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SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

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

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

CASE STUDY

North Carolina Department of Transportation

Implementing a Suite of Travel Time Reliability Tools in North Carolina

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 North Carolina Department of Transportation (NCDOT) project included the following tools:

DATA COLLECTION AND INTEGRATION

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.

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

NCDOT, in collaboration with the Institute for Transportation Research and Education at North Carolina State University, participated in the SHRP2 Implementation Assistance Program (IAP) with a proof-of-concept pilot study ending in 2020 that used the SHRP2 reliability and data analysis tools. NCDOT sought to improve their travel time reliability (TTR) monitoring, modeling, and analysis capabilities. NCDOT evaluated how well the SHRP2 reliability tools could support their TTR systems and program.

After reviewing other States' implementation efforts, NCDOT selected three SHRP2 reliability products for the pilot project: L02, L05, and L08. NCDOT also assessed the L07 tool at a high level. The tools were applied to freeways in the Research Triangle region of Raleigh, Durham, and Chapel Hill:

- A 48.7-mile segment of I-40 between I-95 and North Carolina Highway 147. A mixture of rural and urban interstate, NCDOT studied this route in several portions, which experience differing levels of congestion.
- I-440, a 16.4-mile beltway partially encircling central Raleigh.
- I-540, a 25.8-mile component of the Raleigh Outer Loop beltway.
- Wade Avenue Extension, a four-lane freeway linking I-40 to I-440.

PRODUCT IMPLEMENTATION

Data

Using these SHRP2 tools requires various types of data, including travel time, traffic flow, incident rates, planned special events, and weather data.

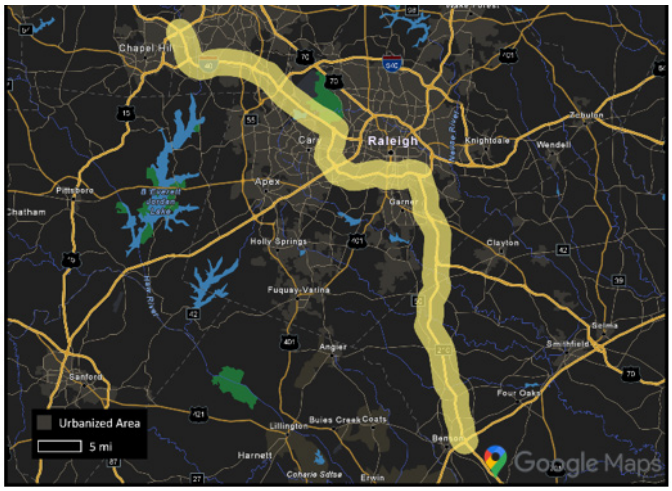

Figure 1. Map. I-40 project segment in the Research Triangle area. Source: NCDOT. Map Data © 2020 Google.

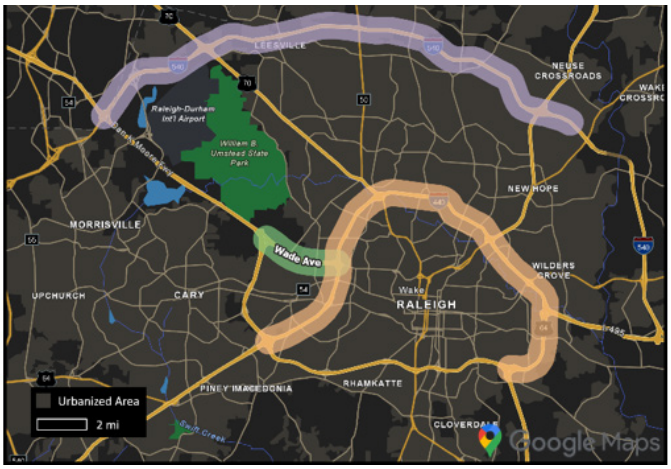

Figure 2. Map. Project segments: I-440 (orange), I-540 (purple), and Wade Avenue Extension (green). Source: NCDOT. Map Data © 2020 Google.

NCDOT used speed and travel time data from INRIX®, segmented by Traffic Message Channel (TMC) segment. Flow data for the study year was sourced from 60 radar sensors deployed across the Research Triangle. Incident data was sourced from the NCDOT Travel Information Management System. Planned special events on weekdays, such as football games and concerts, were counted as special demand generating events. The study used two types of weather data: observational data from local weather stations, and adverse weather warnings from the National Weather Service.

L02

NCDOT used the L02 reliability monitoring guide on all four highways in the Raleigh area. NCDOT assembled data of travel rates, flow rates, weather, incidents, and planned events that spanned 206 TMC segments. The TMC segments provided data at 5-minute granularity for the entirety of 2010. After gathering the data, the research team classified observations of operating conditions as either "normal" or "abnormal" and tagged observations with explanations of what abnormality occurred.

After preparing the data, NCDOT developed statistical distributions to visualize how roadway conditions vary. The team separated the performance by time of day and different operating conditions using the "normal" and "abnormal" tags. NCDOT performed facility-wide and route-based analyses for all four facilities, along with additional incident- and special event-focused analyses for I-40.

At a facility level, NCDOT found incidents significantly increased travel rates during all analysis periods. Results for I-440, the only facility with significant geometry changes along the route, showed that the structural bottleneck has a greater impact on travel time than abnormal events.

L05

The project team presented key findings and recommendations from the L05 project to other NCDOT and MPO officials. The partners agreed that providing reliable transportation options is important to the citizens and businesses of North Carolina, but that TTR is difficult to understand and articulate. Therefore, NCDOT needs to pursue continued internal discussions and dialog with MPOs before the department can determine how and at what level TTR monitoring and analysis should be included in project planning and programming.

L07

The project team implemented the L07 tool on a 12.5-mile segment of I-40 to compare its segment-based approach to the L08 facility-based approach. The research team provided facility geometry, demand, weather, and incident rate inputs meant to be representative of a 12.5-mile segment of I-40. NCDOT found that L07 tends to estimate less congestion and travel time degradation than L08 because the tool does not account for effects of bottleneck queuing. For this reason, the NCDOT team did not explore the tool further.

L08

NCDOT implemented the L08 tool on four freeway routes, varying in length and conditions, along I-40 in the Triangle region. NCDOT implemented the L08 tool using 15-minute

analysis periods of a 24-hour study period for all weekdays in 2015. NCDOT used facility geometry, demand, incident, weather, and probe vehicle data for the study.

NCDOT calibrated the single day facility using an automated approach for the HCM bottleneck capacity calibration process that reproduces speed contours similar to real-world target speeds. After the single day calibration, NCDOT performed calibration of the reliability scenarios using vehicle count station data to estimate demand multipliers and incident frequency, duration, and lane impact data.

NCDOT compared the distributions of travel time indices calculated using the L08 tool to those found using INRIX probe data. The study team found that the TTIs and Level of Travel Time Reliability measures were within 15 percent of the INRIX observations for three study routes, with incident calibration causing the one route's estimates to vary slightly more.

ASSESSMENT OF THE TOOLS: BENEFITS, CHALLENGES, AND RECOMMENDATIONS

L02

The NCDOT experience piloting an L02-based monitoring program was positive. The L02 guidebook provides a rigorous description of TTR modeling procedures and provides DOTs a basis for selecting the desired functionality of a new system. Building a monitoring program is challenging: NCDOT found data assembly, preprocessing, mapping, interpolation, and classification to be challenging. Limited data availability, especially in rural areas, may also pose a challenge.

L07

NCDOT did not study the L07 tool in depth. The study team concluded that they could not accurately model TTR without accounting for bottlenecks and queueing conditions on freeways along multiple segments.

L08

NCDOT found the L08 tool to use rigorous analysis of active and hidden bottlenecks. NCDOT has decided to use FREEVAL Statewide, a testament to the quality of the L08 tool. NCDOT also identified several shortcomings of the L08 tool during the course of the research project, many of which have already been addressed in follow-on work. NCDOT recommends improving the realism of facility travel time by enabling temporal and spatial stitching in travel time calculations and using a true cell transmission model approach to model interacting bottlenecks.

IMPACTS ON BUSINESS PRACTICES

As mentioned, the State of North Carolina is funding a Statewide implementation of the L08 tool called FREEVAL-NC and will cover all interstate facilities in the State. NCDOT plans to use FREEVAL-NC for core facility, work zone, and reliability analyses.

CONCLUSION

Overall, NCDOT's participation in the SHRP2 IAP was a positive experience: NCDOT gained experience with FREEVAL and will continue using the software to analyze reliability impacts throughout the State. NCDOT disseminated the evaluations of the TTR monitoring and modeling tools via webinar. The outcomes of the IAP project will be useful for NCDOT and MPO stakeholders to develop a consensus definition of TTR to incorporate into planning and programming.

FOR MORE INFORMATION

NCDOT Project Report
https://connect.ncdot.gov/projects/research/Pages/ProjDetails.aspx?ProjectID=2016-32
SHRP 2 Solutions
https://www.fhwa.dot.gov/goshrp2

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