Development of Tools for Road Infrastructure Safety Management

Marcin Budzynski[a], Chris Jurewicz[b], Kazimierz Jamroz[a], Wojciech Kustra[a], Joanna Wachnicka[a], Joanna Zukowska[a]

[a]Gdańsk University of Technology, [b]Australian Road Research Board

Abstract

The development of modern tools for road infrastructure safety management will help to reduce the number of fatalities and serious injuries as one of the main objectives adopted in 2013 in the National Road Safety Programme 2014-2020 and the new Road Safety Programme 2011-2020 in the EU. Risk Management in Highway Engineering can be applied in developing tools essential in the process of safety management. The Risk Management in Highway Engineering deals with two quite strongly interrelated concepts: risk and hazard. The use of this relationship will allow the development of models for estimating selected road safety measures.

Background

Risk and hazard are two intertwined terms in high-way engineering risk management. In risk measure analysis (Jamroz, 2011) describes risk as the hazard of a consequence occurring at a specific point in time. This is why risk is usually defined as the anticipated consequence which may be caused by a potential source of hazard. Hence, a hazard that may lead to a specific con-sequence will materialise if certain unfavourable conditions occur. The risk will be a consequence suffered by the driver (e.g. a fatality) and the sources of the hazard may include: road infrastructure, weather, traffic, etc. (Jamroz & Kustra 2011). Depending on the assumptions, three types of risk are usually distinguished: collective, individual and group risk (Hauer, 1995). The level of risk has a strong correlation to growing traffic on a specific road section (Lynam et al. 2004).

Method

Drawing on the collective risk model methodology (Jamroz 2011), partial models were developed to define collective risk on long road sections. This will help forecast these rates depending on the availability of factors which represent the hazard:

- MRS_O shows a single component model used for calculating overall collective risk (RS_O^A). The rate being estimated is the sum of consequences (V_T) of a selected category in a unit of time.
- MRI shows a two component model used for calculating overall collective risk (A) using individual risk models. The rate being estimated is the result of the probability of a consequence (P_{AR}) subject to risk exposure (E_{VKT}) in a unit of time.

The model consists of three components: probability distributions of the dependent variable, linear predictor ηi and non-linear link function. The probability distribution of the dependent variable is from the exponential distribution family. For the purposes of this work the negative binominal distribution was used (Budzynski et al., 2011; Elvik, 2014; Jurewicz &Thompskon, 2010; Lord, 2006; Sawalha, 2002; Ye, 2013). It works well with dispersed data which are common in the case of accidents on junctions or road sections. Many sections have few accidents and victims, and there are not many sections where these rates are high or very high.

Results

A road accident model is presented as an example of a road safety model. Formula (1) shows a model which uses section length (L) and traffic volume (AADT).

$$A=\beta_0*T*L^{\beta 1}*AADT^{\beta 2}*\exp(\beta_3*PBA+\beta_4*PWS+\beta_5*PAL+\beta_6*DIS_N+\beta_7*DIS_R\beta_8*T+\beta_9*RL) \quad (1)$$

were:

A - number of accidents in year i

T, RL, PBA, PAL, PWS, DIS_N, DIS_R - factors related to the risk of an accident (independent variables)
β_{1-9} - equation coefficients

Conclusions

By building road safety models, we were able to identify the effects of selected road and traffic factors on safety. The next step will be to build models for specific types of accidents (hitting a pedestrian, side impacts and head-on collisions, run-off-road) and develop methods for estimating the real risk on the road network based on road and traffic features.

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