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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

Kentucky Transportation Cabinet

Implementing a Suite of Travel Time Reliability Tools in Kentucky

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 Kentucky Transportation Cabinet 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 analysis tool to assess how different design improvements affect reliability, delay, safety, and benefit versus cost for 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.

DECISION-MAKING

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 Kentucky Transportation Cabinet (KYTC), in partnership with the University of Kentucky, participated in SHRP2 with a project ending in 2020 that explored reliability across the State. In 2008, KYTC embarked on an approach to develop "right-sized" solutions that meet a project's purpose and need. The SHRP2 tools help planners and operators evaluate roadway performance and provide information to decision makers for determining the optimal solution. The project included four pilot study routes:

- A 3.4-mile segment of Scottsville Road (US 231/231X) that connects I-65 and downtown Bowling Green (figure 1). Designed as a rural highway, the road now carries 33,000 vehicles per day due to growth along the highway.
- A 14-mile segment of Dixie Highway (US 31W) between Elizabethtown and Radcliff (figure 2). This highway suffers from congestion caused by unrestricted access across an open median.
- A 5.1-mile segment of I-471 that connects I-275 to downtown Cincinnati (figure 3). Travel on this freeway is hindered by significant weaving between exits, especially on the relatively short bridge crossing the Ohio River. The proposed solutions (e.g., adding a fourth lane) would be a significant investment. Prior to implementing this solution, a detailed benefit-cost analysis is needed.
- The interchange between I-71/75 and I-275 in the Cincinnati metropolitan area (figure 4). I-71/75 northbound backs up through the area most mornings, and ramps from I-275 to southbound I-71/75 are congested most afternoons.

Figure 1. Map. The US 231/231X project segment in Bowling Green. Source: KYTC. Map Data © 2020 Google.

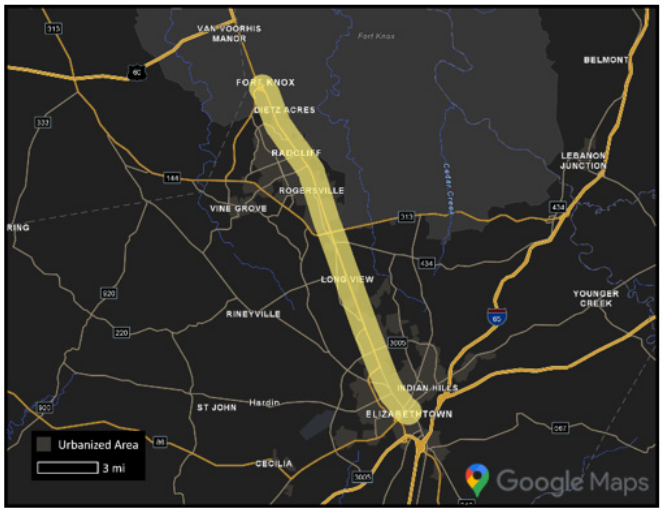

Figure 2. Map. The US 31W project segment between Elizabethtown and Radcliff. Source: KYTC. Map Data © 2020 Google.

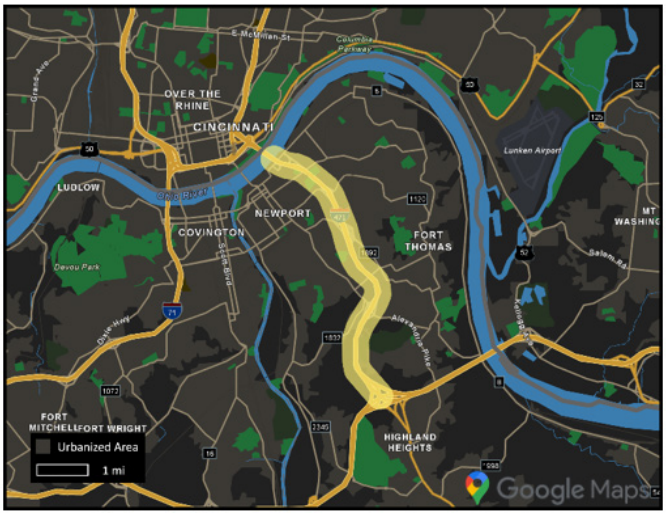

Figure 3. Map. The I-471 project segment in the Cincinnati metropolitan area. Source: KYTC. Map Data © 2022 Google.

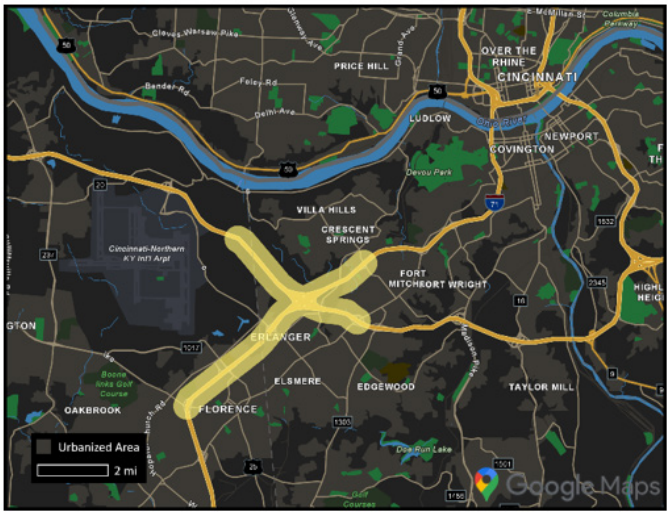

Figure 4. Map. The project interchange between I-275 and I-71/75 in the Cincinnati metropolitan area. Source: KYTC. Map Data © 2020 Google.

PRODUCT IMPLEMENTATION

Data

KYTC used speed data from multiple private sources combined with State incident data and weather data from the National Oceanic and Atmospheric Administration (NOAA). The speed data came from four different sources: HERE™ link-referenced speeds (for all sites); SpeedInfo (for Cincinnati area sites); Bluetooth® readers (for US-31W and US-231/231X sites); and the National Performance Management Research Data Set.

L02

Using the L02 guide, KYTC generated reliability measures and established a framework for a travel time reliability tracking system. KYTC used the guide for the two freeway sites in the Cincinnati metropolitan area (I-471 and the interchange between I-71/75 and I-275) – a data-rich area with multiple data sources available (figure 5).

KYTC used the data to analyze the contributing factors to congestion and reliability issues on the two freeway corridors, and to assess the impact of non-recurring events (such as

collisions, road work, and special events) on travel time and reliability.

The project team also investigated potential improvements to the L02 tool using a spatiotemporal methodology to separate recurring and non-recurring congestion.

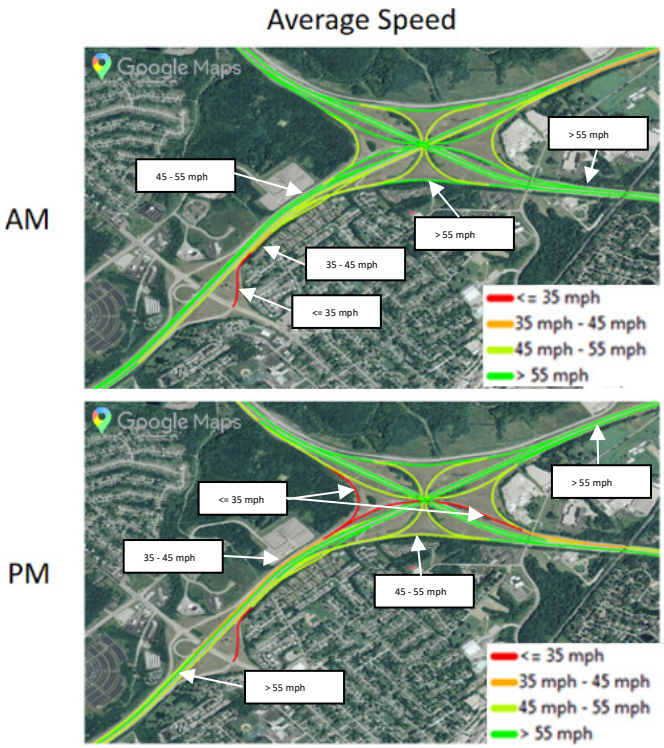

Figure 5. Map. Example of average speed indications at the interchange of I-71/75 and I-275 during AM and PM peak periods. Source: KYTC. Map Data © 2020 Google.

L05

KYTC reviewed the L05 guide and considered its recommendations when developing a plan for incorporating reliability into State project prioritization practices.

Though KYTC is able to calculate reliability metrics using probe data, such data are often sparse for rural roads and make meaningful comparison on reliability difficult across the State.

L07

KYTC implemented the L07 tool to assess the reliability benefits of design elements for the reconfiguration of an interchange along I-471. An Interchange Justification Study evaluated three alternatives to improve the old cloverleaf design. The project team calibrated the tool using site-specific demand data and incorporated data about road work, incident, and special events. In the year 2030, the annual operations and safety benefits of adding a fourth lane to I-471 between I-275 and US 27 would be $235,000.

L08

The project team used the L08 Urban Streets Reliability (USR) tool to evaluate operations on the Dixie Highway and Scottsville Road surface street sites.

USR is an add-on to the Highway Capacity Software and can estimate several reliability service measures (such as speed, travel time, and delay) using weather, crash, demand, and turning data. Simulated speed and capacity statistics are useful for these project sites, as they have insufficient private sector speed data, or do not have continuous traffic monitoring.

To apply the tool, the project team generated scenarios based on historical information to estimate a distribution of traffic speeds. The team then used the distribution to calculate congestion and reliability and followed for the different design improvements proposed for each site. For the Scottsville Road site, the project team found the total annual benefit of all the spot treatments considered would be more than $513,000.

C11

The project team applied the C11 tool to the I-471 site in the Cincinnati metropolitan area to assess the economic benefits of reliability, factoring in impacts to the surrounding area. This segment of I-471 experiences reliability issues due to significant weaving. One of the proposed solutions was the addition of a fourth lane. Using the C11 tool, KYTC performed a benefit-cost analysis on the proposed solution. The tool predicted that a fourth lane could save commuters $4.7 million in year 2066.

ASSESSMENT OF THE TOOLS: BENEFITS, CHALLENGES, AND RECOMMENDATIONS

KYTC found the tools made the methodologies developed in the SHRP2 studies convenient to use. The project allowed KYTC to develop a working knowledge of the reliability concepts and gain familiarity with the tools by applying them to corridors with well-known reliability issues.

KYTC identified some limitations that impact the tools' usability and accuracy in specific applications. Currently, the USR tool's

output statistics are formatted differently for side streets versus main corridors. If a user wants statistics for side streets, they need to compile information from multiple output files. KYTC also noted that since the tools were developed using HCM models, the tools perform optimally when analyzing under-saturated conditions.

KYTC expressed interest in integrating L07 and C11 methodology and travel demand models to provide a reliability benefit to the project prioritization process. This would more accurately measure and predict the impact of non-recurring events. The tool would also assist KYTC in evaluating the benefits of different incident management strategies in KYTC's program.

IMPACTS ON BUSINESS PRACTICES

The pilot tests enabled KYTC to integrate reliability data directly into their project selection and prioritization process.

KYTC became more familiar with travel time reliability and the data required to move away from analyses based on simple averages. They improved their ability to analyze data quality, develop techniques to integrate the data into existing KYTC data sources, and promote potential use cases. The project has helped KYTC explore how to incorporate aspects of travel time reliability into their data-driven project prioritization process, the Strategic Highway Investment Formula for Tomorrow (SHIFT) program. SHIFT now uses vehicle hours of delay as its primary measure for congestion. To aid the inclusion of this new performance measure, the project team developed an automated approach to match KYTC's linear referencing highway network with a third-party data provider's network, making integration of private sector data easier.

CONCLUSION

The SHRP2 project provided KYTC an opportunity to apply tools for collecting data and assessing the benefits of improved reliability. The tools are helping KYTC to incorporate travel time and reliability data into a wide range of functions, including project prioritization, work zone user cost estimation, operations planning, and more.

The effective partnership between KYTC and the University of Kentucky was essential to the project. The Kentucky Transportation Center at the University of Kentucky functions as the research arm of KYTC and has benefited the State for decades. Their collaboration was the key to KYTC embarking on the project and improving travel time reliability in Kentucky.

FOR MORE INFORMATION

KYTC SHIFT website:
https://transportation.ky.gov/SHIFT/Pages/default.aspx
FHWA SHRP2 Home Page:
https://www.fhwa.dot.gov/goshrp2
FHWA SHRP2 website on tools discussed in this case study:
https://ops.fhwa.dot.gov/shrp2/products.htm#monitoring

CONTACTS

John Moore
Kentucky Transportation Cabinet
johnw.moore@ky.gov

Mei Chen
University of Kentucky
mei.chen@uky.edu

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