Texas Department of Transportation

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PROJECT SUMMARY REPORT

0-7144: Develop a Real-Time Decision Support Tool for Urban Roadway Safety Improvements

Background

Urban roadway safety has become a growing concern, particularly with the increasing number of fatalities and serious injuries in urban areas. While traditional methods for assessing safety primarily rely on general traffic data and static models, they fail to integrate dynamic factors such as real-time traffic speed, volume, and weather conditions, which are crucial for accurate safety assessments. With urban traffic crashes contributing significantly to road fatalities, particularly those involving pedestrians and cyclists, there is a clear need for real-time, location-specific safety analysis. This research aims to develop a tool that incorporates real-time data to provide a more accurate, actionable safety analysis. The primary goal of this research was to develop a real-time decision support tool for urban roadway safety improvements. The research focused on achieving the following objectives: develop a conflated database incorporating key data sources such as roadway inventory, traffic volume, operating speed, weather conditions, and crash data, establish safety evaluation models based on the conflated database, considering real-time factors like weather and traffic conditions, and create an interactive decision support tool that integrates these safety evaluation models and allows real-time safety assessments for urban roadways.

What the Researchers Did

The researchers undertook three major tasks to achieve the project's objectives. In the first task, they focused on data conflation, integrating multiple data sources such as real-time traffic speed and volume data from the National Performance Management Research Data Set (NPMRDS), crash data from the Crash Records Information System (CRIS), weather data from the National Oceanic and Atmospheric Administration (NOAA), and roadway inventory data from the Road-Highway Inventory Network Offload (RHiNO). This merged dataset allowed for efficient analysis of the relationship between real-time traffic conditions, weather, and crash occurrences. The second task involved the safety evaluation of urban roadways. The researchers developed both annual-level and short duration level safety performance functions (SPFs) using the conflated data. These models incorporated various factors such as real-time operating speed, traffic volume, and weather conditions, providing a more accurate understanding of urban roadway safety compared to traditional models. The developed decision support tool is a GIS-based, web platform that estimates and visualizes crash risk using speed, traffic, and weather data. Built on Shiny, it allows users to filter by district, facility type, AADT, and crash severity, and supports both built-in and user-uploaded data. It enables localized, time-sensitive safety analysis and provides downloadable outputs for informed decision-making.

What They Found

Annual level analysis: The annual-level SPFs showed that across all urban facility types, crash frequency is significantly influenced by AADT, excess speed, and geometric characteristics. For freeways, higher traffic volumes and speeding increased crash risk, while wider lanes, shoulders, and medians reduced it, with truck-heavy routes showing lower crash rates due to higher design standards. Multi-lane divided highways were sensitive to driveway density and lane count,

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with wider cross-sections mitigating risk. For multi-lane undivided roads, especially those with four lanes or continuous left-turn lanes, precipitation and excess speed had strong impacts—raising crash risk by 30–45% per 10 mph over the speed limit. Two-lane undivided highways with continuous left-turn lanes also showed increased crash risk from traffic volume and driveways, reinforcing the importance of access management and shoulder design. Across all models, the context-specific Crash Modification Factors (CMFs) demonstrated improved calibration for Texas conditions when compared to national models like the HSM and Texas WB.

Short duration analysis: The short-duration SPFs provided critical insights into the temporal variability of crash risk across urban roadway types. Key findings indicate that higher Monthly Average Daily Traffic (MADT), greater speed variability, and precipitation consistently elevate crash frequency, while wider shoulders and higher average speeds on well-designed roads help mitigate crashes. However, the influence of predictors such as shoulder width and precipitation varied by year and facility type, revealing the importance of context-specific modeling. Notably, two-lane undivided (2U) roads were especially sensitive to shoulder width and driveway presence, while four-lane undivided (4U) and divided (4D) roads were more affected by speed variability. Three- and five-lane roads with center turn lanes (3T, 5T) showed the greatest crash increases from travel time variability, underscoring the need for improved access management and signal timing.

What This Means

One of the primary challenges in urban roadway safety evaluations is the limited integration of dynamic, real-time data such as traffic speed, volume, and weather conditions, which are critical for more accurate safety predictions. Traditional safety models tend to rely on static data, such as average traffic volume and geometric features, without accounting for fluctuations in real-time road conditions. This study has shown that incorporating real-time traffic speed and weather data into safety models significantly improves the accuracy of crash frequency predictions. The findings underscore that factors like operating speed variability and precipitation are directly linked to increased crash occurrences, highlighting the importance of real-time data in assessing roadway safety. Researchers developed an interactive, web-based decision support tool (with data upload options) that visualizes the safety performance of urban roadways based on real-time operational data, such as traffic speed and weather conditions, in addition to traditional roadway features. This tool enables transportation professionals to evaluate the safety of roadway segments more effectively and take informed actions to address safety issues. The study recommends the adoption of the decision support tool as a valuable resource for urban planners and engineers.

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