EFFICIENCY ASSESSMENT OF SELECTED ROAD SAFETY MEASURES

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Abstract: The objective of this research is to investigate and assess the efficiency of selected road safety measures, implemented in various EU countries, aiming at increasing the road safety level. Efficiency assessment process is based on the examination of several issues related to cost-benefit and cost-efficiency evaluation techniques for road safety measures, including methodological issues, data availability and quality, and identification of the most important barriers, through eighteen case-studies in nine countries. The main steps and data components needed to perform these evaluation techniques are presented, while the main results of evaluation techniques application are analysed. Conclusions concern both the efficiency of the measures and the assessment process. Furthermore, the main difficulties encountered in the above case studies and the alternatives for dealing with them are discussed. Analyses results revealed that efficiency assessment can facilitate decision-making related to road safety measures, but also the necessity for a common road safety efficiency assessment framework at international level.

Key words: efficiency assessment, road safety measures, decision-making, cost-benefit analysis, cost effectiveness analysis

1. INTRODUCTION

Budgets for road safety policies and activities are not infinite, thus politicians have to decide about the best possible use of these budgets. The criteria used, when deciding about policies and budgets, are mainly suitability, lawfulness, and/or legitimacy. However, in the recent years, efficiency is often mentioned as a criterion for a good policy. The efficiency of an intended policy is determined by the use of efficiency assessment tools, which enable decision making and choice of the policy with the highest return in monetary terms (Elvik 2003). Cost-benefit analyses and cost-effectiveness analyses are the widely used efficiency assessment tools. Cost-benefit analysis mainly investigates the social output of a measure or a policy (Layard *et al.*, 1994; Hanley *et al.*, 1993), while cost-effectiveness analyses is used for partial efficiency questions and investigates the casualties saved (Tengs *et al.*, 1995). In this research, cost-benefit analysis is implemented to assess cost- effectiveness of road safety measures. Generally, cost-benefit analysis provides a logical framework for evaluating alternative courses of action when a number of factors are highly conjectural in nature. Essentially, it takes into account all factors influencing either the benefits or the cost of a project, even if monetary value can not be easily assigned. (Smith, 1998).

However, it should be noted that there are certain barriers regarding the use of efficiency assessment tools in road safety policy (Elvik 2001). These barriers are mainly divided into three categories: fundamental (rejecting principles of welfare economics, rejecting efficiency as the most relevant criterion for priority setting, etc.), institutional (lack of consensus on relevant policy objectives, costs of cost-benefit analysis, etc.) and technical barriers (lack of knowledge of relevant impacts, inadequate monetary valuation of relevant impacts, etc.) (CETE SO *et al*, 2004).

The objective of this research is to investigate critical parameters of the application of road safety measures efficiency assessment. On this purpose, eighteen case studies in nine EU countries concerning measures' efficiency assessment aiming at increase road safety, were carried out. Efficiency assessment process is based on the examination of several issues related to cost-benefit and cost-efficiency evaluation techniques for road safety measures, including methodological issues, data availability and quality, and identification of the most important barriers. The main steps and data components needed to perform these evaluation techniques are presented, while the main results of evaluation techniques application are analysed.

2. SELECTING THE CASES FOR EFFICIENCY ASSESSMENT

The applicability of the efficiency assessment techniques were tested in light of both the limitation of available data and restrictions of decision-making procedures in the different countries. Various issues were considered before a safety measure was considered a test case.

Different categories of safety-related measures, i.e. user-related measures, vehicle-related measures, infrastructure related measures, organisation and rescue services. The available experiences and data from different countries have been analysed with the purpose to cover as many safety-related categories as possible.

Safety measures can be attributed to different levels of implementation (national, regional and local), which influences the effect of the treatment on its environment. Local measures are limited to certain spots on the road network and small areas, respectively, while national measures affect the whole of a specific population. Therefore, decision-making as well as implementation becomes complicated as measures pass from the local to the regional and national level. All levels of implementation should be considered during case selection to guarantee an overall analysis of the various decision-making processes.

Measures mentioned in different national road safety programmes were preferred, as these are characterised through long-term and clearly worked-out methods, as well as a detailed catalogue of measurements. A cost-benefit analysis is conducted for measures that have already been implemented (ex-post evaluation). The goal of such studies is to assess whether a certain measure can be economically viable. However, decision-makers are frequently interested in an ex-ante analysis, to compare potential costs and benefits of certain road safety measures that have not yet been implemented.

The selected cases were carried out in close cooperation with the user reference group, which allowed the users to be trained in the application of these tools.

3. BASIC COMPONENTS OF EVALUATION TECHNIQUES

In order to assess the cost-effectiveness of a road safety measure, the following basic elements are required (Hakkert *et al*, 2004): the basic formulae, the safety effects, the implementation units, the target accidents, as well as the accident and implementation costs.

<u>a. Basic formulae</u>
The cost-effectiveness of a road safety measure is defined as the number of accidents or casualties (injuries, fatalities) prevented per cost of implementation unit of the measure:

Cost-effectiveness = Number of accidents prevented by a given measure / Unit costs of implementation of measure

In order to calculate this ratio, the following information is necessary:
A definition of suitable units of implementation for the measure,
An estimate of the effectiveness of the safety measure in terms of the number of accidents it can be expected to prevent per unit implemented of the measure,
An estimate of the implementation costs for one unit of the measure.

The accidents affected by a safety measure are referred as target accidents. In order to estimate the number of accidents it can be expected to prevent per unit implemented of a safety measure, it is necessary to initially identify target accidents and further estimate the number of these accidents expected to occur per year for a typical unit of implementation. Then the safety effect of a specific measure is estimated.

The numerator of the cost-effectiveness ratio is estimated as follows:
Number of accidents prevented (or expected to be prevented) by a measure = Number of accidents expected to occur per year * Safety effect of the measure

The cost-benefit ratio is defined as:
Benefit-cost ratio = Present value of all benefits / Present value of implementation costs

When a cost-benefit analysis is carried out the monetary values of the measure's benefits are also required; these are mainly related to accident costs, but depending on the range of other effects considered, costs of travel time, air pollution, traffic noise, vehicle operating and other costs may also be taken into account. In order to make costs and benefits comparable, a conversion of their values to a certain time reference is necessary.

In a basic case, where benefits are only derived by the accidents or casualties prevented (and no influences on travel expenses and the environment are considered), the numerator of the benefit-cost ratio is estimated as:
Present value of benefits = Number of accidents prevented by the measure * Average accident cost * Accumulated discount factor,

where the accumulated discount factor depends on the interest rate and the length of life of the measure.

b. Safety effects
The most common form of a safety effect is the percentage of accidents/casualties reduction following the treatment and is usually given in the form of a percentage (Elvik *et al*, 1997, Ogden, 1996). The main source of evidence on safety effects is the observational before-and-after studies (Hauer, 1997). However, due to the diverse nature of road safety measures and the limitations of empirical studies, other methods for quantifying safety effects are also used. Those, provide mainly theoretical values of the effects based on the relationships between risk factors and the effects.

The safety effect of a measure is stated as available when the estimates of both the average value and the confidence interval of the effect are known. Moreover, it is important to ensure that both the type of measure and the type of sites (units) for which the estimates are available, correspond to those for which the cost-benefit / cost-effectiveness analysis is performed.

Local values of safety effects are preferable i.e. those attained by the evaluation studies performed in a country; when these are not available, the summaries of international experience can also be used (Elvik et al., 2004). Furthermore, if the value of a safety effect is provided by a current research study, the estimation of safety effect should satisfy the criteria of correct safety evaluation. This implies that the evaluation should account for the selection bias and for the uncontrolled environment (e.g. changes in traffic volumes, general accident trends).

c. Implementation units
When carrying out cost-effectiveness or cost-benefit analysis on road safety measures, it is essential to choose the appropriate implementation units. In the case of infrastructure measures, the appropriate unit will often be one junction or one kilometre of road. In the case of area-wide or more general measures, a suitable unit might be a typical area or a certain category of roads, whereas in the case of vehicle safety measures, one vehicle will often be a suitable unit of implementation. In the case of legislation introducing a certain safety measure on vehicles, the percentage of vehicles equipped with this safety feature or complying with the requirement could be appropriate. For police enforcement, it might be a kilometre of road with a certain level of enforcement activity (i.e. the number of man-hours per kilometre of road per year) and in the case of public information campaigns, the group of road users, influenced by the campaign.

d. Target accidents
The accidents affected by a safety measure present a target accident group. Depending on the type of safety measure it can also be a target injury group, target driver population, etc. Target accidents depend on the nature of the safety measure considered. For general measures like

black-spot treatment, traffic calming, speed limits, etc. the target accident group usually includes all injury accidents. There are also cases where adjustments to the accident costs should take place when evaluation methods are applied to a specific accident group.

e. Accident costs

A detailed survey of practice in estimating road accident costs in the EU and other countries was conducted by an international group of experts, as part of the COST-research programme (Alfaro *et al.*, 1994). The following five major components of accident costs were identified in this research initiative:

(1) Medical costs
(2) Costs of lost productive capacity (lost output)
(3) Valuation of lost quality of life (loss of welfare due to accidents)
(4) Costs of property damage
(5) Administrative costs

The relative shares of these components vary between fatalities and the various degrees of injuries and also among countries. In the framework of this study, official valuations of accident injuries and damage from each country were considered (when available), otherwise, comparative figures from recent studies were used. Furthermore, for consistency and comparability reasons of the evaluation results, all monetary values were converted to € at 2002-prices.

f. Implementation costs

Implementation costs should be determined for each safety measure considered and they are the social costs of all means of production (labour and capital) employed to implement the measure. Implementation costs are generally estimated on an individual basis for each investment project. As there are no strict rules available, all components of the implementation costs should be clearly explained. Typical costs of engineering measures, which are recommended for cost-benefit analysis evaluations are desirable and in any case, implementation costs should be converted to their present values, which include both investment costs and the annual costs of operation and maintenance. Similar to the case of accidents costs, for the sake of comparability of the evaluation results, the monetary values will be converted to € at 2002-prices.

4. RESULTS OF EFFICIENCY ASSESSMENT

The efficiency of various road safety measures was assessed through eighteen case-studies conducted in different countries and the ten selected measures covered different road safety related categories, decision-making levels and target accident groups. More specifically, three cases concerned vehicle-related measures (fitting motorcycles with ABS, compulsory DRL for the whole year), nine cases concerned infrastructure-related measures (traffic calming measures in urban areas, grade separation of at-grade rail-road crossings, installation of roadside guardrails, introducing signal control at a rural junction, constructing 2+1 road sections) and six cases concerned user-related measures (automatic speed enforcement, large-scale projects of intensive police enforcement, compulsory helmet wearing for cyclists).

The following Table 1 summarises the results of the efficiency assessment analyses and the characteristics of evaluation methods applied.

Table 1: Summary characteristics of the case-studies

Nr.		Case Study	Category of measures				Level of implementation			Country of measure	Case-responsibility	Description of measure	Target group			Implementation costs			Accident costs			Source of safety effect value				Other effects				CBA results
			Vehicle-related	Infrastructure-related	User-related - Enforcement	User-related - others	National	Regional	Local				All accidents	All drivers	Accident/ driver sub-group	Official data	Literature	Estimates	Official data	Literature	Estimates	Before-after comparison	Regression model	Literature	Assumptions	Air pollution	Noise	Time savings	Fuel consumption	Benefits to costs ratio
A	1	ABS-Motorcycle	√				√			AT	AT	Fitting motorcycles with ABS and reducing ABS taxes			√		√	√	√					√	√					1.1-1.4 9.4-11.7
B	1	Section Control			√				√	AT	AT	Automatic speed enforcement in a tunnel (motorway)	√			√			√			√				+				5.4
	2	Section Control			√				√	NL	AT	Automatic Speed Enforcement on a motorway	√				n/a		√					√		+	+			n/a
C	1	Daytime running lights	√				√			CZ	CZ	DRL for the whole year		√			√	√	√					√		-			-	4.3
	2	Daytime running lights	√				√			AT	CZ	DRL for the whole year		√			√			√				√		-			-	3.6
E	1	Traffic calming (urban areas)		√					√	IL	IL	Speed humps (1 road)	√			√			√		√	√						-		2.0-4.0
	2	Traffic calming (urban areas)		√					√	GR	GR	Speed humps, woonerfs (area)	√			√			√		√	√						-		1.9-2.4
	3	Traffic calming (urban areas)		√					√	CZ	CZ	Roundabouts instead of four-arm intersections	√			√			√			√								1.5
F	1	Rail-road crossings		√					√	IL	IL	Grade separation of at-grade rail-road crossing	√			√		√	√		√		√					+	+	1.4 (urban) 2.8 (rural)
	2	Rail-road crossings		√					√	FI	FI	Grade separation of at-grade rail-road crossing	√					√	√						√			+	+	0.94 (urban) 2.5 (rural)
G	1	Measures against collisions with trees (guardrails)		√					√	FR	FR	Implementation of roadside guardrails			√	√			√			√								8.7
H	1	Road improvement mix (rural areas)		√					√	IL	IL	Introducing traffic signal control at a rural junction	√			√		√	√		√	√								1.25
I	1	Intensive police enforcement			√		√			GR	GR	5-year project (interurban roads), with emphasis on speed and alcohol	√			√		√	√		√		√	√						6.6-9.7

Nr.		Case Study	Category of measures				Level of implementation			Country of measure	Case-responsibility	Description of measure	Target group			Implementation costs			Accident costs			Source of safety effect value				Other effects				CBA results
			Vehicle-related	Infrastructure-related	User-related - Enforcement	User-related - others	National	Regional	Local				All accidents	All drivers	Accident/ driver sub-group	Official data	Literature	Estimates	Official data	Literature	Estimates	Before-after comparison	Regression model	Literature	Assumptions	Air pollution	Noise	Time savings	Fuel consumption	Benefits to costs ratio
	2	Intensive police enforcement			√		√			IL	IL	1 year project (interurban roads)	√			√		√	√		√	√	√							3.5-5.0
J	1	2+1 roads		√					√	FI	FI	Constructing a 2+1 road section (without median cable)			√	√			√						√					1.25
	2	2+1 roads		√					√	SW	FI	Constructing a 2+1 road section (with a median cable)			√	√			√						√			+		2.26
K	1	Compulsory helmet regulation for cyclists				√	√			AT	AT	Compulsory bicycle helmet wearing			√			√	√					√						1.14-2.28
	2	Compulsory helmet regulation for cyclists				√	√			DE	AT	Compulsory bicycle helmet wearing			√			√	√					√						2.23-4.45

As shown in the above Table, enforcement-related measures appear to be more cost-effective than other road safety measures, obviously due to lower implementation costs. The efficiency of other user-related measures and of vehicle-related measures is also relatively high due to the same reason (low implementation costs per unit of implementation). On the other hand, the efficiency of infrastructure-related measures varies widely, depending both on the construction costs and safety effects of the measures. National-level measures in general, seem to be more cost-effective than local-level measures; however, this mostly stems from the fact that the majority of local-level measures are road infrastructure improvements, with usually high implementation costs.

Table 1 also indicates that no significant differences can be found in the efficiency of similar measures applied in different countries. Additionally, the target accident group / target population usually includes all road accidents / all drivers, with some obvious exceptions such as case A ("fitting motorcycles with ABS") for which "motorcycle riders" are the natural target population, case G ("implementation of roadside guardrails") which is dedicated to the prevention of roadside collisions with trees, case J ("2+1 roads") which struggles with head-on collisions and case K which only concerns bicycle riders.

The calculation of the accident costs was based on official national data and only in a few cases (mostly, in the Israeli and Greek case-studies on infrastructure-related measures and intensive police enforcement) some adaptations of the official injury costs were made to provide a valuation of an average accident.

Another outcome of the efficiency assessment concerned availability of implementation costs, which proved to be problematic in many cases. Nevertheless, in the majority of cases the estimations of implementation costs were based on the official data provided by relevant authorities. In the cases where the evaluation was performed prior to the measure's implementation (i.e. ABS for motorcycles, Daytime Running Lights, compulsory helmets for cyclists) some practical assumptions or the evaluations of similar measures applied in other countries were accounted for in the costs definition.

The main source of evidence on safety effects in most cases were the observational before-and-after studies, using control-groups (Elvik, 1997; Gitelman *et al*, 2001). In other cases, estimates from the literature or from previous research studies were applied and only in a few cases a number of simple assumptions were applied, in order to estimate the safety effect of the measure.

In half of the cases, additional (other than safety) effects were also estimated. In some other cases a need to account for the additional effects was mentioned but not realized due to lacking data/ models which could isolate the effects (i.e. changes in air pollution, noise level, travel time or fuel consumption) associated with the measure.

5. CONCLUSIONS

Cost-benefit and cost-efficiency analyses are considered to be the most important tools in the hands of decision makers, for the economic appraisal of various road safety measures. Their application on eighteen case studies in nine EU countries concerning measures' efficiency assessment revealed the important potential of these evaluation techniques in the overall decision-making process in several EU countries. These research initiatives provide some insight on the existing road safety activities; they are frequently leading to interesting conclusions and thus are usually transferred to policy-makers. The main conclusions concerning the basic components for the execution of efficiency assessment as derived through the evaluation techniques application are presented below.

5.1 Applied evaluation techniques

Only cost-benefit analysis was applied in all case studies examined, as many limitations related to the cost-effectiveness analysis application were identified, especially in cases where only a single measure is evaluated and specifically, when the evaluation should also account for other than safety effects. Moreover, the discussions on the efficiency assessment results with the various decision-makers seem easier when the outcomes are presented in monetary terms.

In all studies no project alternatives were considered and the implementation of a specific measure was assessed against no safety measure application at all. All other steps of the cost-benefit analysis evaluation procedure, i.e. consideration of safety effects and side effects (on mobility and environment), presenting all effects in monetary terms, estimating implementation costs, calculation of present values of costs and benefits and of efficiency measure (cost-benefit ratio), were applied in the majority of the studies; any exceptions were mainly due to lack of data.

During the estimation of the safety effects of the measures, emphasis was put on the application of correct safety evaluation. In the "ex-ante" evaluations the best available values of safety effects, which are based on a summary of previous experience/studies, were typically applied. In the "ex-post" evaluations, the safety effect value was typically estimated by means of the odds-ratio with a comparison group. A weighted value of the effect, based on the safety experience of a group of treated sites, was applied when possible, and in these cases, confidence intervals for the estimated safety effects were also provided.

With reference to the economic evaluation, typical scenarios adopted can be characterised as "conservative" or "best estimate", although they were based on different approaches in each case. In some cases, different scenarios were dictated by several values of safety effects and in others by a consideration of safety effects only versus a combination of safety effects with other side-effects. In any case, consideration of a number of scenarios appears to be useful for testing sensitivity of the results and is therefore recommended for the usual evaluation practice.

Summarizing the performance of the evaluation studies, several conclusions can be drawn, indicating common technical problems which might occur during the cost-benefit analysis evaluations. These are mainly related to the correct application of the odds-ratio technique, identification of ways for validating the statistical significance of the evaluation results, the proper selection of side-effects to be considered along with safety effects and also the correct distinction between the implementation costs and negative side-effects of the measure. Especially when cost-benefit analysis is applied on safety-related measures, categorization of all cases, indicating the types of impacts that will be considered in the evaluation of each category of measures, can lead to a more accurate and uniform performance.

For example, in the cases of infrastructure or enforcement measures, which have an implication on travel speeds, consideration of changes in travel time would be useful. Another question concerns the inclusion of fines in the economic evaluation of enforcement measures and a possible recommendation is to include all the investments made for enforcement measures in the costs, in order to consider fines as benefits.

In cases where a number of impacts are combined in the evaluation of a measure, a distinction should be made between the implementation costs and negative benefits of the measure. Implementation costs are the social costs of all means of production (labour and capital) that are employed to implement the measure, whereas the benefits include all effects which stem from the measure's application. Some benefits may be negative, i.e. increased travel time and in such cases, their values are subtracted from the total benefits.

In general, estimated safety effects should satisfy the criteria of a correct safety evaluation, i.e. to account for general accident trends, selection bias and possible confounding factors. The effect on number of accidents needs to be based on a comparison of the null hypotheses (accidents which would occur if no measure had been taken) with actual accident numbers observed after applying the specific measure. The applicable techniques can be found in many literature sources (i.e. Elvik, 1997; Elvik, 1999) and it is common belief that a distribution of a brief guide on standardized techniques for the evaluation of safety effects would be helpful for safety practitioners and particularly, for the improvement of quality of the efficiency assessment studies.

5.2 The efficiency assessment components: data and values

Accident data were easily accessible in most case-studies. The valuations of road accident injury costs were usually provided by recently published evaluation studies, however, it was difficult to attain costs of road safety measures. In the cases of infrastructure improvements and enforcement projects, the investments are in most cases paid from the public sector, therefore it frequently appears difficult to determine the total values of these costs. Consultations with the responsible decision-makers and analysis of valuations from similar studies may serve as the appropriate sources of values in such cases.

Establishing databases with typical implementation costs of safety improvements can be a practical solution for the systematic use of these values for efficiency assessment studies. While the "ex-post" studies typically estimate the actual safety effect which can be associated with the application of safety measures, the "ex-ante" studies apply the available values, which should be based on previous research. To stimulate the application of more uniform and well-based values of safety effects, it would be useful to establish a database with typical values of the effects, based on international experience. Such a database might be open to a European network of experts and provide for general values of safety effects on initial steps of cost-benefit/cost-effectiveness analyses, as well as assist in judging the local effects observed.

Lack of models for evaluating side-effects associated with the safety measure (i.e. changes in air pollution, noise level, travel time or fuel consumption) and sometimes lack of local valuations of theses effects, deter their consideration by the efficiency assessment studies. This constrain can be tackled by a systematic accumulation of recommended values and solutions, depending on safety measures considered, within the guidelines for the efficiency assessment performance.

5.3 Role of barriers

The fundamental barriers to the application of efficiency assessment techniques to road safety measures were not really considered when conducting these case-studies. None of the decision-makers involved rejected the principles of efficiency assessment but concerning decision-making at local level, some experts doubted the practical influence of the evaluation results, mostly due to the awareness of other factors (political, emotional), which usually influence similar decisions.

On the other hand, the relative barriers, of institutional or technical nature, significantly influenced the cases' performance. Technical barriers such as typical problems with the evaluation techniques or lacking of data, were generally overcome by the evaluation studies. In some cases, thoroughly based statistical models were developed to ascertain the lacking values of the effects and generally, most technical barriers, which appear during the performance of an efficiency assessment study, can be successfully treated.

Lack of obligatory procedure for the performance of cost-benefit evaluations of safety effects is also acknowledged as a major institutional barrier for the application of the efficiency assessment on road safety measures. However, in many cases the cost-benefit analysis results emphasised the accident reduction effects and the economic savings associated with the measures' application. As a result, the decision-makers were interested in the distribution of the efficiency assessment outcomes and in further performance of the analyses.

As to the barriers for implementation of safety measures, which were evaluated by the studies and found effective in the majority of cases, different forms of these were identified. The wide application of the measure is frequently limited due to lack of finance, high costs, and other economic reasons. Sometimes, safety reasons may conflict with other considerations (i.e. environmental issues) and in other cases (i.e. helmets for bicycles, daytime running lights, automatic speed enforcement) lack of publicity support or lack of acceptance by the general public deters the decision-makers from the measure's promotion. However, in several cases (e.g. daytime running lights for the Czech Republic, grade-separation of rail-road crossings in Israel, traffic calming in urban areas in Greece) the cost-benefit assessment results highlighted the expected benefits of the measures and in this way, contributed to the acceptance of the measure by the decision-makers.

5.4 Role of efficiency assessment in decision-making

Efficiency assessment is often an important part of the preparation of regional or local road safety plans. At the initial stage of evaluation, safety effects are usually unknown and in order to influence any decision making process, the efficiency assessment studies have to be prepared ex-ante, using impact data from similar measures application. This stresses the need for availability and accessibility of evaluation studies on road safety measures, as well as dissemination of efficiency assessment results on an international basis.

At the local level, the application of a road safety measure does not only depend on its economic profile but also on subjective judgment. In case a program of efficient measures is developed at the national level but executed at regional or local level, benefits estimated at the national level may not be visible at the local level, where costs and local political interests dominate the decision makers' perspective. During the preparation of efficiency assessment studies within such an environment, the financial benefits need to be explained, considering the level of future decision making in the best possible way. Moreover, there are cases where decision-making at local level is influenced by personal experiences, highlighting the conflict between traditional arguments used in decision making and efficiency assessment as an instrument to be promoted. Decisions at the local level involve both global and local interests, thus in order to present any results it is important to fit the arguments to the level of decision-makers. To preserve the intentions of the national safety programs, the arguments need to include an appropriate presentation for the promotion of the original intentions at the regional or local level. It should also be mentioned that local decision makers in charge of road safety decisions believe that other than casualties (i.e. mobility costs, time use, environmental costs) can hardly be used in local decision-making.

Difference between cost-benefit and cost-effectiveness analyses also depends on the formal process of funding. As far as the French model was concerned, the question of selecting guard-rail installation versus tree felling could be based on cost-effectiveness analysis, but emotional arguments were dominating the negotiations in the detailed planning process. In general, at local level efficiency assessment should be more directed to road safety and economic experts than to local decision makers.

In countries where the safety budget is centralized and projects are mostly financed by the government, the requirement of a cost-benefit analysis of safety measures may be distributed by stating it as a condition for the application of projects coming from the central budget.

Summarizing the performance of the case-studies, cost-effectiveness analyses can be more applicable at the local level as no comparison with conflicting targets is usually performed. The method of cost-benefit analysis at lower levels of decision making appears to be quite abstract. Specifically, in discussion with local peer groups, benefits at the national or even global level are weighted low or even disregarded, since impacts are not visible at the local level.

This study revealed that several common technical constraints for performing efficiency assessment of road safety measures may occur, with lack of data/information on safety effects and costs, as well as doubts on the validity of the available values being the two major ones. Additionally, lack of obligatory procedure for the performance of cost-benefit and cost-effectiveness evaluations of safety effects is acknowledged as the most important institutional barrier for the application of the efficiency assessment of safety measures (Winkelbauer *et al*, 2005).

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ΑΠΟΤΙΜΗΣΗ ΤΗΣ ΑΠΟΤΕΛΕΣΜΑΤΙΚΟΤΗΤΑΣ ΕΠΙΛΕΓΜΕΝΩΝ ΜΕΤΡΩΝ ΟΔΙΚΗΣ ΑΣΦΑΛΕΙΑΣ

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Περίληψη: Στόχος της παρούσας εργασίας, η οποία πραγματοποιήθηκε στο πλαίσιο του ευρωπαϊκού ερευνητικού έργου "ROSEBUD - Ανάλυση κόστους-ωφελειών και κόστους-αποτελεσματικότητας μέτρων οδικής ασφάλειας και προστασίας του περιβάλλοντος για την υποστήριξη των αποφάσεων" του 5ου Προγράμματος - Πλαισίου της Ευρωπαϊκής Επιτροπής, είναι η διερεύνηση και αξιολόγηση της αποτελεσματικότητας των μέτρων οδικής ασφάλειας που λαμβάνονται σε διάφορα κράτη της Ευρωπαϊκής Ένωσης, με στόχο τη βελτίωση του επιπέδου οδικής ασφάλειας. Η διαδικασία αποτίμησης βασίστηκε στην εξέταση των κυριότερων παραγόντων καταλλήλων μεθοδολογιών αξιολόγησης της αποτελεσματικότητας μέτρων οδικής ασφάλειας και συγκεκριμένα αναλύσεων Κόστους-Ωφελειών και Κόστους-Αποτελεσματικότητας, οι οποίες εφαρμόστηκαν σε "πραγματικές" συνθήκες και ελέγχθηκαν με την πραγματοποίηση δοκιμαστικής εφαρμογής σε δεκαοκτώ υφιστάμενα μέτρα για τη βελτίωση της οδικής ασφάλειας σε εννέα Ευρωπαϊκά κράτη. Τα βασικά βήματα και τα απαιτούμενα δεδομένα για την εκτέλεση των παραπάνω αναλύσεων εξετάστηκαν αναλυτικά με έμφαση στους βασικούς ορισμούς και τύπους των μεθοδολογιών, στα αποτελέσματα της εφαρμογής των διαφόρων μέτρων στην οδική ασφάλεια, στα χαρακτηριστικά των εξεταζόμενων επεμβάσεων και των εξεταζόμενων ατυχημάτων, καθώς και στα κόστη ατυχημάτων και μέτρων εφαρμογής. Τα συμπεράσματα αφορούν τόσο στην αποτελεσματικότητα των μέτρων οδικής ασφάλειας και των μεθοδολογιών αποτίμησης, όσο και στον εντοπισμό των κυριότερων προβλημάτων και παραγόντων που εμποδίζουν την αποτελεσματική εφαρμογή τους. Τα αποτελέσματα των αναλύσεων κατέδειξαν την αναγκαιότητα κατανόησης των βασικών αρχών των μεθοδολογιών αξιολόγησης, προκειμένου να τεκμηριώνεται η λήψη σχετικών αποφάσεων και να μεγιστοποιείται η αποτελεσματικότητα των μέτρων που υιοθετούνται. Επιπλέον, έγινε εμφανής η ανάγκη για ανάπτυξη κοινού πλαισίου αποτίμησης δράσεων οδικής ασφάλειας σε διεθνές επίπεδο.

Λέξεις κλειδιά: αξιολόγηση αποτελεσματικότητας, μέτρα οδικής ασφάλειας, λήψη αποφάσεων, ανάλυση κόστους-ωφελειών, ανάλυση κόστους-αποτελεσματικότητας

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