A SHRP 2 Reliability Project Brief

PROJECT L02

Establishing Monitoring Programs for Travel Time Reliability

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Transportation agencies strive to provide reliable travel times for travelers and shippers, who want to avoid variability and delay in how long it takes to make a trip. Travel time reliability monitoring systems (TTRMS) can help transportation agencies—especially those with transportation management centers—monitor the performance of their system, understand the impacts of the various factors that influence travel time variability, provide credible information to the system users about what travel time reliability to expect, and decide what actions to take to help improve reliability.

SHRP 2 Reliability project L02 developed guidance for operating agencies about how they can put better measurement methods into practice and understand the relationship that travel time reliability has to the seven major sources of non-recurrent congestion:

- Traffic incidents,
- Work zones,
- Weather,
- Special events,
- Traffic control devices,
- Fluctuations in demand, and
- Inadequate base capacity.

Published as the *Travel Time Reliability Monitoring System (TTRMS) Guidebook*, the guidance was developed to help operating agencies create, operate, and maintain a TTRMS.

Requirements and Benefits of a TTRMS

Creating a TTRMS involves creating a new module that plugs into an existing traffic management center (TMC) platform. Although one could be built from scratch, this path is unlikely to be cost-effective. The TTRMS relies on TMCs to gather the sensor data, manage the data processing and storage, and communicate the results of its findings to the outside world. The TTRMS focuses on using the incoming sensor data, along with supplemental information about the influencing factors, to create a credible picture of how well the system is performing at the present time and in the past. The payoff is better reliability.

To fulfill its mission as a decision support tool, the monitoring system needs to do four things as illustrated by Figure 1.

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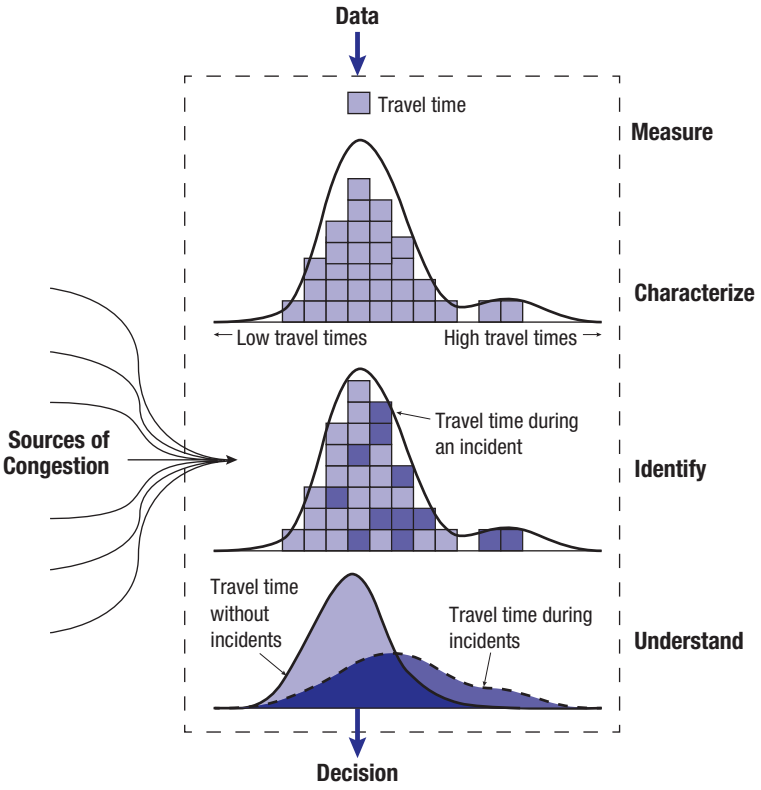
Figure 1. Information Flow in the Monitoring System



First, the monitoring system needs to measure travel times. This is a complex technical task due to the variability of traveler behavior and the plethora of different measurement sensors. Fortunately correctly measuring travel times along a given route is relatively easy if one can draw from an existing traffic monitoring system. Otherwise collecting basic travel time information requires a great deal of systems development effort and the ability to portray how travel time varies over time in a meaningful way. The guidebook serves as a primer on how to measure travel times effectively, using available technologies and statistical techniques. Measuring an individual's travel time is the foundational unit of analysis for reliability monitoring.

Second, the monitoring system needs to characterize the reliability of a given system. This is the process of taking a set of measured travel times and assembling them into a statistical model of the behavior of a given segment or route. The statistical paradigm outlined in the guidebook is that of using probability density functions or cumulative distribution function (CDF) to characterize the performance of a given segment or route, usually specific to a particular operating regime (a combination of congestion level and non-recurring event). Indeed, the cumulative distribution function is the signature of travel time reliability. As shown in Figure 2, CDF curves further to the left and/or more erect, indicate reliability is better. Characterizing the reliability of a segment or route is fundamental to making good decisions about what to do to improve the performance of that segment or route.

Third, the monitoring system needs to identify the sources of unreliability. Once the reliability of a segment or route has been characterized, transportation managers need to understand what caused the unreliability (and how to "fix" it). The guidebook follows the causal list that FHWA uses to describe why congestion arises, breaking these sources into the seven major influencing factors described previously. It discusses how to pull in data for these influencing factors and effectively fuse them with the travel time data generated in previous steps. Identifying the travel times impacted by these sources of congestion is required preparation for understanding system reliability.

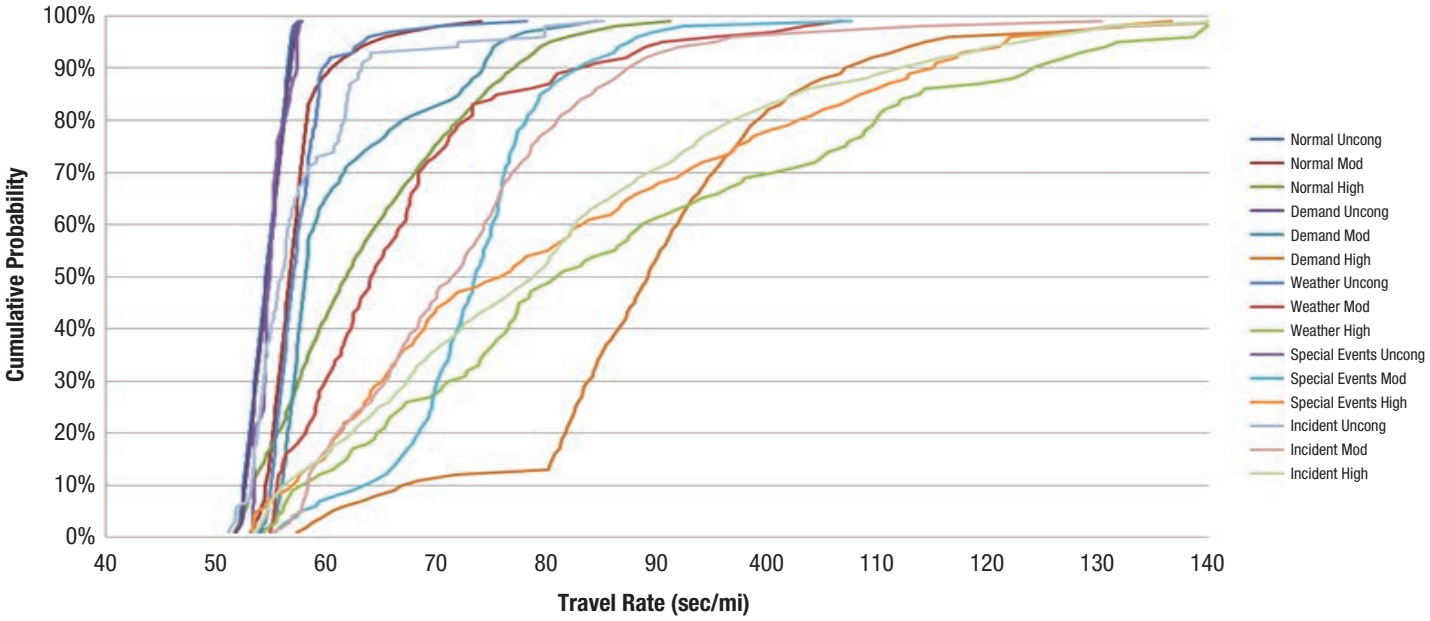
Finally, the monitoring system needs to help operators understand the impact of these sources of unreliability on the system. This final step in turning raw data into actionable decisions requires both quantitative and qualitative methodologies: operators need clear visualization of data, as well as quantification. This dual approach supports both data discovery and final decision making about a given route. Understanding reliability is the key to good decision making about improving system reliability.

A monitoring system that accurately and consistently executes these four steps can be a powerful tool for traffic management. It enables decision makers to understand how much of their delay is due to unreliability, and prompts ideas about how to mitigate that delay. For example, it helps a freeway operator understand whether to deploy more service patrol vehicles (to clear incidents more quickly) or focus their efforts on coordinating special event traffic (to reduce delay from stadium access). A reliability monitoring system, as outlined in the guidebook, can help an operator understand which of these activities is worth the investment, and what the payoff might be. Such systems add a new, powerful, practical traffic management tool to the arsenal of system operators.

Implementing a TTRMS

Much of the work of developing a TTRMS can be carried out by a team that includes expertise in database management, statistics, traffic detection technology, and traffic engineering. Executive-level guidance to the implementation team should include the desired geographical scope of the system; the desired frequency of reports from the sys-

Figure 2. TR-CDFs by Regime for the CA-163 Route



tem; whether the information is primarily for the agency's internal use, or if the intent is to provide information to the public in a way that will influence travel decisions; and how much detail is required.

Additional details to support implementation of a TTRMS are provided in four appendices to the guidebook. *Monitoring System Architecture* presents examples of detail data structures for the organization of various data sources. *Methodological Details* discusses the analytical methods that can be used to calculate travel time reliability measures from a variety of input sources. *Case Studies* presents a series of detailed case studies that exercise various aspects of the guidebook, including system architecture, analysis of recurrent and non-recurrent sources of congestion, and different types of traffic detectors such as loops and bluetooth. And *Use Case Demonstrations* illustrates the application of a variety of use cases for a travel time reliability monitoring system.

Products

The primary product of the research is the *Travel Time Reliability Monitoring System (TTRMS) Guidebook,* which is available online at http://www.trb.org/Main/Blurbs/168764.aspx.

A second product is the *Handbook for Communicating Travel Time Reliability through Graphs and Tables,* which illustrates ways in which travel time reliability information can be portrayed. Various audiences want to receive reliability information in different ways. Travelers and shippers want to know when they need to leave, or when the truck has to depart, in order to make an on-time arrival. Both groups also want to know what paths they should use to minimize the likelihood of encountering unforeseeable delays. Managing agencies want to know where the problem spots lie; where the network segments are that make the travel times vary. The Handbook offers ideas on how to communicate travel time reliability information for each of these audiences. It is available online at http://www.trb.org/Main/Blurbs/170608.aspx.

The final research report, *Establishing Monitoring Programs for Travel Time Reliability,* is online at http://www.trb.org/Main/Blurbs/168765.aspx.

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Project Briefs are also available for these Reliability topics:

Preparing for the Future

Requirements and Feasibility of a System of Archiving and Disseminating Data from SHRP 2 Reliability and Related Studies (L13)

Travel Time Reliability 2030: Innovations and Strategies for Today and Tomorrow (L11, L15B)

Data and Analysis for Travel Time Reliability Performance

Improved Models for Better Decisions: Planning Models, Traffic Operations Models, and Activity-Based Models (L03, L04)

Reliability in Planning, Programming, and Geometric Design

Incorporating Reliability into the Transportation Planning and Programming Process (L05)

Organizing Transportation Agencies to Improve Reliability

A Guide to Improving Travel Time Reliability by Integrating Business Processes (L01)

A National Traffic Incident Management Training Course for Incident Responders and Managers (L12, L32A, L32B, L32C)

Improving Travel Time Reliability (L01, L02, L06, L12, L13, L17)

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