U.S. Department of Transportation
Federal Highway Administration

Incorporation of Travel Time Reliability Concepts within FHWA's Traffic Analysis Toolbox

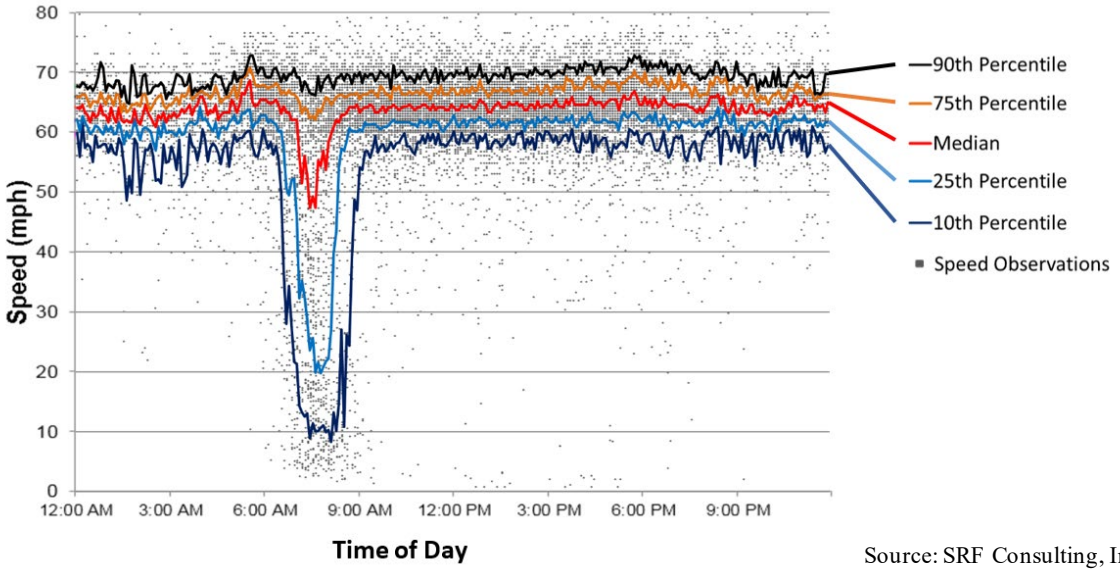
Source: Getty Images

The Case for Reliability Analysis and Probabilistic Thinking

Non-recurring factors are the norm in real-world traffic operations.

The emergence of travel time reliability as an approach to traffic analysis has drastically enhanced the understanding of factors influencing transportation system performance and impacts to users. Reliability analysis methods provide a more accurate representation of real-world travel experiences than traditional traffic analysis approaches.

Demand variability, crashes, incidents, weather, and other conditions often define travelers' experience, and in turn influence their behavior. Traffic analyses and designs that fail to account for such factors are more likely to produce incorrect conclusions and sub-optimal designs. Studies have shown that drivers' route choices depend upon the 80th-90th percentile worst travel times on the given route.[1] In other words, individuals' route choices are a function of travel time reliability. Figure 1 illustrates the range of National Performance Management Research Data Set (NPMRDS) travel time observations along US Highway 169 for an entire year. **The percentile traces show that the median speed during the morning peak does not tell the whole story about the level of congestion and delay experienced at the lowest 10th or 25th percentiles.** There is a need in the traffic analysis industry to provide a common reference point for these methods surrounding travel time reliability analysis.



Source: SRF Consulting, Inc.

Figure 1. Graph. NPMRDS travel time observations on US Highway 169.

[1]Fosgerau, M., & Karlström, A. (2010). *The value of reliability*. Transportation Research Part B: Methodological, 44(1), 38–49.

Evaluation of travel time reliability is critical to understanding the operational performance of transportation facilities. As agencies are contemplating improvements to highways and other infrastructure, they must consider the full range of conditions to which it will be subject. This provides a more complete picture of how the proposed improvements will function and lead to more informed decision making.

Reliability analysis is essential to effective stakeholder communication by building credibility around the traffic analysis. Travelers and operators directly experience the range of conditions occurring on the transportation system, and rightly expect planners and engineers to take these into account.

Traffic Analysis Toolbox and Reliability Reference Guide

Absent from the current Traffic Analysis Toolbox volumes is clear direction on the role of travel time reliability analysis in the traffic analysis process.

The Traffic Analysis Toolbox (TAT) is a widely referenced resource that provides valuable guidance to practitioners in their selection of analysis methods and tools. Recent research and data analysis advancements have shown that all of the data sources and performance measures need to be considered in traffic evaluation to understand the conditions that drivers experience. This range of conditions must additionally be viewed in a probabilistic framework, in that a specific ideal condition cannot be predicted to occur, but that statistical methods can help describe the range of outcomes expected, provided a set of baseline conditions. These will span the range of topics covered through the TAT volumes, as reliability analysis and probabilistic approaches can and should be applied at all stages of the traffic analysis process. To incorporate reliability, gaps in the existing TAT volumes had to be identified. Further, new content had to be generated to fill these gaps and present reliability analysis techniques fitting into each analysis theme. The FHWA developed update content to incorporate into the existing TAT volumes to include:

- All of the mechanisms needed for practitioners to successfully complete a travel time reliability analysis, starting with input data source, and including both collection and storage considerations.
- Description of analysis techniques and available tools to provide an understanding of their functionality and utility.
- Discussion on analysis output values and how to turn them into presentable results to guide the practitioner to a successful outcome.

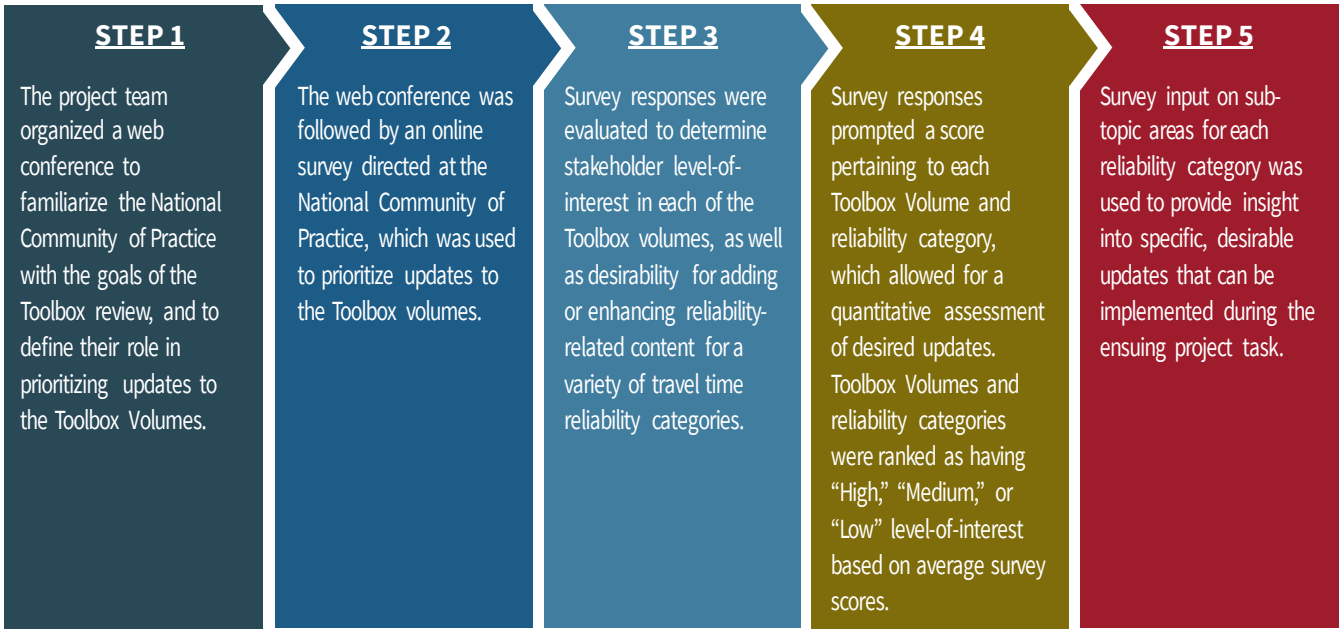
- **The update of Traffic Analysis Toolbox Volumes prominently features real-world examples where reliability has been used in project applications.**
- **It demonstrates past successes to the reader and encourages them to use creativity in applying their reliability evaluations.**

Similar to traditional traffic tools that provide value at the planning, design, or operational phases of traffic, reliability evaluation should be scaled to a level of scope and detail that is appropriate for the project at hand.

Traffic Analysis Toolbox Updating Procedure

Prioritizing the Updates

The update of the TAT volumes involved coordination with the National Community of Practice, which included representatives from Federal Highway Administration (FHWA), State Departments of Transportation (DOT), private industry, and academic interests. The steps shown in Figure 2 were followed to prioritize the volumes that needed updates most significantly and the reliability analysis categories of greatest interest to the National Community of Practice. Accordingly, six Toolbox Volumes were assigned high priority status, as shown in Table 1.



Source: Federal Highway Administration

Figure 2. Prioritization process for Traffic Analysis Toolbox volume updates.

Table 1. Decision criteria for prioritizing updates to the Traffic Analysis Toolbox.

Toolbox Volume	Coverage of Reliability	Estimated Revision Level of Effort	Stakeholder Level of Interest	Priority
Volume 7: Predicting Performance with Traffic Analysis Tools	★	◑	High	**High Priority**
Volume 5: Traffic Analysis Toolbox Case Studies – Benefit Applications	★★	●	High	
Volume 3: Guidelines for Applying Traffic Microsimulation Modeling Software	★★★★	◑	High	
Volume 6: Definition, Interpretation, and Calculation of Traffic analysis Tools Measures of Effectiveness	★★	●	High	
Volume 2: Decision Support Methodology for Selecting Traffic Analysis Tools	★★	◑	High	
Volume 14: Guidebook on the Utilization of Dynamic Traffic Assignment in Modeling	★★	●	Medium	
Volume 13: Integrated Corridor Management Analysis, Modeling, and Simulation Guide	★★★★	○	High	Medium Priority
Volume 1: Traffic Analysis Tools Primer	★★	○	Medium	
Volume 8: Work Zone Modeling and Simulation – A Guide for Decision-Makers	★	○	Low	
Volume 9: Work Zone Modeling and Simulation – A Guide for Analysts	★★	◑	Medium	
Volume 12: Work Zone Traffic Analysis – Applications and Decision Framework	★★	●	Low	Low Priority
Volume 4: Guidelines for Applying CORSIM Microsimulation Modeling Software	★	○	Low	
Volume 11: Weather and Traffic Analysis, Modeling, and Simulation	★★★	◑	Low	
Volume 10: Localized Bottleneck Congestion Analysis Focusing on What Analysis Tools Are Available, Necessary, and Productive for Localized Congestion Remediation	★	●	Medium	

Source: FHWA.

Coverage of Reliability: More stars indicate the topic is more relevant to reliability.
Level of Effort: Open circle is high level of effort, half-filled circle is medium level of effort, filled circle is low level of effort.

Developing the Updates

The project team initially submitted a Final Travel Time Reliability Needs Report, which provided an inventory of proposed technical updates. One set of updates involved edits to the existing text within these documents. The second and more significant set of updates involved developing a series of addenda, as summarized below.

The Volume 2 addendum described some of the most common reliability tools for different types of traffic analyses. Regarding the Volume 14 guidance on dynamic traffic assignment (DTA), the addendum provided details of the Second Strategic Highway Research Program (SHRP2) L04 Phoenix case study, in which the research team used DTA to conduct corridor-level travel time reliability evaluations.

The Volume 3 addendum described five procedural options for scenario analysis: the spatiotemporal traffic matrix, manually-generated scenarios, Monte Carlo analysis, Mix-and-Match, and cluster analysis.

The Volume 5 addendum furnished the following reliability case studies:

I–94 Value of a Shoulder

- Sketch-planning, segment-level evaluation using SHRP2 L07.
- Evaluating nonrecurring delay under two build alternatives to assist decision-making.

I–94 Corridors of Commerce

- Used SHRP2 L02 methods to evaluate reliability performance of recently completed freeway expansion project.
- Used findings to inform decision-makers on full benefits of similar project types.

Incorporating Reliability and Safety into the Long-Range Transportation Plan: The Hillsborough County Experience

- Used SHRP2 C11 methods in conjunction with regional travel demand model to forecast travel time reliability conditions.
- Results are intended for project prioritization purposes into Long-Range Transportation Plan.

I–95 in Broward County

- Used SHRP2 L08 methods in conjunction with microsimulation to produce predictive travel time reliability metrics.
- Process was intended for project development and using reliability performance measures in alternatives analysis.

SHRP2 L04 Guidance Microsimulation Case Study

- Outlines how microsimulation tool can be used with Scenario Manager and Trajectory Processor to perform reliability analysis.
- Provides several methods to develop useful reliability metrics from model outputs.

The Volume 6 addendum provided a comprehensive set of travel time reliability measures, their definitions, and their optimal use within different types of analyses.

The Volume 7 addendum outlined three approaches to predictive reliability analysis and provided one case study example of a predictive reliability analysis.

For more information, please contact:

James Colyar
Office of Operations (HOP)
Office of Transportation Management (HOTM)
Federal Highway Administration
James.Colyar@dot.gov

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FHWA-HOP-22-040

May 2022