National Operations Center of Excellence

NOCoE Best Practices: Use of Data to Support TSMO

Report #4

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Use of Data to Support TSMO

The use of data to support transportation operations has evolved but has always played a key role in managing the transportation system. Figure 1 from the Transportation Operations Manual (TOM) (AASHTO, 2023) outlines the evolution from intrusive road sensors to the anticipated uses of Connected Vehicles in collecting, managing, and applying data in a variety of application areas.

Big data, the concept of collecting and integrating data from numerous sources, has provided practitioners with new opportunities to manage and visualize transportation data, enabling increased capabilities in performance management, real-time traffic operations, traffic signal retiming, ramp metering, incident management, and traveler information.

These benefits require careful consideration for transportation system management and operations (TSMO) departments. First, the collection and management of data may require a robust data management program to drive "data collection and procurement, validation, quality control, creation, processing, storage, backup, organization, documentation, sharing, protection, integration, dissemination, archiving, and disposal." (AASHTO, 2023) Additionally, big data that relies on smart phone and vehicle data may miss the "complete transportation patterns and needs of unique and underrepresented groups and users." (AASHTO, 2023).

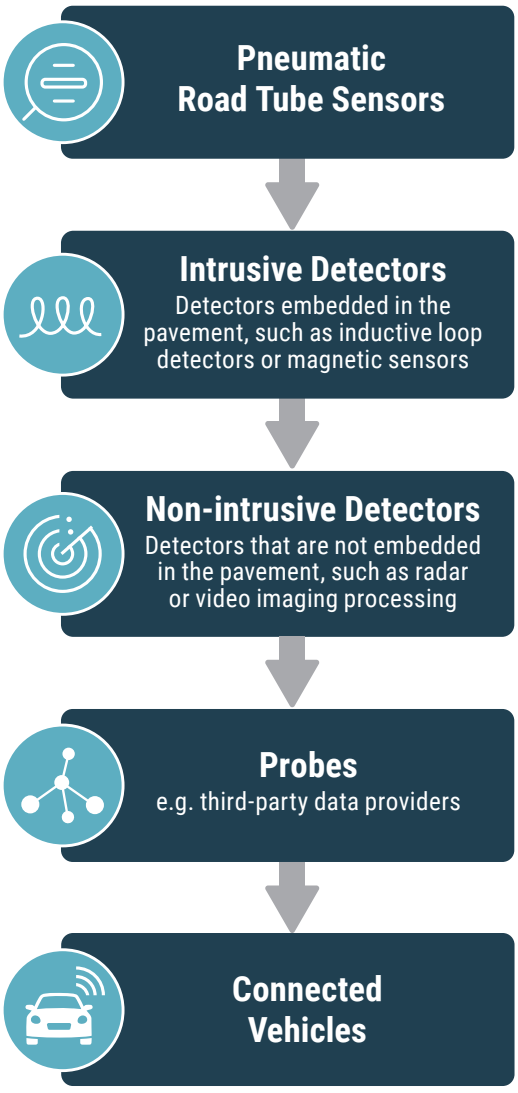


Figure 1
Source: AASHTO Transportation Operations Manual

DATA USES TO SUPPORT TSMO STRATEGIES

Data can directly enable and enhance TSMO strategies. Figure 1 provides a selection of TSMO strategies and the data required to support their impact on the transportation system. The TOM is a valuable resource in providing a high level of data needs, as each sub section on TSMO tactics identifies specific data needs for implementation.

This report highlights best practices in implementing data use to support TSMO in two areas: freight and traffic incident management (TIM). It will also provide key practices in use and application of crowdsourced data.

BEST PRACTICES IN DATA USES FOR FREIGHT OPERATIONS

NCHRP Project 08-119, ***Data Integration, Sharing, and Management for Transportation Planning and Traffic Operations***, outlines a set of broad freight data needs:

- Leadership regarding freight data collection, organization, analysis, and standards
- Continual communication of the benefits of freight data investments to agency leadership
- Partnerships amongst agencies involved in freight planning and operations
- Coordinated data-sharing and exchange file formats
- Freight data collection standards
- Centralized data repository
- Funding to support a collaborative freight data program

The report also developed a data decision tree for big data in freight transportation planning and operations to provide guidance on "which data sources best address specific planning and operations uses cases." The tool provides information on data sets from:

- American Transportation Research Institute (ATRI)
- Freight Analysis Framework (FAF)
- Freight Mobility Trends Dashboard – National Freight Bottlenecks
- Geotab
- Highway Performance Monitoring System
- National Performance Management Research Data Set (NPMRDS)
- StreetLight Insight
- North American Transborder Database
- Transearch
- Weigh-in-Motion (WIM) Stations

DATA NEEDS FOR SELECT TSMO STRATEGIES

Ramp Management and Control

- Vehicle volumes for freeway lanes and arterials
- Freeway speeds
- Ramp demand
- Ramp design
- Crash history for 1-2 years

Dynamic Speed Limits

- Traffic volumes
- Traffic speeds
- Climate and weather conditions for the area
- Incident presence and location

Integrated Corridor Management (ICM)

- Events (incidents)
- Speeds
- Weather
- Transit
- Prediction

The freight data decision tree can be accessed on the NOCoE website and is available to use for free. As the website outlines:

> *"The freight data decision tree, illustrated below, uses a JavaScript library that renders an embedded data structure into a collapsible tree view. A sub-tree expands when the user clicks on each node on the tree until the applicable list of data sources for that use case appears. When a user selects a data source, they are taken to the section describing the content of the data, including metadata and use cases for the data source as identified from the literature." (NCHRP Report 08-119, n.d.)*

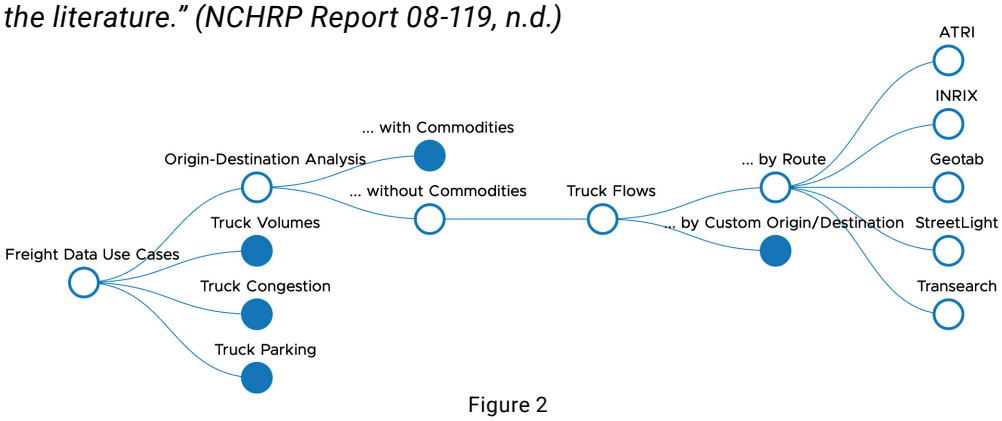


Figure 2
Source: https://transportstudies.org/apps/freight_big_data/index.html

Additionally, NCHRP report 08-119 provides a Freight Data Interoperability Framework to:

1. summarize the state of practice in freight data interoperability in the areas of data processing, data fusion, and data querying
2. present a proposed freight data querying methodology
3. demonstrate the querying methodology for various use cases

The paper also presents a suggested approach for:

- reconciling differences in location and vehicle classification
- addressing vehicle routes, inferred from the start and end locations

CLICK TO READ THE REPORT

Best Practices in Data Uses for Traffic Incident Management (TIM)

TIM is a practice to detect, respond to, and remove traffic incidents as safely and as quickly as possible to restore transportation capacity. This involves planning and coordination among a variety of partners, including law enforcement, fire and rescue, emergency medical services, transportation, towing and recovery and others.

Performance measurement is a key aspect of TIM as it demonstrates the process efficiency and improvements made through training, planning, and coordination. Measures include:

- **Roadway clearance time (RCT)** – the time between the first recordable awareness of an incident (detection/notification/verification) by a responsible agency and first confirmation that all lanes are available for traffic flow.
- **Incident clearance time (ICT)** – the time between the first recordable awareness and the time at which the last responder has left the scene.
- **Secondary crash** – beginning at the time of detection of the primary incident where a collision occurs either a) within the incident scene or b) within the queue, including the opposite direction, resulting from the original incident.

Unlike other TSMO strategies that can and will rely on data warehouses to support automated decision and management choices, the data to support TIM performance measures has relied almost exclusively on an agency's own data, including paper and pencil timesheets inside DOT vehicles to track incident occurrence and clearance times.

NCHRP Project 08-119 provides a guide to improving the sharing, quality, and management of data to support TIM. The guide contains four sections:

Section 1. TIM Data Sharing – describes a wide range of TIM relevant data, presents shared challenges and limitations in data sharing, provides examples of successful data sharing in TIM and the benefits associated with sharing and gaining access to data from internal DOT groups, external TIM partner agencies, and private data providers in support of a range of TIM use cases.

Section 2. TIM Data Quality – presents the findings from comprehensive assessments of TIM data quality, including the quality issues and limitations with certain datasets, and offers recommendations for agencies to improve data quality.

Section 3. TIM Data Management – summarizes the most common data management challenges and associated limitations and provides recommendations and guidelines for modern data management from recent research.

Section 4. Opportunities – discusses opportunities for TIM agencies to accelerate the collection, sharing, and use of data to improve TIM practices and policies, performance, and the overall impacts of traffic incidents on transportation networks.

The key to the nationwide improvement in TIM in the last few decades has been collaboration and training amongst TIM stakeholder groups and practitioners.

USES OF CROWDSOURCING DATA FOR TSMO STRATEGIES

Crowdsourced data includes both active data from social media apps and passive data from cell phones, transponders, and vehicle systems. The potential use for these data sources is numerous, however the use of these big data methods requires transportation agencies to build the resources, workforce, and programs necessary to facilitate decision-making.

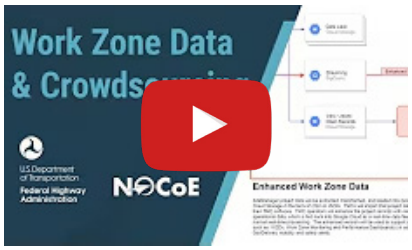
The most common uses of crowdsourced data currently are incident management and traveler information. However, additional uses are being implemented. NOCoE's Crowdsourcing for Operations webinar series, showcase a variety of these uses:

Crowdsourced Data to Advance Transportation Operations

Collaborating with Navigation Providers

Crowdsourced Incident Management Tools

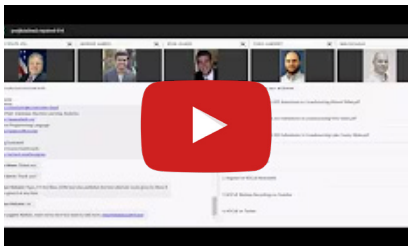
[Crowdsourced Data for Arterial Operations]



[Work Zone Data and Crowdsourcing]

[Analytics Tools to Improve Operational Planning]

[Crowdsourced Data for Commercial Vehicles]



[Open Source Code to Jumpstart Analytics]

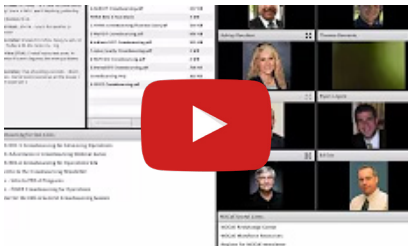
[Emergency Management]

[Vehicle Video Analytics & CV Data for Operations and Planning]

[Modern Data Management]

[Active Work Zone Monitoring and Management]

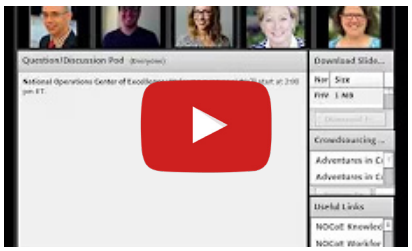
[New Destinations with FHWA EDC-6 Innovation]



[Business Case for Crowdsourced Data]

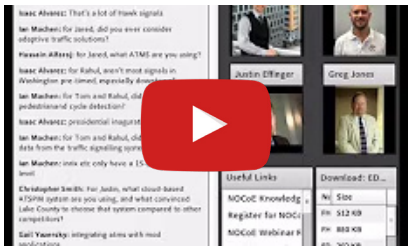
[Using Crowdsourced Data for Traveler Information]

[Verifying Crowdsourced Data]



[Social Media for Improved Operations]

[Identifying and Managing the Back of Queues]



[Crowdsourcing Traffic Signal Applications]

[Crowdsourced Data Management and Governance]

[Crowdsourcing and Vendor Engagement]

[Engaging Navigation Providers]

Additionally, NCHRP project 08-119 provides a primer on vehicle probe date use, including the following sections: (NCHRP Report 08-119, n.d.)

1. **Data availability** – Vehicle probe data vendors offer numeric and visualization products for speed, origin-destination, and vehicle trajectory. Real-time, minute-by-minute, speed and travel time data are available along with historic average speeds for freeway and arterial road segments.

2. **Data use** – There are a variety of vehicle probe data uses, including real-time monitoring of traffic, winter weather operations, traffic incident detection, back of queue detection, and evacuation and event management. Agencies use archived data for a variety of critical transportation agency functions, including performance management, planning, investment and programming decisions, and research.

3. **Data management** – Vehicle probe data and other emerging data sources create new data management challenges for transportation agencies. To handle the enormous amount of data produced from these technologies requires agencies to transition from traditional to more modern, flexible, and scalable data management practices.

4. **Data quality** – One of the most common concerns transportation agencies have with the use of vehicle probe data is the quality of the data. Each vehicle probe data vendor has its proprietary approach to collecting, managing, and processing the data, making data source and integration a black box. Agencies have addressed this challenge by performing data quality and validity assessments to evaluate the quality of the data, mainly as it relates to travel speed and time.

5. **Data integration** – Integrating vehicle probe data with other programmatic and enterprise data provides an opportunity to enhance operations and decision-making by using both real-time and archived data; however, integrating vehicle probe data is one of the most significant deterrents to its use by state DOTs. To be useful, probe vehicle data must be conflated temporally and spatially to a roadway network, which can be a challenge.

6. **Agency vehicle probe data applications** – This section presents vehicle probe data applications from four agencies, including Indiana DOT, Colorado DOT, Tennessee DOT, and the District of Columbia DOT.

7. **Future of vehicle probe data** – Vehicle probe data will become available at greater geographic fidelity and data quality as vendors ingest greater volumes of data from connected vehicles. The evolution of vehicle probe data means continued integration of new data sources (e.g., connected vehicle data) and the provision of analytics services for greater precision and accuracy of speed, trip, and path data.

DATA USAGE BEST PRACTICES GOING FORWARD

The TOM is an essential resource for identifying the data needs to implement TSMO strategies; the identification of data needs for most TSMO tactics and strategies provides the practitioner with a starting point to understanding data needs and a checklist for agency readiness.

NOCoE will continue to capture and highlight uses of data for operations via the Data for Operations portal, supported by NCHRP 08-119. Additionally, future best practices reports will cover additional data uses and implementation strategies.