

Development of an online Repository of Accident Prediction Models and Crash Modification Factors

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1. The PRACT project
2. Review of existing APM/CMF Databases and Road Safety Toolkits
3. Development of PRACT Repository
4. Repository Operation and Features
5. Conclusions



Predicting road accidents - A transferable methodology across Europe

<http://www.practproject.eu/>

funded by the National Road Authorities of Germany, Ireland, UK and the Netherlands within the Conference of European Directors of Roads (CEDR) 2013 Transnational Research Programme - Safety.



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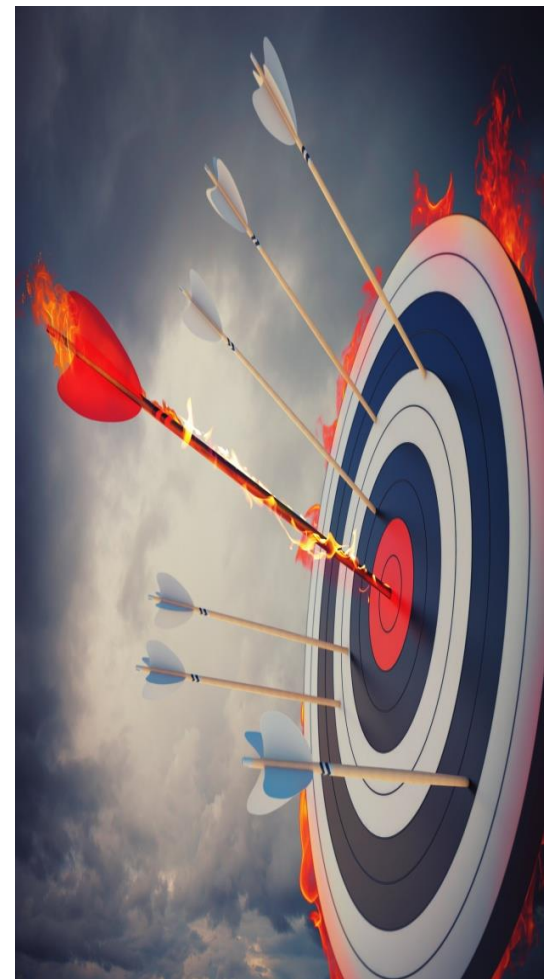
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Project Manager: Elizabeth Mathie, Highways England - UK

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

- adapt the basic Accident Prediction Model (APM) functions to local conditions based on historical data;
- identify the Crash Modification Factors (CMFs) that could be relevant for the specific application;
- verify if the selected CMFs are transferable to the specific conditions;
- apply the calibrated model to the specific location to be analysed.



WP0 – Project Management
Francesca La Torre (UNIFI)

WP1 – Overview of existing APMs and data sources
George Yannis (NTUA)

TK 1.1
Inventory and critical review of existing APMs (NTUA)

TK 1.2
Inventory of existing Data Sources (TUB)

WP2 – Identification and prioritisation of CMF needs
Daniel Graham (ICL)

TK 2.1
Inventory and critical review of available CMFs (TUB)

TK 2.2
Identification of CMF needs (UNIFI)

TK 2.3
Development of key missing CMFs (ICL)

WP4 – Implementation of an APMs and CMFs Repository
George Yannis (NTUA)

WP3 – Development of the Guidance Document
Francesca La Torre (UNIFI)

TK 3.1
Analysis of the transferability of selected APMs and CMFs (ICL)

TK 3.2
Production of the Guidance Document (UNIFI)

WP5 – Dissemination management and organization
Thomas Richter (TUB)

Accident Prediction Model (APM) = a full model that allows an evaluation of the predicted number of crashes in a given condition

**Safety performance function
(full APM)**

Base APM x CMFs x C

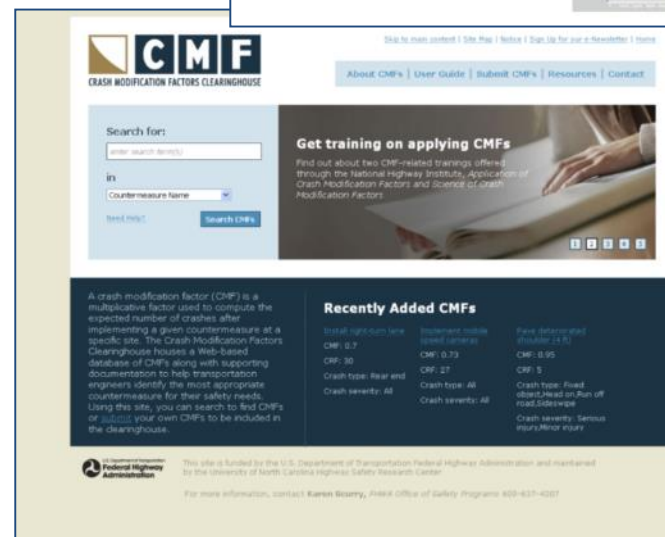
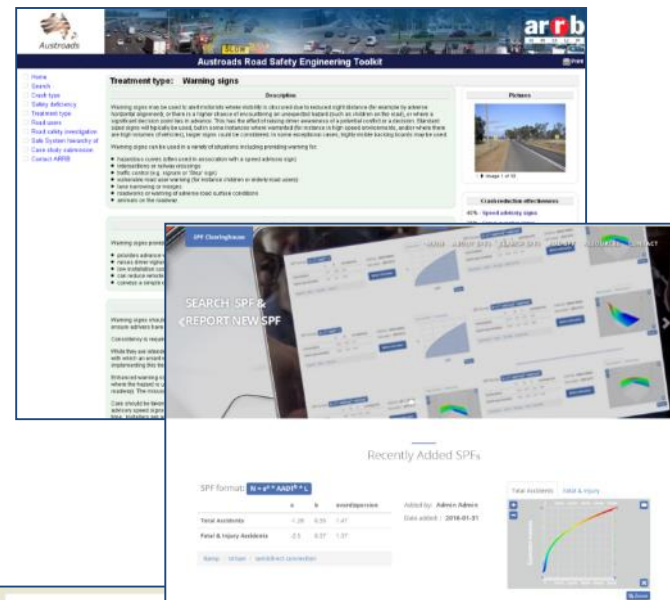
- In the inquiry phase both were investigated and the results were collected in the web repository.
- The PRACT Model is based on the second approach.

- FHWA CMF Clearinghouse
(<http://www.cmfclearinghouse.org>)

- AustRoads Road Safety Engineering Toolkit
(<http://www.engtoolkit.com.au/>)

- iRAP Road Safety Toolkit
(<http://toolkit.irap.org/>)

- SPF Clearinghouse
(<http://spfclearinghouse.org/>)



- Stand-alone Regression Equation APMs are not available in any of the above web databases.
- SPF's are available only in SPF Clearinghouse (to subscribers only), without however providing adequate background information.
- Existing Databases include mostly data from USA and Australia. Results from European studies are rare.



www.pract-repository.eu

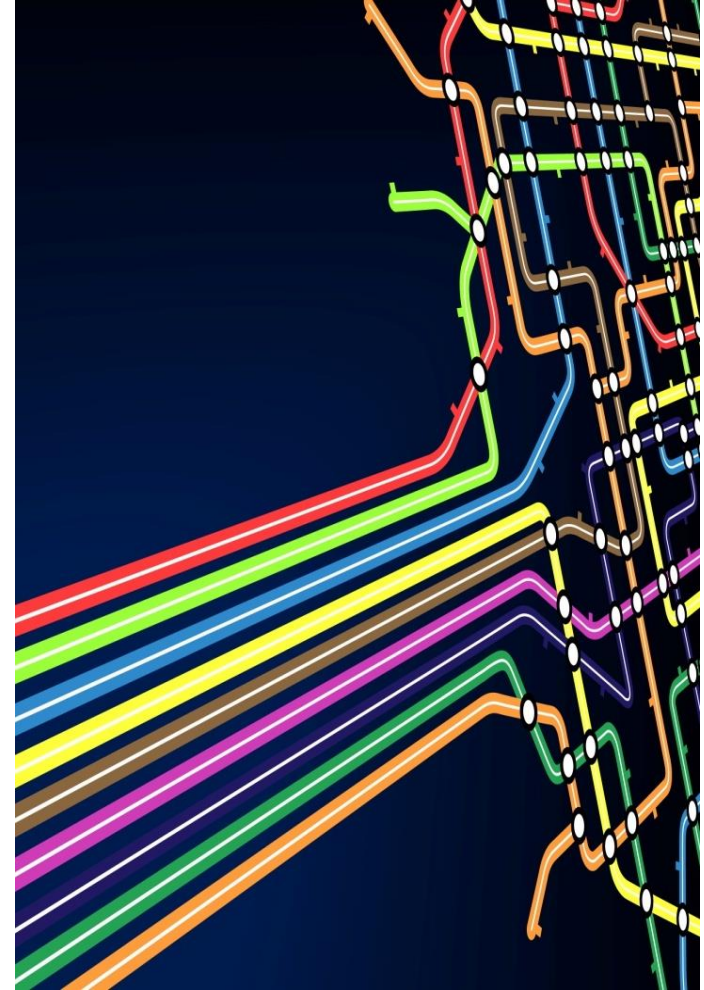
In PRACT Repository:

- All types of data required in accident prediction are available:
 - CMFs,
 - SPFs, and
 - Regression Equation APMs.
- The quality of included CMFs has been verified through an evaluation process.
- User is provided with additional information to verify the quality and the transferability of CMFs and APMs.
- Data from European studies are included.



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- The repository has **two parts**: the CMF part and the APM part.
- Both parts are based on the respective inventories developed within PRACT review process.
- **All reviewed APMs** were included in the repository.
- Only **high quality CMFs** were included in the repository, on the basis of specific criteria.



- Quality criteria refer to:
 - statistical design,
 - testing for statistical significance, and
 - sample size.
- CMFs originating from the Highway Safety Manual were considered “a priori” of adequate quality and were included in the repository.
- All other CMFs were assessed prior to inclusion in the repository, on the basis of fulfilling **all** of the quality criteria.



- **Naive B-A analysis** (no comparison group): **not accepted**
- **Simple cross - sectional analysis**: **not accepted**
- **B-A with comparison group**: **accepted**, provided that:
 - the comparison group (CG) is comparable to the treated group,
 - CG is properly selected to address most common biases, and
 - there are sufficient controls to deal with time trends in accidents.
- **Empirical Bayes B-A analysis**: **accepted**, provided that:
 - there are no evident problems in the choice of the reference group.
- **Poisson / Negative Binomial / Quasi - Poisson Regression modelling**: **accepted** only for treatments with random treatment allocation (e.g. blanket treatments), **not accepted** for treatments applied to high risk sites.

- Statistically significant at **10% level** as a minimum.
- **95% interval does not include 1.**
- If 95% interval includes 1 and all other criteria are met, the CMF was included in the repository with the code "not significant" instead of the CMF value, as an indication that the treatment has no significant impact to accidents.



- **B-A analysis studies:** at least 10 treated sites and at least 3 years of data, both for the before and the after period.
- **Multivariate cross-sectional models** inclusion criteria depended on the number of explanatory variables (EV) and on whether observations for each year are treated as separate observations in the model e.g.:
 1. If observations for each year are treated as separate observations:
 - For 5 or less EV, the criterion is: sites x years > number of EVs + 50
 - For 6 or more EV, the criterion is: sites x years > number of EVs x 10
 2. If average / mean values of variables over all years are used in the model:
 - For 5 or less EV, the criterion is: sites x years > number of EVs + 50
 - For 6 or more EV, the criterion is: number of sites > number of EVs x 10



- The quality criteria were applied to the CMFs (1,526 Factors and Functions) gathered during the review process.
- **889 CMFs** were found to satisfy the quality criteria and were included in the repository.



- Link to website: www.pract-repository.eu
- Five basic sections:
 - HOME: About PRACT project & Repository
 - **SEARCH FOR APMs**: search the database for APMs with specific characteristics,
 - **SEARCH FOR CMFs**: search the database for CMFs with specific characteristics,
 - GLOSSARY: definitions of the most commonly used terms
 - CONTACT: for contacting PRACT partners website.



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ABOUT PRACT – PREDICTING ROAD ACCIDENTS – A TRANSFERABLE METHODOLOGY ACROSS EUROPE

This Repository contains the most recent Accident Prediction Models and Crash Modification Factors, highlighting effectiveness of road safety measures worldwide, for use by road safety decision makers and practitioners worldwide.

This Repository has been developed within the framework of the project PRACT, (Predicting Road Accidents-a Transferable methodology across Europe) carried out by the University of Florence, the National Technical University of Athens, the Technical University of Berlin and the Imperial College London, commissioned by the Conference of European Directors of Roads.

The basic assumption on which the PRACT Repository is built is that Accident Prediction Models (APM) and Crash Modification Factors (CMF) 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 conditions based on historical crash data.

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GLOSSARY

Accident Prediction Model (APM) or Safety Performance Function (SPF): an equation used to estimate or predict the expected average accident frequency at a location, as a function of traffic volume and road infrastructure characteristics (e.g. number of lanes, type of median, traffic control). In PRACT repository, APMs are divided in two types: Regression Equation Models and SPF& CMFs Models (see also respective definitions in the glossary).

Average Annual Daily Traffic (AADT): the counted (or estimated) total traffic volume in one year divided by 365 days/ year.

Before – After Study: the evaluation of implemented safety measures in terms of crash reduction, by comparing frequency or severity of crashes before and after implementation, that often result in the development of CMFs. There are several different types of before – after studies – see also: Naive Before-After Study, Before-After with Comparison Group Study, Empirical Bayes Before-After Study, and Full Bayes Before-After Study.

Before-After with Comparison Group Study: a type of before-after study, in which a group of untreated sites that are similar in nature to the treated sites is used to control for changes in crash frequency not influenced by the treatment. For the approach to give unbiased estimates, treatment implementation must be random (e.g. a blanket treatment applied to all sites) rather than related to accident rates and reference sites must have similar characteristics to the treatment sites, including accident rates in the before period.

Crash Modification Factor (CMF) or Function, or Accident Modification Factor: the relative change in accident frequency due to a change in one specific condition (when all other conditions and site characteristics remain constant). CMF is the ratio of the expected accident frequency after a modification or measure is implemented to the estimated

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- The search page allows the user to search the database for APMs by providing any of the characteristics displayed in the figure to the right.
- If one or more of the above search criteria are left blank (or the blank field is selected at the drop-down list), the criterion is ignored. Thus, a search with all fields blank will return **all the 273 entries of the APM database**.

APM SEARCH PAGE

Types of APM:

Applicable to Motorway segments: Yes No

Motorway Speed Change Lanes: Yes No

Interchange Ramps: Yes No

2-way 2-lane Rural Road Segments: Yes No

Rural Road Intersections: Yes No

Road Elements:

Road Types :

Study name:

Year study published from: Year study published to:

Authors:

Geographic Data Origin :

Inside Tunnel: Yes No

Intersection/Interchange types:

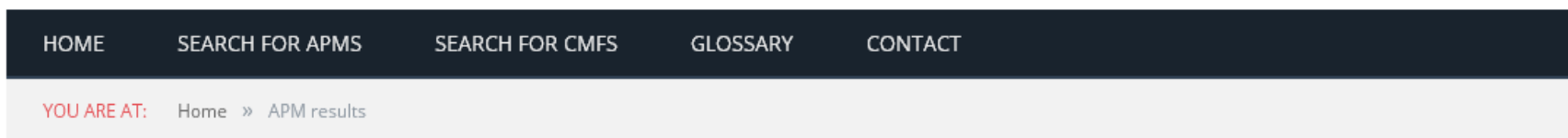
Traffic Control in Intersection:

Crash severity:

Crash types:

Number of vehicles:

- The search leads to a **results page** with a list of the APMs in the database that meet the search criteria and their most basic characteristics.
- Further clicking on any specific ID number from this list provides the user with all the available data related to this specific APM.



APM RESULTS

ID	Road Elements	Types of APM	Equation	Road Types	Geographic Data
1-020	Intersection	Regression Equation	$Af = 9.62 \times 10^{(-11)} \times AADTa \times AADTc^{0.5} \times V^2$	Two-lane two-way rural road	Queensland - Australia
1-019	Intersection	Regression Equation	$Af = 3.63 \times 10^{(-14)} \times AADT \times L \times (V + \bar{A}V)^2 \times \{[(V + \bar{A}V)^2 / R^{1.5}] + 47.4\}$	Two-lane two-way rural road	Queensland - Australia

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1-029

BY PRACT REPOSITORY ON FEBRUARY 29, 2016

APM ID: 1-029

Type of APM	Regression Equation
Is applicable to Motorways Segments?	No
Is applicable Motorway Speed Change Lanes?	No
Is applicable to Interchange Ramps?	No
Is applicable to 2-way 2-lane Rural Road Segments?	No
Is applicable to Rural Road Intersections?	Yes

For Regression Equation

APM variable 1	Traffic Volume of Major Road AADT1 (veh/day)
APM variable 2	Traffic Volume of Minor Road AADT2 (veh/day)
APM variable 3	Major Road median width MEDWmj (feet)
APM variable 4	Number of driveways on major road within 250ft. of intersection center ND ()
APM equation	$Af = \exp(-15.466) \times AADT1^{1.433} \times AADT2^{0.269} \times \exp(-0.0612 \times MEDWmj) \times \exp(0.0560 \times ND)$

APM development information

Study Design	Negative Binomial Regression
Sample Size – No of sites	
Sample Size – No of years	
Sample Size – No of crashes	

Study information

Study name	Crash models for rural intersections: four-lane by two-lane stop-controlled and two-lane by two-lane signalized, Report FHWA-RD-99-128
Year published	Year study published: 1999
Authors	Vogt, A.

Information of considered road elements

Geographic Data Origin	USA - California & Michigan
Road element	Intersection
Road type	Two-lane two-way rural road
Sampling Criteria	-
No. of lanes per direction	
Inside Tunnel	
Minimum Traffic Volume AADT (veh/day)	Minimum Traffic Volume: -
Maximum Traffic Volume AADT (veh/day)	Maximum Traffic Volume: -
Intersection / Interchange type	3-leg at-grade intersection
Traffic control at intersection:	Stop signs to minor road

Information of considered accidents

Period of crash data – start	1993
Period of crash data – end	1995
Crash severity	All
Crash types	At intersection
No of vehicles	
Other accident parameters	Not specified
Road user types	Not specified

Comments

- The search page allows the user to search the database for APMs by providing any of the characteristics displayed in the figure to the right.
- If one or more of the above search criteria are left blank (or the blank field is selected at the drop-down list), the criterion is ignored. Thus, a search with all fields blank will return all the **889 entries of the CMF database**.

CMF SEARCH PAGE

Types of CMFs:	<input type="text"/>		
Applicable to Motorway Segments:	<input type="radio"/> Yes <input type="radio"/> No		
Motorway Speed Change Lanes:	<input type="radio"/> Yes <input type="radio"/> No		
Interchange Ramps:	<input type="radio"/> Yes <input type="radio"/> No		
2-way 2-lane Rural Road Segments:	<input type="radio"/> Yes <input type="radio"/> No		
Rural Road Intersections:	<input type="radio"/> Yes <input type="radio"/> No		
Road Elements:	<input type="text"/>		
Road Types :	<input type="text"/>		
Countermeasure categories:	<input type="text"/>		
Countermeasure Description:	<input type="text"/>		
Study Designs:	<input type="text"/>		
Study name:	<input type="text"/>		
Year study published from:	<input type="text"/>	Year study published to:	<input type="text"/>
Authors:	<input type="text"/>		
Geographic Data Origin :	<input type="text"/>		
Intersection/Interchange types:	<input type="text"/>		
Intersection Traffic controls:	<input type="text"/>		
Crash severity:	<input type="text"/>		
Crash types:	<input type="text"/>		
Road User Types:	<input type="text"/>		

- The search leads to a **results page** with a list of the CMFs in the database that meet the search criteria and their most basic characteristics.
- Further clicking on any specific ID number from this list provides the user with all the available data related to this specific CMF.

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CMF RESULTS

ID	Types of CMFs	CMF Value/Function	CMF types	Countermeasure Description	Road Types	Geographic Data
1139	value	0.660	Intersection - Roundabouts	Conversion of Intersection to Roundabout	Two-lane two-way rural road	Belgium (Flanders)
1140	value	0.610	Intersection - Roundabouts	Conversion of Intersection to Roundabout	Two-lane two-way rural road	Belgium (Flanders)
1141	value	0.580	Intersection - Roundabouts	Conversion of Intersection to Roundabout	Two-lane two-way rural road	Belgium (Flanders)

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1170

BY PRACT REPOSITORY ON MARCH 14, 2016

CMF ID: 1170

Type of CMF	value
CMF Value / Function	0.560
CMF variable 1 (within the study)	-
CMF variable 2 (within the study)	-
CMF variable 3 (within the study)	-
CMF type	Intersection - Traffic control
Is applicable to Motorways Segments?	No
Is applicable Motorway Speed Change Lanes?	No
Is applicable to Interchange Ramps?	No
Is applicable to Interchange Ramp Terminals?	No
Is applicable to 2-way 2-lane Rural Road Segments?	No
Is applicable to Rural Road Intersections?	Yes
Countermeasure Description	Installation of Traffic Signals

CMF development information

Study Design	Empirical Bayes Before-After
Standard error	0.030
Were results tested for statistical significance?	Yes
Sample size: No of sites	84
Sample size: No of years	10
Sample size: No of crashes	Not specified
Explanatory variables included in the safety performance function (if applicable, e.g. EB before-after)	
Explanatory variables included in the model (for multivariate cross-sectional studies)	
Model form for multivariate cross-sectional models (e.g. Negative Binomial model)	
Was the potential for crash migration taken into account? If yes, how? (for countermeasures where crash migration could be an issue)	
Any other sources of potential bias that you identified?	

Study information

Study name	Accident Modification Factors for Traffic Engineering and ITS Improvements, NCHRP Report 617
Year published	2008
Authors	Harkey, D.L., R. Srinivasan, J. Baek, F. Council, K. Eccles, N. Lefler, F. Gross, B. Persaud, C. Lyon, E. Hauer, and J. Bonneson / NCHRP, Transportation Research Board, Washington, DC, 2008.

Information of considered road elements

Geographic Data Origin	USA (states of California & Minnesota)
Road network length	
Road element	Intersection
Road type	Two-lane two-way rural road
Sampling Criteria	Not specified
Comparison Group Selection Criteria	Not specified
No. of lanes per direction	Not specified
Minimum Traffic Volume AADT (veh/day)	
Maximum Traffic Volume AADT (veh/day)	
Ramp terminal type	Not applicable
Intersection / Interchange type	4-leg at-grade intersection
Traffic control at intersection	Stop signs to minor road

Information of considered accidents

Period of crash data - start	1993
Period of crash data - end	2001
Crash severity	All
Crash types	At intersection - all
No of vehicles	
Other accident parameters	Not specified
Road user types	Not specified

Countermeasure information

Safety deficiency	Inadequate Intersection Traffic Control
Countermeasure category	Intersection Traffic Control and Operational Elements

Comments

The PRACT Repository is a **valuable road safety decision support system** because:

- it organizes current knowledge on accident prediction (both APMs and CMFs) in a user-friendly and easily accessible by all road safety practitioners website,
- it is a complementary database to the PRACT Tool & Guideline,
- it provides all the available background information on the APM or CMF development, to assist in the assessment of the suitability of the provided data.

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