

# Tools for safety management of roads

## Accident prediction models and accident modification factors

TØI Report 1924/2022 • Authors: Rune Elvik, Alena Katharina Høye • Oslo 2022 • 74 pages

*Accident prediction models and accident modification factors are two important tools for the safety management of roads. These tools can be used to identify road sections that need treatment and select the most effective treatment for those sections. This report compares accident prediction models and accident modification factors developed in Norway to accident prediction models and accident modification factors developed in other countries or in international projects. It is concluded that the Norwegian accident prediction models and accident modification factors are close to the state-of-the-art. It is, however, important to update the models and the estimates of the effects of road safety measures regularly.*

### Tools for safety management


Since 2002, safety management of roads in Norway has been based on accident prediction models and the empirical Bayes method for road safety estimation. The first modern accident prediction model for national roads was developed in 2002. The model was updated in 2006, 2014 and 2016. It was expanded to include county roads in addition to national roads. The model is currently being updated.

To identify locations that have a high number of killed or seriously injured road users, the empirical Bayes method is applied. This method has been implemented in a software called “road safety effects”, which is used to select road safety measures and estimate their effects. Estimates of the effects of road safety measures are updated regularly and new studies published in scientific journals whenever possible.

Although the Norwegian system for safety management of roads is close to the state-of-the-art, it is nevertheless useful to ask whether the system can be further improved. To help answer this question, this report compares the Norwegian system to systems for road safety management developed in other countries or as part of international research projects.

### International comparison

The following systems for road safety management have been compared to the current Norwegian system:

- 
- Accident prediction models and accident modification factors developed in Denmark
  - The Finnish TARVA system
  - Models developed in the European PRACT-project
  - The EGRIS-models for classifying roads according to safety
  - The Highway Safety Manual and the Crash Modification Factor Clearinghouse
  - The International Road Assessment Programme (IRAP)

The Danish accident prediction models are the most comprehensive ones, and quite similar to the Norwegian models. An important difference is that in Denmark, the models have been fitted to specific types of roads and junctions, rather than the entire road system. Thus, there are separate models for motorways, rural roads and urban roads and separate models for different types of junctions. The accident modification factors used in Denmark are also very similar to those used in Norway.

The Finnish TARVA-system is similar to the Norwegian “road safety effects” software. Separate models using traffic volume as the only independent variable have been fitted to 50 different types of road and 15 different types of junctions. The system is updated regularly and has been used for almost 20 years.

The PRACT-project, funded by CEDR, was started in order to develop a common European method for developing and fitting accident prediction models. Models were developed in England, Germany, and Italy. These models were similar to the accident prediction models in the first edition of the Highway Safety Manual. In general, the models included just a few variables.

The EGRIS-models were developed for the purpose of classifying road according to their safety level. There are two types of models, called the reactive model and the proactive model. The reactive model consists of estimating accident rate on a specific road and comparing it to a normal value for similar roads. The proactive model consists of a road safety inspection of a road. Results of the two models are combined and roads classified into five groups with respect to safety.

The accident prediction models presented in the first edition of the Highway Safety Manual are all quite simple and use only traffic volume and section length as independent variables. The effects of all other variables influencing the number of accidents are captured by crash modification factors and calibration factors. The Highway Safety Manual is now being updated. The updated version will no longer contain crash modification factors. These will be collected in the Crash Modification Factor (CMF) Clearinghouse.

The CMF Clearinghouse is a database of estimates of the effects on accidents of road safety measures. It includes measures related to highway design and traffic control. By May 2022, the CMF Clearinghouse contained more than 8,000 estimates of effect; most of them based on studies performed in North America. Estimates are assigned a score for study quality ranging from 0 to 150. The CMF Clearinghouse is updated each quarter.

The International Road Assessment Programme (IRAP) started in Europe in 1999 and has since been introduced world-wide. It rates the safety of roads according to a fairly detailed scoring system. Scores can be assigned for up to 78 characteristics of a road. The scores are then converted to a star rating, in which one star is poor safety and five stars the highest safety. The star rating has been found to correlate well with accident rate (accidents per million vehicle kilometres of travel). It is judged that performing an IRAP scoring of roads in Norway would add little information on the safety of roads, given that current accident prediction models in Norway contain a large number of variables that are known to influence the number and severity of accidents.



## Lessons learnt

The main conclusion of the study is that the current Norwegian system for safety management of roads is close to the state-of-the-art. It is nevertheless important to keep this system updated. This means that accident prediction models should be updated regularly. An update is now (2023) going on; the last update was in 2016 and one should, in general, update the accident prediction models every 5-7 years.

Accident prediction models have also been developed for specific road elements in Norway, including junctions, pedestrian crossings, bridges, tunnels and horizontal curves. These models are all becoming outdated and should be updated.

As far as the effects of road safety measures are concerned, estimates are being updated continuously as part of the revision of the Handbook of Road Safety Measures. The effects of road safety measures are increasingly presented as functions, rather than point estimates, reflecting the fact that the effects of the measures vary systematically.