

Developing a Research-Grade Iowa Work Zone Database

tech transfer summary

December 2020

RESEARCH PROJECT TITLE

Developing a Research-Grade Iowa Work Zone Database

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Iowa Department of Transportation
(InTrans Project 18-675)

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This project developed the foundation for the Iowa DOT's new work zone database, along with the processes that integrate the data from their 511 system and their connected temporary traffic control devices.

Problem Statement

Accurate work zone data are a challenge that all agencies face. Agency staff that want to be proactive in their work zone management are limited by the accuracy of their work zone data and are looking for ways to improve the methods of collecting their data.

Background

In Iowa, as well as most other states, work zone data are manually collected using forms or lane closure planning systems. This works well for planned work zone data but is not ideal for collecting actual work zone data from the field where the work zones are actually located and when and where lanes are closed. While a variety of standards that include work zone data are available, there is no concurrence among states on the data that should be included in a work zone database (WZDB).

Objectives

- Define relationships between a potential work zone activity monitoring system and relevant Iowa Department of Transportation (DOT) business processes
- Identify desired data entry methods that would not create an undue burden on Iowa DOT construction engineers and inspectors
- Identify any components of this system that can be adapted from existing open-source software platforms
- Develop a plan for integrating the WZDB with the future Iowa DOT Permitted Lane Closure System (PLCS) and its 511 system
- Develop a prototypical process for archiving work zone data



Smart arrow board at the beginning of a work zone in Iowa

Research Description, Findings, and Results

To develop a research-grade WZDB, the current data collection method needed to be understood first to determine what and where data can be collected, in addition to identifying improvements to existing collection methods. The current process of collecting work zone data in Iowa was documented, including the various ways to input work zone data, as well as the systems that are using the data. Additionally, any issues with the process were documented, including accuracy and the need for a research-grade WZDB.

As part of understanding the process and working with the Iowa DOT, it was identified that field staff and contractors are not ideal sources for collecting work zone data, because field staff and contractors are primarily focused on controlling work activities and can introduce human error in collecting data. The agency is also sensitive toward placing additional burden on inspection staff to collect these data.

In lieu of a mobile application to collect work zone data, the Iowa DOT focused on other methods of collecting the most critical elements of a work zone, which are location and time. Connected temporary traffic control devices (cTTCDs), like smart arrow boards, are available in the market today and can be used to collect work zone location and time information. The combination of the planned work zone data that are already input by users and the cTTCD data should be included in the WZDB.

There are currently no reference guides or agreed upon standards available to provide insight toward digitally describing and communicating the dynamic work zone activities that take place on roads and highways. However, multiple standards exist in the area of traffic management, which can be used to gain insights into the critical information that is needed for a research-grade WZDB.

The Federal Highway Administration (FHWA) Work Zone Activity Data (WZAD) Framework and Data Dictionary were ultimately used to identify the data elements that are needed for a WZDB given that they comprehensively cover all aspects of a work zone including the data requirements. Additionally, the Work Zone Data Exchange (WZDx) was used to identify any additional data elements that should also be included in the WZDB.

Identifying the data elements in the WZAD Data Dictionary allowed for an entity relationship diagram to be developed showing the relationship between all data elements for the WZDB. Slight modifications were made to adapt the data dictionary to Iowa for better integration with other data sources within the Iowa DOT, including representing mileposts as linear referencing measures and also including the route identifier from the linear referencing system (LRS).

Once the data elements were identified, the structure of the WZDB was established, including the following seven tables:

- SubTask table
- Recurring table
- Restrictions table
- SubTask Activity table (future data collection)
- SubTask Intersection Location table (future data collection)
- SubTask Advanced Warning table (future data collection)
- Detour Path table (future data collection)

All of the tables are related based on the wZ-SubtaskID. Three of the tables include data that is currently collected, while the remaining four tables are for future use, representing the items that are not currently collected by the Iowa DOT.

The SubTask table contains the majority of critical work zone information. The subtask identifier is used instead of the task identifier because the WZDB represents the individual lane closures that occur throughout the state. All of the lane closures can be summarized up to a higher level representing the entire work zone project.

With the database structure established, a process to begin populating the database with work zone data was developed. The archival of the work zone data is a two-fold process that is scheduled to run every five minutes and update the WZDB with any new work zone information.

Part 1 of the process cleans the existing 511 field data and then formats it to match the fields and data enumerations from the WZAD Data Dictionary. The data are also conflated to the Iowa DOT's LRS to extract additional data elements needed for the WZDB that are not currently collected, including the total number of lanes and the facility type.

Part 2 of the process takes the output from Part 1 and integrates the cTTCDs from another existing process based on the LRS. The data from the cTTCDs can then be used to populate the verified location and time data elements.

Given that all of the 511 work zone and cTTCD data are processed every five minutes, not all of the data should be archived in the WZDB since most data are likely redundant. Instead, the process compares the final results with the data in the work zone database to identify if the final data represents a new work zone or includes updates such as verified location and time. These final data can then be used to update the work zone database while the other redundant data are discarded. The process results in a populated work zone database that includes verified coordinates and time, which will provide confidence for users on the accuracy of the work zone data.

Conclusions

The establishment of a WZDB is an initial step in improving the work zone data collected in Iowa. This research identified the current process of collecting work zone data and established the WZDB without any additional undue burden on field staff or contractors by using cTTCD data to supplement the planned work zone data with verified location and time data. This eliminated the need for a data entry screen and instead relied on the smart arrow board protocol developed by the Iowa DOT.

The FHWA WZAD Framework and Data Dictionary were invaluable resources for identifying and establishing the data elements needed for a WZDB. The Work Zone Plan Dissemination to Third Party Data Providers use case identified in the data framework became the foundation for developing the WZDB in Iowa.

The FHWA WZAD Data Dictionary was then used to develop the database structure by understanding the relationships between all of the data frames and data elements. An entity relationship diagram was created to show these relationships and identify the similar data elements for the various tables in the WZDB. Implementation of other use cases can follow a similar methodology of using the FHWA WZAD documents as a guide for the data elements needed for the use case.

Finally, the WZDB was developed and in lieu of a data entry screen, and work zone data were archived by integrating the planned 511 work zone data with data from smart arrow boards that are currently deployed in Iowa. The smart arrow boards allow for verified coordinates and time to be included in the WZDB to provide confidence for users on the accuracy of the location and time for the data.

Implementation Readiness/ Recommendations for the Future

The major challenge with the current implementation is the accuracy of the planned work zone data that are entered into the 511 system. The Iowa DOT is currently developing the requirements for its PLCS that should improve the accuracy of the planned work zone data and remove redundant work zones that are entered into the 511 system. Having redundant work zones causes ambiguity when relating the work zone to the cTTCD data that should be eliminated.

Various data elements are also not collected in the current 511 system that should be included in future systems by the Iowa DOT, if deemed necessary. These include the contract number, the reduced speed limit, worker presence, the work zone separation type, and the temporary traffic control standard that is used (e.g., TC-421, TC-418).

The current WZDB should be viewed as a starting point and should be expanded in the future as other data become available or improved methods of collecting data are added. Finally, the Iowa DOT should continue the deployment of cTTCDs, such as connected pins/panels, smart flaggers, and smart temporary signals. The current use of smart arrow boards provides accurate begin points of the work zone but does not include any end points of the work zone.

Implementation Benefits

The smart arrow boards were an easy starting point for the Iowa DOT given they did not require any changes to worker activity in the field. The continued deployment of other cTTCDs will further improve the accuracy of work zone data, which in turn improves both safety and mobility.