COMPARATIVE ASSESSMENT OF ROAD SAFETY PERFORMANCE IN GREECE

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Abstract

Within this paper an attempt is made for the comparative assessment of road safety performance in Greece in relation to other European Union countries, by the use of a specially developed methodology. The «footprint» methodology was developed in the framework of the SUNflower+6, EU research project, aiming to support a comprehensive comparative analysis of road safety performance in various countries and / or regions. The core of the analysis lays on the trend of three elementary indicators over time; namely, personal risk (fatalities per unit of population), traffic risk (fatalities per unit of vehicle fleet) and fatality risk (fatalities per traveled vehicle-km). The analysis of the relationship between traffic risk and personal risk allowed for the interpretation of current trends of road safety performance in Greece, especially in relation to the performance of other Southern European countries. Basic road accident causes were identified and related countermeasures were examined.

Keywords: Road safety, comparative analysis, weighted expressions of fatalities, footprint methodology

1. Introduction

Background

The number of road traffic crashes and casualties (fatalities – injuries) is decreasing in all European countries, as in other high-income and highly motorized countries in the world. This has been achieved in spite of an ongoing increase of motorization, by means of investing in the safety quality of the road traffic system. However, the toll of crashes on European roads is still considered as unacceptably high. Most of the European Union (EU) countries have set specific targets for road safety, expressing their will to improve the situation. The European Commission (EC) itself has set a most ambitious target: to halve the number of fatalities within ten years (2000-2010).

There have been recent high-quality projects (SUNflower and SafetyNet mainly) that can be considered as an important contribution to the approach of this goal, by means of comparing road safety policies, programs and performances in different European countries. In terms of the former, a methodology was developed to compare policies in different countries and, by doing so, to understand trends. The results are of potential value for involved countries, for other countries and for the EU, offering participants the possibility to learn from each other and, subsequently, to speed up road safety improvements.

As the road safety problem is rather complex, one needs to understand the past as deeply as possible in order to learn from it and to even change the future. Those familiar with this are aware that fast, fragmentary fixes cannot improve road safety noticeably. The methodology in question is data driven and knowledge based, so as to deal with the complex nature of comparing policies / trends in different countries.

The SUNflower projects

The outcomes of the two phases of the SUNflower project (Koornstra *et al.*, 2002; Wegman *et al.*, 2005) were indicative of the underlying relation between the mentality of citizens and decision makers, on one hand, and the total cost of road accidents on the other. The first phase of the program took place between 2000-01 and involved the SUN countries (Sweden – United Kingdom – Netherlands), as the ones exhibiting by far the highest level of safety in their road networks.

Since the SUN countries exhibit similar performance at the highest level, certain means of transferring associated results and conclusions to other interested territories should be constructed. Such a broader comparison took place in the second phase of the project (SUNflower+6, see Handanos and Katsochis, 2005) providing a comprehensive methodology applicable to countries with varying road safety performances, comprising thus 9 countries. Apart from the SUN countries, 3 Southern (Greece, Portugal and Spain, as well as Catalonia as autonomous territory) and 3 Central European countries (Czech Republic, Hungary and Slovenia) took part in this second phase of the project.

Objectives

For each of the abovementioned three groups a comparative analysis was performed, aiming to contribute to outcomes defined by the EC in the Road Safety Action Plan for the period up to 2010. This was drawn up in 2003 as part of the policy actions defined in the White Paper (EC, 2003). The objectives of this comparative study, dealt with in this paper, are to:

- define indicators and assemble the best possible data so as to examine specific case studies and overall policy;
- provide insights concerning the reliability of different data sources for the comparison of road safety policies and actions in European countries;
- identify the strengths and weaknesses of each region through comparative benchmarking;
- contribute to a science-based understanding of differences between benchmark values.

If these objectives are to be met, there should be a way of allowing for a direct comparison among all different regions examined, ensuring that all major aspects of each road network are considered. The so-called "footprint" methodology was developed in terms of SUNflower+6 as the tool that addresses this requirement, allowing for the efficient (i.e. both prompt and effective) identification of actions that can improve the current situation by use of historical data.

In terms of this paper, this specially developed methodology was used to assess the performance of Greece in road safety, compared with other selected EU regions as well. The outcome of this comparative assessment could be proved beneficial for the development of targeted road safety strategies, programs and measures, contributing thus to the improvement of road safety in Greece and Europe in general.

2. Methodological framework for assessing road safety performance

Safety pyramid – footprint scheme

The assessment of road safety status in a region requires fundamental understanding of traffic safety processes at different levels in the hierarchy of causes and consequences. The safety pyramid model that describes a target hierarchy of *'structure and culture*' towards *'social costs'* serves as basis for this goal. It was developed by the Land Transport Safety Authority in New Zealand (LTSA, National Road Safety Committee, 2000) and further elaborated in the first phase of the SUNflower project (Koornstra *et al.*, 2002). The pyramid (presented in Figure 1) serves as a three-dimensional comparison framework. A detailed description of its function is provided in Wegman *et al.*, 2005, along with the principles in the design of the footprint form.

****Please insert Figure 1 here****

Figure 1. A target hierarchy for road safety (Koornstra *et al.*, 2002 and LTSA, 2000)

The fulfillment of the comparative analysis goals has been related to the formation of a concise form, incorporating the fewest possible information regarded sufficient to attribute a region's profile with respect to road safety. This should enhance direct comparison, so that recommendations are produced at country or EU level. The footprint of road safety for a country may be defined as a depiction of:

- The current situation in terms of social cost (casualties and monetary units);
- relevant evidence for which one may build concrete cause – effect relations in distinct moments in time

Two versions of this representation tool of road safety status have been constructed (Wegman *et al.*, 2005). The first footprint scheme was developed in the form of a rather detailed Table. The respective quantitative configuration involves several graphs, mainly at the level of final outcomes and SPI's. Two types have been used, depending on the contents; namely, bar graphs and star-shaped graphs.

The second scheme constitutes a promising further step for future applications. It stands as a compact form that yields a first impression, for which the first (complete) scheme may be too comprehensive. This is a most useful tool, since it allows for:

- The illustration of a region's progress through comparison of footprints obtained for different time landmarks;
- the classification of regions within a wider area through comparison of their footprints at a particular moment in time

The idea is to develop a frame, where each region's performance is reflected by a total score of certain indicators. This presupposes full understanding of causal relationships between indicators on the different levels involved in the problem, in order to classify causes and effects in terms of social cost of road accidents. This is where the pyramid of target hierarchy is introduced.

The pyramid may be viewed as three-dimensional. The first (vertical) dimension concerns five levels that should be distinguished to deal with the problem. Each country's performance is indicative of local mentality (structure and culture – policy input) at the bottom level and common practice (safety measures & programs – policy output), as result, right next at level 2. Such a comparative analysis is facilitated by a group of intermediate outcomes, illustrated by safety performance indicators (SPI) in issues like speeding, drinking & driving, etc at level 3; it also requires a concise depiction of the road network and the main features of the vehicle fleet. Final outcomes expressed in terms of casualties are necessary to understand the scale of the examined issue. This type of information is found at level 4, as largely related to the indicators that describe the three components of a road network (road – vehicle – user) at level 3. Ideally, the top of the pyramid should include a sound estimate of the total social cost of road traffic accidents in any area.

The second (horizontal) dimension regards each region's performance, based on the allocation of final outcomes to the three major components of the system. Various combinations of behavioral factors with vehicle classes, road types and age groups may be constructed. Time constitutes the third dimension. One of the key features of the SUN approach is the retrospective analysis of data on road crashes covering up to several decades. Ideally, these trends should be a (chrono)logical effect of well-understood interventions (measures and programs) and developments (SPIs).

In terms of SUNflower+6, collected data concern the periods 1981-83, 1991-93 and 2001-03, assuming that the use of 10-year intervals should generally suffice to record substantial changes of the situation. The analysis has been limited to fatal accidents, so that accuracy of outcomes is satisfactory. Including accidents with lighter bodily harm (only injuries) or sole property damage may cause problems due to the associated under-reporting –which is actually different across examined areas (ETSC, 2006). The examined approach is based on collection of high-quality, comparable data, unlike previous road safety related initiatives of qualitative nature (expert assessment, e.g. Phare).

It should be admitted that, for comparisons of absolute levels and developments of road safety between countries, total numbers of fatalities per year as such are not enough. A control (exposure) factor is necessary to ensure fair comparisons. The most crude control factor over time is the population size of a country per year. A more precise factor is the size of vehicle fleet per year, but the most desirable one would be the number of motor vehicle kilometers traveled per year (exposure data). These measures however are hardly available in the International Road Traffic and Accident Database (IRTAD) and often not available at all.

Such weighted expressions of fatalities across control factors are essential for the construction of a region's "footprint". The core of the footprint lays on the trend of three elementary indicators over time; namely, personal risk (mortality rate, fatalities per unit of population), traffic risk (fatality rate, fatalities per unit of vehicle fleet) and fatality risk (fatalities per traveled vehicle-km). These ratios usually provide a fast overview of a territory's profile.

Application of the SUNflower footprint methodology

Over the period from the early 1980s to the present, all countries have improved in terms of these indicators. For Czech Republic and Hungary the path to improvement involved an initial increase in mortality rate. This occurred at times of political change and rapid increase in motorization. The countries starting from higher levels of mortality and fatality rates have demonstrated faster progress in reducing these.

The nine examined countries are still separated by a factor of 3 in mortality rate and a factor of almost 5 in fatality rate. The SUN countries exhibit much higher level of road safety. This has to do with the fact that they experienced problems associated to the rapid growth of motorization rate earlier than the other ones.

Examined data comply to a satisfactory extent with the hypothesis that the graph of traffic risk over personal risk follows a parabolic shape, similar to the form adopted for the depiction of density over traffic flow for interurban roads. Each region is described by its own curve. Figure 2 includes the SUN and the Southern countries. For each depicted region, the rightmost point corresponds to the average value of the period 1981-83, the middle point to 1991-93 and the leftmost point to 2001-03. The SUN countries by now find themselves on the declining branch of their curves. Southern countries appear to have passed their turning point during 1990s.

****Please insert Figure 2 here****

Figure 2. Comparison between SUN and Southern countries

The graph may generally be viewed as consisting of two distinct areas: the right area corresponds to decrease of traffic risk while personal risk increases, whereas the left one follows a turning point –i.e. a characteristic value of motorization rate. In the latter part both personal and traffic risk decrease. It is important to keep in mind that this graph develops from the right to the left, as the vehicle fleet increases over time. Graphically, this resembles cases where highway bottlenecks dissipate and vehicles speed up after some obstacle (physical or related to the O-D table) is removed.

The general improvement path is of a similar shape but the ratio between personal safety and traffic safety is still quite different in each case, although Sweden, Britain and the Netherlands virtually follow the same route. If the group of countries that are currently worse than these three follow their most recent trend, their mortality rate will remain significantly higher when their fatality rate is similar to the current rate in the SUN countries.

Although the graph in question tends to be practical in use and almost intuitive in interpretation, exposure data remains absolutely necessary to obtain the full picture. A fundamental factor to the casualty toll observed in different countries is the split in travel between different modes, as individual modes vary considerably in terms of risk level. Also, a substantial part of differences recorded 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, but the footprint approach may stimulate activity to this direction. Given these limitations, some aspects of road safety performance in Greece are dealt with in the following section.

3. Comparative assessment of road safety performance in Greece

Road Safety Performance in Greece

Further use of the SUNflower "footprint" methodology on the organizational aspects of the road safety system in Greece provides additional insight on the national road safety performance, which is among the poorest in the enlarged EU of 27 countries.

Prevailing parameters include the insufficient effort of both the Authorities and the citizens. The main barriers that hinder the efficient improvement of road safety performance in Greece can be summarized as follows:

- The fragmentary implementation of road safety measures and lack of coordination between the competent Authorities, resulting in reduced efficiency.
- The lack of systematic enforcement of all road safety related infringements.
- Road network insufficiencies and inadequate maintenance inside and outside urban areas.
- The lack of an efficient system for road safety training and information of the drivers, as well as of a reliable vehicle technical inspection system.
- An insufficient system for road casualty care.
- The lack of systematic monitoring of the road safety level and problems and of the appropriate assessment of the measures efficiency.

These obstacles may, in fact, be identified through careful examination of the country's footprint over several years. Some correction steps have been taken by means of the 1st 5-year Strategic Plan on road safety for the period 2005-2010 (Kanellaidis *et. al*, 2005), which set the target of reducing the number of persons killed in road accidents by 20% up to 2005. This target has been met.

In spite of maintaining a poor record, Greece exhibits notable improvement in terms of road safety, especially since 1998-99. Current trends in all Southern regions show a positive reduction in fatalities, but the trend has not been a steady overall progressive reduction (as in the SUN countries). In relative terms, the reductions for the decade 1993-2003 range:

- in mortality rates, from 17% in Greece to 41% in the case of Portugal (21% for Spain, 27% for Catalonia);
- in fatality rates, from 40% in Spain to 64% for Portugal (44% for Catalonia, 53% for Greece);
- in risk exposures, from 40% in Catalonia to 57% in the case of Portugal (47% for Spain, 51% for Greece);

Risk exposure-related findings are announced with a reservation concerning the accuracy of available data. As far as Greece is concerned, it is interesting to observe a more analytical version of the traffic risk over personal risk relationship curve, decreasing the step of distinct consecutive pairs of values to one year instead of ten. Interest was focused on recent developments and trends and a 20-years time series (1986 - 2005) was used.

As demonstrated also in the corresponding graph (Figure 3), a second order polynomial model seems to describe statistically significantly (R^2 = 0.84) the 20-years road fatalities and exposure datasets. If one assumes that increasing the time increment to two years is an acceptable approximation to reduce data "noise", the model significance is improved (R^2 = 0.95). This may in fact constitute a correct approach, taking into account that some years may be influenced by extreme incidents or seasonal phenomena that are highly unlikely to be repeated in a second consecutive year. It is mentioned, though, that any data aggregation should always be treated carefully.

****Please insert Figure 3 here****

Figure 3. Diagram of "Mortality rate over Fatality rate" for Greece for the period 1986-2004

Interestingly, the turning point from the increasing to the decreasing branch of the curve (as far as the mortality rate is concerned) is tracked at some time between 1998-1999. The motorization rate in that period was estimated at 415 vehicles per 1000 inhabitants (not including mopeds). The figure drops to 258 if passenger cars are considered alone – which might reflect average national ownership in a better way. The respective figures for the period 1994-95, when the annual increase of the mortality rate clearly started to decelerate, mount up to 329 (vehicles) and 202 (passenger cars). Motorized vehicles are recorded according to IRTAD classifications and definitions, i.e. not including mopeds.

The actual values may in fact be slightly different if one includes mopeds in the total vehicle fleet; an interesting choice given that mopeds appear to participate in serious injury and fatal accidents to a non-negligible extent, especially when other European countries are also considered. This is indeed a subtle point that calls for attention in cases where some generally unusual mode becomes rather common. Netherlands could also serve as an example, for the case of bicycles. If mopeds (i.e. Powered Two-Wheelers, PTW, of engine size less than 50 cc) are considered, the motorization rate of the periods 1998-99 and 1994-95 increase to 559 and 454 respectively; but, since there is severe reservation on the precise number of vehicles registered in this large class that are actually used, it is suggested that values close to 485 and 385 are adopted. This is in agreement with similar analyses (e.g. Tsoumani, 2006) that prescribe a range between:

- 300-350 in periods of decline in the increase of fatalities
- 450-500 in early stages of the period of fatalities reduction

From the application of the same increment of one year in the case of the SUN countries it is shown that for these countries road fatality trends are declining for almost the entire period since 1970, as they reached the vehicle ownership rate of 400 vehicles per 1.000 inhabitants in the early '70s.

On the contrary, Spain and Portugal present more similarities with Greece, confirming the choice of the group of Southern European countries as a rather homogeneous group. In fact, in both countries road fatalities started to decrease in the early or mid '90s, when the vehicle ownership rate reached the threshold of about 400 vehicles per 1.000 inhabitants (somewhat more for Portugal).

Even further, some effort could be organized to superpose curves of the relationship between personal and traffic risk for all European countries on a common, normalized-like curve. This can only happen if all graphs are suitably shifted in time and refer to a common magnitude. The insight obtained by such exercises may prove to be most valuable, as the comparison of the actual road fatality trend with the expected road fatality trend (as resulted from the relationship between fatalities and vehicle ownership) could reveal a lot of information on the country's road safety performance (Tsoumani, 2006).

Road Safety Performance in Greece and Slovenia

The use of the SUNflower "footprint" methodology at a less macroscopic level, taking into account the specific characteristics of the Greek road traffic, brought up some additional insight on the road safety performance in Greece. For example, the case study: Greece vs. Slovenia is indicative of the influence of geomorphology or density / classification of road infrastructure on modal split and associated risks (see APPENDIX 1). It also shows how territories in rather different regions of the continent may be viewed comparatively in a constructive manner. The graphs presented in this example illustrate a small – but indicative – part of the total information required to perform a comparative assessment of two countries by using their footprint at some specific year.

With respect to fleet composition, cars constitute the dominant vehicle type in Slovenia, whereas PTW only account for about 4% of all vehicles. Heavy vehicles are also scarce (approximately 7%). In Greece, on the other hand, only one out of two registered vehicles falls into private vehicles, in spite of a continuing sharp rise in the number of cars during the past 10 years. Heavy vehicles also possess a notable share, about 15%. This may be related to the comparative advantage that road preserves against railway in the freight transport context.

The wearing rate of seat belts for drivers is double in Slovenia than in Greece (90% over 45%), implying difficulties in the application of existing legislation in the latter. Comparisons with respect to Child Restraint Systems (CRS) are not facilitated by the lack of well-organized surveys at national level. Regarding PTW, Slovenia presents relatively satisfactory helmet wearing rates –namely over 70% in mopeds and over 80% in motorcycles. No such information is available for Greece, but according to accident-related data it appears that helmet use remains severely low, presumably close to 40%. Enforcement should be more intensive and effective.

Motorways account for almost 3% of all roads in Slovenia, compared to less than 1% in Greece. This may be related to the more central position of Slovenia in Europe, combined with its relatively small area. The share of A-level roads is relatively low in both countries. It is worth noting that motorways and A-level roads, viewed together, account in both countries for about 9% of total network. Greece exhibits proportionately too many urban roads, a typical pattern of a country with many islands and a rather mountainous hinterland.

Fatality rates are almost equal in the two countries for car occupants, implying similar motorization rates. Respective rates for PTW are significantly higher in Slovenia (especially in motorcycles). Considering that the fleet of PTW is considerably smaller than in Greece, this finding implies that Slovenia has not experienced yet a phase of rise in the registration of PTW. Equivalently, Slovenia may be positioned to the right of Greece on the [fatality rate over mortality rate] graph –constructed solely for PTW. Overall, the two countries present extremely similar mortality rates in all age groups. This common pattern is typical of their comparable experience with respect to the increase of motorization rate. The particular graph illustrates the success of the selection of the particular pair for comparison, verifying the value of the aforementioned graph in drawing traffic-related conclusions on each country's status.

Road Safety Performance in Greece and in other Southern Regions

Considering the social (demographic, ownership, mobility etc) context of the Southern countries in the examination of their transportation patterns facilitates analysis. Table 1 includes relevant information. Indicatively, Spain has more than five times the number of passenger cars than Greece, but less than four times the number for Portugal. Catalonia comprises 6% of the area of Spain, but 16% of its passenger car stock. The motorway length per area is similar for Portugal and Spain, being four times that of Greece; in terms of motorway length per capita, Spain has the highest ratio, and that for Portugal is around 2.8 times that for Greece.

Table 1. Characteristics of the road transportation systems in the Southern countries of SUNflower+6

****Please insert Table 1 here****

Drink and driving remains undoubtedly a severe problem for Southern countries. Considering limitations in data accuracy, it is estimated that approximately 1500-1600 persons were killed in the three countries in year 2003 due to this cause. Data availability remains rather limited, although it is compulsory to have drivers involved in fatal accidents blood-tested by the Police. The comparison remains reliable, if one considers toxicology tests performed on killed drivers in each country. The proportion of positive tests is close to 32-33% in all three countries for the past few years, exceeding the expected upper value of 25% for the EU according to the report of a recent study (Euro Care, 2003). One may conclude that the problem is severe and of similar scale in all examined areas.

Table 2. Basic road safety related trends in Greece for the period 1998-2005

****Please insert Table 2 here****

Given the limitation of data incompleteness, Greece shows some improvement. The proportion of fatal accidents with drivers involved who where found over the Blood Alcohol Limit (BAC) limit of 0.5 gram/lit has decreased from an average share of 32.5% for the period 1991-1995 to 27.2% during 1996-2001 and 22.4% in 2003, still slightly higher than the upper limit anticipated by Euro Care (20%). This is certainly attributed to an extent to the notable intensification of enforcement since 1998, with tests increasing six-fold within 5 years. In 2003 over 1.2 million checks were performed (about 1 for every 3 cars), approaching in fact relevant EC recommendations (1 check per 2.5 cars).

****Please insert Figure 4 here****

Figure 4. Drivers under alcohol influence involved in fatal accidents in Greece between 1991-2003

The large share of "vulnerable" road users (PTW riders and pedestrians) in the road traffic is a fundamental reason behind the increased number of road fatalities in Greece. Increased associated traffic is mainly due to prevailing weather conditions but also due to the Greek economic and urban organization particularities, which are not found in most of the Northern and Western European countries. For example, the rate of killed two-wheeler occupant over two-wheel vehicles fleet is significantly lower than in several other European countries, although PTW riders account for about 23% of total fatalities. The respective shares for Portugal and Spain are 23%

and 15%. Detailed collision matrices of the Southern regions for the years 1991-93 & 2001-03 may be found in the corresponding report (Hayes *et al.*, 2005).

Greece may appear to perform somewhat better in relative terms, but there is no doubt that the consequences of accidents with PTW would be much lighter if elementary compliance with helmet use was achieved. The low level of helmet use by motorcycle riders in Greece is striking both in fatal and serious injury accidents: 32% & 28% respectively (20% for mopeds). This is so although helmet usage is mandatory since 1986 and several campaigns aiming at the improvement of driving behavior have been organized since then. Still, this is a remarkable progress since 1998, when both figures were at 11% (5% for mopeds). At least in part, this can be attributed to the intensified enforcement of helmet non-use (216,500 penalty notices in 2003 instead of 81,250 in 2000 –for all PTW).

This disappointing use of safety equipment is also apparent in seat belt wearing rates, although this is mandatory (as in most European countries, under Council Directive 91/671/EEC) in the front (since 1987) and rear (since 1993) seats of vehicles of less than 3.5 tones. Furthermore, practically all vehicles registered today are equipped with front seat belts (99%), while back seats also present a high rate of belts installation (77%). The latter value was just 47% in 1996. Seat belt wearing rates for Greek drivers are much lower than those of most EU countries. According to ETSC estimates of 2003, Greece –along with Portugal– exhibits the lowest rates among EU-15 members (45% for front and 9% for rear seat occupants, compared to a weighted mean rate of 76% and 46% respectively).

In terms of young driver safety, the “relative risk ratio” has been used. This ratio compares the number of drivers in fatal accidents related to the population aged 18-25 years with those of the [30-59] age group. For all regions, the ratio was between 1.5 and 2.0 in year 2003, indicating that this is a common problem of similar magnitude. Relevant trends show some improvement for Portugal and slight worsening for Greece and Spain. In Greece, the ratio has increased from 1.2 in 1994 to 1.7 in 2003, but this is mostly due to the reduction of the older group’s participation (from 15 to 12 accidents per 100,000 people) rather than due to increase of young drivers’ participation. It is worth noting that the relative ratio is significantly lower for women (close to 1). Among young drivers, male ones are almost 10 times more likely to be involved in a fatal accident than female ones.

An interesting analysis –including passenger cars and PTW– for Greece involves accident involvement per 1000 license holders for each major age group. The highest value involves the [18-20] age group (10.6), followed by the group of [21-24] (7.8). The reduction of the indicator is constant as the age increases, up to the lowest value of 1.4 for the [74+] group. The average value for all drivers is 3.8. During 2003 the proportion of drivers holding a license for less than 3 years was only 8.6% (passenger cars). These drivers represent 20.7% of all car drivers involved in accidents in Greece that year, indicating a safety problem associated with novice drivers. Young persons account for a large part of novice drivers. According to data on the period 1998-2004, about two thirds of new car drivers belong to the [18-24] age group.

4. Conclusions

Within this paper an attempt is made for the comparative assessment of road safety performance in Greece in relation to other European Union countries, by the use of the «footprint» methodology. This process produced a tool developed in the framework of the SUNflower+6, EU research project. Three elementary indicators were analyzed over time; namely, personal risk (fatalities per unit of population), traffic risk (fatalities per unit of vehicle fleet) and fatality risk (fatalities per traveled vehicle-km). The analysis of the relationship between traffic risk and personal risk allowed for the interpretation of current trends of road safety performance in Greece, especially in relation to the performance of other Southern European regions. Basic road accident causes were identified and related countermeasures were examined.

The SUNflower "footprint" methodology was proved to be an adequate tool for assessing road safety performance at national level. This methodology takes into account all major components of a road system; namely, vehicle (size of vehicle fleet per type), road (classification of road network per type) and user (participation of each of certain age groups in recorded casualties –involved in combinations of the former two keys).

Behavioral factors such as the use of safety equipment (seat belt etc), drinking & driving or speeding are also considered in this analysis. It is apparent that many lives would be saved if compliance with legislation were higher. Only 40-45% of Greek car drivers involved in serious accidents did use their seat belt, whereas proportions are even lower when helmets for PTW riders are considered. Speeding has not been effectively monitored yet and some reform of accident data report forms is examined.

Especially the trend of weighted expressions of fatalities over some major features of the system (population – fleet – km traveled) offer a first but reliable assessment of progress achieved over time. In the case of Greece, the relationship curve of traffic safety plotted over personal safety implies that, for certain reasons, the status of road safety entered a phase of improvement at the late '90s. This turning point coincided with a motorization rate of about 415 vehicles per 1000 inhabitants. The important decrease that is recorded in the number of road accidents and associated casualties since 1998 (Table 2) may be attributed to the enforcement intensification, especially with respect to drinking & driving (Figure 4) and speeding. It should also be related to the important traffic flows increase (and the subsequent decrease of average speed) in the urban and interurban road network of the country.

The latter is related to the steep increase in vehicle ownership. It is not possible to appoint some share of contribution to those two factors, especially since there are other parameters that probably intervene as well, such as the modernization of vehicle fleet, the improvement of road infrastructure and the subsequent improvement of driving behavior. Still, it appears that the value of about 250 cars per 1000 inhabitants was some "site-specific" threshold for Greece under prevailing conditions by 1998. A similarly significant decrease of accident casualties has also been observed in several European countries in the period of important increase in the vehicle ownership (UK & Netherlands early '70s, Spain mid '90s).

However, some deceleration of the up-to 2003 spectacular fatalities decrease was observed in years 2004 and 2005. Overall, the reasons lying behind the progress recorded during the last years should be investigated, allowing for the identification of successful measures and the strengthening of their implementation. Additionally, the large share of "vulnerable" road users (riders of mopeds / motorcycles and pedestrians) in the road traffic remains an important parameter behind the increased number of road casualties in Greece. This over-presence of such users in the Greek roads is not found in most other European countries and is certainly a major explanatory factor for the country's poor road safety performance in comparison to other European countries.

Finally, Greece suffers a lack of coordination between competent Authorities and only enjoys systematic enforcement for a few road safety related infringements. Significant discrepancies in drivers training and in vehicle technical inspection system still remain, while monitoring of provided road safety level is rather poor and misses essential points. It is expected that many of these drawbacks will improve in terms of the 2nd 5-year Strategic Plan on the improvement of road safety for the period 2005-2010 (Kanellaidis *et al.*, 2005).

The findings of this research could also be applicable in other similar cases or areas as far as the aforementioned methodology is adapted to take into consideration the particularities of each other case. In conclusion, analyzing road safety performance with the SUNflower "footprint" methodology involves performances and experiences from several regions. This could prove to be very beneficial for the improvement of road safety at national and regional level, as it allows for reliable identification of road safety problems as well as for the definition of appropriate road safety strategies, programs and measures.

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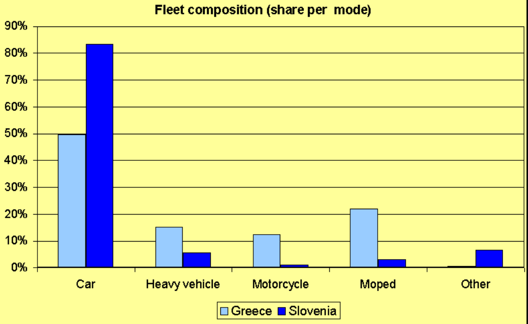
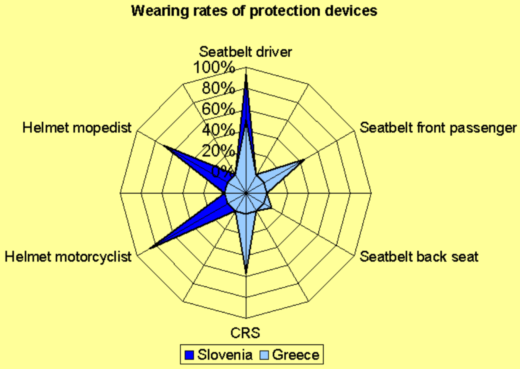
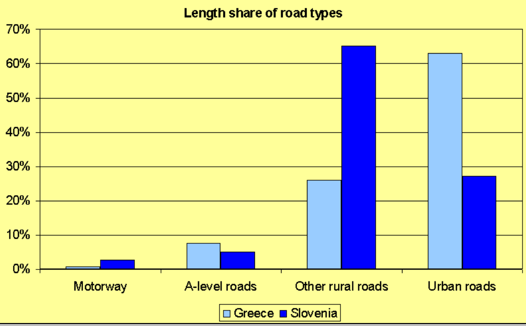
APPENDIX 1. Case study of comparison across groups: Greece vs. Slovenia

(Also see: Hayes et al., 2005, p. 40; Handanos and Katsochis, 2005)

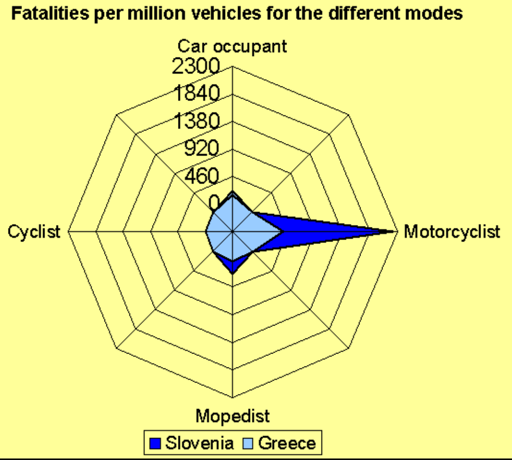
Safety Performance Indicators (SPI)

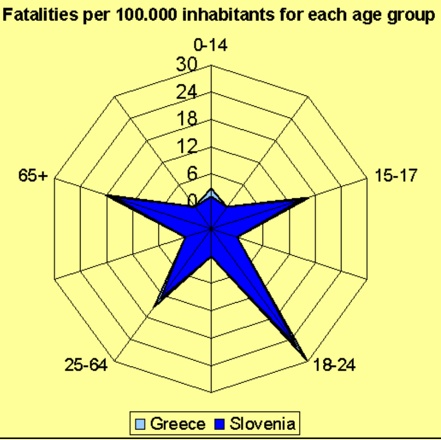


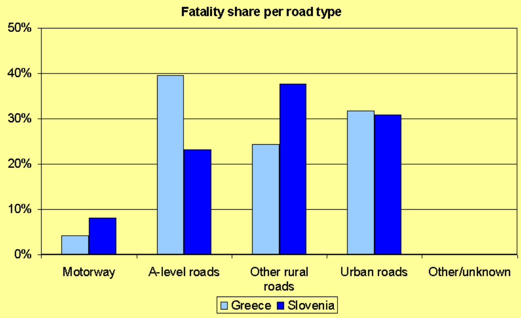




Final outcomes (casualties)







Share of collision partners (%) in fatal crashes (2003)

	Single vehicle	Passenger car	Lorry	Coach	Motorcycle	Moped – bicycle
Greece	36,0	28,7	14,9	3,2	4,0	0,3
Slovenia	35,1	41,3	14,9	4,1	0,8	0,4

Table 1. Characteristics of the road transportation systems in the Southern countries of SUNflower+6

2002	Greece	Portugal	Spain	Catalonia	Note
Road traffic fatalities	1.634	1.675	5.347	812	
Road traffic fatal accidents					
Population (million)	10,99	9,89	41,55	6,79	1
Road length (thousand km)	120,0	125,0	665,2	61,7	
Motorway length (km)	742	1,835	9,739	937	2
Area (thousand km^2)	131,96	89,04	505,99	32,11	
Motor vehicles (million)	5,74	5,29	25,07	4,22	
Passenger cars (million)	3,69	4,98	18,7	3,0	
Lorries (3,5 tonnes) (thousand)	1,109	158	1,935	281	3
Van/station-wagon (thousand)			2,324	420	3
Motorcycles (million)	0,91	0,15	1,52	0,43	
Mopeds (million)	1,61	0,46	2,04	0,31	
Other motor vehicles (thousand)			557,0	0,09	
Motor vehicle km (x 10^9)	67,94	73,75	345,52	49,61	4
Motor veh. km on motorways (x 10^9)		10,23	74,34	17,89	2, 5
Cycle kilometers (x 109)					
Motorcyclist kilometers (x 109)			0,635	0,58	5
Mopedist kilometers (x 109)					
Road user person-km (x 10^9)	136,33	109,1	788,75		6
% passenger cars of motor vehicles	64	94,2	74,7	71,1	
% lorries of motor vehicles	19	3,0	7,7	6,7	
Meter road length per capita	10,6	12,6	16,0	9,1	1
Meter motorway length per 1000 inhabitants	67,5	186	234,4	111,2	
Population density per area km^2	83,3	111,5	82,1	211,4	
Kilometre road length per area km^2	0,88	1,40	1,31	1,92	
Meter motorway length per area km^2	5,6	21	19,2	23,5	
Mot. veh. km on motorway per mot. veh.		1,93	2,97	4,24	5
Mot. veh. km on motorway per person		1,03	1,79	2,63	5
% of motor veh. km on motorways		13,87	64,7	87,1	5
Motor vehicles per inhabitant	0,52	0,535	0,6	0,6	
Motor veh. km ('000) per motor vehicle	11,84	13,95	13,8	11,8	4
Motor veh. km ('000) per inhabitant	6,18	7,46	8,32	7,31	4
Kilometres travelled per person	12,4	11,03	18,98		
Motor veh. kms per road km and day	2.032	1.616	1.423	2.201	
Mot. veh. kms per motorway km and day		15.272			

Table 2. Basic road safety related trends in Greece for the period 1998-2005

	1998	1999	2000	2001	2002	2003	2004	2005
Injury road accidents	24.819	24.231	23.001	19.671	16.809	15.751	15.509	16.937
Persons killed	2.182	2.116	2.037	1.880	1.634	1.605	1.670	1.658
Vehicles (x1000)	4.323	4.690	5.061	5.390	5.693	5.968	*6.257*	*6.579*
Speed infringements	92.122	97.947	175.075	316.451	418.421	447.249	382.970	374.712
Drinking & driving infringements	13.996	17.665	30.507	49.464	48.947	45.546	40.986	46.938
Drink & drive checks	202.161	246.611	365.388	710.998	1.034.502	1.271.217	1.281.102	1.376.307

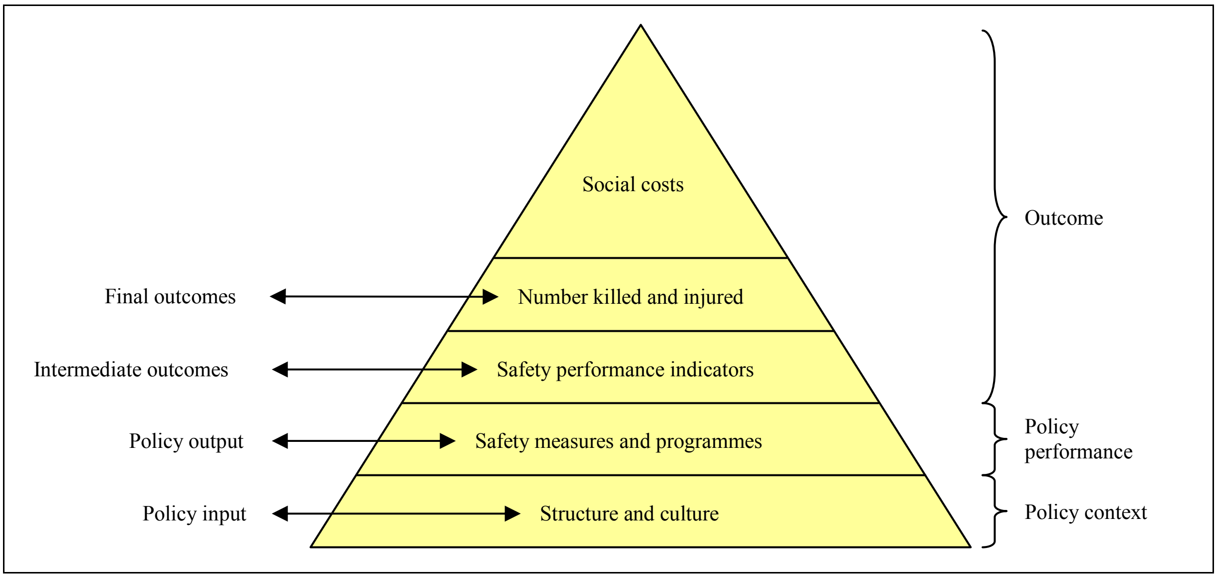
CAPTIONS TO ILLUSTRATIONS

Figure 1. A target hierarchy for road safety (Koornstra et al., 2002 and LTSA, 2000)

Figure 2. Comparison between SUN and Southern countries on the diagram of "Mortality rate (personal risk) over Fatality rate (traffic risk)" (for each country: rightmost point → average value of 1981-83, middle point → 1991-93, leftmost point → 2001-03)

Figure 3. Diagram of "Mortality rate over Fatality rate" for Greece for the period 1986-2004

Figure 4. Drivers under alcohol influence involved in fatal accidents in Greece between 1991-2003



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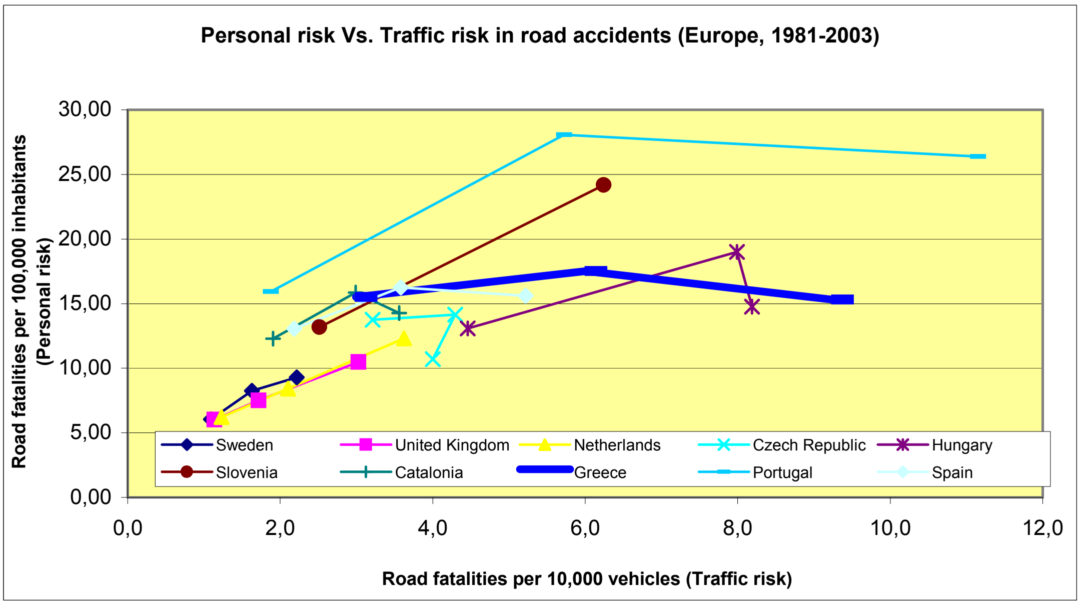

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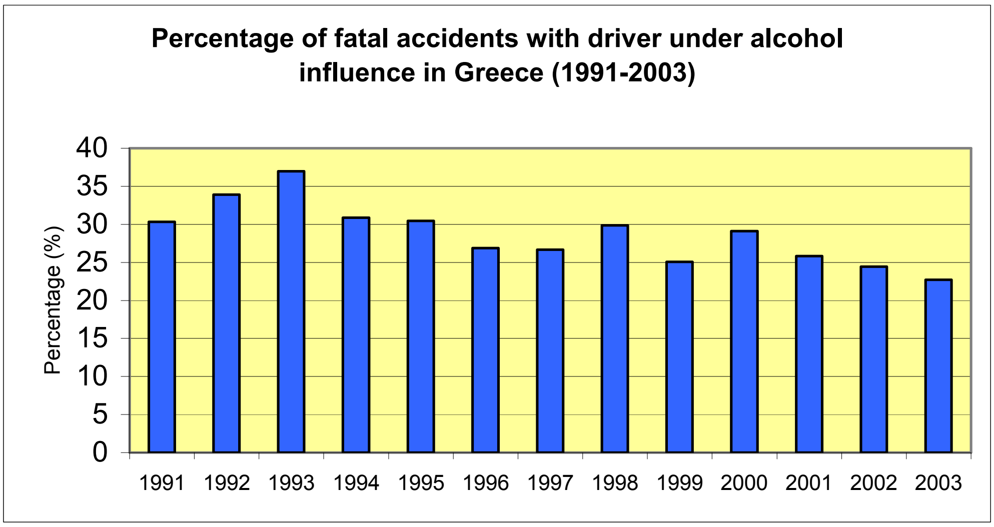

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