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Sensitivity of road safety outcomes to uncertainties in the computational model for assessing the impact of policy measures at the regional level

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ABSTRACT
This research aims at evaluating the sensitivity of road safety outcomes to uncertainties in the computational model assessing the impact of road safety policy measures for the region of Flanders in Belgium. The model comprises five stages from which the main output is the number of saved injury accidents. Considering several possible uncertainties during the model process and using sensitivity indices, the most influential factors are identified. Future research is directed towards these factors as better knowledge of these factors will establish the largest reduction in the uncertainty of the number of saved injury accidents.

Key words: road safety measure effectivenes; sensitivity indices

1. Main text

Methods estimating road safety effects are an essential prerequisite to assess the effects of policy measures in a broader perspective. Starting from the regional road safety explorer model developed by SWOV (Reurings and Wijnen, 2008), a computational model for the region of Flanders in Belgium is developed to assess the road safety effects of a set of measures at a regional level (Nambuusi et al., 2010). The model consists of five stages: the reference situation, the baseline prognosis, the measure prognosis, the number of saved injury accidents and the cost-benefit analysis. The reference situation describes the current exposure (or the degree of participation in traffic) and the current road safety situation (in terms of road injury accidents) in the region. Since interest is in evaluating road safety effects by 2010, the evolution in important underlying road safety factors is taken into account in the baseline prognosis such as the evolution in kilometres travelled and the collective learning process caused by the growing knowledge of road users, the constant improvement of road safety education, better equipped motor vehicles and roads and, increasing legislation and enforcement. The measure prognosis relates to the situation after applying and estimating the effectiveness of measures on road safety. The main outputs of the model are the number of saved injury accidents and the cost-benefit ratios of the measures taken. By expressing the saved injury accidents in monetary values, the cost-benefit analysis determines whether the applied measures are cost-effective. Through this analysis, policy makers are assisted in selecting target oriented policies that make the most efficient use of resources.

Given the model implications, an evaluation with respect to the uncertainty in the output caused by the various input factors is essential yet not studied before. In the different stages of the model, input factors that are not known with certainty are present, highlighting uncertainty in the estimated output. For example, the future evolution in kilometres travelled can be predicted (e.g. based on the

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past) but is not entirely known. The more variable such factors are, the more uncertain are the estimated effects of road safety measures based on them. Therefore, we believe that a methodologically valid model in which uncertainty is recognized and accounted for has value in the field of road safety. As stated in Saltelli (2002) and Saltelli et al. (2008), the use of sensitivity analysis provides information concerning the robustness of the output and identifies ways of reducing its uncertainty for enhanced decision making.

In the present study, eight input factors (the degree at which injury accidents are reported by the police, the evolution in collective learning, the evolution in kilometres travelled, the effectiveness of four measures (alcohol or drugs checks, fog warning signals, more stringent road works warnings and scent signals to frighten game) and the combined effect of two measures) obtained from literature (Elvik and Vaa, 2004; Ministerie van de Vlaamse Gemeenschap, 2007) are investigated. The analysis indicates which of these input factors require urgent effort to reduce the output variance.

First, a probability distribution function is assigned to each input factor from which 65,500 values are randomly drawn. Multiple evaluations of the model with randomly selected input values are performed, each resulting in an amount of saved injury accidents. Finally, 65,500 output values are produced and the average is the output of interest. The variance based method for sensitivity analysis is utilized in this work because of its advantages (Saltelli et al., 2008). First-order indices and total effect indices are computed and interpreted.

Although the computational model is able to consider the entire road safety situation and road network, it is illustrated using data on injury accidents on 96 highway segments in the region of Flanders. The analysis shows that the degree of reporting for injury accidents, the evolution in collective learning, the evolution in kilometres travelled and the combined effect of two measures (considered as dependent or independent) are the factors where effort should be directed to reduce the uncertainty in the estimated number of saved injury accidents by 2010. Hence, better knowledge with respect to these factors should be obtained, for example, by improving the level of accident reporting and the methodology for computing the combined effect of measures.

2. References

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