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Development of Work Zone Crash Modifications Factors for Iowa

tech transfer summary

Crash modification factors for Iowa work zones with automated queue warning systems indicate the effectiveness of this countermeasure in reducing different types of work zone crashes.

Objective

This research aimed to develop Iowa-specific crash modification factors (CMFs) for work zones with automated queue warning systems through the evaluation of work zone-related crashes.

Background

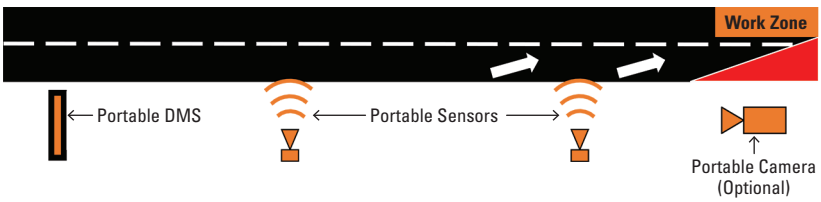
An automated queue warning system is an emerging traffic enforcement strategy in work zone areas that alerts drivers of slow traffic ahead to mitigate rear-end crashes. The system accomplishes this by providing timely information to drivers, often through a portable dynamic message sign (PDMS) upstream of the work zone, about queue lengths and expected delays.

CMFs are widely used to predict the safety performance of countermeasures such as an automated queue warning system or changes from specified base conditions. A number of work zone-specific CMFs have been developed, notably those in the *Highway Safety Manual* (HSM) and the CMF Clearinghouse, that reflect a range of work zone operations and countermeasures.

Problem Statement

While previous studies have shown that the presence of a work zone significantly affects the frequency of rear-end crashes, the safety impacts of countermeasures that aim to reduce rear-end crashes in work zones, like automated queue warning systems, have seldom been assessed.

Challenges arise when existing work zone CMFs are applied in regions like Iowa. Most of these CMFs were developed specifically for principle arterial roadways and Interstates in California, which complicates their application to Iowa's unique conditions and work zone strategies. Moreover, these CMFs do not fully capture the effects of newer work zone operations and advanced countermeasures such as PDMS and automated queue warning systems.



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Automated queue warning system used by the Iowa DOT

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RESEARCH PROJECT TITLE
Development of Work Zone Crash Modifications Factors for Iowa

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Research Description

CMFs were developed for work zones with automated queue warning systems versus work zones without this countermeasure through an analysis of work zone-related crash data in Iowa from 2016 through 2023.

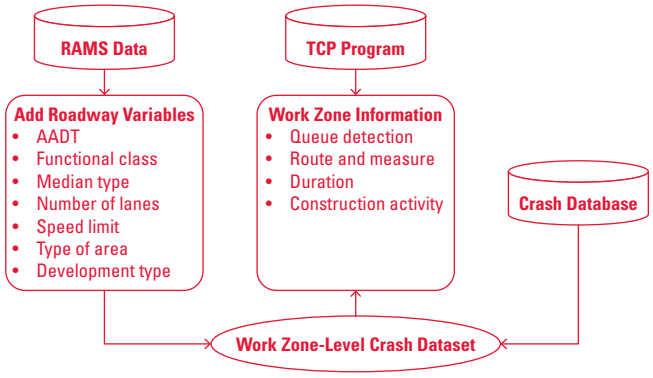
Three sources of data were obtained and processed to create a work zone-level crash dataset with the relevant information for analysis:

- Historical data on work zones and the smart work zone devices deployed during the study period from the Iowa Traffic Critical Project (TCP) program
- Law enforcement-reported crash data, including dates and spatial coordinates as well as route and measure information
- Roadway characteristics from the Iowa Roadway Asset Management System (RAMS)

To assess the impact area of an automated queue warning system, two buffer zones were created around either the work zone's PDMS (for work zones with a queue warning system) or around the start of the work zone (for work zones without a queue warning system). One buffer was 1 mi upstream and 0.5 mi downstream, and one was 0.5 mi upstream and 0.5 mi downstream.

The data were evaluated using negative binomial-P (NB-P) and Sichel models, which are well suited for handling overdispersed crash count data. These models were selected based on their log-likelihood values and cumulative residual (CURE) plots.

Additionally, connected vehicle data from Wejo were utilized explore vehicle speeds in real-world work zones. Four work zone segments with PDMS were selected from the TCP program data, and 85th percentile and mean speeds were plotted along each of the work zone routes during periods when the work zones were and were not in effect.



Data collection and processing

Key Findings

Four CMFs were developed for the two buffer areas and for two crash categories: total crashes and fatal, major injury, and minor injury (KAB) crashes.

CMFs for work zones with a queue warning system

Buffer	Total Crashes	KAB Crashes
Upstream 1 mi, downstream 0.5 mi	0.969	0.681
Upstream 0.5 mi, downstream 0.5 mi	0.979	0.766

The key findings from the analysis were as follows:

- The presence of a queue warning system leads to a slight decrease in total crashes (up to 3.1%) and a significant reduction in KAB crashes (up to 31.9%).
- The impact is more pronounced for the 1 mi upstream and 0.5 mi downstream buffer, suggesting that the queue warning system influences vehicle speeds around 1 mi upstream of the work zone.
- The higher effectiveness in preventing KAB crashes is likely due to decreased vehicle speeds in the presence of a queue warning system.
- The analysis of connected vehicle data found consistent patterns of speed reduction in most of the work zones compared to periods when the work zone was not present.

Implementation Readiness and Benefits

The high-quality work zone CMFs developed in this research are valuable for Iowa-specific applications as well as the broader transportation engineering community through the CMF Clearinghouse.

The use of automated queue warning systems in work zones is a viable strategy for mitigating the severity of work zone crashes and more broadly enhancing road safety.