Application of Macroscopic Safety Models for Hot Zone Identification

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Abstract

Macroscopic safety research provides important insight into dealing proactively with road safety problems in the transport network. This research explores the need to develop and use macroscopic safety models in Australia, especially for network screening. Using road crash data from Melbourne, Australia (2010-2012), safety performance functions (SPFs) are developed for total, serious injury and minor injury crashes. Potential for Safety Improvement (PSI) is adopted as the measure of the crash risk. The developed PSI's are used to identify the various hot zones (high-risk crash zones) in the Melbourne transport network.

Background

In most Australian states, road safety research has mainly been conducted at the microscopic level. The main objective of the microscopic safety research is to identify transportation system locations (road segments, intersections, etc.) that possess underlying correctable safety problems (Cheng and Washington, 2005). Microscopic collision prediction models (CPMs) take into account the characteristics of the crash locations as well as vehicles and individuals involved in the crash.

Microscopic safety studies are known to be a reactive approach to road safety research as assessments are undertaken after safety problems have arisen (Hadayeghi et al, 2003). Although microscopic safety studies have proved successful, they require a significant crash history in each micro-location(Lovegrove and Sayed, 2007) and are difficult to be integrated in regional transportation planning.

Conversely, recent research has shown that analysing crash frequency at the macroscopic level is an insightful tool to investigate traffic safety problems. At the macroscopic level, crashes aggregated into a defined spatial unit are modelled to understand and quantify the impacts of socioeconomic and demographic characteristics, land use characteristics, transportation demand and network attributes so as to provide countermeasures from a planning perspective. Macroscopic models provide a safety planning decision-support tool that facilitates the assessment of safety implications of alternative network planning initiatives and scenarios (Hadayeghi, 2009).

Such studies have a low cost (Lovegrove, 2007) and allow a proactive approach, by targeting road safety at an early planning stage, with the potential for significant reductions in collision frequencies. The objective of this research is two-fold: (1) to demonstrate safety modelling at the macroscopic level and (2) to demonstrate the importance and application of macroscopic safety models for transport hot zone screening in Australia.

Method

Accident frequency analysis is commonly modelled using crash-data modelling techniques such as the Poisson and negative binomial (NB) models, along with their variants. In this research, crashes are modelled using the NB model to start with. The study proceeds to address two very fundamental methodological issues in crash modelling: spatial autocorrelation and unobserved heterogeneity using the random parameter NB and the semi-parametric geographically weighted Poisson regression models. Using road crash data from Melbourne Metropolitan area (2010-2012), aggregated into statistical area level 2 (one of the spatial units defined by Australian Bureau of Statistics (ABS)), safety performance functions (SPFs) are developed for total, serious and minor injury crashes. Potential for Safety Improvement (PSI) is developed and used as a measure of the crash risk. Three screening categories are also developed from the PSI for the hot zone screening.

Results

The result demonstrates the capability of macroscopic safety models and PSI measures to identify hot zones in a large metropolitan area. For the total crash model, 9 zones (3.11%) were identified as in the top 10% for priority treatment. In the serious injury and minor injury models, 8 (2.77%) and 10 (3.46%) hot zones were identified respectively. An important observation made is that 49.54% of the zones for total, serious injury and minor injury are warm zones. This result indicate that nearly 50% of the zones have the potential of becoming hot zones in the future. The spatial distributions of the hot and warm zones for the three crash types are found to be similar, with the hot zones mostly concentrated in the south eastern part of Melbourne.

Conclusions

The macroscopic safety analysis undertaken in this paper is of critical importance as it provides planners with an essential tool in incorporating safety considerations into long term transportation planning. It is expected that safety practitioners and planners will be able to suggest appropriate safety countermeasures that would be effective in dealing with the current hot zones as identified using the PSI screening method as well as the future expected road safety conditions. The proactive nature of macroscopic models would greatly contribute to the achievement of the Towards Zero Strategy in Australia.

References

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