicators,* and *policy output* are included.

A summary footprint is a more compact scheme and is proposed in addition to the detailed footprint scheme, to further illustrate the footprint and to facilitate a first glance impression. Data relating to specific topics can be abstracted from the same database, but can be presented in a more traditional tabular form.

5.2. Detailed footprint scheme

The proposal for the detailed footprint scheme is presented in Table 5.1.

<table>
<tr><td colspan="6">Transport background</td></tr>
<tr><td colspan="2">Road traffic fatalities
Population
Area
Public paved road length
Motorway length
Number of motor vehicles
Motor vehicle kilometres
Motor vehicle kilometres on motorways</td><td colspan="4">Percentage of vehicle kilometres per road type</td></tr>
<tr><td colspan="6">Final outcomes - fatalities</td></tr>
<tr><td colspan="6">Collision matrix</td></tr>
<tr><td>Modes</td><td colspan="2">Fat./km (pkm and vkm)</td><td colspan="2">Fat./veh.</td><td>Fat./pop.</td></tr>
<tr><td rowspan="4">Age groups</td><td>0-14</td><td>15-17</td><td>18-24</td><td>25-64</td><td>65+</td></tr>
<tr><td>Fat./km per mode</td><td>idem</td><td>idem</td><td>idem</td><td>idem</td></tr>
<tr><td colspan="3">Fat./population per age group</td><td colspan="2">% Fatalities per age group</td></tr>
<tr><td>0-14
% Fatalities
per mode</td><td>15-17

idem</td><td>18-24

idem</td><td>25-64

idem</td><td>65+

idem</td></tr>
<tr><td>Behaviour</td><td colspan="5">• Percentage of on-the-spot fatalities resulting from crashes involving at least one impaired active road user
• Impaired killed drivers/all killed drivers
• Percentage of fatalities due to excessive speeds
• Percentage of fatalities due to car occupants not wearing a seatbelt
• Percentage of fatalities of riders of powered two-wheelers not wearing a safety helmet</td></tr>
<tr><td rowspan="2">Roads</td><td>Motorways</td><td>A-level roads</td><td>Other rural roads</td><td colspan="2">Urban roads</td></tr>
<tr><td>Fat./vkm per mode</td><td>idem</td><td>idem</td><td colspan="2">idem</td></tr>
<tr><td colspan="2">Fat./vkm per road type</td><td colspan="3">Fatality share per road type</td></tr>
</table>

Fat. = fatalities; pop. = population; veh. = vehicles; pkm = person kilometres; vkm = vehicle kilometres.

Table 5.1. *Proposal for a detailed footprint scheme*

Safety Performance Indicators					
Modes		Crashworthiness	• Compatibility ratio • Fleet composition		• Fleet age • Vehicle inspection frequency
Behaviour	Speeding	Motorways Drivers over the limit	A-level roads idem	Other rural roads idem	Urban roads idem
		Mean values and standard deviation per road type			
	Daytime running lights (DRL)	Motorways DRL rate per vehicle type	A-level roads idem	Other rural roads idem	Urban roads idem
		DRL rate per road type			
	Other	• Percentage of impaired road user population • Seatbelt wearing rates (front, rear, child restraint systems) • Helmet wearing rates (motorcycles, mopeds)			
Roads		Length share of road types			
		Per road type: • Percentage of intersection types • Intersection density • Percentage of road length with a wide median or median barrier • Percentage of road length with a wide obstacle-free zone or roadside barrier • Percentage of road length with facilities to separate vulnerable road users from motorized traffic			
Trauma management		• Arrival time of emergency services • Quality of medical treatment			

Fat. = fatalities; pop. = population; veh. = vehicles; pkm = person kilometres; vkm = vehicle kilometres.

Table 5.1 *(continued). Proposal for a detailed footprint scheme.*

Policy output		
Types and number of measures		Types and number of measures that have been taken (e.g. regarding: drinking & driving, seatbelts and helmets, speed, vehicle fleet characteristics, infrastructure, young drivers, vulnerable road users)
National road safety policy documents		• The political support of the document • The precision of the definition of goals/objects/targets • The use of valid causal theory (problem - solution) • The available means (implementation + monitoring) • The reduced necessity of inter-organizational decisions • The sanctions/incentives for co-producers and target audience • The implementation priority for all stakeholders • The active support of stakeholders
Implementation	Organization	• National government support and funding • Linkages between central and local government
	Modes	• Existence and quality of periodical vehicle inspection • Percentage of cars completely equipped with seatbelts • Percentage of bicycles with side reflectors/lighting
	Behaviour/ enforcement	• Legal BAC limit • The speed limit system (limits per road type) • The chance of getting caught (violations/population); too high BAC, not wearing a seatbelt/helmet, speeding • The penalty level; violation of BAC, seatbelt/helmet, speed • Attitude/awareness of the public
	Behaviour/ education	• Training programmes and access age per mode • Existence/quality annual test (e.g. an eye test) for elderly driver • The quality of the education for powered two-wheelers • The type of driver's licence for powered two-wheelers
	Roads	• The quality of the design standard • The percentage of all residential areas designed as a '30 km/h zone' • Traffic calming schemes application

Fat. = fatalities; pop. = population; veh. = vehicles; pkm = person kilometres; vkm = vehicle kilometres.

Table 5.1 *(continued). Proposal for a detailed footprint scheme.*

5.3. Examples of detailed footprint schemes

5.3.1. Comparing a country with a reference

A country's footprint is useful to monitor the current safety status and to understand the interaction of safety processes, and also the contribution of different components of the traffic system to safety for all pyramid levels. As an example, the footprint of the Netherlands is compared in Table 5.2 with the SUNflower+6 average.

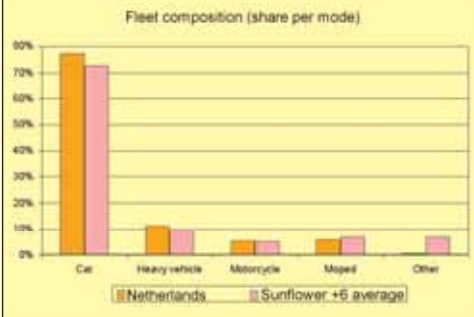
5.3.2. Development of individual countries over time

Monitoring a country's performance over time increases the understanding of developments. For this purpose, average values over three successive years are used to overcome data fluctuations, and three 3-year periods have been selected to identify changes over time; 1981-1983, 1991-1993 and 2001-2003. Each graph then displays values of the three 3-year periods: see Table 5.3. The selection of graphs is in accord with that in the previous section, and again the example for the Netherlands has been worked out.

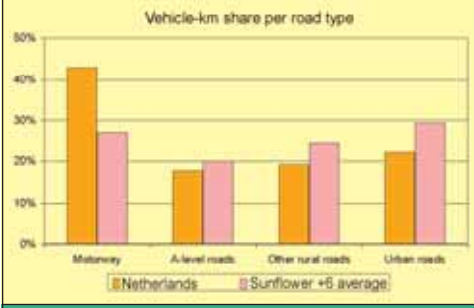
5.3.3. Comparing individual countries

A comparison of two or more countries can be done by displaying values of the countries involved in each graph. This can be done for one time frame, and can be repeated for others. Table 5.4. has information of a comparison between Spain and Portugal for the period 2001-2003.

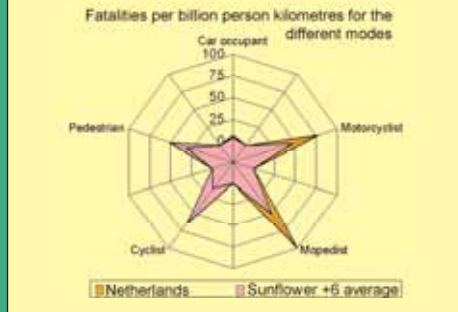
Safety Performance Indicators

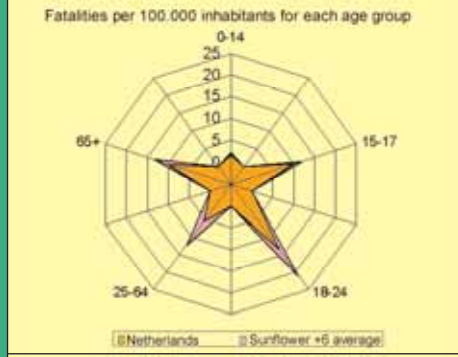


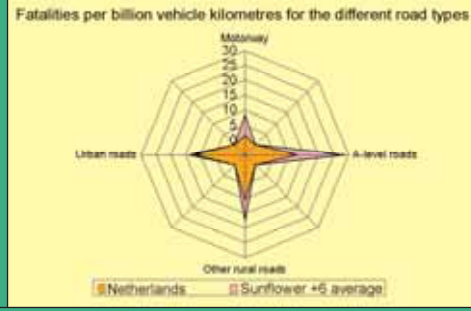
Transport background



Final outcomes







Percentage of crash opponents in fatal crashes (2003)

Country	Single vehicle	Passenger car	Lorry	Bus	Motorcycle	Moped/Cycle
Netherlands	34.9	39.4	13.5	2.0	1.0	2.5
SUNflower+6 average	32.7	38.1	13.4	2.6	1.4	0.7

* Excluding the Czech Republic and Hungary.

Table 5.2. *Safety Performance Indicators and final outcomes for the Netherlands compared with the SUNflower+6 average for the period 2001-2003.*

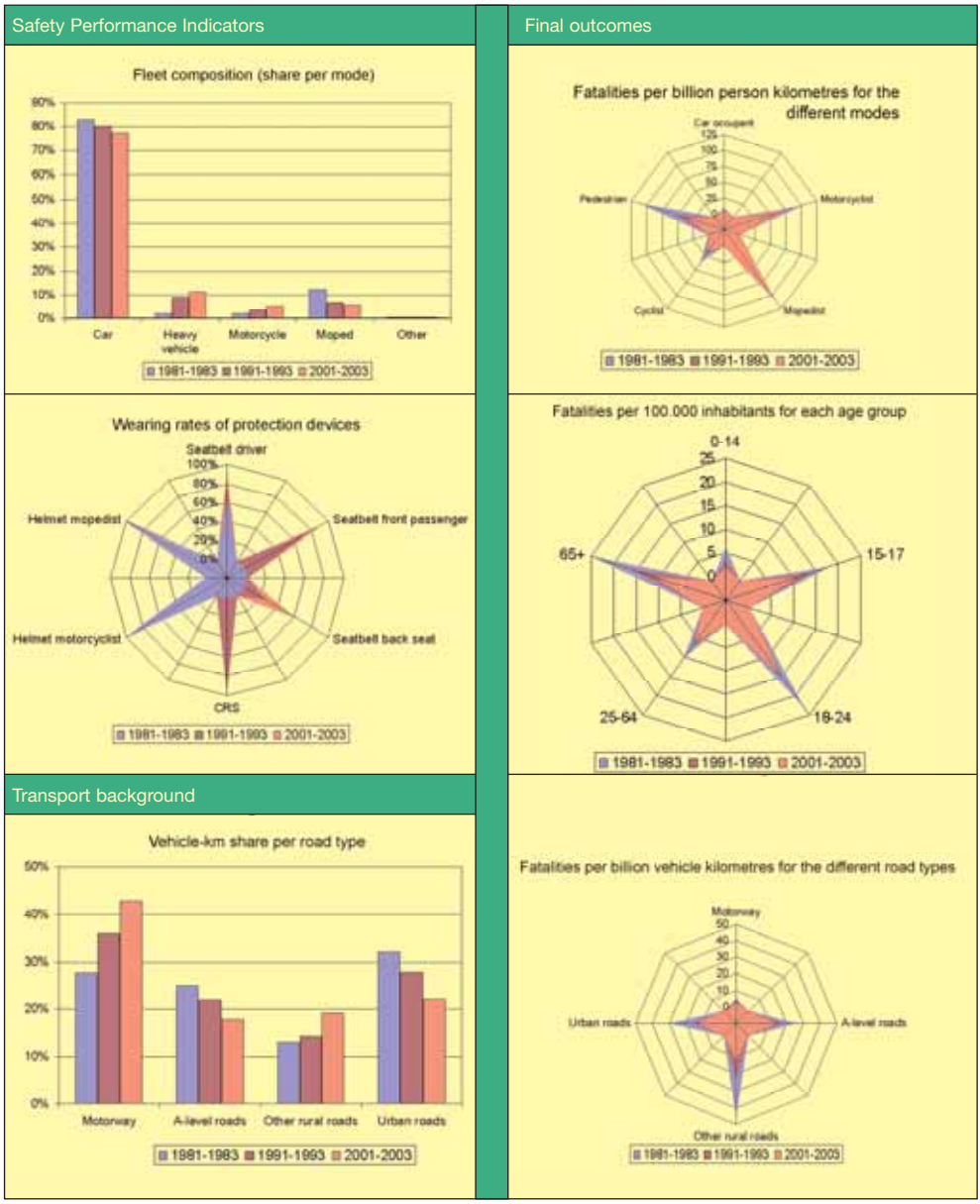
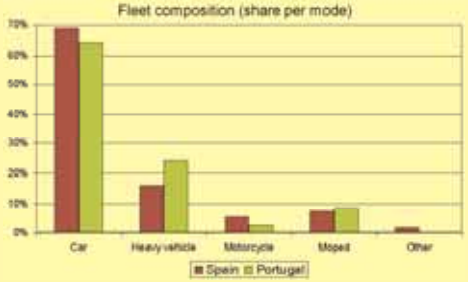
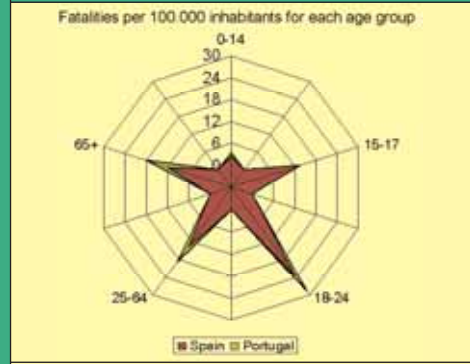


Table 5.3. *Safety Performance Indicators and final outcomes for the Netherlands compared over three 3-year periods 1981-1983, 1991-1993 and 2001-2003.*

Safety Performance Indicators



Final outcomes



Percentage of crash opponents in fatal crashes (2003)

Country	Single vehicle	Passenger car	Lorry	Bus	Motorcycle	Moped/Cycle
Spain	36.0	38.0	9.1	1.4	0.6	0.7
Portugal*	33.6	40.3	8.8	1.3	1.2	0.7

* Values for Portugal: national roads only.

Table 5.4. *Safety Performance Indicators and final outcomes for Spain and Portugal for the period 2001-2003.*

5.4. Summary footprint scheme

The detailed footprint scheme intends to give a detailed overview of the contribution of different components of the traffic system to road safety. Furthermore, it intends to give a framework for monitoring and understanding the effects of relevant safety processes through the levels of the pyramid (Figure 1.1). It provides extensive information for thorough benchmarking. However, the scheme may be too comprehensive for some users. Therefore, a more compact scheme has been developed in addition to the detailed footprint scheme: a summary footprint scheme. A first proposal has been depicted in Table 5.5 in which Table 5.2 has been summarized. Three colours (red, orange and green) are used to respectively indicate a bad/worse-than-average, moderate/average, or good/better-than-average score. A grey box means that no data is available.
We recommend to develop both the detailed and the summary footprint schemes further.

Organizational background	
Safety org. foundation	
Quantitative targets	
Range of measures	

Transport background	
Motorways	
% Vehicle km	
A roads	
% Vehicle km	
Other rural roads	
% Vehicle km	
Urban roads	
% Vehicle km	

Safety Performance Indicators	
Per mode	
Car occupant	
% cars	
Belt wearing rates	
Driver	
Front passenger	
Rear seat	
Child restraint	
% Heavy vehicles	
% Bicycles	
% Other vehicles	
Motorcyclist	
% Motorcycles	
Helmet wearing	
Mopedist	
% Mopeds	
Helmet wearing	
Per road type	
Motorways	
% Road length	
A-level roads	
% Road length	
Other rural roads	
% Road length	
Urban roads	
% Road length	

Final outcomes				
Per mode				
Car occupant				
All	Fat./pop.			
All	Fat./veh.			
All	Fat./vkm			
0-14	Fat./pkm		% Fatality	
15-17	Fat./pkm		% Fatality	
18-24	Fat./pkm		% Fatality	
25-64	Fat./pkm		% Fatality	
65+	Fat./pkm		% Fatality	
Pedestrian				
All	Fat./pop.			
All	Fat./veh.			
All	Fat./pkm			
0-14	Fat./pkm		% Fatality	
15-17	Fat./pkm		% Fatality	
18-24	Fat./pkm		% Fatality	
25-64	Fat./pkm		% Fatality	
65+	Fat./pkm		% Fatality	
Cyclist				
All	Fat./pop.			
All	Fat./veh.			
All	Fat./vkm			
0-14	Fat./pkm		% Fatality	
15-17	Fat./pkm		% Fatality	
18-24	Fat./pkm		% Fatality	
25-64	Fat./pkm		% Fatality	
65+	Fat./pkm		% Fatality	
Motorcyclist				
All	Fat./pop.			
All	Fat./veh.			
All	Fat./vkm			
0-14	Fat./pkm		% Fatality	
15-17	Fat./pkm		% Fatality	
18-24	Fat./pkm		% Fatality	
25-64	Fat./pkm		% Fatality	
65+	Fat./pkm		% Fatality	
Mopedist				
All	Fat./pop.			
All	Fat./veh.			
All	Fat./vkm			
0-14	Fat./pkm		% Fatality	
15-17	Fat./pkm		% Fatality	
18-24	Fat./pkm		% Fatality	
25-64	Fat./pkm		% Fatality	
65+	Fat./pkm		% Fatality	
Per road type				
Motorways				
	Fat./vkm		% Fatality	
A-level roads				
	Fat./vkm		% Fatality	
Other rural roads				
	Fat./vkm		% Fatality	
Urban road				
	Fat./vkm		% Fatality	

Fat. = fatalities; pop. = population; veh. = vehicles; pkm = person kilometres; vkm = vehicle kilometres.

Table 5.5. *Summary footprint scheme for the Netherlands compared with the SUNflower+6 average in the period 2001-2003.*

6. Recommendations

These recommendations follow the topics investigated in detail in the SUNflower studies, including the initial Sunflower report, but do not cover all issues relevant for road safety, for example vehicle safety and major infrastructure improvements which have not been addressed across the nine countries.

Many of the topics cover well known road safety problems, which have been addressed to some extent by most countries. However, unacceptable safety risk still exist in these countries. Whilst some of the challenges can be considered to be "improved housekeeping" such as improving seatbelt and helmet wearing performance, sustained enforcement will require the adoption of improved technologies and procedures. The first Sunflower report (Koornstra et al., 2002) recommended the European Commission to encourage enlarged national investment in large-scale implementation of infrastructural road safety measures and intensified enforcement.

The nine countries thus far examined by applying the SUNflower approach, show that this approach is useful for identifying common characteristics and in identifying the better practice(s) that could be applied to the lesser performer(s). We recommend that the approach is adopted more broadly by the Commission and across all European (Union) countries. Some issues in benchmarking between countries are discussed in Section 6.5. It is important to recognize that national fatality rates appear to be influenced strongly by network characteristics and traffic levels in different countries, and these should be taken into account when assessing what future rates might be achieved.

6.1. Specific recommendations for the European Commission

The Commission should

- note that on the basis of current trends, the majority of the nine countries are unlikely to contribute their "share" of the European fatality reduction target for 2010. Despite encouraging reductions in 2004 in Sweden, Great Britain and the Netherlands, it is unclear whether these can be sustained over a long period. The contribution from the three Central countries is uncertain and may be small. The Southern countries of Greece, Portugal, and Spain (including Catalonia) are making progress towards this ambition, but more needs to be done to ensure that progress is sustained and that best practice is more widely adopted.

- note that little progress has been made over the last decade in reducing fatality rates among young drivers and encourage more initiatives in this area.

- note that a similar approach of conditional subsidy is equally applicable to the powered two-wheeler problem. The SUNflower benchmarking shows where improvements should start (helmet enforcement, improved driver training).

- encourage further effort to educate motorcyclists about risks and teach them effective strategies for riding more safely, noting particularly the safety issues associated with older drivers taking up motorcycling either for the first time or after a long break.

- give consideration to supranational initiatives that enhance vehicle safety for powered two-wheelers (and not just four-wheeled vehicles). These initiatives should make it easier to automatically detect infringements made by riders of such vehicles (for example, helmet-use advisors.

- note the overall high share of powered two-wheeler fatalities, and make greater efforts to develop appropriate technological solutions to make powered two-wheelers safer. Much more needs to be done to introduce protection systems such as external airbags.

- continue to encourage major initiatives in modifying urban road layouts as vulnerable road user rates are unlikely to fall substantially without these, unless exposure is reduced through less activity. Such initiatives would also support use of safer modes (walking, public transport).

- raise awareness of work-related road risk, including speedy and effective implementation of cross-border enforcement for foreign drivers who do not comply with other national traffic rules.

- be aware that there is some evidence beginning to emerge of worsening behaviour among some groups of road users and potentially negative influences from changes in the vehicle fleet that will erode casualty reductions.

- note that, if the overall EU objective of halving fatalities is to be achieved, it is likely that greater use will need to be made of alcohol ignition interlocks, seatbelt interlocks and speed limiters.

- encourage strong and accountable links between central governments and local authorities and increase public participation in policy definition in order to deliver efficient and effective safety measures that are seen as fair by the majority of road users. The Commission should focus on the organization and management of road safety at regional and local levels, where the initiatives with a considerably high safety effect should be supported. We recommend the Commission to support a further development of the SUN methodology at the regional/urban level.

- note that benchmarking of basic parameters (vehicle, user, and road) is hampered by a lack of good data, particularly on exposure by different modes and age groups. The collection and data processing of crashes and exposure should be GIS related, with better linkages to information from digital navigational maps.

- encourage further methodological work on understanding the link between national fatality rates and the network characteristics and traffic density in each country.

6.2. Specific recommendations for the SUN countries

Sweden should

- make the transport environment more forgiving to reduce injuries when crashes occur; this could reduce the high proportion of elderly pedestrian and cyclist fatalities and also reduce injuries among elderly car occupants.

- consider more efforts to improve public acceptance of enforcement initiatives possibly through more community/municipality partnerships. There would seem to be the opportunity to increase the use of automatic detection, mainly of speeding offenders. But increased enforcement also needs a change in the legislative system concerning both fines and vehicle owner responsibility to be as effective as possible.

- seek in the longer term to move to a lower speed limit for two lane rural roads, and develop a network of higher quality rural roads which can safely sustain higher speed limits.

Britain should

- continue to encourage increased use of 20 mph zones in areas having high pedestrian crash rates.

- focus more effort on seeking innovative road designs which cater for mixed vehicular and vulnerable road user activities at the higher traffic volume levels evident in Britain.

- continue to seek ways of reducing the higher risk associated with pedestrians during the evening which mainly arises as a result of the pedestrian's excessive consumption of alcohol.

- improve facilities for cycling, especially in the context of the Government's desire to increase cycling.

- give more attention (than many other countries) to helping drivers recognize the presence and behaviour of motorcyclists in traffic, and give particular attention to countermeasures to reduce bend and overtaking crashes involving motorcyclists.

- ensure that the latest policy statements on enforcement promising greater visible presence are accompanied by sufficient resources to achieve this. Britain should ensure that senior police managers demonstrate a genuine commitment to road safety by maintaining an appropriate level of traffic policing.

- improve its package of drink-drive measures and particularly increase the real level of detection to the perceived level. The increasing number of speeding offences also suggests that the balance between enforcement and public awareness might be improved.

- seek in the longer term to move to a lower speed limit for two lane rural roads, and develop a network of higher quality rural roads which can safely sustain higher speed limits; through this approach there should be clearer separation in Britain between the road standards (and speed limits) in the rural network.

The Netherlands should

- continue to increase the proportion of 30 km/h roads in urban areas, and make pedestrian crossing design more consistent with road categories.

- seek measures to reduce the high proportion of pedestrian fatalities involving mopeds.

- continue to provide for physical separation of cyclists and motorized traffic on main roads and traffic calming measures at intersections.

- increase the training required by moped riders aged 16-17 before access to the road, increase (correct) helmet wearing rates, and introduce a more structured licensing system and vehicle registration plates to help enforcement of the behaviour of this group, especially regarding speeding.

- seek ways of increasing the experience gained by young drivers before they take the driving test, including considering accompanied driving before the driving test.

- seek ways to make the road environment further comply with relevant speed limits and investigate particularly the situation on 80 km/h roads which have a high fatality risk.

- consider whether the very high level of speeding offences suggests that a different approach to modifying speeding behaviour might be needed. Greater focus on enforcement of repeated or extreme offenders should be considered.

6.3. Specific recommendations for Central European countries

The Czech Republic should

- seek measures and apply short-term evaluation measures to ensure that the goals defined in the National Road Safety Strategy will be met, possibly through the establishment of a National Road Safety Observatory, monitoring not only progress towards the targets set, but also collecting Road Safety Performance Indicators.

- encourage different stakeholders and regions to get them more involved in road safety management processes.

- seek measures to reduce the high proportion of (elderly) pedestrians and cyclist fatalities and increased involvement of heavy goods vehicles in road crashes.

- consider the application of the special regulations controlling vehicle use by novice drivers.

- consider the recent system of police enforcement: make owners of their cars responsible for the offences related to their car, reconsider the amount of fines and make more transparent how the fines are used.

- reconsider speed management schemes, with a stronger emphasis on general deterrence and prevention, and possibly reconsider speed limits on road sections in rural areas. Give more support to 30 km/h zone applications.

Hungary should

- take immediate decisions in connection with the revision of the National Road Safety Programme, the setting of a new quantified target, eventually the national adoption of the EU and CEMT goals. To this end, the EU programme needs to be adapted to Hungarian circumstances. The elaborated programme - together with quantifiable targets - has to be widely disseminated and accepted.

- consider the distribution of responsibilities for road safety, as it is not clearly defined which of the ministries has the main responsibility for road safety. It causes a basic problem that the ministries assess their own activities in this field; no emphasis is laid on detailed, objective, and independent analysis of the road safety situation. Professional interpretation and presentation, as well as the evaluation of the different ministries' work, and the coordination of their activities would also be the task of a high-level organization, independent of the ministries.

- increase the resources for road safety improvement, because the existing budgets for this purpose are inadequate. Measures are required in order to support the road safety fund by a systematic contribution from car insurance premiums. The principles of cost efficiency should be applied during expenditures.

- focus on drivers' education and training courses (while they are efficient influencing elements of the behavioural factors) from the road safety point of view; basically the selection of the safe speed and in general the strict requirement of rule obedience must get a greater role.

- develop effective speed management, which is of primary importance nowadays. This should include the enhancement of police presence. Determined and strict police activity is

required, which consistently enforces the most important rules (speed limits, alcohol consumption, wearing of safety belts).

Slovenia should

- consider the establishment of a central Road (Transport) Safety Agency with proper funding (budget) to coordinate/manage road (transport) safety activities.
- apply legislation changes regarding driving under the influence of alcohol (introduction of zero BAC limit) in order to influence the patterns of social behaviour related to excessive drinking in general.
- seek measures to reduce the high proportion of young drivers involved in injury crashes, especially those involved in weekend night crashes.
- consider effective enforcement of zero BAC and pay even more attention to education and preventive work in this field.
- encourage the implementation of effective speed management.
- encourage further accelerated arrangement of traffic calming schemes in urban areas.
- better manage the system of Road Safety Performance indicators data collection, including regular research surveys on protective systems use, speeding, and alcohol level distribution among drivers.

6.4. Specific recommendations for Southern European countries

Common (for all Southern territories studied):

- There is a common need to maintain (and in some cases increase) the police control effort directed at young drivers, drink-drivers and speeding drivers.
- There is a need to improve the procedures and databases to improve police effectiveness in tracking and dealing with re-offending drivers involved in serious infringements (drinking, speed, non-use of protective systems). The introduction/improvement of points-based driving licences should facilitate improved tracking of habitual offenders, should include reduced thresholds for young drivers, and should cover drivers of powered two-wheelers.
  The re-training of drivers who lose their licence is an opportunity that can reduce certain types of crashes such as single vehicle crashes (applicable especially to car drivers in Greece and Spain).

- Measures of risk exposure in terms of kilometres travelled, need more precision to examine exposure by mode, age, road type etc. The need to monitor actions by road type implies the improvement of databases and, typically, information exchange between administrations.

- All countries could save lives if the rear seatbelt wearing rates were raised.

- All countries need to improve the monitoring of child restraint system use and the monitoring of related sanctions. Once the data recording is improved, attention should be given to analysis of usage rates of children by year of age.

- The analysis of risks of motorcycle and moped identifies higher risks in urban areas. This result leads to a recommendation for more enforcement of road discipline (controls of drink-driving, red-light running, excess speed as well as helmet wearing) in urban areas targeted on powered two-wheelers.

Greece should

- improve driver compliance with the existing seatbelt law; at this point in particular, Greece could save lives. By applying the same approach to drink-driving (active, intensive police control and monitored sanctions), it is likely that seatbelt-related safety performance can be much improved.

- seek ways to reduce over-representation of young drivers in single vehicle crashes, for example by considering accompanied driving before the driving test.

- give more attention to pedestrian safety on through-roads and new measures should be studied and eventually be implemented (street lighting, improvement of pedestrian visibility, etc.).

- address the low level of helmet usage (both motorcycles and mopeds) by better police enforcement and increased sanctions.

- increase police enforcement (of seatbelts and helmets) by incorporating such controls into the drink-driving checks. Some rationalization of police deployment is needed; this could improve overall effectiveness without requiring a too large increase in policing.

Portugal should

- improve seatbelt wearing rates of front/rear seat car occupants by mass media campaigns together with police enforcement.

- improve data collection in order to improve the understanding of young drivers' attitudes.

- facilitate safer pedestrian movements on both urban roads and on rural roads passing through towns, with elderly people at night as the design criteria. Improved infrastructure needs to be reinforced by the continued effort to educate road users of all ages.

- address the problem of elderly mopedist fatalities; re-training courses and/or enforcement of helmet usage could be appropriate measures.

- place the safety problems of powered two-wheelers high on the political agenda in order to curb reckless driving.

Spain should

- make greater efforts to fully fight drink-driving. We recommend to record BAC levels in crashes as a basis for a legal interpretation of the intermediate and higher alcohol levels, so that stricter punishments can be applied without having to follow court procedures. The severity of sanctions for such offences should be increased at least to that in Portugal.

- consider stricter legal measures on drinking and driving that include the setting of a standard BAC level of 0.02% for motorcyclists, or the establishment of a common minimum punishment of unconditional suspension of the driving licence for 6 months for anyone passing the limit.

- seek measures to improve rear seatbelt use.

- develop strategies of automatic speeding detection to reduce speeding and to change driver behaviour. Experience gained through early deployment in Catalonia needs to be reviewed so as to facilitate wider deployment in other regions, and to ensure effective monitoring by road type at the various levels.

- improve data reporting of urban pedestrian casualties to better know the real scope and nature of the problem.

Catalonia should

- try to intensify the coordinated efforts (of policing and marketing of “Zero tolerance”) on drink-driving problems. Catalonia shows a relatively low detection level of drink-drivers (1 out of 7 cars tested) and this can only be increased through increasing police controls.

- increase the number of speed offenders detected in an efficient manner, by using speed camera's. To build upon the encouraging initial results, camera control needs to be extended to cover the entire road network (of locations with speed-related crashes) so as to ensure a change in driver behaviour. It should be possible to compare performance for different road types, taking into account the varying exposure levels.

- give more attention to the use of child restraint systems and rear seatbelts, and the authorities should consider a campaign to increase driver awareness about the consequences of not wearing belts or using child restraints.

- consider whether its participation in EuroNCAP vehicle testing could facilitate a testing of new protective devices for motorcycle users (e.g. external airbags). It should also investigate how licensing might be improved (number plate type, electronic tags, etc.) to facilitate recognition of motorcycles at automated speed controls.

6.5. Specific recommendations for a further development of the SUNflower methodology

For SUNflower+6 countries

Many helpful suggestions for the improvement of safety in each country have been formulated. No country turned out to be in the lead on all safety issues. We therefore recommend that the weak parts are identified in each country's state of the art on safety, in order to detect promising areas for improvement.

We also recommended that this exercise be continued in later years using the SUNflower methodology, and more specifically the footprint method, the resulting schemes, and the available prototype of an expert system, in order to find future developments that need attention.

Finally, the quality of data should be improved for future comparisons, particularly of exposure data, safety performance indicators, policy output, and severely injured road users.

For other EU countries

Other EU countries and other countries could:
- use the results of the SUNflower+6 study as inspiration,
- use the methodology of the 'footprint method' and the working prototype of an expert system which have been developed.

Valuable information is available in the reports of the three groups of countries within the project: the original SUN countries, the Central European countries and the Southern European countries. This report adds information to these group reports, concerning the comparisons between all nine countries. This information can be used for comparisons with the state of the art or developments of safety in other countries. Because of the variety in background of the nine countries, it would not be too complicated to find a SUNflower+6 country for meaningful comparison. Furthermore, numerous detailed comparisons and suggestions for improvement have been made that may be of interest to other countries as well.

A system is now available for benchmarking the state of the art of traffic safety in a country. A working prototype of an expert system has been developed for the comparison of safety between countries. This prototype, together with a concise data template, is available. If this template is filled with data for a country, even with missing data in several spots, the prototype can be used to benchmark safety against any chosen reference.

For the European Commission

We recommend the Commission to focus specifically on three major data issues: exposure data, information on safety performance indicators, and information on severely injured road users.

In addition, we recommend to develop standards for the definition of such indicators and for data collection procedures, in order to achieve unambiguous European data that can be compared at the European level. Another challenging task is to soundly quantify the relationships between particular levels of the road safety pyramid, especially between the level of indicators and outcomes, and to introduce the methods on how to use this knowledge for the prediction and monitoring of road safety outcomes at the country level.

Further knowledge development should be stimulated in order to assure that the footprint gives a valid and reliable representation of countries' road safety performances, now and in the future.

Finally, a prototype of a benchmark system has been developed; the data template used in this project should be improved. We recommend that a European standard be developed of such a safety template, to be used in all European (Union) countries. We further recommend to develop the existing and already working prototype of a benchmark system into a user-friendly final format for use with the safety template.

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