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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

Texas Department of Transportation Houston District

Implementing a Suite of Travel Time Reliability Tools in the Houston District

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 Texas Department of Transportation (TxDOT) Houston District 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	
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

TxDOT Houston District, through the agency's Transportation and Emergency Management Center (Houston TranStar), collects travel information and monitors traffic to inform the public of travel speeds, travel times, roadway incidents, and weather data on the region's transportation network. The Texas A&M Transportation Institute provides research support for traveler information data acquisition and data analysis for TxDOT and TranStar in the Houston region.

The goal of the TxDOT SHRP2 pilot project from June 2019 to June 2020 was to improve the quality of traveler information for the Houston metropolitan area and, as a result, sharpen decision making for transportation plans, programs, and projects. TxDOT examined the L02, C11, and L05 SHRP2 reliability products. TxDOT tested its strategy with data from the following high-volume highways selected for (1) their medium to heavy congestion (annual average daily traffic 200,000 or higher) lasting beyond core peak hours; and (2) their instrumentation with newer intelligent transportation systems (ITS) devices (figure 1):

- I-10 West (Katy Freeway).
- I-69/US-59 (Southwest Freeway).

Figure 1. Map. L02 Data - Test Highways. Source: TxDOT. Map Data © 2020 Google.

PRODUCT IMPLEMENTATION

Data

TxDOT used the following data sets for its application and evaluation:

- Travel time and speed data provided by TranStar and collected via two methods:
  - Anonymous Wireless Address Matching (AWAM) monitoring Bluetooth®-equipped devices.
  - Automatic Vehicle Identification (AVI) readers utilizing vehicles with toll tags.
- Traffic incident data provided by TranStar's Regional Incident Management System (RIMS).
- Flood sensor data provided by the Harris County Flood Control District.

L02

TxDOT used the L02 Guide to design, develop, and implement a travel information dashboard, including traffic heatmaps. TranStar's existing visualization tools limited displays to one data type or time segment. The SHRP2 project enabled TxDOT to merge multiple data sets from different sources and display those data types so that users could simultaneously analyze their interactions over a range of time.

TxDOT used the L02 methodology to develop an interactive method of visualizing three different types of roadway information (traffic speeds, incidents, and precipitation) dynamically on the same interface. The new tool, the Houston TranStar Data Dashboard, is a web-based data-fusion and data-visualization user interface (figure 2) that links to congestion heatmaps (figure 3) generated from Houston TranStar's traffic data. Users may select a highway segment and display segment-wide speeds and location-based events over an entire 24-hour period.

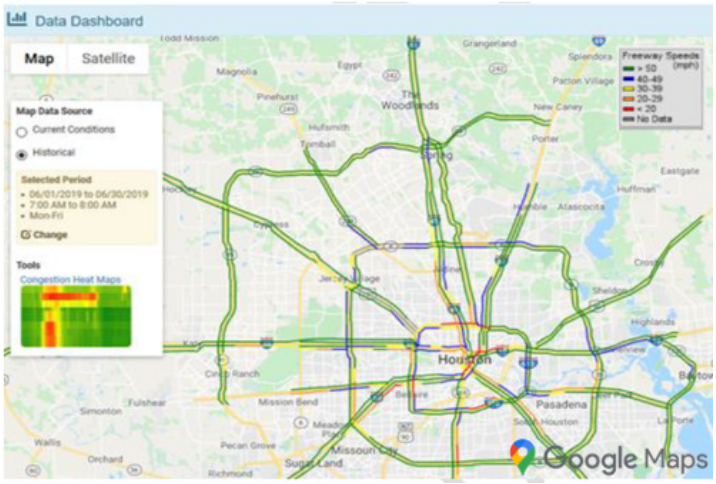

Figure 2. Map. Example of the Houston TranStar Traffic Map Display. Source: TxDOT. Map Data © 2020 Google.

Figure 3. Graphic. Example of Vehicle Crash Details on Heatmap. Source: TxDOT

The display visualizes the location, cause, duration, and intensity of congestion. The team tested the new tool using data from two specific highways, but the tool is usable for any highway having robust roadside ITS instrumentation to collect fine-grained traffic data. Key research activities were determining and developing methods to link and integrate these three data sources (traffic speeds, incidents, and precipitation) in addition to ensuring consistency with each other.

The new tool can also use other data sets, such as the National Performance Management Research Data Set (NPMRDS), point-based speeds from radar sensors, or other types of event data such as planned lane closures, as long as the data contain spatial and temporal elements.

C11

Employing the data developed using the L02 Guide, the SHRP2 C11 database, and data on proposed local projects, TxDOT tested the ability of local agencies to use the C11 methodology to determine the economic benefits of transportation projects.

TxDOT sought to estimate the economic benefits of implemented projects using the SHRP2 C11 toolkit: Econworks Case Studies (formerly Transportation Project Impact Case Studies [T-PICS]) and the Wider Economic Benefits (WEB) Analysis Tool. The former provides a set of cases for which benefits, primarily jobs created, have been estimated. The analyst matches these cases to planned projects and analogously estimates the potential benefits of the planned projects. The latter, WEB, estimates the economic benefits of reliability, as well as accessibility and intermodal connectivity.

TxDOT found it challenging to apply these tools since Houston-area projects did not match well with the projects in the SHRP2 database based on size, scale, traffic volume, and project timing with respect to the economic cycle. Nevertheless, TxDOT was able to use WEB to estimate the economic impacts by performing a comparative analysis using before-and-after TranStar traffic data for a specific project. Researchers also performed a sensitivity analysis of the model by varying the magnitudes of reliability estimates and delays.

L05

The Houston metropolitan region has a long history of experience with reliability and raw travel time measures. TxDOT's existing processes were already consistent with L05 Guide principles to identify problem areas and inform project development. TxDOT intended to use the dashboard and heatmaps developed using the L02 tool to identify areas of congestion, determine the cause of the congestion, and tailor the project to meet reliability goals as part of its regional transportation planning and programming processes. TxDOT also planned to help improve other goals such as safety by identifying the relationship between travel time and incident data sets.

The suite of new tools developed in the L02 activity helped link congestion, incidents, and other data types to provide a full picture of the causes of congestion. An example of applying the method was developing the region's new "Tow and Go" vehicle tow program. The program recognized that crashes and stalls are the major source and aggravators of Houston's congestion. As a result, the quick tow program established a goal to have vehicles moved within six minutes to reduce secondary crashes and congestion.

ASSESSMENT OF THE TOOLS: BENEFITS, CHALLENGES, AND RECOMMENDATIONS

As a result of the SHRP2 reliability tools evaluation, TxDOT engineers and planners report that they have better tools to visualize reliable travel times and decision-makers have a better dashboard with the functionality to help them make better and more informed data-driven decisions.

L02

The principal benefit of the new data fusion tool developed through the L02 Guide was for analysts and planners to determine the location, causes, and timing of congestion in a relatively straightforward and intuitive manner. With the new tool, TxDOT and TranStar staff can rely on data rather than speculation to ascertain the causes of congestion. Integrating crashes, geometrics (e.g., lanes, curves, ramps) with the travel time data allows analysts to see the causes of congestion, including the compounding effects of, for example, heavy rain, a crash, and a lane reduction may have at the same location during the same time period.

An unanticipated benefit of heatmaps is that they provide an easy method of identifying data gaps, including missing or low-quality data due to inoperative roadside devices or low sample sizes for a road segment. The visualization allows analysts to more easily perform quality assurance/quality control (QA/QC) on suspect travel time reliability calculations.

Data integration proved to be a challenge in developing the dashboard and heatmaps, particularly:

- Reconciling different base reference maps.
- Combining link and point data.
- Merging legacy data sets with inflexible formats.
- Obtaining needed permissions to use disparate data sets.

C11

TxDOT found the C11 tool's basic concept of a database of prior projects to be useful for discovering how other agencies performed an economic evaluation of their projects. At the same time the projects in the C11 database were not well matched to characteristic Houston-area projects, mainly due to traffic counts being typically lower than those in Houston. Where a C11 project's scale seemed appropriate, unique project characteristics

negated the possibility of a match. Analysts also determined that an important determinant of economic impact was the timing of the project with respect to the economic cycle; e.g., whether the project was constructed in boom times or in a recession.

Overall, the C11 WEB model was simple and easy to use, with data typically available. The model did provide some results for TxDOT, but the calculated economic benefits were insensitive to a reduction in incident time and frequency.

L05

TxDOT possessed a direct measure of reliability with the L02 tool-based dashboard and heatmaps that removed its need to estimate reliability using the models suggested in the L05 Guide. TxDOT noted that the Guide does provide options for an agency having no direct reliability measures. It also provides a window on how other agencies have incorporated reliability into the planning process, guidance on the performance measures needed to document the benefits or value of projects, and how to integrate the measures into long- and short-range plans.

IMPACTS ON BUSINESS PRACTICES

TxDOT has long-time experience with applying reliability measures to its planning and programming. The Houston TranStar Data Dashboard developed using the L02 Guide has greatly simplified how planners identify the incidence and causes of congestion, and consequently, potential countermeasures. Having a one-stop solution to visualizing and analyzing multiple data streams, expedites TxDOT's response. More generally, developing the new tool has provided TxDOT with a better understanding of the limitations of various measures and a foundation on which to continue to integrate additional "siloed" data sets. An additional important impact on business practices is that the new tool is being used to alert maintenance staff when roadside sensors are down or need adjusting, which has increased sensor uptime.

CONCLUSION

Development of the Houston TranStar Data Dashboard was the principal result of the TxDOT Houston District SHRP2 reliability product pilot. The dashboard has enhanced the ability of TxDOT to better integrate reliability into its planning and programming processes. TxDOT extracted valuable lessons learned from working with the C11 tools and the L05 Guide, but TxDOT's project types and TxDOT's recent developed capability measure reliability directly meant that those SHRP2 products were less applicable.

FOR MORE INFORMATION

Houston TranStar Data Dashboard
https://traffic.houstontranstar.org/shrp2_dashboard/
Operations Performance Measures Map
http://traffic.houstontranstar.org/textreports/operations_performance_map.aspx

ADDITIONAL TECHNICAL COMMENTS	
STRENGTHS	
C11	See Assessment of the Tools.
GAPS	
C11	The model may not accurately represent capacity and near-capacity values.
SUGGESTED ENHANCEMENTS	
C11	Additional enhancements that would be beneficial would be the linkage of traffic volume data to the travel time data to calculate delay (*travel time benefit* × *traffic volume* = *delay*). Once the delay is calculated, a portion of the economic costs could be calculated, although this would not be the only component impacting a project's long-range benefit.

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