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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

Tennessee Department of Transportation

Travel Time Reliability Tools Pilot Implementations and Highway Capacity Manual

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 by transportation practitioners. The SHRP2 Program provided funding to help agencies test the tools and incorporate reliability into their business practices. The Tennessee Department of Transportation (TDOT) 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

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

TDOT, in partnership with the Knoxville Regional Transportation Planning Organization (Knoxville TPO), the University of Tennessee, and a transportation consultancy firm, participated in the SHRP2 Implementation Assistance Program (IAP) to integrate reliability tools into their programs and business practices. In recent years, TDOT has adopted an operations-oriented highway management philosophy. TDOT is incorporating reliability and other operations performance measures into its roadway management and deployment planning process. Objectives of the TDOT IAP project, concluded in 2020, were to:

- Increase use and awareness of the reliability data and analysis (RDAT) tools among practitioners.
- Integrate RDAT tools and materials into relevant programs and initiatives.

The project team deployed four SHRP2 products: L02, L05, L08, and C11. The project collected additional data for:

- Evaluating reliability
- Developing a framework for travel-time reliability monitoring systems (TTRMSs)
- Developing additional functionality for tools assessing the economic benefits of reliability improvements
- Deploying a scenario-based planning tool for reliability in corridors.

The project implemented the L02 and C11 tools for the Knoxville metropolitan area with intent to extend the work to other Tennessee MPOs if successful in Knoxville.

The project used the L08 tool on two pilot study routes:

- A 20-mile segment of eastbound I-24 between Nashville and Murfreesboro. This freeway segment carries heavy commuter traffic on weekdays and congestion frequently develops during peak hours.
- A 2.56-mile segment of Sutherland Avenue in Knoxville. The road is a two-way urban minor arterial.

PRODUCT IMPLEMENTATION

Data

TDOT used several data sources in their IAP project. Travel time data from the National Performance Management Research Data Set, an FHWA-funded dataset made available to States and MPOs for transportation planning, was the primary data source for the study. TDOT also acquired private travel time data from HERE™ Technologies, a private-sector firm that provides mapping and location data, which proved valuable to the study. To analyze the impact of events and incidents, TDOT used existing internal data from the State's SmartWay ITS system. Weather data from the National Oceanic and Atmospheric Administration (NOAA) allowed TDOT to analyze the impact of adverse weather conditions.

L02

The L02 guide provides information on how to implement TTRMS—including methods for ingesting, cleaning, and processing data—that allows an infrastructure operator to calculate reliability measures. Knoxville TPO and TDOT both developed frameworks for travel time reliability monitoring programs following the L02 guide. The systems, initially limited to freeways and major arterials in the Knoxville area, would provide better information about travel time reliability to planners and operators.

The report from the project team examines what TDOT and Knoxville TPO need to implement a TTRMS and establishes a framework for each to do so. Though the document does not describe exactly how TDOT or Knoxville TPO should implement a TTRMS, it provides a detailed framework of how data should be processed, combined, and analyzed to create value for the system's users. The report recommends a relational database structure with five types of tables: raw data; configuration of routes and route segments; travel time information; travel time density functions; and reliability summaries. The report also recommends data imputation strategies, computational methods, and performance measures.

L05

TDOT drafted a report that provided guidance on how to approach and include reliability in planning and programming decision-making processes. This report was based on the results of other project tasks and the L05 handbook. The TDOT guide covers:

- Measuring and tracking travel time reliability.
- Incorporating reliability into policy statements and planning documents.
- Evaluating reliability needs and deficiencies.
- Incorporating travel time reliability into programming and project investment procedures.
- Discussing how to compute TSMO performance measures with the current data set.

TDOT embraced linking transportation operations with transportation planning and included the improvement of travel time reliability as its management and operational goal. The guide offers specific performance measures—such as Planning Time Index, the ratio of the 95th percentile travel time to the free-flow travel time—for use in evaluating progress toward their management and operational goal of improving travel time reliability. The guide also discusses how to regularly compute performance measures for reliability, traffic incident management, and work zone operations.

C11

The C11 tool assesses the economic benefits of transportation investments beyond traditional benefits such as travel time, safety, and vehicle operating cost. Used in conjunction with the C11 Post-Processor, a tool for producing reliability measures from travel demand forecasts, it assessed the reliability impact of programmed highway projects.

Knoxville TPO implemented the C11 tool, with the modifications created by Florida and Maryland during their SHRP2 implementation projects. Those States developed a post-processor tool for C11 that incorporates State-specific traffic and reliability inputs, allowing the tool to evaluate entire regions and not just individual projects. The modified tool is useful for MPOs seeking to incorporate reliability into their regional planning processes.

The TDOT C11 Post-Processor works with a network file from Tennessee MPO transportation modeling software and can present results at the corridor or system level. TDOT's IAP project added the ability to assess the reliability impacts of traffic

variability and weather, in addition to recurring congestion and incident impacts.

Knoxville TPO used the C11 Post-Processor to calculate reliability statistics for the Knoxville area in the year 2040 based on the committed projects in the Knoxville TPO 2040 plan.

L08

The L08 tool enables planners to calculate reliability measures for a corridor. It includes two products to assess reliability measures along a route: FREEVAL for freeways and STREETVAL for arterials. TDOT implemented the L08 tools on two facilities: FREEVAL for a 20-mile segment of eastbound I-24 between Nashville and Murfreesboro (figure 1), and STREETVAL for a 2.56-mile segment of Sutherland Avenue in Knoxville (figure 2).

The freeway reliability site used facility geometry and control information, demand by 15-minute analysis periods, weather data, and incident data. The case study looked at the PM peak period (4:00 p.m.-8:00 p.m.) during 2015. The study found a mean travel time index value of 1.66, meaning the average travel time through the segment is 1.66 times longer than it's free-flow travel time.

Analysis of the Sutherland Avenue site studied 2016 data for the PM peak period (4:30 p.m.-6:30 p.m.). This segment lacked detailed crash and demand data, so STREETVAL's default values were used (these values are assigned based on the street's functional classification). The study found a mean TTI value of 2.46. The L08 implementation calculated reliability statistics for the facilities in their current forms and did not consider design changes to the facility.

ASSESSMENT OF THE TOOLS: BENEFITS, CHALLENGES, AND RECOMMENDATIONS

TDOT found the pilot to be a useful opportunity to assess the SHRP2 reliability tools. TDOT used the L02 and L05 guidance to issue recommendations for future travel time reliability monitoring and planning in the state. TDOT provided more specific feedback about the C11 and L08 tools.

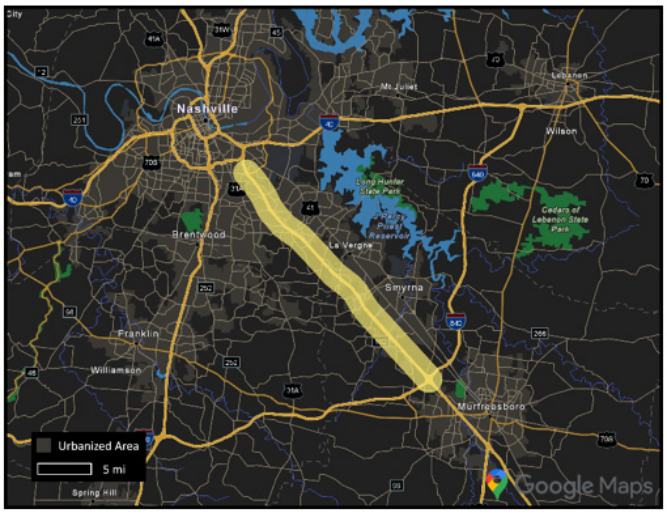

Figure 1. Map. L08 FREEVAL evaluation site along I-24 from Nashville to Murfreesboro. Source: TDOT. Map Data © 2020 Google.

Figure 2. Map. L08 STREETVAL evaluation site along Sutherland Avenue in Knoxville. Source: TDOT. Map Data © 2020 Google.

C11

TDOT found C11 and the Post-Processor generate useful statistics for assessing reliability and are useful for setting targets. While the C11 Post-Processor provides useful forecasts, TDOT suggests porting the C11 software to another platform to improve ease-of-use. The tool would be more accessible if packaged as executable code in a language that does not require additional user licenses, or if it employed a graphical user interface for users to provide inputs. However, these optimizations are not required

to use C11; the software is usable as-is, and already features elements that assist usability (such as the ability to leverage existing network files).

L08

TDOT's implementation of the L08 tool gave the State a chance to apply the SHRP2 methodologies on individual corridors. TDOT identified several challenges worth considering when working with the L08 tool. The tool's performance is optimized when higher quality input data are available, and when users adjust calibration factors to account for demand fluctuations, changing weather conditions, and incidents. The tool requires some detailed data that some agencies may not have readily available, such as reliable flow/demand data at 15-minute intervals.

IMPACTS ON BUSINESS PRACTICES

TDOT and Knoxville TPO have adopted reliability as a core operational goal and developed reliability-based objectives and performance measures to guide their progress. Neither agency specified how they intend to incorporate the SHRP2 products into their daily transportation system management and operations decision-making processes.

CONCLUSION

TDOT's IAP project helped familiarize the State with the tools available from the SHRP2 RDAT bundle and provided an opportunity for the State to consider the logistics of incorporating reliability into Tennessee's planning and operations processes.

FOR MORE INFORMATION

Tennessee DOT Website
https://www.tn.gov/tdot.html
SHRP 2 Solutions
https://www.fhwa.dot.gov/goshrp2

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