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SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

RELIABILITY DATA AND ANALYSIS TOOLS (L02/L05/L07/L08/C11)

A tool suite to help transportation planners and engineers improve data monitoring and analysis to achieve more consistent, predictable highway travel.

CASE STUDY

Wisconsin Department of Transportation

Reliability of Travel Times on Urban and Rural Highways

ABOUT THIS CASE STUDY

The second Strategic Highway Research Program (SHRP2) developed data and analysis tools to improve the measurement and management of travel time reliability (TTR) by transportation practitioners. The SHRP2 Program provided funding to help agencies test the tools and incorporate reliability into their business practices. The Wisconsin Department of Transportation (WisDOT) project included the following tools:

DATA COLLECTION

L02 Guide to Establish Monitoring Programs for Travel-Time Reliability
Guidebook, visualization tools, and methods for integrating data to analyze reliability, including causes and locations of unreliable performance and identification of potential mitigating strategies.

ANALYSIS

L07 Reliability by Design
Spreadsheet-based treatment analysis tool to assess how different design improvements affect reliability, delay, safety, and benefit vs. cost over the lifecycle.

L08 Incorporating Travel-Time Reliability into the Highway Capacity Manual
Highway Capacity Manual (HCM) update to estimate travel-time reliability performance measures on major freeways and urban arterials.

C11 Tools for Assessing Wider Economic Benefits of Transportation
Spreadsheet-based tools that expand economic benefits analysis of highway projects to contain network-oriented concepts, including reliability.

BETTER DECISIONS

L05 Handbook for Incorporating Reliability Performance Measures into Transportation Planning and Programming
Guide to the institutional arrangements and technical steps needed for State Departments of Transportation (DOTs) and metropolitan planning organizations (MPOs) to incorporate reliability into their decision-making.

BACKGROUND

The overarching goal of WisDOT's project was to expand the concept of reliability in highway improvement planning and evaluations. To accomplish this research, concluded in 2020, WisDOT partnered with the University of Wisconsin–Madison, University of Wisconsin–Milwaukee, a consultancy firm. WisDOT's objectives for the reliability tools pilot were to:

- Assess causes of non-recurrent congestion to improve roadway geometry and operation programs.
- Assess potential cost and operational effects of implementing solutions to improve reliability.
- Support WisDOT's interest in advancing tools to provide insight into the economic impacts of reliability.
- Provide institutional feedback to SHRP2 on findings of product testing and evaluations.

The project implemented the SHRP2 reliability procedures and products at six locations:

- A 5-mile segment of I-41 northbound from Wisconsin Highway 15 to County Highway E near Appleton (figure 1). This segment has traffic patterns consistent with urban freeway facilities.
- A 12-mile segment of I-41 between Scheuring Road and Lineville Road near Green Bay in Brown County. This segment included a long-term work zone where a Freeway Service Team (FST) provided service.

- A 10.7-mile segment of I-39/90/94 between Wisconsin Highway 60 and Wisconsin Highway 78 in Columbia County (figure 2).
- A 7.4-mile segment of US-12/14 eastbound from Forward Drive to South Towne Drive. This urban freeway has high amounts of weaving since spacing between consecutive on-ramp and off-ramps is relatively small. A portion of the segment was expanded to improve roadway capacity.
- A 45-mile segment of I-39/90 between the Wisconsin/Illinois State line and Madison. This segment has significant recreational traffic during the summer and heavy truck traffic, in addition to regular traffic traveling between Beloit, Janesville, and Madison.
- A 7-mile segment of US-14 between Cross Plains and Middleton used by commuters to and from Madison.

Figure 1. Map. I-41 segment near Appleton. Source: WisDOT. Map Data © 2020 Google.

PRODUCT IMPLEMENTATION

Data

WisDOT databases and third-party sources provided speed, travel time, incident, work zone, volume, weather, special event, crash, and FST data that supported testing of the tools. Data sources include the NPMRDS and WisDOT's Traffic Data System (TRADAS) among others.

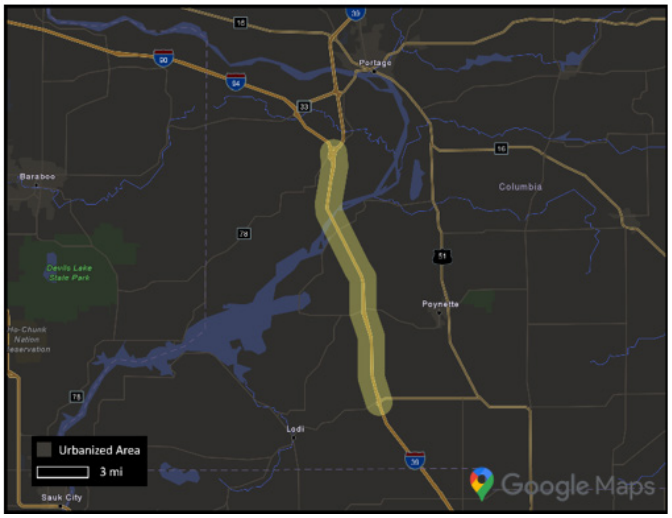

Figure 2. Map. I-39/I-90/I-94 segment. Source: WisDOT. Map Data © 2020 Google.

L02

The L02 guide describes methods to collect, archive, and integrate the data required for reliability estimation, and methods for analyzing and visualizing the causes of unreliability based on the collected data. Using L02 product guidance, WisDOT assessed the causes of non-recurrent congestion on I-41 near Appleton to improve traffic management strategies, and the potential economic and operational effects of implementing solutions to improve reliability. The test confirmed that WisDOT has access to the necessary data types from traffic sensors and other systems. Data include, for example, travel times, incidents, and work zones. Data coverage for the Interstate system is excellent but decreases for lower volume segments. WisDOT used the data to visualize the distribution of travel rates (time to travel one mile) under different conditions and identified incidents and demand as the factors affecting reliability the most. The University of Wisconsin–Madison Traffic Operations and Safety (TOPS) Laboratory reviewed data output.

L07

The L07 tool is a spreadsheet-based treatment analysis tool and design guidebook that helps agencies analyze current conditions and the effects of design and operational treatments to improve reliability. The treatment analysis tool predicts benefits from a wide range of treatments and strategies and facilitates reliability and non-recurrent congestion considerations in planning and design.

WisDOT applied the L07 methodology using incident duration data to quantify the benefits of its FST. WisDOT intended to evaluate the potential deployment of FST in the Columbia County site and measure the reduction of FST incident durations in a long-term work zone site in Brown County. The highway service patrol, the FST in Wisconsin, is not a treatment option in L07 tool, so WisDOT created a new option named "Custom Incident Treatment." The custom option allowed the user to input crash and non-crash incident counts and durations with and without the treatment (figure 3). WisDOT compared results from two different incident data sources: Traffic Management Center (TMC) Event Manager and FST databases. WisDOT found that the FST would present significant delay benefits, order-of-magnitude smaller reliability benefits, and even smaller safety benefits.

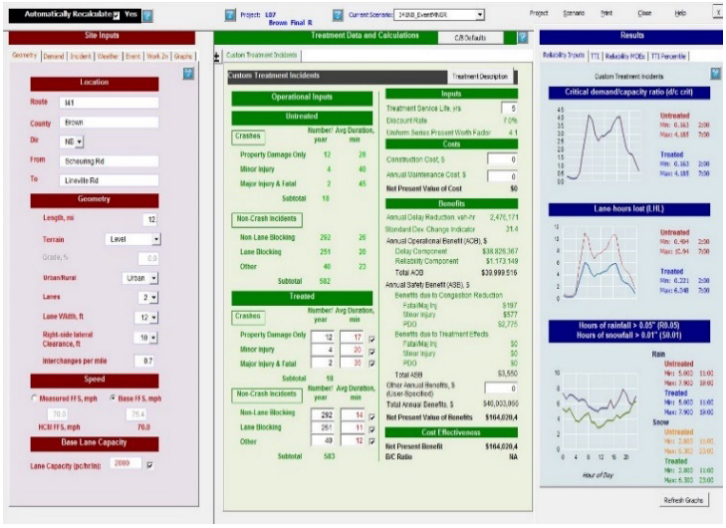

Figure 3. Graphic. Example of L07 tool custom incident treatment interface. Source: FHWA

L08

WisDOT tested FREEVAL-RL, a Microsoft Excel[1]-based tool that enables users to estimate the reliability impacts of projects by dynamically modeling multiple operating scenarios along the facility using a Monte Carlo model, in the US-12/14 segment in Madison. WisDOT conducted two tests: one using default data, except for traffic demand data; and the other using facility-specific data. The latter included two options for incident input: data poor and data rich data facilities. WisDOT also analyzed reliability before and after the capacity expansion of a segment using default and facility-specific data. The analysis found improvement using both data sets for most traffic conditions along the distribution of the travel time index (TTI) and for measures such as the reliability rating.

C11

WisDOT applied the C11 Reliability Module to three segments to assess output results across facility types and traffic conditions. WisDOT compared the outputs from the module to observed conditions from other data sources, such as NPMRDS. Key data inputs for analyses involving the C11 Module include:

- Analysis period.
- Highway type.
- Free-flow speed.
- Annual average daily traffic.
- Annual growth rate.
- Truck percentage.

The analysis compared the existing facility with a hypothetical improved condition for the years 2016 and 2035. An analysis was also performed using WisDOT's travel time analysis tool to check the C11 outputs. The C11 tool delay outputs were significantly lower than expected. When compared with other tools developed by WisDOT to quantify nonrecurring effects, the delay results from C11 in most cases were lower by multiple orders of magnitude, and nonrecurring delay hours were minimal.

L05

The L05 product is a guide describing how to incorporate reliability into transportation planning and programming. The target audiences for the guide are planning, programming, and operations managers, who can incorporate reliability into the agency's business practices. WisDOT conducted outreach with these stakeholders through peer exchanges. Testing the other SHRP2 reliability products allowed WisDOT to demonstrate reliability applications on projects and treatments familiar to staff involved in the planning, programming and evaluation of financial investments. One example is using the benefit calculations generated by the L07 test to support project prioritization for investment decisions. The project team prepared a factsheet, which provides an overview of the reliability products and how they have been applied. The factsheet will assist staff in incorporating reliability into the planning or evaluation process.

[1] Microsoft and Excel are trademarks of the Microsoft group of companies.

ASSESSMENT OF THE TOOLS: BENEFITS, CHALLENGES, AND RECOMMENDATIONS

The project demonstrated reliability applications on projects and treatments familiar to WisDOT planning, and evaluation staff. WisDOT focused on comparing these reliability tools to existing practices for creating reliability measures within WisDOT. The overall benefit was that a cross-section of WisDOT staff gained a better understanding of the data needs, strengths, and limitations of the set of reliability tools.

L02

The L02 pilot was a proof of concept of the process needed to collect and integrate travel time reliability data. WisDOT found that data input was manual or relied on web interfaces but concluded that the tool can be improved with more data input automation. WisDOT generated a report of results for its two pilot evaluations and recommends that the output be presented in a web-based report.

L07

L07 estimated operational and safety benefits separately along with travel time reliability performance measures. The reliability benefit output obtained from the L07 tool test run was low compared to the delay benefit. An in-depth exploration of the tool's methodology is needed to identify the key contributors of reliability benefits. The WisDOT test also identified software issues which have since been addressed.

L08

The L08 tool has a user-friendly interface, which helped the agency easily evaluate it and may speed the adoption of the tool in other States. WisDOT also identified challenges with the L08 tool. The tool requires manual entry of a large amount of data to create the seed file. In addition, WisDOT found that the FREEVAL-RL output may not resemble field conditions, decreasing the applicability of the tool. Specifically, the tool may not provide reliable output in the presence of a bottleneck downstream of the data collection point. The L08 tool allows users to define a mainline segment with up to six lanes in one direction. Though Wisconsin has very few sites that would require more than six mainline segments, this limitation may restrict other agencies' use of the tool.

C11

Through its evaluation, WisDOT found C11 to be a useful tool; however, its results are presented at a higher level of aggregation than the Department's existing, more detailed cost-benefit evaluation tool. The high relevancy and familiarity of C11's minimal requirement for inputs promoted active participation and dialogue among agency users and researchers. WisDOT also observed that adjustments in the computation methodology and underlying assumptions in the C11 tool would improve its results.

IMPACTS ON BUSINESS PRACTICES

Prior to the SHRP2 project, WisDOT had already laid the foundation for adopting reliability tools into its planning process. Wisconsin's Traffic Management Center Standard Operating Procedures, for example, includes reliability. Figure 4 shows the WisDOT performance measures web page. Overall, participation in the pilot led WisDOT to recommend that more program managers analyze alternative highway design strategies and features to improve reliability. WisDOT also plans to measure and track reliability performance in work zones and during adverse weather events across the State highway system.

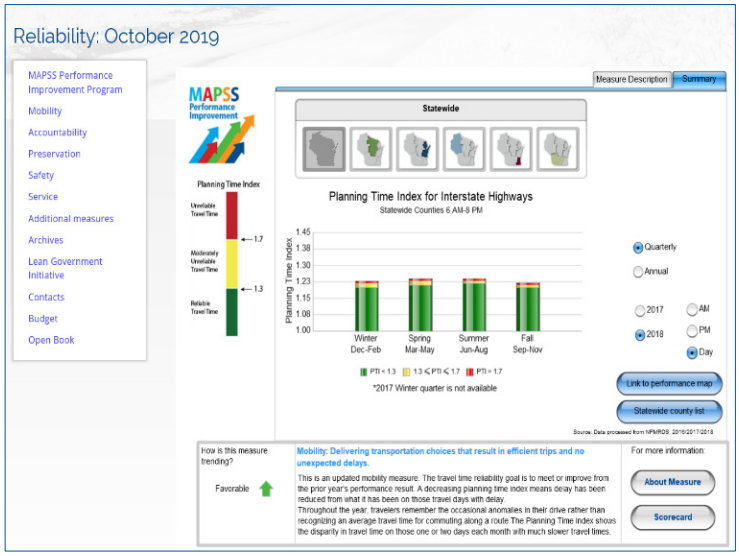

Figure 4. Graphic. Example of WisDOT Reliability Performance Measure Web Page. Source: WisDOT

WisDOT refrained from implementing the tools into its business practices after participating in the pilot due to WisDOT staff's acceptance of its already existing practices. WisDOT's existing tool incorporates reliability based on representative highway types, which WisDOT found to be more useful. Improvements to

the SHRP2 product features could lead WisDOT to implement the L07 and L08 products in the future.

CONCLUSION

The project provided WisDOT the opportunity to test each of the SHRP2 reliability tools. The project focused on establishing mobility as a proxy for level of service across the State's highway system. The tools helped WisDOT evaluate strategies for reducing recurring and non-recurring congestion, its impact on travel time reliability, and its benefits for safety and economic growth. Most of WisDOT's challenges in implementing the tools were attributed to a lack of quality input data for certain segments and errors stemming from manual data entry.

Nevertheless, these measures and their results contributed to new tool applications for comparative performance results and promoted documentation of agency policies.

FOR MORE INFORMATION

Wisconsin Department of Transportation Reliability
https://wisconsindot.gov/Pages/about-wisdot/performance/mapss/measures/mobility/reliability.aspx
SHRP 2 Solutions
https://www.fhwa.dot.gov/goshrp2

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CONTACTS

Elizabeth Schneider
Wisconsin Department of Transportation
elizabeth1.schneider@dot.wi.gov

Tracy Scriba
Federal Highway Administration
tracy.scriba@dot.gov