TRANSFERABILITY OF OVERSEAS CRASH PREDICTION MODELS TO NEW ZEALAND

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ABSTRACT

Over the last 15 years a multitude of accident prediction models have been developed for rural and urban intersections and mid-block sections in New Zealand. Although used extensively, the majority of these models focused on a limited set of features that were of interest at the time. There is a growing need for more comprehensive models, similar to those developed internationally. These comprehensive models uniquely partition the safety impacts of a range of road variables, allowing simultaneous assessment of a range of features. Such models provide better prediction of the expected crash risk associated with new or changed facilities, facilitate the identification of situations with abnormally high crash risk, allow more robust assessment of a range of potential solutions, and guide the development of design standards and policies.

However, the limited size of the New Zealand road network and the associated data holdings means it will be difficult and or expensive to develop robust models. This paper discusses the latest research being undertaken, in conjunctions with a researcher in Canada, into the transferability of models between North America/Europe and NZ. It presents a discussion on the differences between the models produced in each country and the likely factors that produce these differences. This note also discusses methods that have been developed elsewhere to transfer models between the different jurisdictions, and shows how such methods can be applied in New Zealand.

INTRODUCTION

In the past 10-15 years there have been substantial advances worldwide in the development of accident prediction models for individual roadway elements. These models, which are also known as safety performance functions, relate collision experience of a roadway element such as an intersection or road segment to the traffic volume and other characteristics of that element. Typically traffic volume accounts for the majority of the variability in collision frequency.

It is now timely to undertake some international comparisons of these models with a view to demonstrating what lessons can be learned from comparisons at the individual roadway element level after normalizing for volume differences. Of particular interest is whether it is worthwhile to seek explanations about why differences exist and the implications for those explanations in developing road safety initiatives, including revisions to design practices for individual roadway elements. It is also of interest in the process of this investigation to see if models of collision experience in different countries are similar enough that they can be transferred from one to another, given that some countries may not have sufficient data to calibrate these models for some roadway elements.

Given this background, this technical note has been prepared with two fundamental objectives in mind. Comparisons of accident prediction models from New Zealand, North America and Sweden at roundabouts are made to 1) illustrate how such comparisons might be used to learn lessons from differences in crash experience for similar roadway elements and 2) illustrate how to assess the transferability of these models among countries. Comparisons of accident prediction models for other site types can be found in Turner et. al. (2007).

Comparison of Accident Prediction Models from different countries

The objective of this part of the work was to compare prediction models for several jurisdictions/countries with a view to illustrating lessons that can be learned from such a comparison of the safety experience at roundabouts. The problem, of course, in making such comparisons is that observed differences in collision experience of individual roadway elements could be due simply to accident reporting and definition differences. To alleviate this problem in this paper, the comparison is done on the basis of police reported injury collisions, recognizing that the major differences in reporting and definition likely pertain mainly to non-injury collisions.

Accident prediction models for roundabouts from New Zealand, North America and Sweden are the main components of the comparison. Combined accident type models have been selected for each country to avoid issues associated with different ways of classifying the various accident types. The focus is on models of reported injury accidents as the classification and reporting of non-injury (NI) accidents is known to be quite variable.

In most countries both ‘flow-only’ and ‘full variable’ models are available. These ‘full variable’ models consider layout, operational (e.g., speed) and, where relevant, signal phasing predictor /independent variables. There is still a lot of uncertainty around the influence of ‘non-flow’ variables, particularly in New Zealand, due to correlation between such variables and the lack of information on potentially important predictor variables. Given that this is the case, and that traffic volume is generally found to explain most of the variation in accident occurrence, it was decided to focus this study on flow-only models in each of the countries.

Model prediction plots – Roundabouts

Figure 1 compares roundabouts models from the US, Sweden and New Zealand. The details of these models are listed in Table 1. As is evident from the plots, the Swedish and US models predict more accidents than the New Zealand models. The shapes of the US and New Zealand models are more compatible with each other than with that of the Swedish model in that they both indicate a decreasing slope with increasing AADT. It is also worth noting that the New Zealand models were recently calibrated and contain relatively more new and better-designed roundabouts and so predict fewer accidents compared to older New Zealand models in Turner (2000).

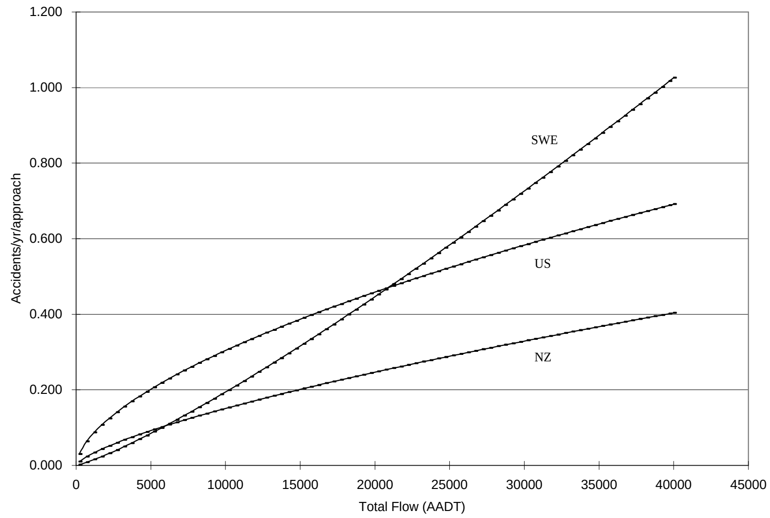

Figure 1 - Comparison of Roundabout Models for Injury Accidents.

Country	Model Form for Accidents/year (A)[#]	b_0	b_1	Data Period
New Zealand[1]	$A = b_0 Q^{b1}$	2.18E-04	0.71	2000-2004
US – Multiple jurisdictions[2]	$A = b_0 Q^{b1}$	1.3E-03	0.59	1996-2001
Sweden[3]	$A = b_0 Q^{b1}$	3.08E-06	1.2	1994-1997

[#] Where Q_{major} is the major road entering AADT, Q_{minor} is the minor entering AADT and Q is total entering AADT
[1] Turner et al. (2006);[2]National Cooperative Highway Research Project (NCHRP) 3-65;[3]Brude and Larsson (2000)

Table 1 - Models for Injury Accidents at Roundabouts

Possible areas of difference between the countries in accident experience at intersections include:

1) Levels of accident reporting rates,
2) The definition for intersection accidents (e.g., how close to the intersection does an accident have to be to be included in a model),
3) Climatic conditions, and
4) Speed limits and operating speeds.

Transferability of Models among Countries

The previous section provided a qualitative assessment of sorts in that models from North America and elsewhere were compared at equivalent volume levels and differences and similarities discussed. The implication is that if it is possible to rationalize differences in accident experience and normalize for them then it would be reasonable to attempt to transfer models between countries.

To investigate and illustrate transferability issues, we have used prediction models from several countries for two-lane rural road segments (refer to Turner et. al. 2007 for details on these models). The question is how to assess the transferability of a model to other countries where design standards and driver characteristics are different. With such an assessment it would then be possible to choose among competing models being considered for such applications. Of particular interest is the transferability of North American models to other countries such as New Zealand.

This section illustrates a more formal, less qualitative procedure for making a transferability assessment. In this process data from a jurisdiction of interest are used to recalibrate a model from another jurisdiction. The recalibration is achieved with the use of a factor estimated by applying the other jurisdiction's model to the jurisdiction of interest and calculating the ratio of the sum of the accident count observations to the sum of the predictions. This is essentially the recalibration procedure being implemented in the Highway Safety Manual (TRB, 2007). Recalibration factors for transferring each model to another jurisdiction are shown in Table 2.

	Recalibration factor for transferring model to another jurisdiction				
Origin of Model	Minnesota	North Carolina	Ohio	Washington	New Zealand
Minnesota	1	2.997	2.032	2.283	1.310
North Carolina	0.270	1	0.726	0.831	3.840
Ohio	0.360	1.407	1	1.135	2.540
Washington	0.453	1.323	0.894	1	2.900
New Zealand	0.780	0.330	0.456	0.333	1

Table 2 - Recalibration Factors for Two-lane Rural Accident Prediction Models

How well the recalibrated model fits the data for the other jurisdiction can be assessed using a variety of goodness of fit indicators. For this illustration we have chosen to use Cumulative Residual (CURE) plots proposed by Hauer & Bamfo (1997) in which the cumulative residuals (the difference between the observed and predicted accident frequencies for each site) are plotted in increasing order for each covariate, in this case AADT. The resulting graph shows how well the model fits the data with respect to each individual covariate; this method has been used by Persaud et al. (2002) to assess model transferability. Figure 2 shows the CURE plots for applying the New Zealand models and the recalibrated US ones to New Zealand data. It is seen that the Washington and Minnesota plots closely mirror the New Zealand plot. It can be concluded on this basis that the three models from Minnesota, Washington and New Zealand are compatible with each other.

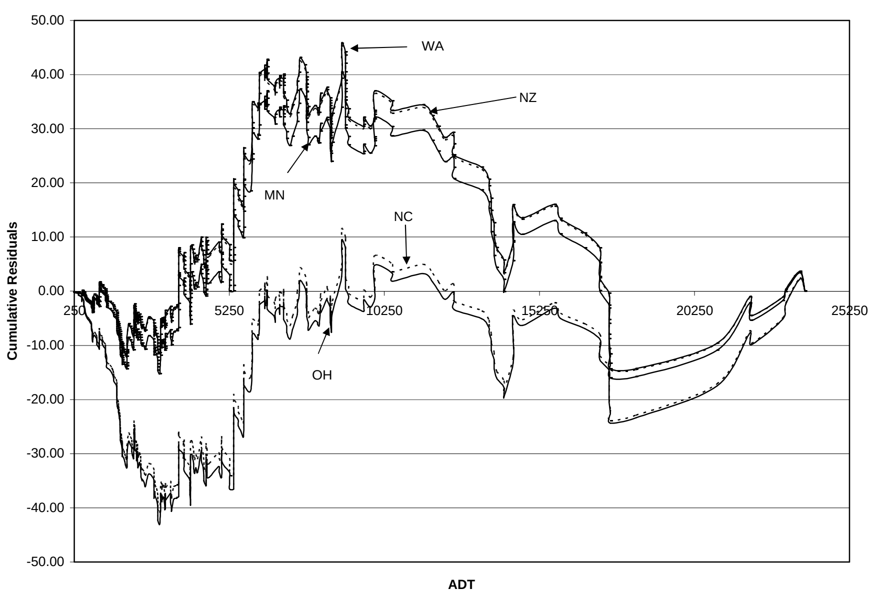

Figure 2 - CURE Plots for New Zealand and USA Injuries on Two-lane Rural Roads.

DISCUSSION/CONCLUSIONS

This paper provides a method to increase the availability of high quality accident prediction models by investigating the feasibility of transferring models from one country to another, in this case transferring models between USA/Sweden and New Zealand. Based on the results provided it does appear possible to transfer models from one country to the next, but there are a number of differences in the models that need to be accounted for by considering issues such as reporting rate, which vary from around 30% in New Zealand and Sweden up to 70% plus in North America.

The investigation of model transferability revealed that it is reasonable to consider transferring models from one jurisdiction to another. Some models transfer better than others and CURE plots can be useful in deciding which models transfer best. The investigation and illustration was done for two-lane rural roads. For this element type, it was seen that the transferability property is reciprocal. Given the promise of this initial investigation, and the clear need for improved accident prediction models in many countries, it would seem worthwhile to do more research on model transferability.

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