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Περίληψη: Στόχος της παρούσας εργασίας είναι η αποτίμηση της επιρροής της αστυνόμευσης δύο ιδιαίτερα επικίνδυνων παραβάσεων οδικής ασφάλειας, της υπερβολικής ταχύτητας και της οδήγησης υπό την επήρεια αλκοόλ, και ο προσδιορισμός του λόγου ωφελειών / κόστους από την εντατικοποίηση της αστυνόμευσής τους στην Ελλάδα κατά την περίοδο 1998-2002. Για τον σκοπό αυτό χρησιμοποιήθηκαν στοιχεία οδικών ατυχημάτων, παθόντων προσώπων, επικίνδυνων παραβάσεων και αριθμού ελέγχων επικίνδυνων παραβάσεων που συλλέγονται από την ΕΣΥΕ και τη Διεύθυνση Τροχαίας για την εξεταζόμενη περίοδο. Πρόσθετα στοιχεία που αφορούν στο κόστος της αστυνόμευσης συλλέχθηκαν από τη Διεύθυνση Τροχαίας. Για τον υπολογισμό της επιρροής της αστυνόμευσης στην οδική ασφάλεια χρησιμοποιήθηκαν στατιστικά πρότυπα οδικών ατυχημάτων σε σχέση με συγκοινωνιακά και δημογραφικά χαρακτηριστικά στις διάφορες περιοχές τις Ελλάδας. Στη συνέχεια υπολογίστηκε το κόστος των οδικών ατυχημάτων στην Ελλάδα, ενώ ειδικότερα όσον αφορά στο ανθρώπινο κόστος των οδικών ατυχημάτων αξιοποιήθηκαν στοιχεία έρευνας με τη μέθοδο "πρόθεση-να-πληρώσω". Τέλος, πραγματοποιήθηκε ανάλυση κόστους-ωφελειών, με βάση την ενδεδειγμένη μεθοδολογία από τη διεθνή βιβλιογραφία, για δύο σενάρια: ένα "συντηρητικό" σενάριο και ένα "βέλτιστο" σενάριο. Από τα αποτελέσματα προκύπτει ότι ανταποδοτικότητα της εντατικοποίησης της αστυνόμευσης της υπερβολικής ταχύτητας και της οδήγησης υπό την επήρεια αλκοόλ ήταν ιδιαίτερα υψηλή κατά την εξεταζόμενη περίοδο και για τα δύο εξεταζόμενα σενάρια.

Λέξεις κλειδιά: οδική ασφάλεια, αστυνόμευση, υπερβολική ταχύτητα, οδήγηση υπό την επήρεια αλκοόλ, ανάλυση κόστους-ωφελειών.

COST-BENEFIT ASSESSMENT OF THE INTENSIFICATION OF ROAD SAFETY ENFORCEMENT IN GREECE

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Abstract: The objective of this research is the assessment of the safety effect and the cost-effectiveness of the intensification of road safety enforcement in Greece in the period 1998-2002, with particular focus on two most important types of enforcement, namely speed and alcohol enforcement. On that purpose, data concerning the number of road accidents and related casualties, as well as the number of police speed and alcohol controls performed and violations recorded were used. Moreover, additional data on the amount and type of resources allocated in the enforcement scheme were obtained by means of interviews with Head Officers of the Police. The safety effect of enforcement was estimated by means of statistical models describing road safety, transport and demographic trends in various regions of Greece. A separate analysis was devoted to the estimation of accidents cost in Greece; especially as regards the estimation of human cost in road accidents, willingness-to-pay survey results were exploited. A cost-benefit analysis was eventually carried out, on the basis of the standard methodologies, according to which, speed and alcohol enforcement in the examined period in Greece was very cost-effective, both within a "conservative" and within a "best" estimation scenario.

Key words: road safety, speed enforcement, alcohol enforcement, cost-benefit analysis.

1. INTRODUCTION

Road accidents and related casualties presented a increasing trend during the past decade in Greece, mainly due to insufficient maintenance of the road network, inappropriate behaviour of the road users and lack of efficient and systematic enforcement (NTUA/DTPE, 2003). Since 1998, an important effort was devoted to the improvement of this situation in Greece, focusing on an intensification of enforcement aiming to improve driver behaviour. In particular, in 1998, the Greek Traffic Police started the intensification of road safety enforcement, having set as target the gradual increase of traffic controls for the two most important violations: speeding and drinking and driving. Since then, all controls and related violations recorded were systematically monitored and the related enforcement and casualty results at local and national level were regularly published, as shown at Table 1 with basic road safety related trends in Greece. Seta belt and helmet use were two additional offences, which the police started to enforce more systematically on 2002. The target group of the measure included the entire population of Greek drivers. Although the intensification of enforcement was more significant on the interurban road network, it is considered that the entire number of accidents were affected.

Previous research on enforcement assessment has indicated that only a significant increase in enforcement level, may affect the number of accidents (Bjørnskau, Elvik, 2003). Additionally, very little validation of enforcement effect at national level has been available in international literature. In particular, most evaluation attempts concern a temporary increase in local resources or concentrated enforcement efforts in a selected area (ESCAPE, 2003). However, as far as Greece is concerned, the measures were implemented at national level, and a systematic intensification of enforcement covering all types of violations was achieved.

Table 1. Basic road accidents and police enforcement trends in Greece 1998-2002

	1998	**1999**	**2000**	**2001**	**2002**	5-year change
Injury road accidents	24,819	24,231	23,127	19,710	16,852	**-32%**
Persons killed	2,182	2,116	2,088	1,895	1,654	**-24%**
Vehicles (x1000)	4,323	4,690	5,061	5,390	5,741	**33%**
Speed violations	92,122	97,947	175,075	316,451	418,421	**354%**
Alcohol violations	13,996	17,665	30,507	49,464	48,947	**250%**
Alcohol controls	202,161	246,611	365,388	710,998	1,034,502	**412%**

Moreover, the various enforcement schemes implemented in different countries are seldom evaluated in terms of cost effectiveness. Cost-benefit analysis is a formal analysis of the impacts of a measure or programme, designed to assess whether the advantages (benefits) of the measure or programme are greater than its disadvantages (costs). Cost-benefit analysis is one of a set of formal tools of efficiency assessment (Hakkert and Wesemann 2005). In general, cost-benefit analysis results for road safety enforcement are very satisfactory for all types of enforcement schemes, as shown in Table 2.

Table 2. Cost-benefit analysis results for road safety enforcement schemes in various countries (ROSEBUD, 2006)

Enforcement scheme	**Country**	**B/C ratio range**	
Concentrated general enforcement	Israel	3.5	5.0
Tripling stationary speed enforcement	Norway	6.5	
Tripling alcohol and seat belt enforcement	Norway	1.2	3.6
Increasing alcohol controls	Sweden and Norway	1.5	
Increasing speed controls	Sweden and Norway	2.0	8.8
Section automatic speed control on motorways	Austria	5.5	
Red light violations enforcement cameras	Scotland	2.2	
Red light violations enforcement cameras	Sweden	1.7	
Alcohol enforcement + publicity campaign	New Zealand	7.0	
Increased road safety enforcement + publicity campaign	Australia	3.9	7.9
Risky driving enforcement + publicity campaign	Switzerland	20.0	

2. OBJECTIVES, METHODOLOGY AND DATA

The present research concerns a cost-benefit evaluation of police enforcement for speeding and drinking-and-driving in Greece for the period 1998-2002. In particular, the analysis aims to estimate the magnitude and significance of the safety effect of speed and alcohol enforcement in the examined period, as well as the costs related to the implementation of the enforcement scheme. Moreover, it aims to exploit existing research in order to accurately estimate the costs of accidents and fatalities in Greece. Finally, it aims to use this data for the calculation of the benefit / cost ratio of speed and alcohol enforcement.

The cost-benefit analysis was therefore based on the detailed police controls and violations data, available by the police for the examined period. Additional information was collected by means of interviews with police officers, in order to estimate the implementation costs of the measures. As far as the safety benefits are concerned, the results of three recent studies were exploited; one research concerning the calculation of accident economic cost in Greece, one research on willingness-to-pay for accident risk reduction in Greece, and one research concerning the quantification of the safety effect of enforcement and other safety related parameters in Greece.

The standard methodologies for estimating the safety effects of road safety measures and for performing cost-benefit analysis were used in this research. In particular, safety effects were calculated by means of statistical modeling, accounting for regression-to-the-mean and for overall changes in road safety trends (Hauer, 1997, Elvik and Vaa, 2004) Moreover, all the criteria for correct cost-benefit evaluations (Hakkert and Wesseman, 2005) were taken into account.

3. RESULTS

3.1. Enforcement Costs

Enforcement costs include labour costs, vehicle costs and enforcement equipment costs (speed cameras, alcoholmeters etc.). As the intensification of enforcement in the examined period was not part of a specific project with a specific budget and resource allocation foreseen, there was very little information available on the police related costs. The additional

necessary information for CBA calculations was obtained by means of exhaustive interviews with Head Officers of the Police. In particular, on the basis of the available detailed information on the yearly numbers of speed and alcohol violations, the interviews aimed at yielding the related labour and capital parameters through the adoption of typical conversion measures. The calculations for speed and alcohol enforcement are based on the following assumptions, as reported from the experience of the Head Police Officers interviewed:

- 75% of speed and alcohol violations are recorded on typical days
- 25% of speed and alcohol violations are recorded on special days (weekends, holidays, special events)
- An average of 15 speed violations per shift are recorded on typical days
- An average of 20 speed violations per shift are recorded on special days
- An average of 1 alcohol violations per shift is recorded on typical days
- An average of 2 alcohol violations per shift are recorded on special days
- 3% of speed violations recorded result to driver's prosecution, both on typical and special days
- 10% of alcohol violations recorded result to driver's prosecution, both on typical and special days

On the basis of the above, the yearly numbers of police control shifts on speed and alcohol enforcement and prosecutions for speeding and drinking-and-driving were calculated. Additionally, the detailed labour breakdown for control shifts and prosecutions, obtained though the interviews (number of persons and person-hours of a typical control shift / prosecution, typical policeman hourly rate), was used to calculate the total yearly labour costs for alcohol enforcement. It should be noted that the police person-hour rate (€) refers to year 2002. In particular:

- 3 policemen are involved in one control shift for 8 hours each
- 1 policeman is involved in an prosecution for a total of 14 hours
- The hourly rate of a policeman is 7,5 €

The calculation of vehicle costs is based on the number of police control shifts and prosecutions, which was calculated as described above on the basis of the interviews. Additional information on the use of police vehicles collected during the interviews were also exploited. In particular, the following assumptions were included:

- 1 police vehicle is used in each shift
- 1 police vehicle is used for each driver's prosecution
- The average total distance travelled for each shift is 20 km for speed control and 5 km for alcohol controls
- The average total distance travelled for each prosecution is 5 km

Additionally, the average police vehicle cost per kilometre was considered equal to 0,10 € / km (referring to year 2002), according to a recent research (Liakopoulos, 2002).

The number of available devices used for speed and alcohol enforcement for the year 2002 was obtained from the Technical Services of the Police. However, no information on the respective numbers for the year 1998 were available. According to the information collected during the interviews, a reasonable assumption would be to considered that the enforcement equipment was doubled in the examined period. Moreover, the following unit costs of enforcement equipment were considered (2002 prices):

- 1 portable speed gun costs 600 €
- 1 in-vehicle radar costs 500 €
- 1 speed-gun with tripod costs 300 €
- 1 alcoholmeter costs 10 €

Overall, the intensification of speed and alcohol enforcement in Greece in the examined period totaled around 43 million €, in which vehicle and equipment costs are only a minor proportion (Table 3).

3.2. Enforcement Benefits

In the framework of this research, the benefits examined exclusively concern safety benefits, as no significant social or environmental costs were expected from the intensification of speed and alcohol enforcement.

For the estimation of the number of accidents prevented from the intensification of speed and alcohol enforcement, the results the results of a recent research were exploited (Agapakis and Mygiaki, 2003). This research concerned a macroscopic investigation of the effect of enforcement on road safety improvement in Greece, aiming in particular at determining the separate effect of different types of enforcement (speeding, drinking and driving, violating signals, failing to yield etc.), as well as the effect of other safety related parameters (vehicles fleet, vehicle ownership, population) on the significant overall improvement of road safety in Greece during the last few years.

Table 3. Police enforcement costs breakdown 1998-2002

	1998	**1999**	**2000**	**2001**	**2002**
Number of speed violations	92,122	97,947	175,075	316,451	418,421
Number of speed enforcement shifts	5,758	6,122	10,942	19,778	26,151
Number of speed prosecutions	2,764	2,938	5,252	9,494	12,553
Number of alcohol violations	13,996	17,665	30,507	49,464	48,947
Number of alcohol enforcement shifts	12,247	15,457	26,694	43,281	42,829
Number of alcohol prosecutions	1,400	1,767	3,051	4,946	4,895
Number of portable speed guns	231	-	-	-	462
Number of in-car radars	31	-	-	-	62
Number of speed guns with tripod	20	-	-	-	39
Number of alcoholmeters	467	-	-	-	934
Shifts Labour Costs (€)	3,240,743	3,884,141	6,774,446	11,350,654	12,416,389
Prosecutions Labour Costs (€)	437,142	494,016	871,810	1,516,193	1,831,970
Total Labour Costs (€)	**3,677,885**	**4,378,157**	**7,646,256**	**12,866,846**	**14,248,358**
Shifts Vehicle Costs (€)	17,639	19,972	35,231	61,197	73,717
Prosecutions Vehicle Costs (€)	2,764	2,938	5,252	9,494	12,553
Total Vehicle Costs (€)	**20,402**	**22,910**	**40,483**	**70,690**	**86,270**
Total Equipment Costs (€)	**164,620**				
Total Enforcement Costs (€)	**43,222,878**				

This research included two distinct parts; the first part concerned a cluster analysis aiming at identifying groups with similar characteristics within the 52 prefectures of Greece. In particular, road network, population density, vehicle ownership, traffic violations and accidents characteristics were used for the separation of Greece in four groups of prefectures (Figure 1):

- Group I included Athens and Thessaloniki large urban regions, which present high accident and violation rates
- Group II included 5 large prefectures with relatively high population density and accident and violation frequencies
- Group III included 22 prefectures with relatively medium population density, high accident frequencies and medium violation frequencies

- Group IV included 22 smaller prefectures with relatively low population density, accident and violation frequencies

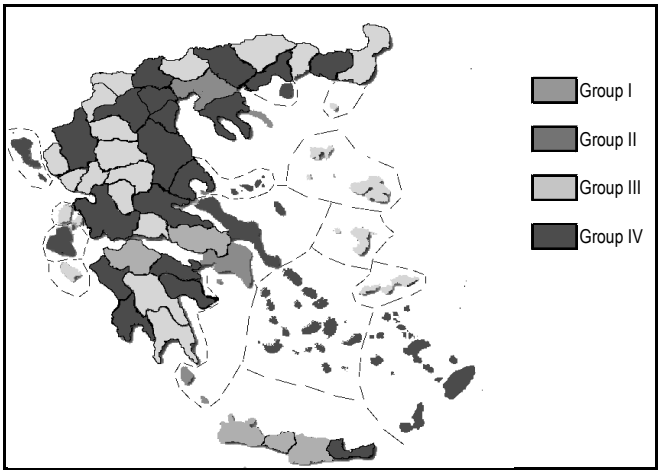

Figure 1. Clustering of the Prefectures of Greece in Groups of similar accidents and violations rates

The second part of the research concerned the development of Poisson regression models for the quantification of the separate effect of various types of enforcement, as well as other parameters on the total number of accidents in each Group of prefectures. In each case, the marginal effects of the various significant parameters were also calculated. Additionally, the modelling process was developed for two different assumptions concerning the effect of enforcement, resulting in two categories of models:

- Models with no time halo effect of enforcement ("conservative" scenario)
- Models with a time halo effect of enforcement ("best" scenario)

The above classification rises from the international experience, according to which, there may be a delay of several weeks before a significant effect of enforcement is observed (Holland and Corner, 1996, Vaa, 1997). This "time halo effect" was taken into account as a two-month delay in the effect of enforcement, corresponding to the "best" scenario in the present analysis.

Among the various types of enforcement examined in the models, the enforcement of speeding and drinking-and-driving was found to have a significant effect on the total number of accidents only in Groups II and IV, whereas in the other Groups, other types of enforcement were found significant, such as traffic signals violations, failing to yield etc. In particular, in the "conservative" scenario models, it was found that an increase of 1000 speed violations prevents approximately 1 accident in Group II prefectures and 2 accidents in Group IV prefectures. Additionally, it was found that and increase of 1000 alcohol controls prevents approximately 2 accidents in Group II prefectures and 1 accident in Group IV prefectures. Moreover, in the "best" scenario models, it was found that an increase of 1000 speed violations prevents approximately 2 accident in Group II prefectures and 2 accidents in Group IV prefectures. Additionally, it was found that and increase of 1000 alcohol controls prevents approximately 2 accidents in Group II prefectures and 3 accidents in Group IV prefectures.

The above results were combined with the related enforcement trends data for the 1998-2002 period, which are available in detail from the National Police, in order to calculate the total number of accidents prevented from the intensification of enforcement in the examined

period. According to the "conservative" scenario, a total number of 772 accidents were prevented in the examined period in Greece, whereas according to the "best" scenario, a total number of 1.142 accidents prevented in the examined period in Greece (Table 4).

3.3. Accidents Costs

The estimation of average accidents cost was carried out on the basis of a recent research on accidents cost in Greece (Liakopoulos, 2002). This research concerned the estimation of the costs of various components of accidents cost (material damage costs, generalized costs, human costs) for fatal accidents, injury accidents and material damage accidents, including:

- Material damage costs
- Generalized costs (Police, Fire brigade, Insurance companies, Court, Lost production output, Rehabilitation, Hospital treatment, First aid and transportation)
- Human costs (Pain and Grief)

Table 4. Police enforcement safety benefits 1998-2002

		1998	**1999**	**2000**	**2001**	**2002**
Number of speed violations	Group II	9,579	16,091	31,533	64,966	82,531
	Group IV	14,648	19,899	30,112	54,164	69,568
Number of alcohol violations	Group II	13,584	19,485	54,498	151,943	213,138
	Group IV	24,967	35,171	60,828	112,066	179,552
Conservative scenario						
Marginal effect speed	Group II	-1.239				
	Group IV	-1.542				
Marginal effect alcohol	Group II	-1.929				
	Group IV	-1.373				
Number of accidents prevented	Group II		19	87	229	140
	Group IV		22	51	107	116
Total accidents prevented		**772**				
Best scenario						
Marginal effect speed	Group II	-2.224				
	Group IV	-2.053				
Marginal effect alcohol	Group II	-2.265				
	Group IV	-2.684				
Number of accidents prevented	Group II		28	114	295	178
	Group IV		38	90	187	213
Total accidents prevented		**1142**				

The various costs were calculated by means of en exhaustive data collection process addressed to various organizations (National Statistical Service of Greece, National Police, Fire Service of Greece, Emergency Medical Service of Greece, hospitals, courts, insurance companies etc.). Additional parameters were adopted on the basis of estimations from experts in each field, as well as the existing international literature.

It should be noted, however, that the above research, did not adequately account for the human cost component, as the pain and grief parameters as reported in the Courts are not sufficiently representative of the human cost (Demogianni et al. 2005). On that purpose, a separate investigation for human cost in Greece was carried out in the framework of the present research. In particular, human cost was estimated according to the following formula (1):

$$VoSL = (NAEIS) / (LSE) \qquad (1)$$

Where:
VoSL: Value of Statistical Life

NAEIS: National Annual Expenditure on Improving Safety
LSE: Expected lives Saved from this Expenditure annually

In particular, the calculations included parameters such as the percentage of the family annual income that each person is willing to pay in his/her entire life in order to reduce the probability of accident involvement of himself/herself or of any family person by 50%, the average members per family in Greece, the proportion of families with an economically active member, the average family annual income in Greece, the National Population, the life expectancy in Greece and the current and new accident risk.

As regards the percentage of the family annual income that each person is willing to pay in his/her entire life in order to reduce the probability of being killed in a road accident by 50%, the results of a recent "willingness-to-pay" survey were exploited (Aggelousi and Kannelopoulou, 2002, Mintsis et al. 2005, Yannis et al. 2005). In this survey, respondents were asked the percentage of annual income they were willing to pay to reduce by 50% the probability of fatal accident involvement. In order to estimate the VoSL for serious and slight injuries, a recommendation by Gaudry (2004) was adopted, according to which the human cost of serious and slight injuries should be taken equal to 13% and 1% of the human cost of fatalities respectively. Consequantly, the human cost of accidents in Greece was estimated as (prices of 1999):
$VoSL_{fatal}$ = 866.627 €/person for fatal accidents
$VoSL_{serious}$ = 112.661 €/person for serious injury accidents
$VoSL_{slight}$ = 8.666 €/person for slight injury accidents

Moreover, in order to calculate the average accident cost in Greece, the costs of fatal and injury accidents were weighted in relation to the average distribution of accident casualties per casualty severity in Greece. In Table 5, the parameters concerning accident cost in Greece are summarized.

Table 5. Accidents cost in Greece (1999)

	Cost of Accidents with		
	Killed	**Seriously Injured**	**Slightly Injured**
Material Damage cost (€)	28,769	18,175	13,904
Generalised cost (€)	442,467	23,907	6,960
Human cost (VoSL) (€)	866,626	112,661	8,666
Total cost (€)	**1,337,862**	**154,743**	**29,531**
Proportion of casualties	6.5%	11.5%	82.0%
Average accident cost (€)	**128,972**		

3.4. Cost-Benefit Analysis

On the basis of the approach described in the previous sections, the Benefit/Cost ratio was calculated for the "conservative" scenario and the "best" scenario for the period 1999-2002; it is noted that year 1998 was not included in the calculations, as no information could be available on the number of accidents prevented in 1998. An accumulated discount factor was applied to the benefits calculation (cost of accidents prevented), on the basis of an interest rate of 4% (National Statistical Service of Greece, 2003).

As shown in Table 6, the "conservative" scenario yielded a high Benefit/Cost ratio equal to [2.7 :1]. In particular, the total value of benefits for this scenario were calculated equal to 107,980,919 €, whereas the enforcement implementation costs totalled 39,524,591 €, all

values referring to year 2002. Accordingly, the "best" scenario yielded an even higher Benefit/Cost ratio equal to [4 : 1]. In particular, the total 1999-2002 value of benefits for this scenario were found equal to 159,681,549 €, whereas the 1999-2002 enforcement implementation cost totalled 39.524.591,23 €, all values referring to year 2002. In both scenarios, the nationwide intensification of speed and alcohol enforcement in Greece was found to be highly cost-effective.

Table 6. Cost-Benefit analysis of enforcement in Greece 1998-2002

	Conservative scenario	**Best Scenario**
Number of accidents prevented	772	1,142
Average accident cost (€)	128,972	128,972
Present value of benefits (€)	107,980,919	159,681,549
Cost of speed enforcement (€)	14,814,729	
Cost of alcohol enforcement (€)	24,709,862	
Total Enforcement Cost (€)	39,524,591	
Benefit - Cost Ratio	**2.73**	**4.04**

4. CONCLUSIONS

The correlation between systematic road safety enforcement and number of road accidents was confirmed in the present research. In particular, an important safety effect of speed and alcohol enforcement was estimated, although, interestingly, this effect was not uniform nationwide but appeared more intensely in specific regions instead. It can be considered that the intensification of road safety enforcement may be one of the two basic reasons (the other one may be congestion), which may explain the important decrease observed in the number of road accidents, persons killed and injured during the last five years in Greece. The effectiveness of this enforcement scheme may be attributed to the strict control of vehicle speed using modern radar equipment, the continuous presence of Police at heavy traffic locations, the rationalization of speed limits, the reduction of speed limits at urban areas, the alcohol controls especially during night and the increased patrolling on highways (Papaioannou et al. 2002).

Moreover, the important intensification of speed and alcohol enforcement was found to be very cost-effective, both in the "conservative" and in the "best" scenario examined, confirming thus existing findings in the literature. The fact that a long-term and nationwide intensification of enforcement was proved to be cost-effective is an interesting finding within the international experience, given that usually more concentrated enforcement schemes appear to be more cost-effective.

The main difficulties encountered within the present analysis concerned the lack of detailed and accurate data on the specific resources allocated in the intensification of enforcement. As in most countries (ESCAPE, 2003), no standards to measure police intensity existed in Greece and no system of performance indicators for enforcement activity was developed. In particular, police costs are not systematically recorded in relation to specific actions, as labour and capital allocation is optimized according to the specific needs of each circumstance. In the present evaluation, the lack of appropriate data for cost-benefit evaluation purposes was overcome by means of exhaustive interviews with experienced Head Officers of the Police, who had also been actively involved in both the decision making process and the monitoring of police effort.

As far as accidents cost is concerned, no social values of reference are officially published. Therefore, existing research results in Greece and standard international methodologies were used for the calculation of the accidents cost. In particular, a willingness-to-pay survey and a generalized cost assessment research provided the main figures that were used in the calculations. It is noted that the accident and fatality costs calculated in the present research are in accordance with the estimated figures for Greece in international literature (Gaudry, 2004).

The important benefit obtained from the intensification of speed and alcohol enforcement, in terms of number of accidents and casualties prevented in the examined period in Greece, could motivate decision makers towards further improvement of the implementation and monitoring of the enforcement activity. Moreover, a lot of additional effort is required, in order to achieve a systematic recording of police labour and capital costs, in a similar way that the related controls and violations were monitored since the intensification of police enforcement in Greece. Eventually, cost-benefit assessment should become a routine procedure in road safety decision making.

5. REFERENCES

Agapakis, J., Mygiaki, E., (2003). *Macroscopic investigation of the effect of enforcement on the improvement of road safety on Greece*. Diploma Thesis, NTUA, School of Civil Engineering, Department of Transportation Planning and Engineering, Athens.

Bjørnskau, T., Elvik, R., (1992). Can road traffic law enforcement permanently reduce the number of accidents? *Accident Analysis & Prevention*, Volume 24, Issue 5, Pages 507-520.

Demogianni S., Mintsis G., Taxiltaris C., Basbas S. (2005). Methods for the estimation of the costs of road accidents. Proceedings of the 2nd Pan-Hellenic Conference on Highway Engineering, Volos, Greece, May 2005.

Elvik, R., Vaa, T. (2004). *The Handbook of Road Safety Measures*. Elsevier, 2004.

ESCAPE consortium (2003). *Traffic enforcement in Europe: Effects, measures, needs and future*. The "Escape" Project Final report, Contract Nº: RO-98-RS.3047, 4th RTD Framework Programme.

Gaudry, M. (2004). *Sur les coûts de la vie humaine utilisés en Europe depuis le rapport Boiteux de juin 2001*. Communication présentée lors de la réunion du 28 avril 2004 du Comité sur les pratiques d'évaluation des grandes infrastructures de transport du Conseil Général des Ponts et Chaussées (CGPC), comité présidé par M. Claude Gressier. (In French)

Hakkert, A. S., Wesemann, P. (2005). *The use of efficiency assessment tools: solutions to barriers*. Report R-2005-2. SWOV Institute for Road Safety Research, Ledschendam.

Hauer, E., (1997). *Observational Before-After Studies in Road Safety*, Pergamon.

Holland, C.A., Conner, M.T., (1996). Exceeding the speed limit: An evaluation of the effectiveness of a police intervention. *Accident Analysis & Prevention*, Volume 28, Issue 5, Pages 587-597.

Kanellopoulou, A., Aggeloussi, K., (2002). *Estimation of the human cost of road accidents and drivers' sensitivity towards accident risk - A willingness-to-pay technique and a stated-preference technique*. Diploma Thesis, NTUA, School of Civil Engineering, Department of Transportation Planning and Engineering, Athens.

Liakopoulos, D. (2002). *Development of a model for the estimation of the economic benefits from accident reduction in Greece*. Diploma Thesis, NTUA, School of Civil Engineering, Department of Transportation Planning and Engineering, Athens.

Mintsis G., Taxiltaris C., Basbas S., Demogianni S. (2005). The role of stated preference studies in the evaluation of the cost of road accidents. Proceedings of the *3rd Pan-Hellenic Conference on Road Safety*, Patras, Greece, October 2005.

National Statistical Service of Greece, (2003). *Greece in figures*. Official Publication of the National Statistical Service of Greece, Athens (www.statistics.gr).

National Technical University of Athens, Dept. of Transportation Planning and Engineering, (2003). *A strategic plan for the improvement of road safety in Greece 1998-2002*. Ministry of Economy and Finance.

Papaioannou P., Mintsis G., Taxiltaris C., Basbas S. (2002). Enforcement and traffic accidents: Recent experience from Greece. Proceedings of the *15th ICTCT Workshop*, Brno, Czech Republic, October 2002.

ROSEBUD Consortium (2006). *Examples of assessed road safety measures - A short Handbook*. Available on-line at http :// partnet.vtt.fi / rosebud / products / deliverable / Handbook_July2006.pdf.

Vaa, T., (1997). Increased police enforcement: Effects on speed. *Accident Analysis & Prevention*, Volume 29, Issue 3, Pages 373-385.

Yannis, G., Kanellopoulou, A., Aggeloussi, K., Tsamboulas, D., (2005). Modelling driver choices towards accident risk reduction. *Safety Science* Vol.43/3, 2005, pp. 173-186.