Project: Work Zone Crash Performance Data Measurement
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Project Purpose

Work zone safety is a major concern for the Federal Highway Administration (FHWA), highway departments of transportation (DOTs), transportation industry, and the public. Work zones have significant impacts, both on traffic conditions, as well as on motorist and agency/contractor personnel safety. To improve insight of how planning or operational decisions may affect work zone safety and mobility, US agencies have been encouraged to, systematically, develop, utilize and improve, through gained experience, work zone performance and impact assessment evaluation methods and metrics. This regulation set the framework for traffic safety and mobility in transportation work zones and encouraged state DOTs to apply a holistic safety and mobility program necessary to address and support: (1) Development and implementation of state-level work zone safety and mobility policies; (2) Standardization of procedures (such as work zone safety and mobility data analysis, impact assessment, personnel training etc.) that assist the implementation of these policies; and (3) Development of procedures and Transportation Management Plans (TMPs) to assist work zone management and assessment of projects. The proposed research will determine, in close collaboration with TDOT, the appropriate set of measures for monitoring and evaluating Tennessee work zones performance in terms of safety, as well as for (monitoring and evaluating) the implemented strategies and the agency staff efficiency and awareness on safety issues. Figure 2 shows the total number of crashes at 10 counties of the State of Tennessee for 2002-2016 and the mean of traffic crashes in the dataset used for this study.

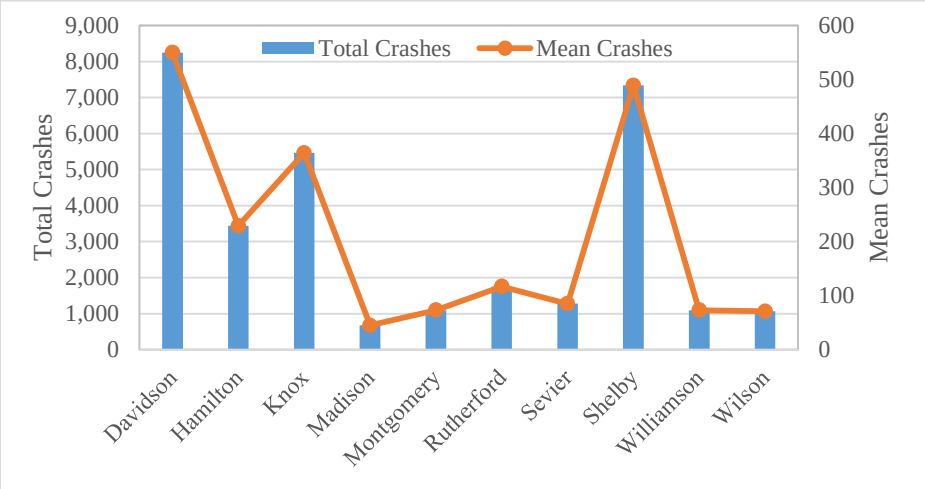

Figure 1. Top ten counties of work zone crashes in TN.

Analytical Approach

In this research, we employ new techniques that advances Neural Network (NN) paradigm to perform the following tasks: (1) open the black-box with a Neural Interpretation Diagram (NID) and graphically present Neural Network architecture with weight matrix such that the thickness of weight connections between neurons represents the strength of the connection; (2) use cross validation method and early stopping policy to determine the structure of a multi-layer perceptron Neural Network and overcome overfitting problem; (3) use the Olden method (1) to determine importance index or statistical significance of each explanatory variable; (4) use the Lek-profile method (2) to calculate the correlation between each response variable and explanatory variables. The overall findings of this study are expected to help public agency and government officials to better understand the characteristics of work zone crashes, effectively prioritize work zone projects for budget allocation, financial programming, and to improve safety measures at work zones by reducing number of crashes, and lowering adverse social economic impacts caused by work zone crashes.

Initial Findings

Figure 2 shows the relative importance of explanatory variables corresponding to two outcome variables, i.e. crash density and economic cost. It is noteworthy that the magnitude and order of relative importance among explanatory variables are different for each response variable. The upward and downward bars in Figure 5 respectively represent the relative importance of the explanatory variables to each response variable proportionally in opposite direction. The results of this study may be applicable to work zone crash analysis and prediction for transportation corridor. The findings from this study indicate the influential factors that contribute to crashes at work zones include number of lanes, AADT, higher speed limit, and length of roadway, etc. The interstate highways have significant influence on vehicle crashes. This study demonstrates that ANN with new techniques introduced in this study is a consistent alternative and an important methodology for analyzing and predicting work zone crashes.

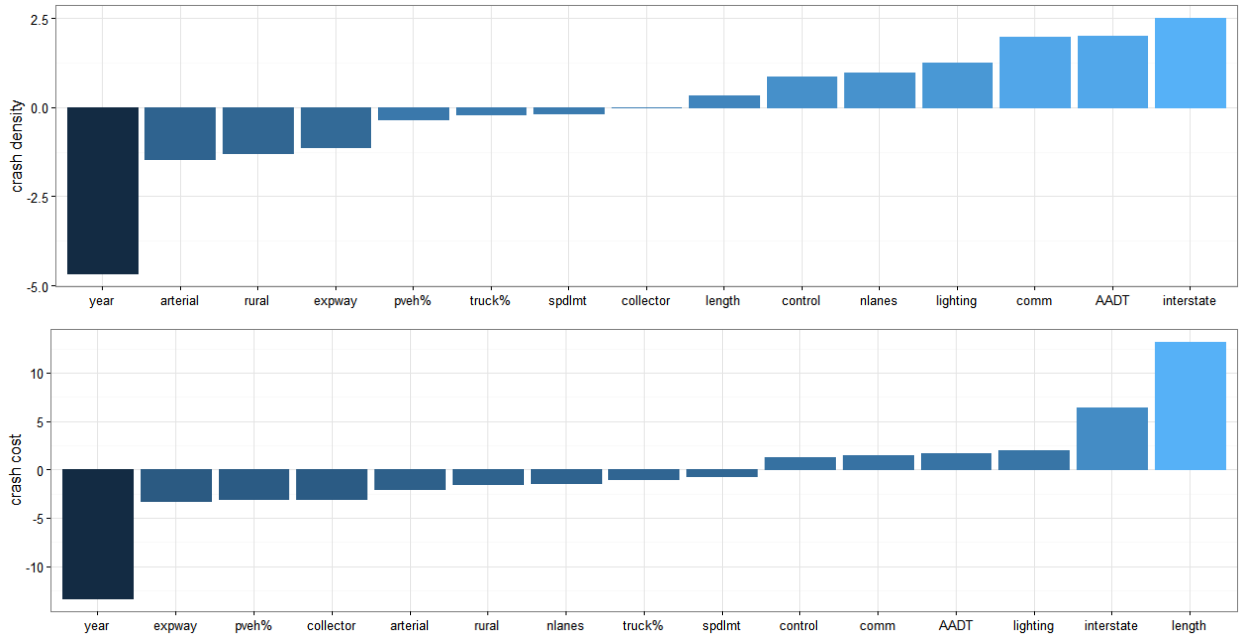

Figure 2. Relative importance of explanatory variables.

Crash Prediction

Figure 3 show comparisons of observed and predicted crash density for the year 2015 and 2016 at the county level. The comparison at county level appears more reasonable than the comparison at individual level. In addition, 2016 work zone data does not represent the complete year yet. The validation represents considering data from 10 counties only. However, the project team now is in the process of collecting data for all 95 counties in TN. The revised validation will consist of a larger data set. Further a prediction will be made for each county to assist TDOT to obtain a target of work zone crashes for short term planning purposes.

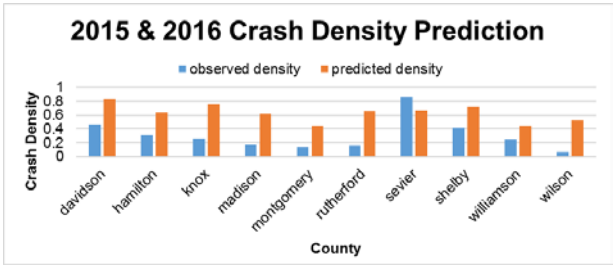

Figure 3. Crash density prediction.

Project Result Dissemination

Ma, T., Haque, K., Mishra, S., Golias, M., and Freeze, B. (2017). Nonlinear Multivariate Crash Prediction Model for Work Zones. Paper submitted for presentation at the 96th Annual Meeting of Transportation Research Board, Washington DC.