Development of CMFs for Traffic Signal Installation at High-Speed Intersections

tech transfer summary

Iowa-specific crash modification factors (CMFs) can help indicate how traffic signal installation affects safety at high-speed intersections.

Objective

The objective of this research was to develop Iowa-specific crash modification factors (CMFs) for traffic signal installation at high-speed intersections.

Background

Several factors can contribute to crashes at unsignalized high-speed intersections. Drivers may fail to recognize the intersection, fail to comply with traffic control, or select inappropriate gaps. Moreover, reaction times decrease and crashes become more severe as speeds increase.

Traffic signal installation is a countermeasure that may be considered at high-speed intersections; however, national research presents mixed findings on its effectiveness.

The potential impact of a safety treatment is estimated using a CMF. A CMF is a multiplicative factor used to calculate the expected number of crashes after a given countermeasure is implemented at a specific site. A CMF value below 1 indicates a reduction in crashes following implementation, while a value above 1 indicates an increase in crashes.

The Federal Highway Administration (FHWA) Crash Modification Factors Clearinghouse (https://www.cmfclearinghouse.org) provides several CMFs pertaining to traffic signal installation.

Problem Statement

The CMF values in the FHWA CMF Clearinghouse can vary widely, originate from studies of varying quality levels and analysis periods, and employ data from geographic regions or states that may not reflect Iowa conditions.

Iowa is well positioned to develop Iowa-specific CMFs for high-speed intersection signalization, given the state's comprehensive intersection database, high-quality crash data, and past/ongoing efforts to develop intersection safety performance functions (SPFs).

Polk County, Iowa GIS – EagleView Technologies

High-speed signalized intersection

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RESEARCH PROJECT TITLE
Development of CMFs for Traffic Signal Installation at High-Speed Intersections

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Iowa Department of Transportation (InTrans Project 24-880)

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The mission of the Center for Transportation Research and Education (CTRE) at Iowa State University is to conduct basic and applied transportation research to help our partners improve safety, facilitate traffic operations, and enhance the management of infrastructure assets.

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Research Methodology

Using roadway imagery and data from the Iowa Department of Transportation's (DOT's) intersection inventory database, crash database, and Roadway Asset Management System (RAMS), a five-step methodology was followed to develop the CMFs:

1. A homogeneous set of treatment sites was identified that included non-ramp signalized intersections where at least one leg has a speed limit over 45 mph. Key site characteristics were collected, including presence of medians, number of legs with separate right- and left-turn lanes, traffic control type prior to signalization, traffic volumes, and crash history.

2. Reference sites (unsignalized intersections) were identified that had characteristics comparable to those of the treatment sites.

3. Based on the availability of signal installation dates and the availability of crash data before and after installation, cross-sectional analysis was selected as the CMF development method.

4. A total of 252 SPFs were developed covering the various intersection and crash characteristics. CMFs were derived from the SPFs and refined based on their statistical significance, sample size, and goodness of fit of the SPFs.

5. The CMFs were validated based on a comparison to values found in the literature, specifically the FHWA CMF Clearinghouse; hypothesis tests of proportions to assess whether the proportions of different crash types follow similar trends to the CMFs; and local agency outreach to explain the impact of traffic signal phasing on CMF values.

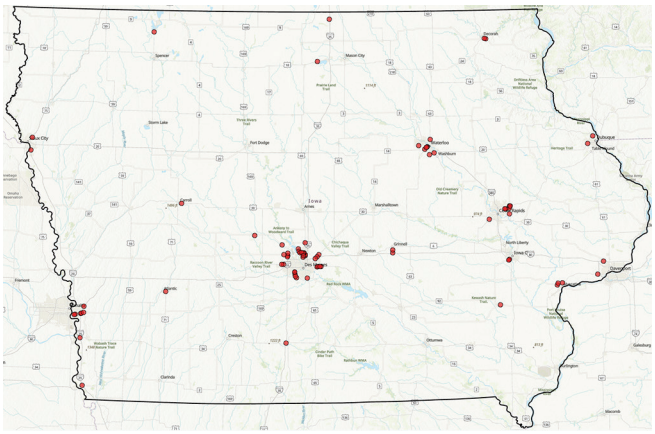
Key Findings and Recommendations

- When a traffic signal is installed at a high-speed intersection, most facility types are predicted to experience an overall increase in crashes (45% to 100% increase) and a more than 70% increase in mainline rear-end collisions (70% to 340% increase). These rear-end crashes are expected to be severe due to the higher speeds.

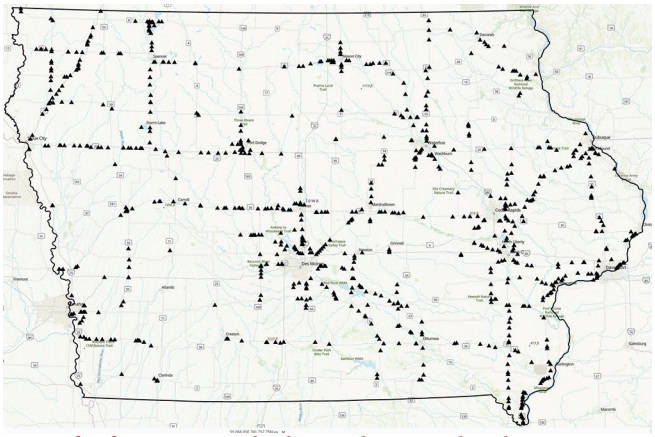
- Most facility types are predicted to experience a reduction in broadside/right-angle collisions (50% to 60% decrease), though some broadside crashes may still occur due to red light running and permissive left-turn (angle) collisions.

- General crash reductions were only observed on undivided intersections. This may be because these intersections generally occur in more suburban/urban transition zones, where drivers are more likely to expect to encounter traffic signals.

- Before a high-speed traffic signal is proposed, alternatives such as a roundabout, a reduced-conflict intersection, right-in/right-out, and median closure should be evaluated.



Map of high-speed signalized intersections



Map of reference sites: high-speed unsignalized intersections

- The trade-offs of high-speed traffic signals should be communicated to the traveling public and local officials during intersection evaluation.

- Any potential traffic signal at a high-speed location should be part of a corridor access management agreement that considers other existing signalized intersections or other intersections that may be signalized in the near term.

- Protected-only left-turn phasing is strongly recommended over permissive or protected-permissive phasing. This could mean all-day protected left-turn movements or left-turn phasing that varies based on time-of-day peak traffic and/or left-turn queue detection.

Implementation Readiness and Benefits

The final report for this project includes a table of CMFs for high-speed intersection signalization.

Though often perceived as a viable safety countermeasure at high-speed intersections, signalization is predicted to increase overall intersection crashes and is not expected to significantly reduce overall serious injury crashes. Alternative intersection treatments should be considered before a high-speed traffic signal is proposed.