EFFECTIVENESS EVALUATION RESULTS OF ROAD SAFETY MEASURES WORLD-WIDE

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ABSTRACT

In the framework of the development of the Strategic Plan for road safety in Greece, an extensive review of successful road safety measures world-wide took place, the results of which are presented in this paper. Special emphasis was given to measures, which their effectiveness was proven through quantitative and / or qualitative evaluation. The measures considered varied from national scale information campaigns to local technical engineering measures, classified into a specially developed hierarchy, allowing for extraction of conclusions for best practices. This research identified the most promising measures for the improvement of road safety at local and national level in relation to the particular characteristics of the traffic environment and the user's behaviour. At the same time, it has been proved that the critical success factors are the way these measures are implemented considering specific safety systems in the road environment, as well as the active participation of all deliverers concerned and road users.

Key-words: road safety, road accidents, road safety measures, measures evaluation, measures effectiveness

1. INTRODUCTION

Since a number of years ago, the best performing countries of the European Union (Sweden, Finland, the Netherlands, UK, Denmark) and world-wide (Australia, New Zealand, USA) have moved on from fragmented actions to integrated targeted Road Safety Strategic Plans and the corresponding results have proved to be encouraging. Countries and local governments that have set quantified road safety targets have had a better safety performance than those which have not set quantified targets (Elvik, 2000). This strategic approach of targeted road safety programmes, has created opportunities for enhancing knowledge about the effectiveness of countermeasures (Breen, 2000). In other words, today, the starting point is well advanced, as the number of effective measures has increased and it is possible to - some extent - predict the consequences of several policy choices.

Moreover, the tools to promote the implementation of best practices across the developed countries exist and at the same time there is a continuously growing awareness in many developed countries, by both politicians and the general public, of the enormous burden that road transport deaths and injuries put on the society in both social and financial aspects. However, the measures effectiveness varies from country to country, as measures, implementation strategies and corresponding effort also differ. In Figure 1 the road safety performance of selected developed countries is presented, showing clearly the variation of road safety measures effectiveness between countries.

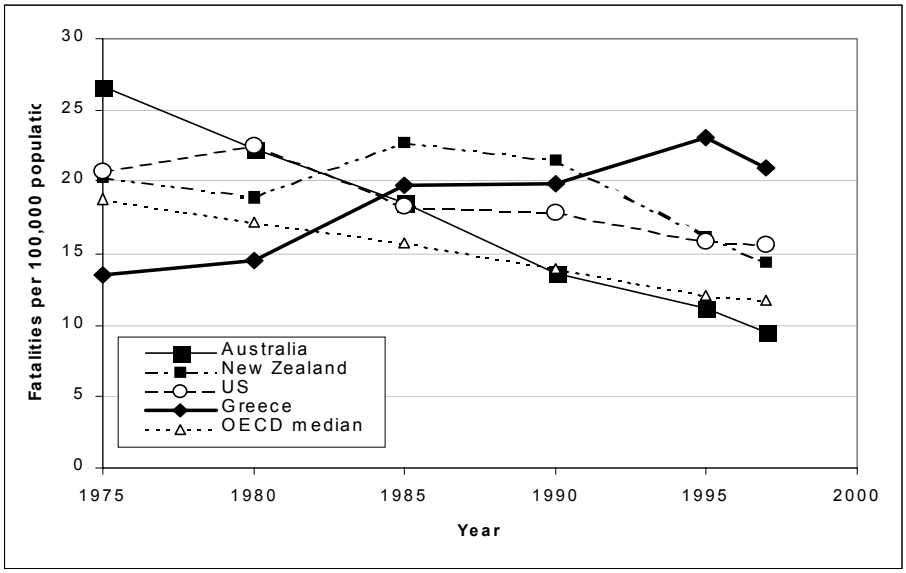

Table 1: *Trends in fatalities per 100,000 population*

It should be understood that indeed, some measures are potentially good, but if they are not implemented well enough or they are not maintained, they may lead to lower effects than expected. Countries or societies can be very different from each other both at a structural and a cultural level. Promising measures internationally cannot just be adopted without thinking and understanding. Traffic Safety is one of many scientific fields that can be characterised by rich data and poor understanding. Just copying of good examples is a poor response if measures are not related to well analysed problems and are not adapted to local conditions (Wegman, 2000). Only targeted research on the measures' effectiveness in each country or even region can produce useful conclusions on the most appropriate measures and the corresponding successful implementation practices.

This research deals with the effectiveness evaluation of road safety measures implemented in various countries world-wide and aims to propose a set of high effectiveness road safety measures to be considered by the road safety decision makers.

On this purpose, within the framework of the development of the Strategic Plan for the improvement of road safety in Greece, an extensive review of successful road safety measures world-wide took place, considering the efforts of most of the European Union Member-States, as well as Australia, New Zealand and USA (NTUA, 2000). Special emphasis is given to measures, which their effectiveness was proven through quantitative and / or qualitative evaluation. The measures considered varied from national scale information campaigns to local technical engineering measures, classified into groups allowing for extraction of conclusions for best practices. In this paper road safety measures implemented in countries outside Europe are considered.

2. ROAD USER BEHAVIOUR

2.1. Drinking and driving

In Australia major initiatives have targeted crashes in high alcohol hours via the application of Random Breath Testing (RBT) programs together with the setting of low permissible blood alcohol levels (effectively zero for novice drivers) and the use of advertising/publicity campaigns associated with drink-driving. Random Breath Tests are mainly conducted using highly-visible Booze-buses, though in recent times random breath testing by any police vehicle when pulling over a driver is being introduced. In this light, any driver pulled over for a traffic violation may also be requested to complete a breath test.

Studies have concluded that concerted attacks on drink driving behaviours, such as increasing highly vehicle RBT to at least one test per two licensed drivers per year, accompanied by massive publicity and intense police activity, can lead to reductions of between 10%- 20% in the number of serious casualty crashes during high alcohol hours (Newstead, Cameron & Narayan, 1998: Vulcan and Corben, 1998).

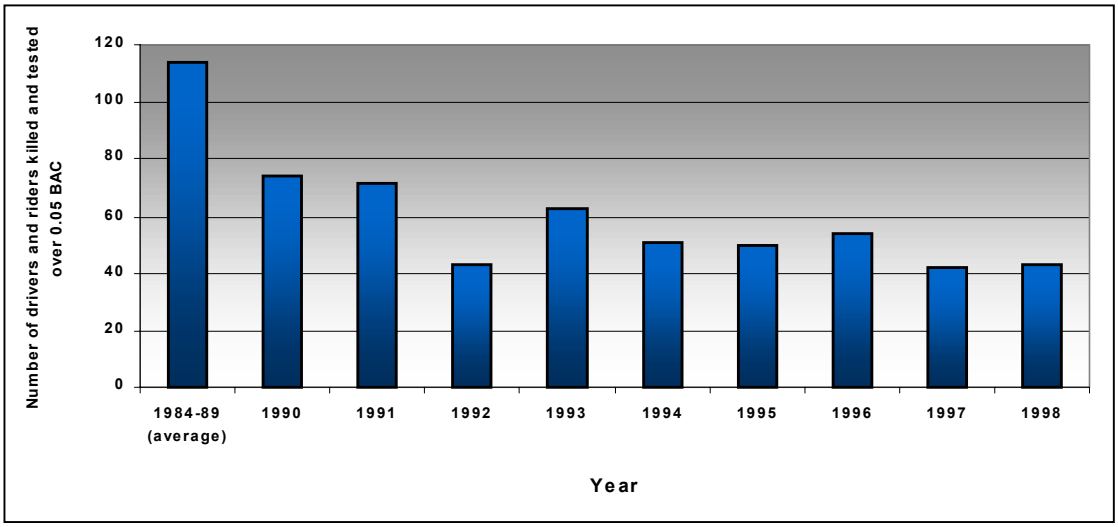

Table 2: *Number of drivers and riders killed and tested over 0.05 BAC*

Studies on the effectiveness of fourteen campaigns against drinking and driving in the USA (NHTSA, 1997) reported 8% to 71% reduction in alcohol related crashes. It has been proved that the most effective campaigns were those with high visibility, frequent checkpoints & high publicity. Additionally, campaigns focussing on the drink-and-drive problem of young drivers were reported to lead to 11% to 33% reduction in alcohol related crashes.

In New Zealand, the high intensity advertising and enforcement campaign implemented during the period 1995-1996 included among other priorities the compulsory breath testing (CBT) enforcement programs, an increase in the number of breath testing devices available to enforcement authorities in order to support the CBT program and the maintenance of publicity levels to support the CBT programs. Evaluation of effectiveness of this campaign (Cameron and Vulcan 1998) showed that the proportion of drivers killed with blood alcohol levels exceeding the legal limit decreased by 21% in the first year and by 34% during the second year (relative to 1994).

2.2. Speed Detection

Many studies have found that extensive use of speed cameras, major publicity campaigns focusing on the need for concentration during travel and intensive policing of speed limits are key factors influencing the number of serious casualty crashes during low alcohol hours. Consequently, the implementation of speed detection programs around Australia has been one of the major factors contributing to declines in the road toll.

In fact, it has been reported that large scale speed camera programs, together with major publicity programs and appropriate penalty structures can result in a decline of around 20% in casualty crashes during low alcohol hours (Vulcan & Corben, 1998). Furthermore, the use of other speed enforcement programs, for example hand-held speed detection devices and car mounted laser equipment recently introduced into some Australian states are likely to further reduce total fatalities by around 5% (Vulcan & Corben , 1998).

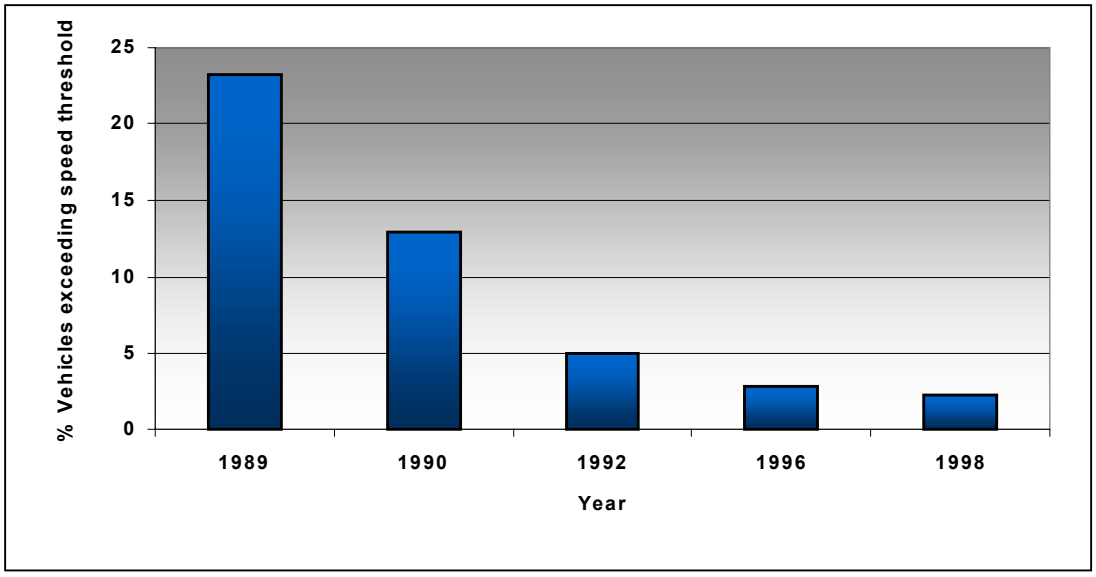

Table 3: *Percentage of vehicles exceeding speed threshold*

In Victoria, (Newstead et al, 1998) found that the effect of enforcing speed regulations, by serving Traffic Infringement Notices as a result of speed camera reading, have contributed to between 9.6% to 11.2% of serious casualty crashes between 1990-1996. Similar results were found in site studies undertaken for the US Department of Transportation (U.S. Department of Transportation, 1997), which have demonstrated the safety benefits associated with lower speed limits.

In New Zealand, the high intensity advertising and enforcement campaign implemented during the period 1995-1996 included among other priorities the improved targeting of speed cameras enforcement programs, the increase in speed camera program hours, the introduction of advanced laser speed detectors to supplement the speed camera program and the maintenance of publicity levels to support the speed camera programs. Evaluation of effectiveness of this campaign (Cameron and Vulcan 1998) showed that the reductions in

speeding were not as important as the effects on seat belt use and drinking and driving. However, the proportion of fatal crashes in which Police reported speed as a contributing factor dropping by 6% in the first year and 6% again in the second year.

2.3. Seatbelts

It has been reported that the mandatory wearing of occupant restraints has seen significant reductions in the number and severity of fatalities and serious casualty crashes. Australia boasts for a very high front seatbelt wearing rates (around 90-96%).

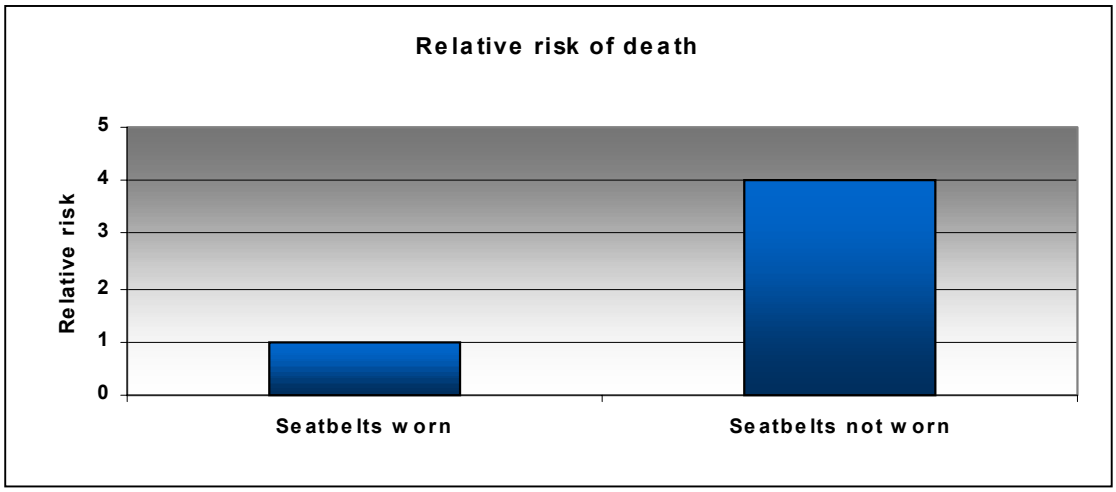

Table 4: *Relative risk of death concerning seat belt use*

Despite this rate a significant proportion of fatalities to vehicle occupants are associated with occupants failing to wear restraints. Consequently, Vulcan and Corben (1998) suggested that further reductions, up to 3% could be achieved from continued enforcement and the promotion of seat belt wearing by all types of vehicle drivers.

Similar studies in the USA (NHTSA, 1998) showed that campaigns focussing on increased seat belt usage resulted in a 15% reduction in the risk of fatality.

In New Zealand, the high intensity advertising and enforcement campaign implemented during the period 1995 - 1996 included advertising campaigns promoting adult seat belt usage and supporting increased enforcement of seat belt offences. Evaluation of effectiveness of this campaign (Cameron and Vulcan 1998), showed that in the concerned period adult compliance rates increased to 88% in front seats and 56% in rear seats.

3. ROAD ENVIRONMENT

The targeted treatment of accident Black Spot locations has been shown to be highly effective in reducing road trauma in our community. The previous Federal Road Safety Black Spot Program, which operated between 1990 and 1993, had proven itself to be effective in reducing road crashes. A study conducted by the Bureau of Transport and Communications Economics (BTCE), Report 90 “Evaluation of the Black Spot Program” 1995, reported that the community benefited by $4 for every dollar spent on each treated black spot.

Previous studies conducted in Victoria [Tziotis, M. (1993); and Corben, B.F. and Foong, C. (1989)], in which also the effectiveness of similar Black Spot programs has been investigated, found that high safety benefits are achieved through the implementation of Black Spot programs. The reports found that at treated sites casualty accidents reduced by about a third while providing an economic benefit to the community of over $7 for every $1 spent (ie benefit cost ratio of 7.3:1).

The federally funded Accident Black Spot Program, first implemented in 1992/3 in Australia saw an average reduction of eight fatalities per annum at the treated sites, with an additional reduction of 186 hospitalised injuries per annum. The total expenditure on these 254 sites was $25.2 million, corresponding to an average of $3.2 million per fatality saved across the life of the Black Spot treatment eight per annum. In 1998 the expenditure allocated to accident Black Spots was in the order of $36 million, with additional amounts of state funding directed toward the treatment of Black Spot sites (Vulcan & Corben, 1998).

For the Australian State of Victoria, the types of road engineering treatments implemented under its Black Spot Program resulted in the following casualty accidents reductions:

Construction of new roundabouts……	80%
New traffic intersection signals……..	55%
New pedestrian signals……..	45%
Remodelling traffic signals (including the full control of turning movements)……	45%
Construction of traffic islands and medians……	40%
Road resurfacing and shoulder sealing……..	20%
Tactile or raised edgelining, improved road linemarking and installation of raised reflective pavement markers…….	10%

Other studies in the USA (FHWA, 1998) have shown that the elimination of roadside hazards could lead in the long term to important reduction of road accidents and respective victims. More precisely, it has been proved that for a multi-year period, the elimination of roadside hazards resulted in 87% reduction in the number of persons killed and 64% reduction in the number of persons injured.

4. VEHICLE SAFETY

The development and implementation of the Australian Design Rules (ADR) seek to improve the protection of vehicle occupants in crash situations. ADRs have been implemented in Australia for many years and have been progressively reviewed during this time. These Rules are the main source of achieving improvements to the safety of vehicle occupants in Australia.

However, these ADRs apply only to the manufacture of new vehicles. Consequently many safety benefits that may result from these ADRs are not currently visible given the age of Australia's car fleet. Approximately 40% of vehicles involved in casualty crashes in Australia are more than 10 years old, and it has been estimated that it will take around 20 years before the entire vehicle fleet in Australia will be renewed. Therefore, the full effectiveness of many ADRs will not be felt until well into the 2010 decade.

Studies in USA (NHTSA, 1998) have proved that the introduction of airbag use has an important positive impact on road safety. More precisely, airbag use leads to 11% reduction in fatality risk.

5. COMBINED EFFECT OF SAFETY MEASURES

According to research in Australia focusing on predicting the level of achievement that can be obtained in the future (Vulcan and Corben, 1998), reductions in road fatalities could be achieved through the continued application of existing programs and proposed new initiatives by the year 2004. More precisely, the following reductions are foreseen:

Road user behaviour……14.0%
Road improvements ……12.8%
Vehicle safety features……..8.8%
Emergency medical services……5.0%

However, these percentages cannot be simply added to estimate the total contribution of various initiatives to levels of road trauma. Some measures will act in sequential manner, so that a multiplicative formula needs to be applied to arrive at an overall contribution. Consequently, applying this method and taking into account predicted growth in the vehicle fleet and travel it is estimated that overall fatalities could be reduced by 35% by 2004.

Based on a previous Victorian study (Cameron, Newstead and Vulcan 1994), which attempted to apportion the reduction in the road toll in Victoria between 1989 and 1992 to differing road safety initiatives, and the above presented reductions anticipated, the following safety reduction estimates are provided.

Road and Road Environment Safety Improvements: Accident Black Spot Program. Mass Action Safety Treatment Program (e.g. broad application of shoulder sealing, edge- lining, etc.). General road improvement / reconstructions New road works (i.e. by-pass roads, road duplications).	20-25%
Improving Road User Behaviour:	
Speeding Operation of speed camera program, in association with mass media campaign	10-15%
Drink Driving Operation of Random Breath Testing (RBT) Program, co-ordinated with mass media campaign	10-15%
Other School education programs, bicycle helmet wearing laws, increased seat belt wearing rates, etc.	5-10%

Table 5: *Road accident reduction estimates*

6. CONCLUSIONS

On the basis of experience gained during the past 20 years in the developed countries, this research identified a series of promising measures for the improvement of road safety at local and national level. The measures examined showed that initiatives implemented have focused on promoting safety in three key areas: the behaviour of the road user, the road environment and the vehicle. Furthermore, the initiatives implemented in relation to these three areas have targeted the well-known factors effecting road safety of speeding, drink-driving, and fatigue.

Quantified evaluation of measures' effectiveness is possible but the results should always be considered with great attention. Quantitative evaluation results should be combined with respective qualitative results allowing for the extraction of a complete picture of the measures effectiveness. Furthermore, the combined effect of several measures should always be taken into consideration when drawing conclusions for the effectiveness of a specific road safety measure.

Additionally, it is noted that the critical success factors of the road safety measures are the way these measures are implemented considering specific safety systems in the road environment, as well as the active participation of all deliverers concerned and road users. The implementation practices play the most important role to the measures' effectiveness and on this purpose special implementation plans should always accompany road safety measures.

It is of great importance to note that for each traffic environment, special implementation provisions should be foreseen. When transferring successful measures in another traffic environment special emphasis should be given to the adaptation of these measures to this new environment. For example, any attempt to implement the above mentioned successful measures to less developed countries - in Europe and world-wide - the particularities of the user's behaviour and the road environment should always be well examined before the implementation. On this purpose, it is necessary that special action will be undertaken at European level, for the adaptation of "Northern" successful practices in the reality of the less developed in terms of road safety "Southern" countries.

Today, at both national and European level, all the available instruments of legislation, information exchange, financial support and research should be utilised in order to advance effective policies through the most promising road safety measures identified here-in. This requires the political will to raise road transport safety to a higher level than it currently occupies, and to provide the finance commensurate with the problems of road transport death and injury. The accumulation and exchange of information and knowledge could better be achieved through the more systematic evaluation of countermeasure effectiveness and the further development of co-operation at national and international level.

Road Safety is a science and research is a vital and indispensable element in any science. Further research in the field of quantified evaluation of measures' effectiveness is necessary focussing in a number of priority field such as the driver's perception of the risk associated with features of road design, the effect of road design on driver's behaviour, the accommodation of the needs of "non-design" drivers (especially older drivers), the effect of enforcement on drivers behaviour (especially on speeding behaviour) and the stimulation and improvement of public consciousness and awareness of safety matters.

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