CEDR Transnational Road Research Programme

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CEDR
Conférence Européenne des Directeurs des Routes
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PRACT

Predicting Road ACcidents - a Transferable methodology across Europe

Project outline

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IRF

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pract

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1 Project summary

Currently only in few countries the evaluation of the effectiveness of road safety measures is part of the culture and a routine within the road safety programme, with a dedicated budget. Where this is in place the evaluation is usually limited to infrastructure and enforcement measures while the evaluation of entire road safety programmes is even more rare.

To improve Road Infrastructures Safety Management the road authorities and the road designers need prediction tools allowing them to analyze the potential safety issues, to identify safety improvements and to estimate the potential effect of these improvements in terms of crash reduction.

The PRACT Project (Predicting Road ACcidents - a Transferable methodology across Europe) aims at developing a European accident prediction model structure that could be applied to different European road networks with proper calibration.

The core principles behind the PRACT project structure are that:

- the idea that a unique Accident Prediction Model (APM) model and unique set of Crash Modification Factors (CMFs) can actually be developed, valid for all Europe and for all the different type of networks of motorways and higher ranked rural roads, is unrealistic;
- the development of a specific APM model and a set of CMFs based on local data is extremely time consuming and expensive and requires data and experience that most road administrations do not have;
- the development of “local” CMFs only based on historical local data prevents the possibility of evaluating the effectiveness of new technologies.

The basic assumption on which the PRACT project is therefore built is that APMs and CMFs can be transferred to conditions different from the ones for which they have been developed if selected based on scientifically valid criteria and adapted to local condition based on historical crash data.

The PRACT project is aimed at addressing these issues by **developing a practical guideline and a user friendly tool** that will allow the different road administrations to:

- **adapt the basic APM function to local conditions** based on historical data;
- **identify the CMFs that could be relevant** for the specific application;
- **verify if the selected CMFs are transferable** to the specific condition;
- **apply the calibrated model** to the specific location to be analysed.

As far as different countries, as well as different road authorities within a country, have different level of expertise and different data availability, the system will be structured with different possible calibration levels ranging from a total lack of historical data (in this case the user will be proposed the most suitable set of calibration parameters among the ones that will obtained within the PRACT project with the available datasets) to situations where crash data, traffic data and geometric data are all available and the system could allow also for the calibration of key CMFs.

An important outcome of the PRACT Project will also be the establishment of a European AMF and CMF web repository with an open access database of Accidents Prediction Models and Crash Modification Factors and hints for their application and transferability on the European road networks.

2 Description of project

2.1 Detailed project description

Background

Evaluation of road safety measures appears to be the weakest component of road safety management systems in Europe. Only in few countries the evaluation of road safety measures is part of the culture and a routine activity within the road safety programme, with a dedicated budget. Where this is in place the evaluation is usually limited to infrastructure and enforcement measures while the evaluation of entire road safety programmes is even more rare [1]. Critically, in this era of economic crisis, the justification of investments in a field such as road safety, where large investments can potentially bring little or no results (and on rare occasions negative results), is more than necessary [2].

To improve Road Infrastructures Safety Management the road authorities and the road designers need prediction tools allowing them to analyze the potential safety issues, to identify safety improvements and to estimate the potential effect of these improvements in terms of crash reduction. For this aim in 2010 the AASHTO Highway Safety manual [3] was released including a very comprehensive set of models for predicting road crashes for two-lane rural highways, multilane rural highways, and urban and suburban arterials. The current release does not include a specific set of models for crash prediction on freeways and interchanges.

A first study addressing the issue of the transferability of the rural two-lane two-way roads model to the European networks has been conducted by Martinelli, La Torre and Vadi [4] with reference to the Italian road network of provincial roads.

Crash Prediction Models (usually called also Accident Prediction Models) for freeways were developed by Hadi et al. [5] adopting a negative binomial regression analysis to develop a set of prediction models categorized by crash severity, area type (i.e., urban, rural), and number of through lanes and using data from Florida roadways; Persaud and Dzbik [6] developed two prediction models using data from urban freeways in Ontario, Canada: one for the total number of crashes and one for severe (fatal plus injury) crashes only. These models, together with that proposed by Wang et al. [7], developed for rural divided highways, with characteristics similar to those of rural freeways and few or no access points, were reviewed and modified by Bonneson et al. [8] to estimate the predicted numbers of severe crashes per year (i.e. fatal and injury crashes). Recently, Park et al. [9] have found that the number of predicted crashes is significantly related to average daily traffic, on-ramp density, degree of road curvature, median width and inside shoulder, number of lanes (for urban freeways), and whether the freeway is in an urban or rural area while off-ramp density was not a statistically significant variable. The NCHRP 17-45 "*Safety Prediction Methodology And Analysis Tool For Freeways And Interchanges*" [10] was published in May 2012 as the final report of a research the objectives of which included the production of a chapter for the future edition of the Highway Safety Manual (HSM) with specific crash prediction models for freeways and interchanges. The proposed chapter for freeways [11] has been approved by AASHTO for publication as part of HSM.

The newly developed HSM Freeway model has been applied in Italy within a study conducted by the University of Florence research team with the support of Dr. J. Bonneson, the author of the HSM Freeway and Interchange Model [12].

Most of the new Accident Prediction Models have identified the following form as the most suitable for allowing the widest transferability:

$$N_p = N_{spf} \cdot (CMF_1 \cdot ...... \cdot CMF_m) \cdot C$$

where:

Np = predicted average crash frequency for a specific site;

N_{spf} = predicted average crash frequency determined for the base conditions of the Safety Performance Function (SPF). This typically is only a function of traffic volumes and segment length;

CMF_1 .... CMF_m = crash modification factors (that could be also derived from crash modification functions) accounting for specific site conditions (geometric design, traffic control features etc);

C = calibration factor to adjust the SPF for local conditions related to the network where the model is to be applied. This accounts for all the factors that lead to safety differences and that are not considered by the safety prediction methodology itself (differences in climate; differences in animal populations that lead to higher frequencies of collision with animals; differences in driver populations and trip purposes; complexity of the geometric layout; driver attitude and behaviour (e.g. rate of compliance with road code rules); vehicle fleet characteristics; crash reporting practices; differences in road standards).

The studies conducted on the Italian network have shown that a single calibration coefficient for the whole prediction model might be insufficient to adapt the HSM models to local conditions that differ considerably from those where the model have been developed.

Crash modification factors and crash modification functions – the indicators that quantify the crash reductions that result from interventions – are the basis for evidence based safety policies. Specifically, CMFs are fundamental to identifying the most effective road safety countermeasures. Furthermore, they are a useful tool for achieving optimal use of resources as they allow for calculating safety benefits in economic analyses of safety policies. Through a crash modification function (CMF) it is possible to combine different evaluation results and consequently better comprehend and implement effective safety measures [13]. A CMF could allow more rapid adoption and dissemination of new safety measures. The narrower the CMF distribution, the larger is the probability that policy decisions are correct [1].

The US Federal Highway Administration has developed a very comprehensive CMF clearinghouse (www.cmfclearinghouse.org) where CMFs developed worldwide are classified and assessed with a “star rating” approach.

As indicated in the DoRN there are several CMFs still missing. For the evaluation of the effects of a lack in sight distance in the expected number of crashes, identified in the DoRN as a critical issue a specific study has been conducted within the project “Evaluation of the influence of geometric layout and operating speed on road accidents in motorways segments” funded by the Italian Ministry (2010-2012) and a first CMF for this specific issue has been developed even though additional research is needed.

For the prediction of expected crashes in tunnels most APMs available worldwide are not applicable. The most used model is the one developed by Salvisberg et al [14] that was developed analysing Swiss roads. The applicability of the Swiss model to the Italian motorway tunnels has been studied and presented in [15]. The results show that the Swiss model fits quite well also the Italian existing tunnels even though it is not structured to consider different safety treatments, as those that equip the new tunnels.

Research Issues and Research Objectives:

In the European context, APMs and CMFs are neither as specific nor as detailed. Due to the lack of a common framework in the European context, researchers and policy makers rely on a number of key publications and resources. Technical challenges for the European context include the lack of uniformity in the performance of related research and the reporting of research results, lack of CMFs for assessing the impacts of combined measures, lack of CMFs for assessing road safety programmes and lack of common values for monetary assessment [1]. While most countries use APMs and CMFs developed in other countries, the process of transferring is imperfect and research findings are not well documented. Properly planned, conducted and documented research will improve the transferability of APMs and CMFs. At the moment relatively few studies meet these standards [1].

The necessary transferability of CMFs relies mainly on analysing the extent to which a CMF is dependent on the circumstances in which it was developed. Research conducted to develop CMFs should provide specific information that describes the countermeasure under consideration, the safety issue being addressed and the roadway environment in which it was tested [13].

The main challenges related to the transferability of existing APM and CMFs concern:

- the lack of a uniform understanding of the value, importance and usage of APMs and CMFs in road safety decision making;
- the need to assess the particularities of setting, context, and implementation features of a specific measure and it's CMF;
- the need to define a common and reliable protocol to adapt the APMs and the CMFs to local networks where the models have to be applied based on the available historical data.

The PRACT project is aimed at addressing these issues by developing a practical guideline and a user friendly tool that will allow the different road administrations and other potential stakeholders to:

- adapt the basic APM function to local conditions based on historical data;
- identify the CMFs that could be relevant for the specific application;
- verify if the selected CMFs are transferable to the specific condition;
- apply the calibrated model to the specific location to be analysed.

As far as different countries and different road authorities within a country have different level of expertise and different data availability the system will be structured with different possible calibration levels ranging from a total lack of historical data (in this case the user will be proposed the most suitable set of calibration parameters among the ones that will obtained within the PRACT project with the available datasets) to situations where crash data, traffic data and geometric data are all available and the system could allow also for the calibration of key CMFs.

Research Hypothesis

The core principles behind the PRACT project structure are that:

- the idea that a unique APM model and unique set of CMFs, valid for all Europe and for all the different type of networks of motorways and higher ranked rural roads, can actually be developed in unrealistic;
- the development of a specific APM model and a set of CMFs based on local data is extremely time consuming and expensive and requires data and experience that most road administrations do not have;
- the development of "local" CMFs only based on historical local data prevents the possibility of evaluating the effectiveness of new technologies.

The basic assumption on which the PRACT project is therefore built is that APMs and CMFs can be transferred to conditions different from the ones for which they have been developed if selected based on scientifically valid criteria and adapted to local condition based on historical crash data.
This assumption has already been tested by the PRACT research team and has been proven effective even though a more complex calibration procedure will have to be developed as compared to the single multiplying factor currently considered by the HSM and the CMF to be applied should be selected for the specific location where they have to be implemented.

General Methodology

To meet the requirements of objective 1 of the CEDR Call “Safety” the PRACT project has been organized into 5 Work Packages (WP), as shown in the flow chart in Figure 1.

The proposed methodology can be summarized as follows:

- collect and analyse the APMs currently used by different national road administrations (NRAs) in Europe and worldwide, as well as the currently used data sources for the development and application of APMs (WP1). The different APMs will be reviewed and assessed in terms of theoretical approaches, characteristics of models in use, implementation conditions, data requirements and available results, with focus on motorways and higher ranked rural roads;
- propose the functional structure of the APM to be implemented in the Guideline (WP1);
- review of the recent and salient literature related to the CMF, including the background and development of the CMF, various methods for developing CMFs, and key issues in the application of the CMF (WP2);
- organize the collected APMs and CMFs in a systematic web-repository to support the analysis within the project and for further public use after the project will be completed (WP4);
- identify key CMFs which have not been fully studied or omitted in the literature and, if possible, develop new CMFs (WP2);
- create a Guideline for the implementation of selected accident prediction models for rural freeways and two lane rural highways and for the evaluation of the transferability of these models to a given road network (WP3). The Guideline will include a section on the models description as well as numerical examples and a section with guidance for the development of CMFs not already included in the Guideline itself;
- produce a user-friendly software tool for calibrating the APM to local conditions and for selecting the CMFs applicable to the specific network (WP3);
- disseminate the results to the potential stakeholders at a national and international level (WP5).

To achieve these goals each of the 4 technical WPs (WP1, WP2, WP3 and WP4), some of which are broken down into 2 or 3 Tasks (TK) with very specific objectives (as shown in the flow chart in Figure 1). Each WP will have a highly experienced leader who will be responsible for the coordination of the tasks and for the final production of the WP deliverable.

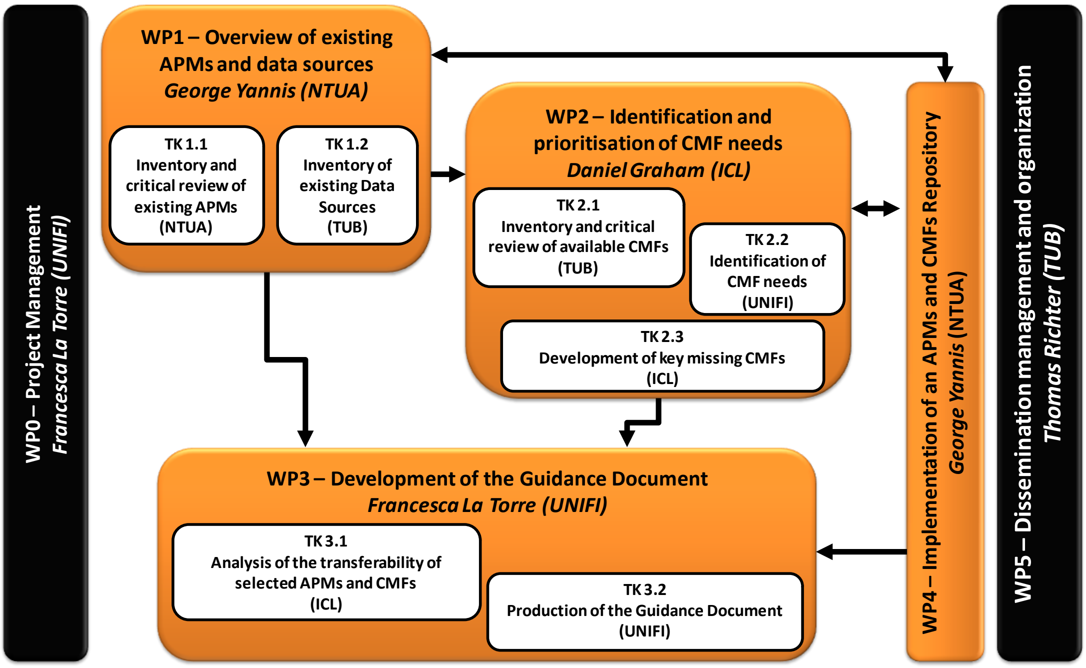


Figure 1: PRACT project flow chart of activities

Given the very short project time frame (24 months) the different WPs cannot run sequentially but there will be overlaps and therefore the scheduling of activities and milestones definition is critical in the proposed project to allow for an acceptable overlap between Work Packages.

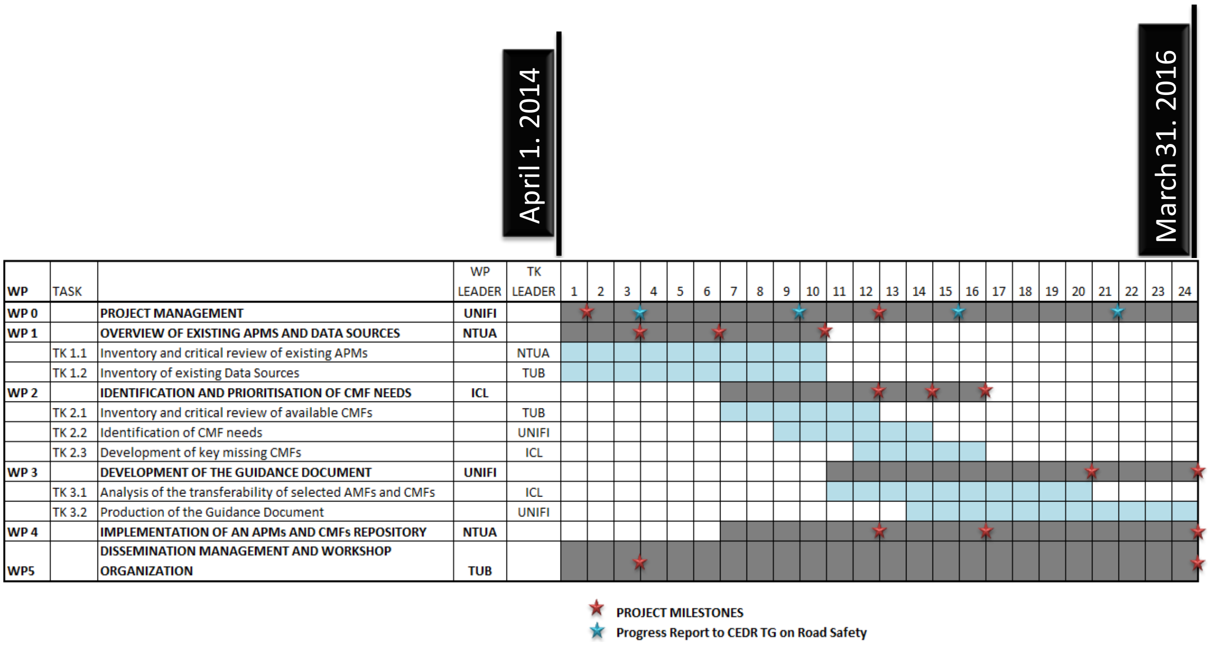
A key issue of the PRACT Project is dissemination and exploitation of the results and findings. Ensuring that the developed Guideline will be practical in use and that it will meet the NRAs and other potential stakeholders' expectations is equally important. For this reason a specific WP has been established under the responsibility of TUB.

The coordinator of the PRACT project being a member of the CEDR TG on Road Safety, presentations are scheduled every 6 months (to be coordinated with the project timing) to update CEDR TG Safety and to gather feedback for the development of the project.

Benefit to road administrations:

Demand for APMs and CMFs is steadily growing as policy makers are increasingly required to demonstrate results and undertake cost-benefit and efficiency assessments. Developing APMs and CMFs for each specific road authority and local condition can be time consuming and economically not feasible. The approach proposed in the PRACT project enables the selection of suitable CMFs and the adaptation of existing APMs to local conditions and this allows any road administration that does not have a specific prediction model to assess the effectiveness of different possible treatments in terms of potential crash reduction.

Timing



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