

Hotspot Identification for Urban Expressways Using Quantitative Risk Assessment Method

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The authors present a new method to add to the existing road safety literature on hotspot identification using Quantitative Risk Assessment (QRA) theory. Their method combines standard tools for predicting crash frequencies at potential road safety hotspots with their associated expected losses, which include direct personal injury and property losses and additional delay losses. In their paper, the authors attempt a comparison of their method for ranking potential hotspots with the standard empirical Bayes (EB) method, via an application to data from the Shanghai Urban Expressway system. The paper is logically set-out and provides an interesting case study of the application of QRA to a new area; however, before the work is accepted for publication in IJERPH I have several concerns that would need to be addressed, and these are now listed below.

1. One of the aims of the paper, as I see it, is to present a state-of-the-art method for hotspot identification that can be seen as a serious competitor to existing methods in the literature. However, the authors make use of a standard empirical Bayes (EB) procedure for combining predicted crashes ($\tilde{N}_i$) with observed crashes ($\bar{N}_i$) in step 1 of their procedure, and yet several relatively recent papers have pointed to fully Bayes (FB) methods as being superior to EB. For example, within a FB approach, analysts have an unlimited choice of prior distributions for crash rates at each site, without the usual Poisson-Gamma restriction required of a conjugate analysis in EB. Different priors can be assessed for their suitability and simple metrics (such as the deviance information criterion) can be used to assess which prior is the best; see, for example, Fawcett and Thorpe (2013). Within an FB analysis we can also get a more representative assessment of the uncertainty in our estimated parameters in the model by assigning prior distributions to the regression coefficients in the crash prediction model (CPM). Standard software tools are now available to perform FB analyses, and at least assessing the sensitivity of their results to the choice of EB/FB methods in step 1 could make a useful and interesting addition to the paper. Certainly, basing results on an FB analysis in step 1 could help bring the authors' overall technique more up-to-date.
2. Step 1 of the authors' analysis makes use of historical crash data through $\bar{N}_i$. Are these historical values aggregated to give a single value for $\bar{N}_i$ at each site? If so, across how many years/time periods? Aggregating across time periods which are too large could result in a loss of vital information between the first time-point and the most recent time-point for which we have historical data, and it would be useful to account for changes through the overall time

period. These changes might include trends, but we might also want to lend estimates of crash frequencies more weight from more recent observations than those from many years ago. Could the authors say a bit more about the historical data they are using, and how they might handle trend and other such changes in crash counts observed over multiple time periods?

3. Although I think the overall structure of the paper is logical and set-out quite well, I think the paper is lacking important details and is sometimes quite difficult to follow. The authors need to very carefully proof-read the paper and make sure they correct any spelling/grammatical errors, but in places I also feel they should give more detail in their description of the methods and techniques they have used. As an example, I found it very difficult to follow what the authors did in step 2.1 at the top of page 7: more detail should be given about the Monte Carlo sampling technique and why this is used. As another example: how are the parameters in the CPM in Eq. (10) estimated? Have the authors used maximum likelihood? Were the estimated parameters significant? Was a reference pool of sites used to estimate this CPM, or did the authors use an 'off-the-shelf' CPM (e.g. COBA model)? As yet another example, in section 4.1, I'm not sure what the authors mean when they say "The expected crash frequency N_i for segments $i(i = 1, 2, \dots, m)$ can be seen as the probability of crash occurrence p ". How can a frequency be seen as a probability? I *think* I understand what they are getting at, but it's far from clear and there are many other examples of such sources of potential confusion.
4. I think the authors need to be more aware of other papers investigating methods for hotspot identification. In their literature review in section 2 they refer to a few key publications; however, others are missing, including Sacchi *et al.* (2015); Wang *et al.* (2011); Heydari *et al.* (2013). Also, without giving any references or explanation, in this literature review the authors mention the "confidence interval technique" and the "crash reduction potential method".
5. Is it realistic to assume that the occurrence time and type of crash are independent? If so, can the authors give a brief explanation?
6. In section 6 the authors compare a ranking of potential hotspots using their QRA-based method to that produced by a standard EB method. The two methods produce different results: why should a practitioner choose their method over the standard method? Of course, their method is very different and ranks according to expected monetary costs (in ten-thousand Yuans), but how would a practitioner be expected to choose between the two methods when it comes to decision-making for road safety scheme implementation?
7. Have the authors considered the use of spatial methods for interpolating between the sites for which they have data? I'm not suggesting they re-do their analyses using a spatial model, but I think some reference to spatial techniques should be made in the conclusion.

References

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