International Transport Forum

Sharing Road Safety

Developing an International Framework for Crash Modification Functions

Research Report

Summary Document

OECD

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INTERNATIONAL TRANSPORT FORUM

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SUMMARY DOCUMENT

This is a summary of the report *Sharing Road Safety*. The report was developed by a group of international experts representing 18 countries, under the aegis of the Research Centre of the International Transport Forum at the Organisation for Economic Co-operation and Development (OECD).

Road safety policy is increasingly dependent on sound indicators of the effectiveness of interventions. Crash modification factors and crash modification functions (CMFs) are indicators that quantify the crash reductions that result from interventions. The purpose of this report is to emphasize the importance of sharing knowledge on the effectiveness of interventions and transferring of results internationally.

This summary document comprises the key messages and recommendations, as well as the table of contents of the full report, together with details of the experts who contributed to the work.

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RECOMMENDATIONS

- Road safety policies should undergo performance and efficiency evaluation. Such evaluations cannot be undertaken without Crash Modification Functions (CMFs). Evaluation processes should be documented to ensure they are transparent.

- Research conducted to develop CMFs should follow the guidance provided in this report and, in particular, provide specific information that describes the countermeasure under consideration, the safety issue being addressed and the roadway environment in which it was tested.

- It is recommended that an international group be composed under an existing organization (e.g. Transportation Research Board, World Road Association, etc.) to foster dialog among researchers and practitioners on CMF research and reporting standards with the aim of increasing transferability of results. Coordination of research across countries on top priority countermeasures should be considered.

- International cooperation should aim to capture documentation and reporting of CMF research in a widely available transnational database.

- A concerted effort should be made to publicize the benefits of decision-making based on CMFs. This should take the form of presentations and workshops at transport, injury prevention and health conferences; press releases; letters to political leaders and senior bureaucrats.

KEY MESSAGES

- The decision making process for safety interventions is complex, involving a number of actors (experts, public, politicians etc) and issues (environment, economy, congestion) competing for the scarce resources available. The risk of making poor decisions and the cost of making better decisions can be reduced by the use of reliable studies on how effective different safety measures are (ie. Crash Modification Functions – CMFs).

- Road safety policy is increasingly dependent on sound indicators of the effectiveness of interventions. Policy makers need not only to justify expenditure on safety in terms of effectiveness but to argue convincingly for measures in the face of sceptical and sometimes hostile lobbies. Crash modification factors and crash modification functions (CMFs) – the indicators that quantify the crash reductions that result from interventions – are persuasive in this context.

- CMFs are fundamental to identifying the most effective road safety countermeasures and for calculating safety benefits in economic analyses of safety policies when trying to make optimal use of resources.

- Demand for CMFs is growing in many jurisdictions as policy makers are increasingly required to demonstrate results and undertake cost-benefit and efficiency assessments.

- Lack of reliable knowledge of the effects of countermeasures is a key barrier to the advancement of many critical, life-saving, initiatives. CMFs can be an effective tool in communicating that knowledge. Improved CMFs – in terms of presentation and dissemination, methodology and transferability between jurisdictions – will have tangible benefits for decision making.

- There is a need for more training and regular practical usage of CMFs to support the development of transferable CMFs. We are currently at a turning point, with the prospect of rapid advances and major cost savings through the transfer of results internationally.

- Transferability of CMFs relies first and foremost on analysing the extent to which a CMF is dependent on the circumstances in which it was developed.

- Variability in CMF research results is a major deterrent to transferability. Reducing variability through proper study design and reporting enhances transferability. Studies should control for the most important confounding factors related to the countermeasure analysed. Variability due to different circumstances can be reduced by making the CMF a function of the relevant circumstances. A key aim of the current report is to provide guidance for uniform screening and control procedures.

EXECUTIVE SUMMARY

The decision making process for safety interventions is complex, involving a number of actors (experts, public, politicians etc) and issues (environment, economy, congestion) competing for the scarce resources available. The risk of making poor decisions and the cost of making better decisions can be reduced by the use of reliable studies on how effective different safety measures are (ie. Crash Modification Functions – CMFs).

Road safety policy is increasingly dependent on sound indicators of the effectiveness of interventions. Policy makers need not only to justify expenditure on safety in terms of effectiveness but to argue convincingly for measures in the face of sceptical and sometimes hostile lobbies. Monitoring and analysis of effectiveness is not without cost, and indicators that relate safety improvements to interventions, "Crash Modification Functions", that are transferable from one situation to another are a valuable tool in spreading effective safety policies.

Crash Modification Functions (CMFs) are fundamental to identifying the most effective road safety countermeasures and for calculating safety benefits in economic analyses of safety policies when trying to make optimal use of resources.

Each year about 1.3 million people are killed and another 50 million people are injured on roads worldwide (WHO, 2010). These road crashes cost countries between 1 and 3 percent of their Gross Domestic Product (WHO, 2004). In addition, they cause great emotional and financial stress to the millions of families that are affected by these crashes. Many of these crashes can be prevented by implementing effective road safety measures. To be able to select the best measure, a decision maker needs information about the effectiveness of different measures. Moreover, information about the effectiveness of measures is needed to ensure governments invest appropriate amounts in road safety compared to the other demands on their budgets. In this light, many countries share the need for reliable estimates of the effectiveness of road safety treatments and strategies.

Many countries are moving toward the development of uniform criteria for establishing the effectiveness of road safety investments and infrastructural projects in general. For example, in the European Union, the Directive 2008/96/CE on "Road Infrastructure Safety Management" was published in November 2008 and will have to be implemented, at least on the Trans European Road Networks, in all the Member States. From both a scientific and policy point of view it is important to adopt a similar approach for determining the effectiveness of measures as this will lead to more reliable, credible and accessible tools and methods for the evaluation of safety effectiveness.

A crash modification function (CMF) allows a synthesis of diverse evaluation results that in turn allows for more universal understanding and application of safety effectiveness measures. The fundamental argument for a CMF is that it could allow more rapid adoption and dissemination of new life-saving safety measures. In the current political and administrative climate, the decision making process often demands a system of experimental local evidence and feedback before countermeasures are accepted as effective. This is the so-called principle of "learning by doing."

A properly developed CMF could facilitate this process and give local authorities more confidence in a particular measure, and allows earlier inclusion in strategies and guidelines sooner in the process.

Many decisions, when acted upon, affect road safety. CMFs facilitate the prediction of safety effect. So-called efficiency assessment tools (EATs) can help governments choose those measures that will likely maximize the social benefits of public investment. EATs have been defined as "a systematic assessment of the improvement in road safety that can be realised by means of various road safety measures" and comprise cost-effectiveness analysis and cost-benefit analysis. Cost-effectiveness analysis (CEA) seeks to compare the number of crashes/casualties prevented per unit of cost, for each of the available road safety measures. Cost-benefit analysis (CBA) addresses the question of integral efficiency, and aims at comparing the costs and benefits of different policy alternatives, measured in monetary units.

The main elements of EATs are:

1. A list of road safety measures available for solving a given safety problem.

2. An estimate of the effectiveness, i.e. the CMF, of each measure.

3. An estimate of the costs of each measure.

4. In CBA, a monetary valuation of impacts on safety, environment, travel time.

As noted, CMFs are used in point 2, and constitute an essential element of any efficiency assessment.

Demand for CMFs is growing in many jurisdictions as policy makers are increasingly required to demonstrate results and undertake cost-benefit and efficiency assessments.

Many countries set specific quantitative road safety targets and adopt road safety strategies to achieve these targets, within the constraints of the established priorities and the resources available. Within this framework, the efficiency assessment of road safety measures is considered to be an extremely useful tool in decision making. In particular, cost-benefit and cost-effectiveness analyses are carried out in several countries, in a more or less systematic way. These studies are based on some estimate of the safety effects of the examined measures following the implementation of the measure. However, a more widespread or fruitful use of efficiency assessment of road safety measure is in most cases limited by a lack of knowledge and data on the safety effects of road safety measures.

Nevertheless, the importance of efficiency assessment in road safety is widely recognised, and the need for more knowledge and best practice examples is becoming more and more pronounced. Existing best practice recommendations may cover the whole range of the efficiency assessment process, from the selection and application of appropriate and standardised methodologies to the interpretation of results and the identification of most efficient measures, especially in case different alternative measures need to be compared and ranked. However, the most important uncertainties involved in developing such best practice recommendations concern the adoption of appropriate values for the safety effects of road safety measures.

In the recent years, important research efforts have been made towards the standardization of the methods for estimating the safety effects of road safety measures by addressing some critical issues. The first issue examined concerns the accuracy of the estimation, so that potential bias or other confounders are eliminated. The second critical issue concerns the conditions and necessary adjustments required to allow the transferability of the safety effect estimates to different settings or countries.

This question has become very important at the international level, and particularly within the development of handbooks and manuals aiming to assist decision makers, researchers or other stakeholders involved in the efficiency assessment of road safety measures.

These sources are often used by countries within their national road safety efficiency assessment analyses, by adopting the values proposed (e.g. in terms of percentage reduction of crashes / fatalities, or CMFs), or by adjusting them to the local conditions. However, due to the important gaps in the knowledge concerning the transferability of such values across countries, several counties have developed their own methods and values for assessing the effectiveness of road safety measures.

The knowledge obtained from the international literature may prove very useful in the identification of good practice and cost-effective measure. However, thorough analysis on a case-specific basis is always necessary in order to produce a precise estimate of the effects of a measure in different countries or areas, taking into account the extent of the implementation, the implementation period, and specific national or local requirements. It is also necessary to ensure that such analyses are carried out in accordance with recognised standard methodologies.

Ultimately, efficiency assessment is an important part of the preparation of national, 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 previous programs using similar measures.

This stresses the need for strengthening the efforts for the estimation of appropriate values for the safety effects of the treatment examined. Moreover, it highlights the need for increasing the accessibility of this information, through the dissemination of efficiency assessment results on an international basis. Utilising information provided in this report can facilitate greater exchange of this information on an international level.

Lack of reliable knowledge of the effects of countermeasures is a key barrier to the advancement of many critical, life-saving initiatives. Improvement of our knowledge of CMFs will have tangible benefits for decision making.

In some instances, no efficiency assessment is carried out at all during the decision-making process. This is often due to a lack of knowledge about the expected impacts of available safety measures. This view is substantiated by a variety of experiences, most notably by Work Programme 2 of the European thematic network ROSEBUD. The main question of the questionnaire had to do with the reasons why efficiency assessment tools were not always performed. About 30 percent of the responses pointed to technical barriers, most of them connected with the lack of knowledge about impacts. A key conclusion from this example and other discussions is that any improvement in our knowledge of the effectiveness of safety measures, i.e. CMFs, will likely have tangible benefit on the way safety decisions are made. This report aims at providing guidance and support for overcoming this kind of technical barrier.

There is a need for more training and regular practical usage of CMFs to support the development of transferable CMFs. We are currently at a turning point, with the prospect of rapid advances and major cost savings through the transfer of results internationally.

While the understanding of CMFs among countries likely ranges from little knowledge of CMFs to a level of spreading knowledge and growing use of CMFs, it can generally be said that there is currently a lack of a full understanding of the value, importance and usage of CMFs in road safety decision making. At this time, CMFs may be integrated into guidelines and some state, provincial or other local governments may be using CMFs systematically to some extent in their decision making. However, there are currently no countries where CMFs are routinely used nationally in a direct manner by practitioners as part of the planning, design and management of roadways. As a result, there is not yet broad demand for a full library of CMFs from the international road profession. Lack of education, knowledge and practical usage of CMFs is currently the biggest obstacle to CMF development and transferability. However, because the underlying drive for effective safety and effectiveness analysis is taking place in a relatively universal fashion, the demand for reliable estimates of safety effects will continue to grow and the demand for knowledge and information on CMFs should grow in a corresponding fashion.

Transferability of CMFs relies first and foremost on analysing the extent to which a CMF is dependent on the circumstances in which it was developed.

International transferability of the results of road safety evaluation studies will take place most effectively in the ideal situation of studies being available from many countries over a long period, and when all these studies are of at least adequate and similar methodological quality. Many designs are used in road safety evaluation studies. The design is often dictated by the circumstances under which the evaluation was carried out and the skills and resources available. It is therefore unrealistic to expect that all studies have applied designs that are identical down to the finest detail. It is, however, reasonable to require that studies uniformly control for at least the most important potentially confounding factors.

While the ideal situation is difficult or impossible to attain, the report makes it clear that transferability of CMFs depends on knowing the circumstances under which different safety measures have been implemented. Two identical measures, implemented under two identical sets of circumstances, should have the same impact on the frequencies of accidents and casualties. Conversely, differences in circumstances are expected to induce differences in effectiveness.

It is essential that researchers disseminating the results of an effectiveness assessment provide as accurate and complete a description of circumstances as possible. This will allow researchers and practitioners from others regions and countries to evaluate the possibilities of successfully transferring the measure. As far as possible, the information about circumstances should be quantitative; only then can accident modification functions be developed. However, there is not any unique set of circumstances that might be said to be relevant to every research project.

Generally, documentation on a variety of supporting information related to the countermeasure, the development process and conditions under which the countermeasure was tested are valuable. The report presents a specific list of items that are considered essential for inclusion in any study presenting safety evaluation results. The report also provides a full list of all the information that would be desirable to have documented in all CMF reports.

Along with information on circumstances, any study should provide safety estimates by severity of the accidents, the standard error of the estimate of effectiveness, as well as some basic information about methods: study design, sample, data sources, biases, and others.

Variability in CMF research results is a major deterrent to transferability. Reducing variability through proper study design and reporting enhances transferability. Studies should control for the most important confounding factors related to a countermeasure analysed. Variability due to different circumstances can be reduced by making the CMF a function of the

relevant circumstances. A key aim of the current report is to provide guidance for uniform screening and control procedures.

When past research indicates that whenever a particular safety countermeasure was implemented instead of some other action, approximately the same safety effect was found, especially under similar circumstances, the issue of transferability in most cases does not arise. Transferability concerns are justified when the same safety effect is not found when the same countermeasure has been applied, i.e. when the variability of the safety effects is large. This concern is valid irrespective of whether the future application is in a different country, city, project or time period.

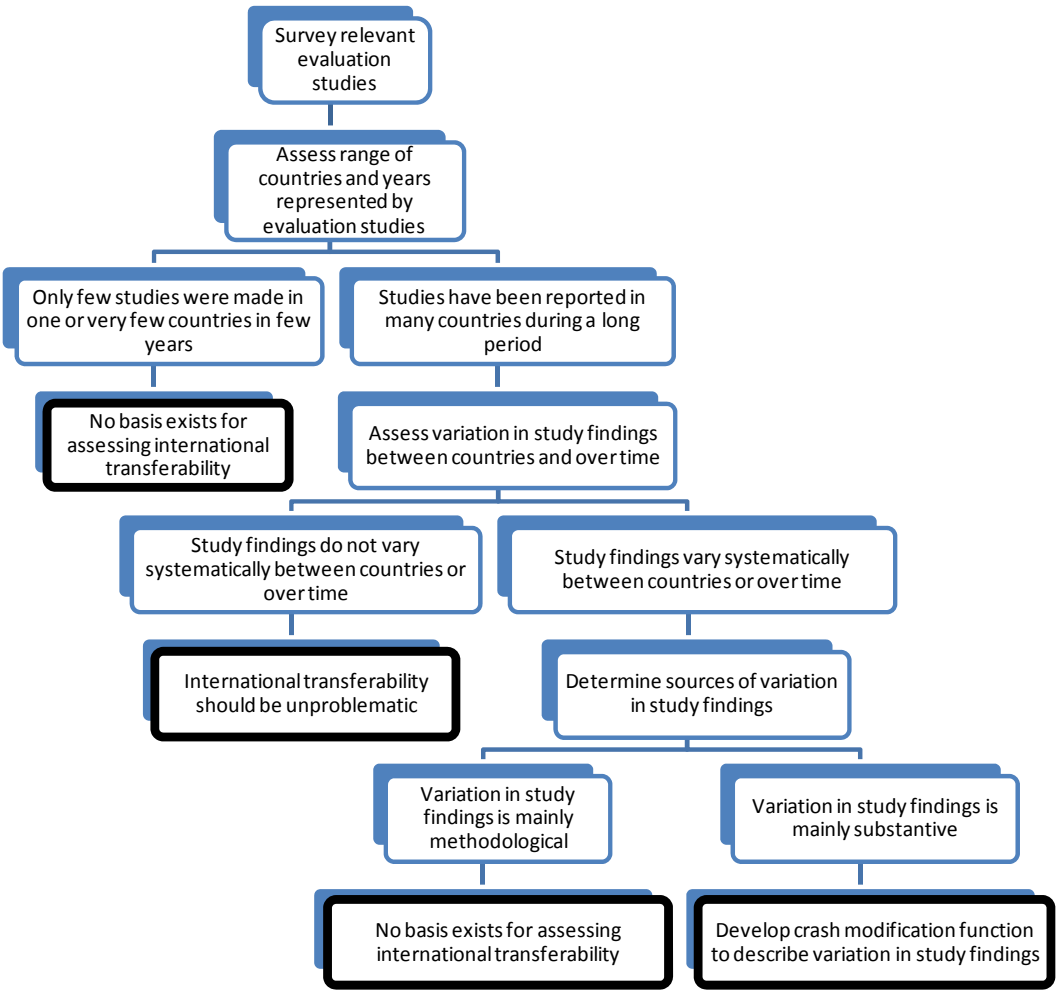
There are two groups of factors that affect the variability of CMFs. One group of factors pertains to the method by which the CMF estimates are obtained. If data is poor, if the sample size is small, if bias and confounding factors are not eliminated, the result will be unreliable. Most statistical attention is paid to this group of factors.

The other group of factors is less commonly examined but is equally important. It has to do with the fact that the same action or measure will have different safety effects in differing circumstances or accidents of different severity. Inasmuch as the CMF estimates we have come from studies conducted in differing times and circumstances, they are bound to differ. They would differ even if data were perfect, the sample size huge, and the experimental method without blemish. The only way by which this source of variability can be reduced is to make the CMF a function of the relevant circumstances. For example, a delineation treatment on curves may be expected to reduce crashes by different amounts depending on the approach speeds and curvature.

To make progress towards reducing the uncertainty about CMFs a two-pronged strategy has to be followed. First, the CMF estimates used to produce the probability distributions have to be reliable. Second, the dependence of the CMFs on the relevant circumstances has to be established. The report indicates one way of trying to answer this question. The answer proposed is that: (1) if there have been many studies of measure X, not just in country A, but in many other countries, and not just six years ago, but spanning three or four decades, and: (2) if these studies obtained highly consistent estimates of the effect of measure X, then: (3) it is more reasonable to conclude that the results of these studies can be applied in country B than to conclude the opposite. In other words, as long as history keeps repeating itself, it is more reasonable to expect it to continue repeating itself than to expect the opposite.

The report describes the range of replications technique and how it can give an indication of the stability of research results across countries and years. The report provides also preconditions that should be fulfilled before applying the range of replications technique. While the applicability of the technique is likely to be limited because of factors such as publication bias, it can be fruitfully applied to assess external validity when a large number of studies have been reported during a long period of time. This is the case with respect to many road safety measures, like road lighting, guard rails, traffic signals, speed limits and seat belts.

Figure 1. Flow-chart for assessing international transferability of road safety evaluation studies



The information contained in the report and summarized above indicate a number of actions that the authors believe could make a difference toward increasing the transferability of CMFs and, ultimately, speed up the process of improving safety on the world's highways.

Road safety policies should undergo performance and efficiency evaluation. Such evaluations cannot be undertaken without Crash Modification Functions (CMFs). Evaluation processes should be documented to ensure they are transparent.

A central element of any cost effectiveness study or cost-benefit study is the requirement to have a reliable or sound estimate of the safety effectiveness of a measure. CMFs are the most effective and supportable measure of safety effectiveness. As such, they offer the greatest opportunity to support a variety of decision making processes. Also, when objective information is used to make safety related decisions, the opportunity to make the processes transparent becomes much greater. The opportunity is greater because substantive, information driven decisions are highly defensible and understandable in the public realm. Non-substantive decisions are generally made in complex political environments behind the scenes and cannot be generally transparent for that reason. CMFs therefore provide a tremendous opportunity to open better and more constructive discussions on the ways and means to address the road safety problem.

Research conducted to develop Crash Modification Functions should follow the guidance provided in this report and, in particular, provide specific information that describes the countermeasure under consideration, the safety issue being addressed and the roadway environment in which it was tested.

Throughout this report, one of the primary issues that hinder the transferability of CMFs and the best practices to improve road safety is the lack of information on the countermeasure being considered and the circumstances under which it was analysed. Without this information, it is impossible to directly understand the safety effects of countermeasure that will be applied in a location different than that where it was previously implemented. Worse yet, it is possible that a lack of understanding can contribute to poor decision making that will lead to an ineffective use of funds or, potentially, the implementation of measures that will result in effective treatments or possibly even to treatments which increase crash frequency or severity. The report has spelled out specific information that should be provided in all reports that identify CMFs. This basic information will be valuable for researchers who want to build upon previous work and for practitioners and policy makers who want to identify countermeasures to address specific safety situations, sometimes in an urgent manner.

It is recommended that an international group be composed under an existing organization (e.g. Transportation Research Board, World Road Association, etc.) to foster dialog among researchers and practitioners on CMF research and reporting standards with the aim of increasing transferability of results. Coordination of research across countries on top priority countermeasures should be considered.

From the beginning of this effort, the group agreed that the final International Transport Forum report would not or could not be a stand-alone end product. Rather, it should establish a starting point for an ongoing process of cooperation and collaboration.

The next step should be in the international review and documentation of CMFs and related supporting information, and in assessment of their quality and potential for transferability. Such efforts would build upon the contents of the present report to continue to enhance and improve research methodologies and approaches for CMF development and reporting. Equally importantly, the report suggests that ideally there would also be efforts made to coordinate or collaborate at an international level on the development of CMFs among countries for high priority countermeasures that several countries have an interest in. Coordination of this type could potentially take many forms, from simply establishing a target countermeasure for research, agreeing on which countries would do independent studies and in what fashion ultimately to be brought back together in a single report. There would also be the possibility of such a group to foster shared research projects that could use “pooled funds” from several countries to develop a single product of value to all participating countries. There are some organizations in the world that would be best suited to convene a group to pursue this work on a sustainable basis. Efforts will be made to inform and enlist these groups as part of the outreach and marketing efforts that follow on the heels of this work.

International cooperation should aim to capture documentation and reporting of CMF research in a widely available transnational database.

International cooperation should advance on the assessment of CMF research results and documentation and reporting of these results should be captured in a widely available transnational database.

Getting the research right so results would be more readily transferable at an international level was the first aim of this work. A concomitant goal was to consider ways to increase availability of CMF information internationally. Ultimately the group believes that an easily available database might be best for people to gain access to this information. Such a database could build upon or be modeled after the work of the CARE database, IRTAD, or the U.S. CMF Clearinghouse. The approach, mechanisms and partnerships for building this database could be established by the group proposed in the previous recommendation.

A concerted effort should be made to publicize the benefits of decision-making based on CMFs. This should take the form of presentations and workshops at transport, injury prevention and health conferences; press releases; letters to political leaders and senior bureaucrats.

The Group believes that efforts should be undertaken to increase awareness, understanding and knowledge about CMFs to foster both greater usage and more international exchange. Members of the group will undertake efforts to promote heightened international information sharing at significant transportation events and elsewhere in the coming years. The Group also recommends that transportation leaders in International Transport Forum member country support, encourage and promote the development, application and international exchange on CMFs to the fullest extent possible. Initiatives of this sort take the form of supporting appropriate research, creating policies that encourage application, and championing decision making based on reliable and quantitative safety information. Ultimately, all of these efforts can propel the International Transport Forum countries to a broader understanding of safety impacts and improve the effectiveness of investments in safety improvements specifically and road expenditures generally.

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