SWZDI
Smart Work Zone Deployment Initiative

Guidance for Incorporating Work Zone Data within Traffic Management Operations

tech transfer summary

The integration of connected temporary traffic control devices into an agency's work zone management system can improve work zone data and benefit agencies and travelers.

Objectives

- Document the existing types of connected temporary traffic control devices (cTTCDs) in terms of the state of the practice for agency use, including the purpose and need for tying cTTCDs to an advanced traffic management system (ATMS) or similar system
- Develop and report on methods for utilizing cTTCDs for both real-time and historical analysis
- Evaluate methods currently being used to integrate cTTCDs for the reporting of verified work zones

Background

The ability for agencies to notify vehicles that they are approaching a work zone has the potential to reduce crashes by increasing motorists' awareness of conditions. A critical element of this ability is providing accurate, real-time work zone location and status information and reducing the potential for false alerts that motorist ignore.

Currently most agencies rely on their 511 website to communicate with the public. However, this information is often inaccurate because field staff and traffic management center (TMC) operators must input data manually.

Improving the accuracy of work zone data is a multilayered problem that a number of agencies have been working to address over the last several years. A promising solution is the use of cTTCDs such as connected arrow boards, connected traffic cones and panels, and temporary traffic signals. These devices have seen increased use over the last several years.

These types of devices differ from many other smart work zone devices such as sensors, cameras, and message signs in that their primary function is to report their own location and status in order to locate a work zone.

Problem Statement

As the number and types of cTTCDs have increased, little guidance has been developed on how agencies can use the information from these devices for both historical and real-time applications. Additionally, guidance is lacking on how cTTCDs, specifically connected arrow boards, can be integrated into an agency's traffic management or similar systems.

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RESEARCH PROJECT TITLE
Guidance for Incorporating Work Zone Data within Traffic Management Operations

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The Smart Work Zone Deployment Initiative (SWZDI) is a transportation pooled fund that supports research investigations into better ways to improve the safety and efficiency of traffic operations and highway work in work zones. The primary objective is to promote and support research and outreach activities that focus on innovative policies, processes, tools, and products that enhance the implementation, safety, and mobility impacts of work zones. The fund is administered by Iowa State University's Institute for Transportation, and the lead agency is the Iowa Department of Transportation.

ctre Center for Transportation Research and Education

Iowa State University Institute for Transportation

Various types of cTTCDs

Research Description

In the first phase of the research, agencies were interviewed to understand the current state of the practice and identify how connected equipment can be better utilized. Five state agencies leading in the use of cTTCDs were interviewed, including Iowa, Colorado, Minnesota, Washington State, and Wisconsin.

In the second phase of the research, work zone and connected arrow board data were evaluated to determine the how the data are currently being used and potential opportunities for integration. A detailed analysis focusing on three states explored the integration of connected arrow board devices with work zones. A broader analysis across 18 states explored considerations involved in associating connected arrow boards with roadways.

Data Processing

Two primary data sources were utilized in the analysis: work zone data from the Work Zone Data Exchange (WZDx) registry and connected arrow board data directly from device manufacturers.

The work zone data from the WZDx represent an agency's planned data for all expected work zones. The WZDx can be enhanced by utilizing the start location, end location, and start date or end date verification fields, which indicate to end users that the data have been generated by a device equipped with Global Positioning System (GPS) capabilities rather than by human entry.

The connected arrow board data represent the actual work zone activity based on the activation of physical equipment in the field. Using historical connected arrow board data, a database of arrow board activations was developed showing the location, start time, and end time of a given work zone. The database also provides the start and end locations of arrow boards that were part of a moving operation, but only the start location was utilized for this research.

Analysis

For the broad analysis of arrow board integration, 498,358 arrow board activations that could be identified based on their proximity to the roadway network were captured between January 2023 and August 2024. Ambiguity was a concern by multiple states, with the potential for arrow boards to be located near multiple roadways. The distance to each route was analyzed and summarized by the presence of ambiguity as well as the type of roadway.

For the detailed analysis, the WZDx data were summarized based on the number of verified work zones. Only Iowa had any verified work zones that were trending upward starting in early 2024 due to the deployment of an alerting system to operators for associating arrow boards to work zones.

The final analysis explored two methods of integrating arrow boards and work zones: a spatial analysis or a route-based analysis. The spatial analysis is simple but can be imprecise because it may associate a work zone on a given road with arrow boards on other roads. The route-based method independently associates arrow boards with the roadway network and then identifies overlaps with work zones based on route and measure data from the network.

The integration analysis included identifying issues with the integration methods as well as highlighting missed opportunities where arrow boards were near planned work zones and potential benefits where arrow boards were activated with no nearby work zones.

Key Findings

- Most of the agencies interviewed currently have limited connected arrow board deployments and are developing methods to integrate the devices into their traffic management or similar systems.
- Leading agencies are pushing for automated methods of associating cTTCDs with work zones. In the absence of automated methods, alerts such as those used by the Iowa DOT have led to an increase in the number of verified work zones.
- Ambiguity is a concern for automatically associating devices with work zones. Larger search radiuses lead to higher ambiguity, while smaller search radiuses may not capture all of the work zones near an arrow board. The research team ultimately used a 50 ft search radius, which limited the amount of ambiguity for the closest route.

- In total, 62% of arrow board activations had the closest roadway within 50 ft of the arrow board, with a majority of arrow board activations within close proximity to a roadway and two-thirds of the closest activations being less than 25 ft.
- A route-based method of integration allows for a smaller search radius for arrow boards and does not introduce as many ambiguity issues as a spatial analysis. The route-based method also allows for searching along a route using larger distances.
- Over half of the ambiguity identified in Wisconsin and Colorado was due to duplicate planned work zones in the WZDx. This issue can easily be resolved by agencies through the implementation of quality checks on the planned work zone data to avoid overlaps in work zones spatially and temporally.
- In terms of the potential benefits of arow board integration, the arrow board activations near a work zone represented only 11.3% of the total activations in Wisconsin, 1.2% of the total activations in Colorado, and 31.1% of the total activations in Iowa. In Iowa, arrow board activations occurred on average 290 minutes before the reported start time and 0.99 miles before the reported start location for verified work zones and on average 139 minutes before the reported start time and 0.51 miles before the reported start location for estimated work zones.
- The connected arrow board data alone can be beneficial for agencies for historical usage. The clustered arrow board data can be used to report the duration, frequency, and number of work zones deployed in a given state.
- County and local roadways may need to utilize different methods of associating arrow boards with work zones because less than half of the arrow board activations were within 50 ft of those roads.

Implementation Readiness and Benefits

The use of cTTCDs such as connected arrow boards is expected to continue to increase in the coming years as work zones become more connected. Analyzing the methods used to integrate the data from these devices with work zones is needed to ensure the accurate and timely reporting of work zone data to the public.

The results of this study provide some initial guidance on how agencies can utilize cTTCDs, including guidance on the integration of these devices into a traffic management or similar system. Automated processes for associating arrow boards and work zones will need to account for some of the issues highlighted in this research, including the potential for ambiguity and the duplication of planned work zone data.