TN | TDOT
Department of Transportation

TDOT Transportation Systems Management and Operations (TSMO)

Program Plan

Tennessee Department of Transportation | Final | February 2022

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List of Acronyms

AADT	Annual Average Daily Traffic
ACEC	American Council of Engineering Companies
AI	Artificial Intelligence
ATM	Active Traffic Management
ATSM	Arterial Traffic Signal Management
C-V2X	Cellular Vehicle-to-Everything
CAD	Computer-Aided Dispatch
CAP	Congestion Action Plan
CAV	Connected and Automated Vehicle
CC	Coordinating Committee
CCTV	Closed-Circuit Television
CFG	Customer-Focused Government
CI	Communication Infrastructure
CM	Corridor Management
CMA	Corridor Management Agreements
CMAQ	Congestion Mitigation Air Quality
CMM	Capability Maturity Model
CV	Connected Vehicle
DMS	Dynamic Message Sign
DOT	Department of Transportation
DSS	Decision Support Systems
DSRC	Dedicated Short-Range Communication
EPIC	Empowering People and Influencing Culture
EV	Electric Vehicle
FCC	Federal Communication Commission
FHWA	Federal Highway Administration
GIS	Geographic Information System
GPS	Global Positioning Systems
HAR	Highway Advisory Radio
HERO	Highway Emergency Response Operators
HOT	Hands-on-Training
HOV	High-Occupancy Vehicle
HSAM	Highway System Access Manual

HSIP	Highway Safety Improvement Program
ICM	Integrated Corridor Management
ICT	Incident Clearance Time
INFRA	Infrastructure for Rebuilding America
IOP	Institutional, Organizational, and Procedural
IPD	Integrated Project Delivery
IPPD	Innovative Planning and Performance Management Division
IT	Information Technology
ITS	Intelligent Transportation System
LOTTR	Level of Travel Time Reliability
LIDAR	Light Detection and Ranging
KPI	Key Performance Indicator
MaaS	Mobility as a Service
MoD	Mobility on Demand
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
NIMS	National Incident Management System
NOCoE	National Operations Center of Excellence
Ops	Operations
PDN	Project Development Network
PM	Performance Measure/Measurement
PMII	Preventative Maintenance Inspections and Inventory
PS&E	Plans, Specifications and Estimates
PSA	Public Service Announcement
PTQ	Protect the Queue
RADAR	Radio Detection and Ranging
RCT	Roadway Clearance Time
RDS	Radar Detection Systems
ROF	Regional Operations Forum
RSU	Roadside Unit
RTE	Region Traffic Engineer
SHSP	Strategic Highway Safety Plan
SHRP	Strategic Highway Research Program
SMART	Specific, Measurable, Agreed-Upon, Realistic, and Time-Bound

SPaT	Signal Phase and Timing
STID	Strategic Transportation Investments Division
TAMP	Transportation Asset Management Plan
TDOSHS	Tennessee Department of Safety and Homeland Security
TDOT	Tennessee Department of Transportation
THP	Tennessee Highway Patrol
TI	Traveler Information
TITAN	Tennessee Integrated Traffic Analysis Network
TIM	Traffic Incident Management
TMC	Traffic Management Center
TOD	Traffic Operations Division
TPM	Transportation Performance Measurement
TPO	Transportation Planning Organization
TSM&M	Traffic Signal Modernization & Maintenance
TSMO	Transportation Systems Management and Operations
TSMP	Traffic Signal Modernization Program
TTI	Texas A&M Transportation Institute
TTSUG	Tennessee Traffic Signal Users Group
TxDOT	Texas Department of Transportation
U.S. DOT	U.S. Department of Transportation
UTK	University of Tennessee, Knoxville
UTC	University of Tennessee at Chattanooga
V2I	Vehicle-to-Infrastructure

1. Executive Summary

The Tennessee Department of Transportation (TDOT) is advancing a department-wide approach to Transportation Systems Management and Operations (TSMO). This TSMO Program Plan (the Plan) captures TDOT's updated TSMO strategy, needs, and priority actions to advance TSMO both programmatically in terms of Department processes and tactically in terms of enhancing core TDOT TSMO activities. The goal of the Plan is to advance a cross-discipline, collaborative, and integrated program of TSMO strategies that improve the safety, reliability, and efficiency of Tennessee's transportation system as a whole.

1.1. What is TSMO?

TSMO encompasses a wide range of strategies in which TDOT already has a strong foundation. Figure 1 illustrates the array of areas that fall under the TSMO umbrella and work together to improve the safety, reliability, and operations of the whole transportation system. The TDOT Definition, below, also captures what TSMO means for TDOT, tailoring national and peer definitions of TSMO to meet TDOT's unique needs. TDOT has employed many TSMO activities for decades. This Plan builds on those activities and recommends actions to advance TDOT's TSMO activities—and their positive impacts on safety, reliability, and efficiency—as an integrated and comprehensive program.

TSMO is an emerging term used to describe a cross-discipline, collaborative, and integrated program of strategies and applications to improve existing and planned transportation infrastructure and multimodal systems through better integration, coordination and implementation of key operational strategies, innovation, and technology. TSMO improves the safety, efficiency, and reliability of the transportation system with lower-cost, high-impact actions that can be implemented relatively quickly as well as enhance traditional capacity projects.

- TDOT Definition of TSMO

1.2. Why Plan for TSMO?

Like TDOT, all State and local transportation agencies have been conducting TSMO to some degree or another for years, but some TSMO activities are more formalized than others. National and peer studies have shown that formalizing a TSMO plan and program greatly improves the effectiveness of TSMO efforts. It helps integrate and leverage TSMO strategies across disciplines to meet Department-wide goals for improving safety, efficiency, and reliability. TSMO strategies can benefit a broad array of TDOT functions and help meet core TDOT goals. TSMO strategies are often quicker to implement and have relatively low costs compared to traditional infrastructure solutions. TSMO helps address system performance from a holistic and multimodal perspective, not just one strategy or project, which creates efficiencies over time. TSMO can also be applied in combination with traditional infrastructure and capacity projects and can enhance the effectiveness of these infrastructure projects, especially when it comes to managing nonrecurring congestion. The goal of this TSMO Program Plan is to enhance and extend the many benefits of TDOT's TSMO activities to support the Department as a whole.
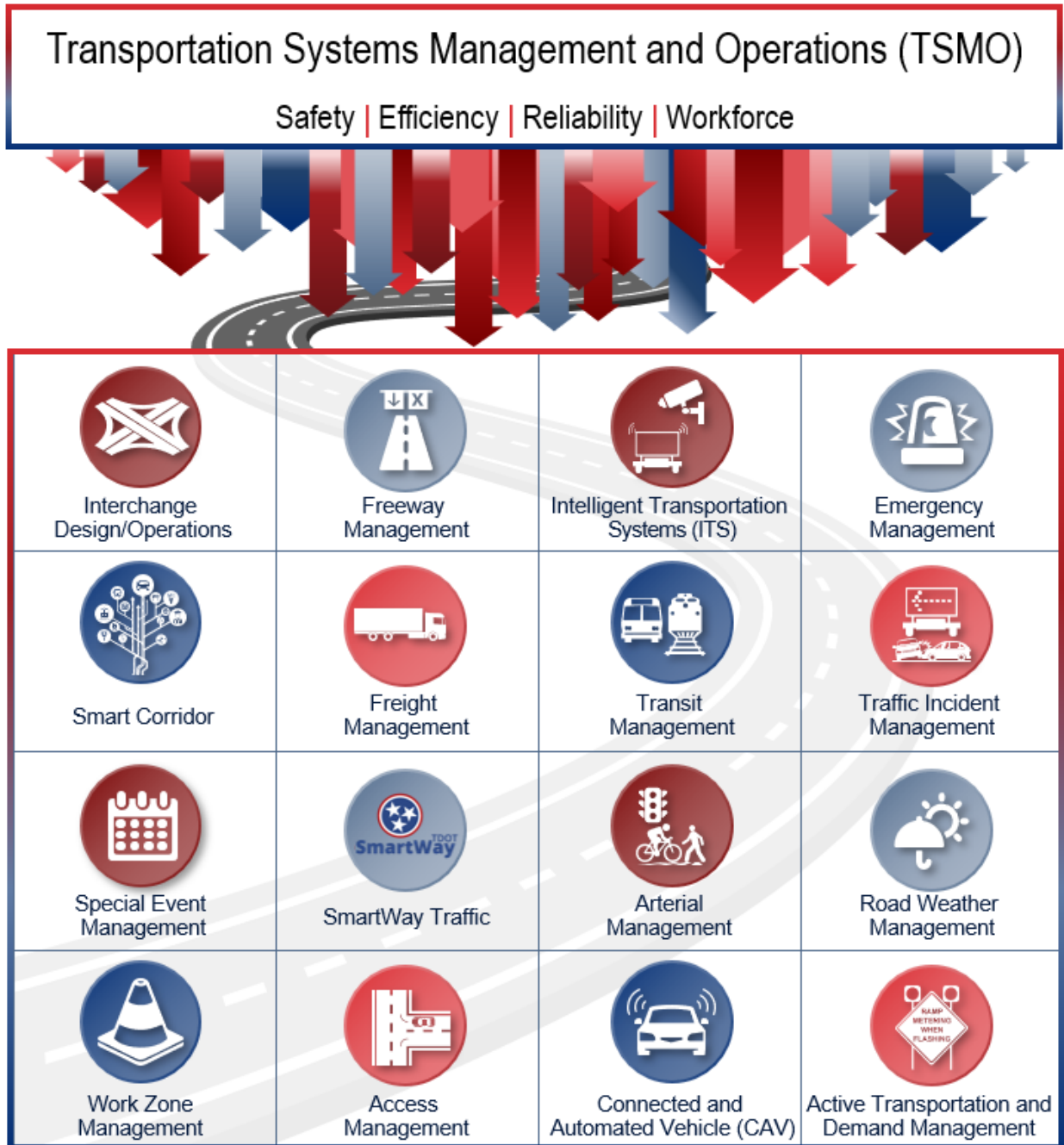
Figure 1: TSMO Strategies

1.3. This Plan

Led by the TDOT Traffic Operations Division (TOD), this Plan builds on the 2017 Traffic Operations Program Plan. The Plan documents TDOT's updated TSMO strategy, needs, and priority actions to advance TSMO across both programmatic areas (such as workforce development and performance measurement) as well as tactical areas (specific TSMO areas such as traveler information and corridor management). The primary focus of the main body of the Plan is on **statewide actions to advance TSMO, led by TDOT Headquarters**. These actions are based on input from a series of outreach

activities across TDOT Headquarters and Regional staff, summarized in section 1.4 below, Section 2.1.1 of the Plan, and the project's associated Stakeholder Engagement Report (separate document).

The Plan development also included tailored outreach to each Region and its partners to update previous TSMO regional actions from 2018–2019. These regional actions are captured in the Appendix in the Region Action Plans and is also described more below.

In a nutshell, this Plan documents the following components of TDOT's TSMO Program. Key components are further summarized below in this Executive Summary and are discussed in more detail in the Plan.

Section 2. Introduction

The introduction defines TSMO, summarizes the scope of the Plan, and gives a Plan overview. It also summarizes the outreach that informed the Plan. A full account of all outreach that informed the Plan is further documented in the associated Stakeholder Engagement Report (separate document).

Section 3. Why Transportation Systems Management and Operations?

This section gives a more detailed account of the benefits of TSMO for TDOT, highlighting success stories from TDOT's previous TSMO efforts. It also summarizes the purpose and benefits of a formal TSMO Program Plan.

Section 4. Transportation Systems Management and Operations Program Vision, Mission, and Goals

As part of the Plan development and outreach, TDOT gained consensus on the Department's TSMO strategy. This section includes the consensus built TDOT TSMO Program Vision, Mission, and Goals. It also shows how this Plan links to other TDOT plans. Integrating TSMO with other TDOT planning processes and vice versa is critical to leveraging TSMO for improved safety, efficiency, and reliability of the transportation network.

Section 5. Strengths, Challenges, and Needs

As part of the Plan development, TDOT conducted a statewide Capability Maturity Model (CMM) self-assessment—or, in this case, a re-assessment of previous TDOT CMM efforts. This staff-led assessment served as the foundation for determining the priority needs to address in this Plan through the recommended actions in Sections 6-8.

Section 6. Institutional, Organizational, and Procedural Strategies

The first of three prongs in TDOT's roadmap to advance TSMO, this section identifies key actions to advance TDOT's programmatic TSMO capabilities, or Institutional, Organizational, and Procedural (IOP) strategies. Based on staff outreach, this Plan focuses on the IOP areas of staffing (including workforce development), business processes and planning, and resource positioning. These actions are summarized in Figure 2.

Section 7. Performance Measurement

The second of three prongs in TDOT's roadmap to advance TSMO, this section identifies opportunities to advance performance measurement for TSMO. Performance Measurement was highlighted as a key need in the CMM assessment and, therefore, the Plan provides a deep dive into advancing performance measurement to improve TSMO effectiveness. These actions are also summarized in Figure 2.

Section 8. Services and Projects

The third of three prongs in TDOT's roadmap to advance TSMO, this section drills down a layer to focus on specific, tactical, TSMO applications. It identifies key actions to improve TSMO capabilities in TDOT's priority service areas for this Plan iteration, including ITS, traffic incident management, traveler information, corridor management, arterial traffic signal management, communications infrastructure, and Connected and Automated Vehicles (CAV). The section also captures several other TSMO-related efforts that are either currently underway or under consideration by the agency. These actions are also summarized in Figure 2.

Section 9. Plan Maintenance, Evaluation, and Reassessment

This section provides guidance on maintaining the TDOT TSMO Program Plan. This effort will be led by the TDOT TSMO Coordinating Committee (TSMO CC), with staff representatives from across Headquarters and the Regions. The TSMO CC will coordinate with staff to implement the actions in this Plan, and to maintain a three-year cycle for updating TDOT's CMM assessment and this TSMO Program Plan.

Section 10. Appendix

The Appendix captures several important efforts associated with this Plan:

- *Links to TSMO Plan Connections.* This Plan documents how the TSMO relates to other TDOT planning efforts. Available links to these other efforts and plans are provided in the Appendix to support coordination.

- *Additional Performance Measurement Case Studies* collected during development of this Plan is also included for those who would like to learn more.

- *Region Action Plans for each of TDOT's four Regions.* As an associated plan effort, the TDOT TSMO Program Plan team helped develop Region Action Plans for each of TDOT's four Regions. See section 1.7 below for more details.

INSTITUTIONAL, ORGANIZATIONAL, AND PROCEDURAL

Action People-1:
Continue Advancing TSMO
Awareness and Education.

Action People-2:
Strengthen and Formalize
Collaboration.

Action Processes-1:
Integrate TSMO into Planning
and Programming.

Action Resources-1:
Identify TSMO Resource Needs.

PERFORMANCE MEASUREMENT (PM)

Action PerfM-1:
Develop a Data
Governance Process.

Action PerfM-2:
Expand TDOT's Performance
Measurement Framework.

Action PerfM-3:
Create a Centralized Repository
of Operations Data.

Action PerfM-4:
Define Staff Roles
and Responsibilities.

SERVICES AND PROJECTS

Intelligent Transportation Systems (ITS)

Action ITS-1: Expand Rural ITS.

Traffic Incident Management (TIM)

Action TIM-1: Expand and Customize the Service Patrol Program.

Action TIM-2: Advance the Existing Statewide/Regional TIM Committees.

Traveler Information (TI)

Action TI-1: Explore Improvements in Rural Traveler Information.

Corridor Management (CM)

Action CM-1: Identify and Document Corridor Level TSMO Advancements.

Action CM-2: Document TSMO Lessons Learned from the 2021 I-40 Bridge Closure.

Arterial Traffic Signal Management (ATSM)

Action ATSM-1: Continue the TSM&M Program.

Communications Infrastructure (CI)

Action CI-1: Assess and Expand the State's Communications Network.

Connected and Automated Vehicles (CAV)

Action CAV-1: Support and Advance CAV Actions for TSMO.

Action CAV-2: Document a CAV Plan for TDOT.

Figure 2. Recommended Statewide Actions in the TDOT TSMO Program Plan.

1.4.   Outreach

This Plan is rooted in outreach across TDOT and input collected directly from staff. The timeline shown in Figure 3 summarizes the outreach and engagement that the team conducted to collect input. As an important note, the main body of this Plan focuses on existing conditions, needs, and actions from a statewide perspective and intended for ownership by TDOT headquarters. Region leadership and staff were also included in engagement for these statewide actions (e.g., Region leadership participated in the Senior Leadership Interviews and also participates in the TSMO Coordinating Committee, etc.). In addition, this project conducted outreach targeted specifically to each Region in order to create Region Action Plans, intended for ownership by each Region and its partners. The outreach efforts are documented in a separate Stakeholder Engagement Report. These Region Action Plans are included in the appendix and reflect input from each Region and its partners within local agencies and first responders.
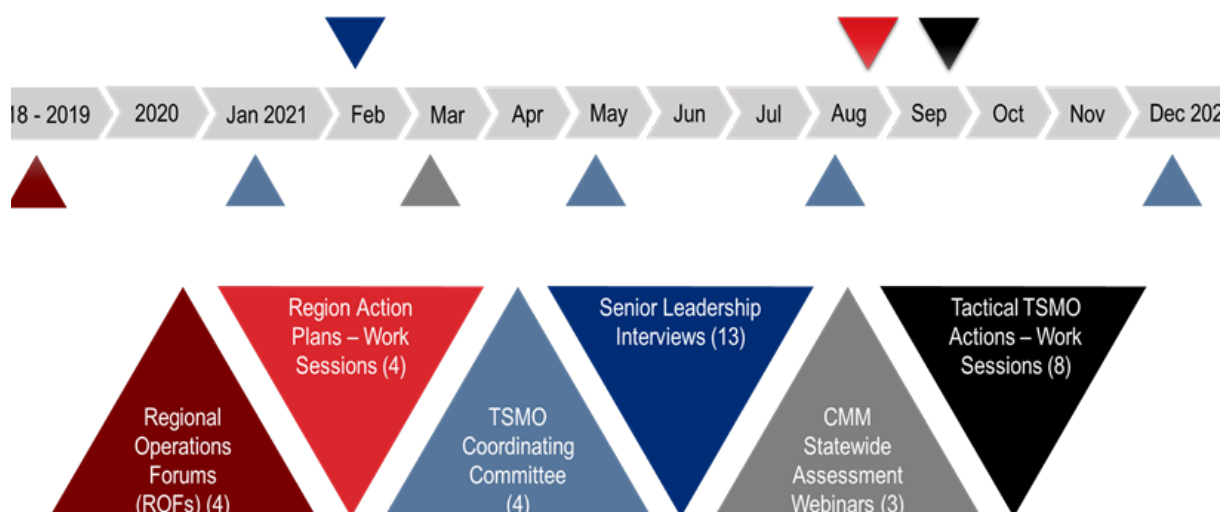
Figure 3: TSMO Plan Stakeholder Outreach Timeline

1.5.   TDOT's TSMO Strategy

Through outreach and consensus-building, TDOT updated its TSMO strategy and established a TSMO Program Mission, Vision, and Goals (see Figure 4). This high-level strategy sets the direction for the actions in this Plan.

1.6.   Statewide Actions to Advance TSMO

Sections 6, 7, and 8 of the Plan discuss and identify priority actions to advance TDOT's TSMO effectiveness using a three-pronged approach: Institutional, Organizational, and Procedural Strategies, Performance Measurement, and Services and Projects. The high-level actions from these three sections are summarized in Figure 2.

In the relevant section of the Plan, every action in the TSMO Program Plan, shown in Figure 2, is further broken down into a Roadmap to Advance with specific sub-steps that TDOT staff can follow to implement each action. The actions and Roadmaps to Advance were developed through outreach and through close work with TDOT staff with expertise in each area.

VISION

Support and promote a TSMO Program in Tennessee that becomes fully integrated into both state and local agency practices.

MISSION

To preserve and optimize the safety, efficiency, and reliability of Tennessee's transportation system for all road users by leveraging data-driven, operational, and technology-based strategies and applications.

GOALS

Safety
Reduce the frequency and severity of crashes on the transportation system through TSMO focused planning, design and management.

Reliability
Improve travel-time reliability by managing transportation network delays and enhancing real-time traveler information.

Efficiency
Operate and maintain a coordinated multi-modal transportation system that provides seamless mobility to users.

Workforce
Support and advance TSMO education, training needs, and resource depositories for TDOT and local partners.

Figure 4: TDOT TSMO Program Vision, Mission, and Goals

1.7.   Regional TSMO Actions

As an associated effort, the TDOT TSMO Program Plan team helped develop **Region Action Plans** for each of TDOT's four Regions. While the actions in the TSMO Program Plan's main body are focused on statewide actions lead by Headquarters, these Region Action Plans are included in the Appendix and work in tandem with this Plan's recommendations.

In 2018–2019, TDOT conducted Regional Operations Forums (ROF) that documented key strengths, needs, and actions to advance TSMO in each Region. During August and September 2021, the TSMO Program Plan team organized a work session with each Region and its partners to revisit their ROF findings and determine the priority actions that will help advance TSMO in the region, in coordination with this Plan. The objective was to identify incremental steps that the Region could implement in the near-term to advance their TSMO work and goals. These steps are detailed in a Region Action Plan developed with each Region.

2.   Introduction

The Tennessee Department of Transportation (TDOT) is advancing a department-wide approach to Transportation Systems Management and Operations (TSMO). TSMO (pronounced "tiz-mo") encompasses a wide range of strategies and applications in which TDOT already has a strong foundation. Figure 5 illustrates the array of areas that fall under the TSMO umbrella and work together to improve the safety, efficiency, and reliability of the transportation system.

TDOT has employed TSMO strategies and solutions for decades with work zone and road weather management strategies, Intelligent Transportation Systems (ITS), traveler information systems, and the traffic incident management HELP program. Other newer approaches to advancing TSMO include Integrated Corridor Management (ICM) systems, active freeway and arterial management systems, and more sophisticated data processing, modeling, and analytics. This Plan builds on these activities and recommends actions to advance TDOT's TSMO activities—and their positive impacts on safety, efficiency, and reliability—as an integrated and comprehensive program.

> ## What is TSMO?
>
> *TSMO is an emerging term used to describe a cross-discipline, collaborative, and integrated program of strategies and applications to improve existing and planned transportation infrastructure and multimodal systems through better integration, coordination and implementation of key operational strategies, innovation, and technology. TSMO improves the safety, reliability, and operation of the transportation system with lower-cost, high-impact actions that can be implemented relatively quickly as well as enhance traditional capacity projects.*
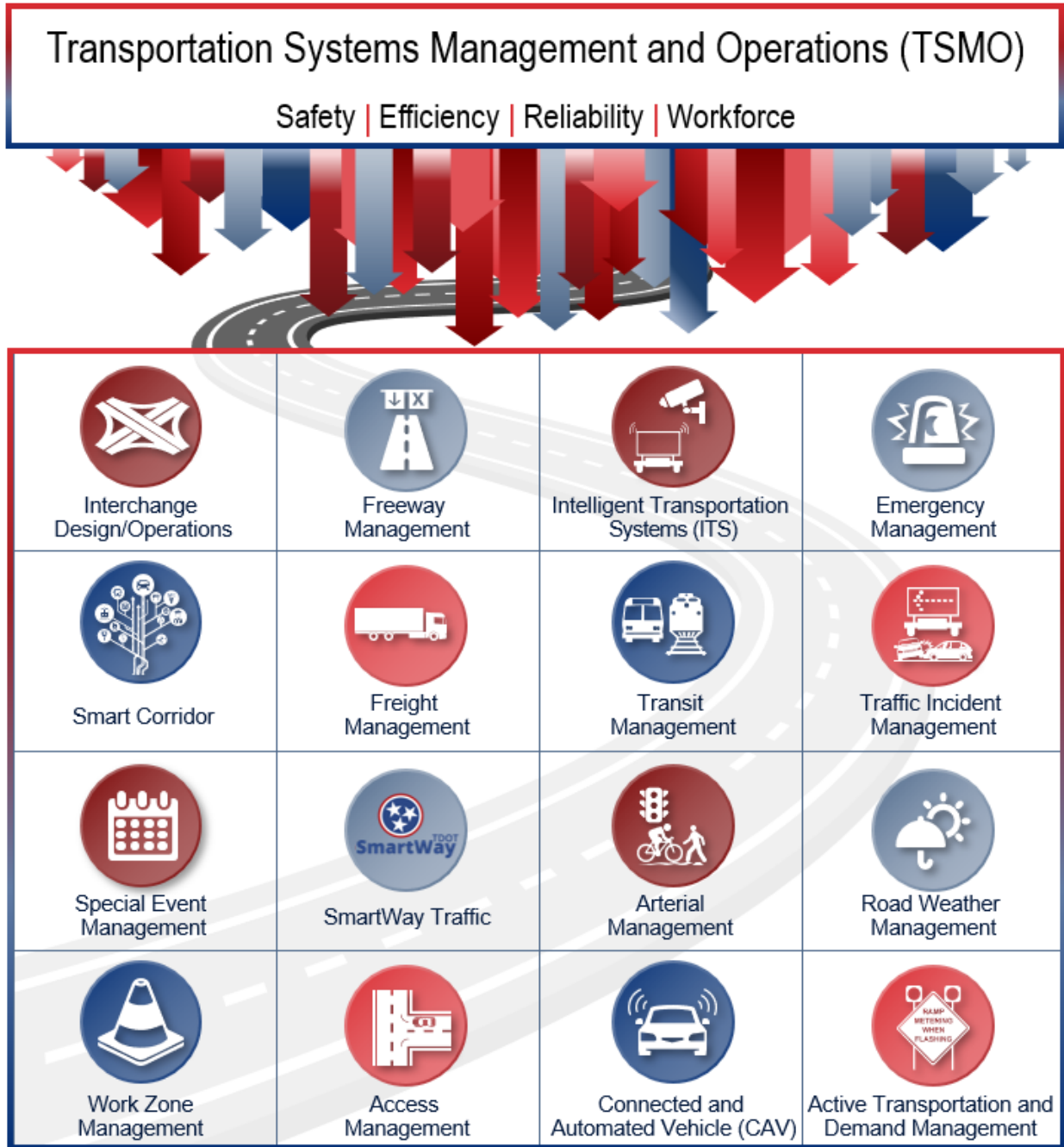
Figure 5: TSMO Strategies

2.1. *This Plan*

2.1.1. Rooted in Outreach

This Plan is rooted in outreach across TDOT and input collected directly from staff. The timeline shown in Figure 6 summarizes the outreach and engagement that the team conducted to collect input. As an important note, the main body of this Plan focuses on existing conditions, needs, and actions from a statewide perspective and intended for ownership by TDOT Headquarters. Region leadership and staff

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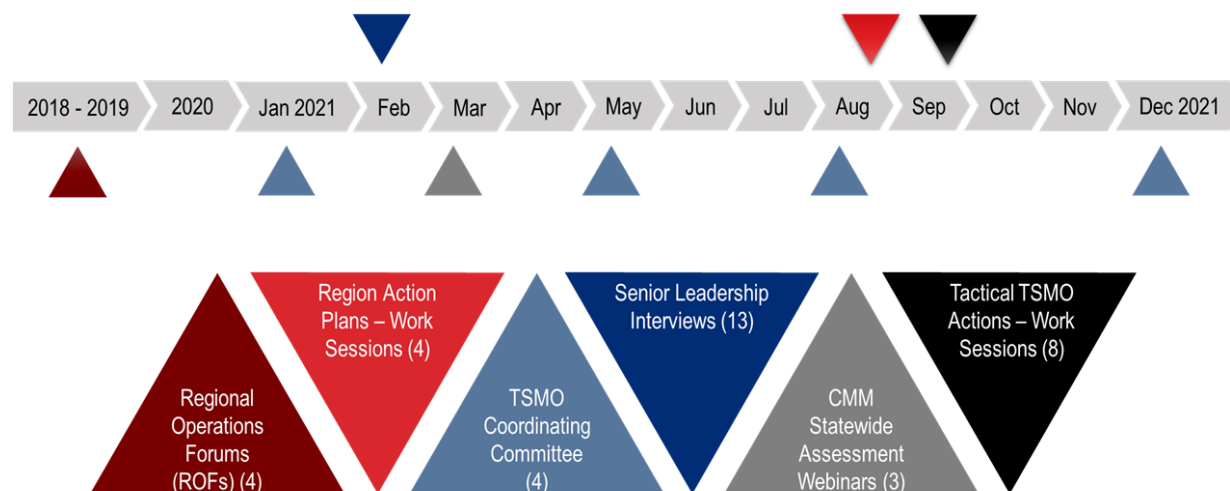
Figure 6: TSMO Plan Stakeholder Outreach Timeline

A more detailed account of the outreach that informed this Plan and the Region Action Plans is provided in an associated **Stakeholder Engagement Report** (separate document). The engagement of the TSMO Coordinating Committee (TSMO CC) members is also summarized in the following chapter under TSMO Strategic Leadership at TDOT.

2.1.2. Plan Organization

Led by the TDOT Traffic Operations Division (TOD), this Plan builds on the 2017 Traffic Operations Program Plan. The Plan documents TDOT's updated TSMO strategy, needs, and priority actions to advance TSMO across both programmatic areas (such as workforce development and performance measurement) as well as tactical areas (specific TSMO areas such as traveler information and corridor management). The primary focus of the main body of the Plan is on **statewide actions to advance TSMO, led by TDOT Headquarters**. These actions are based on input from the series of outreach activities across TDOT Headquarters and Regional staff, summarized above, and detailed in the project's Stakeholder Engagement Report. In a nutshell, this Plan documents the following components of TDOT's TSMO Program.

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Section 10. Appendix

The Appendix captures several important efforts associated with this Plan:

- *Links to TSMO Plan Connections.* This Plan documents how the TSMO relates to other TDOT planning efforts. Available links to these other efforts and plans are provided in the Appendix to support coordination.

- *Additional Performance Measurement Case Studies* collected during development of this Plan is also included for those who would like to learn more.

- *Region Action Plans for each of TDOT's four Regions.* As an associated effort, the TDOT TSMO Program Plan team helped develop Region Action Plans for each of TDOT's four Regions. While the actions in the Plan's main body are focused on statewide actions lead by Headquarters, these Region Action Plan are included in the Appendix and work in tandem with this Plan's recommendations. In 2018–2019, TDOT conducted Regional Operations Forums (ROF) that documented key strengths, needs, and actions to advance TSMO in each Region. During August and September 2021, the TSMO Program Plan team organized a work session with each Region and its partners to revisit their ROF findings and determine the priority actions that will help advance TSMO in the region, in coordination with this Plan. The objective was to identify incremental steps that the Region could implement in the near-term to advance their TSMO work and goals. These steps are detailed in a Region Action Plan developed with each Region.

3. Why Transportation Systems Management and Operations?

3.1. Benefits of TSMO for TDOT

Transportation Systems Management and Operations (TSMO) solutions are often quicker to implement and have a relatively low cost compared to traditional infrastructure solutions. TSMO helps address system performance from a holistic and multimodal perspective, not just one strategy or project. TSMO can be applied in combination with traditional infrastructure and capacity projects, such as adding lanes while considering deeper shoulder depths for hard shoulder operations. It can enhance the effectiveness of these infrastructure projects, especially when it comes to managing nonrecurring congestion. TSMO expands the traditional Department of Transportation (DOT) focus on capacity to also include efficient and reliable systems operations as an equal priority with other program- and project-level decision-making.

TSMO supports Tennessee DOT's (TDOT) mission and critical needs as a State. TDOT's mission is to provide a safe and reliable transportation system that supports economic growth and quality of life. With a mission focused on safety and reliability, TDOT is continuously taking steps to improve these two metrics. Here, a comprehensive approach to TSMO can help improve foundational agency capabilities and coordinate strategies across the agency to optimize how TDOT improves safety and reliability of such a complex, multimodal transportation system. For example, TDOT manages more than 8,400 State-owned bridges and 14,000 highway miles.[1] Bordering eight States, Tennessee also has several key freight corridors that traverse the State. The benefits of a TSMO program include process improvements such as greater agency efficiency, improved collaboration, lower implementation costs, and

TDOT TSMO SUCCESS STORY

TDOT's robust Traffic Incident Management (TIM) demonstrates a TSMO success story. Here, TDOT applies TSMO strategies including real-time data collection, closed-caption television (CCTV) surveillance, and proactive safety services on its Interstate system for faster incident response and clearance.

TDOT has implemented the Protect the Queue (PTQ) campaign since 2013 to help clear roadways as soon as possible after an incident and alert driver to the slow-moving traffic ahead. TDOT operates HELP trucks on Tennessee's most heavily traveled highways in Chattanooga, Knoxville, Memphis, and Nashville in support of their incident response activities. These TSMO strategies and services require both an initial capital investment and continuous operation and maintenance costs. They bring about additional benefits, including reduced delay, fuel savings, and lower emissions since crashes are cleared sooner, and a reduction in the number of crashes since secondary crashes are less likely or even avoided. Through data-driven analysis done by the University of Tennessee Knoxville, the statewide benefit cost ratio of PTQ over a three-year total from 2017 to 2019 is 20:1 and the HELP Program recognizes a statewide benefit cost ratio of 41:1 based on 2018 data.

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[1] TDOT, Transportation System Overview, available at: https://www.tn.gov/tdot/about/transportation-system-overview.html.

faster implementation timelines. The operational benefits of TSMO include a reduction in crashes, improved reliability of the system, lower vehicle emissions and energy costs, and increased travel time reliability.

3.2. Why a TSMO Program Plan?

All State and local transportation agencies have TSMO programs at some degree or another, but some are more formalized than others. Is the program documented and institutionalized or ad-hoc? How effective is the program and how is it measured? What is measured? How is the program (or its elements) funded, organized, and formalized? How do you advance the program with and without funding? The answers to these questions are critical to the efficacy of TSMO within an agency. The Program Plan helps answer these questions, identifies investments and improvements needed to advance operations, and establishes a more formal and collaborative program. In implementing the TSMO strategies and solutions identified in the Plan, TDOT will improve the safety, efficiency, and reliability of the transportation system for all users.

Since the issuance of the 2017 Operations Plan, the Traffic Operations Division has made strides in having TSMO aspects included in agency funding programs. Through the implementation of this version of the Plan, the Traffic Operations Division will accomplish actions that will further integrate TSMO within TDOT Programs to institutionalize funding mechanisms to advance operations throughout agency activities.

TSMO program planning can help an agency increase the effectiveness of its TSMO efforts by providing a clear understanding of what the TSMO program entails, what it aims to achieve, and how it fits within the larger agency context. TSMO program plans can help stakeholders develop operations objectives to guide the selection of management and operations strategies, integrate projects in the region's planning and programming processes, and identify performance measures that will enable them to track progress.

- Federal Highway Administration (FHWA) website "What is TSMO?"

4. Transportation Systems Management and Operations Program Vision, Mission, and Goals

Based on outreach and collaboration across the agency, Tennessee Department of Transportation (TDOT) has developed a Transportation Systems Management and Operations (TSMO) Program Vision, Mission, and set of Goals (shown in Figure 7) to set the direction for this TSMO Program Plan. As part of this Plan's development, the Traffic Operations Division conducted interviews with 16 TDOT leaders across the Department and Regions. These interviews provided the baseline for the TSMO vision, mission, and goals as the leaders brought forward their priorities and inputs on how to align TSMO to the overall agency's programs. Using this as the foundation, the project team then worked with the TSMO Coordinating Committee (TSMO CC), described in more detail below, to further refine the TSMO vision, mission, and goals through facilitated exercises.

VISION

Support and promote a TSMO Program in Tennessee that becomes fully integrated into both state and local agency practices.

MISSION

To preserve and optimize the safety, efficiency, and reliability of Tennessee's transportation system for all road users by leveraging data-driven, operational, and technology-based strategies and applications.

GOALS

Safety
Reduce the frequency and severity of crashes on the transportation system through TSMO focused planning, design and management.

Reliability
Improve travel-time reliability by managing transportation network delays and enhancing real-time traveler information.

Efficiency
Operate and maintain a coordinated multi-modal transportation system that provides seamless mobility to users.

Workforce
Support and advance TSMO education, training needs, and resource depositories for TDOT and local partners.

Figure 7: TDOT TSMO Vision, Mission, and Goals

The TDOT TSMO vision, mission, and goals were developed to align with TDOT's Department-wide mission and vision, highlighting how TSMO strategies support broader TDOT goals. Figure 8 illustrates how the two strategic directions align with one another.
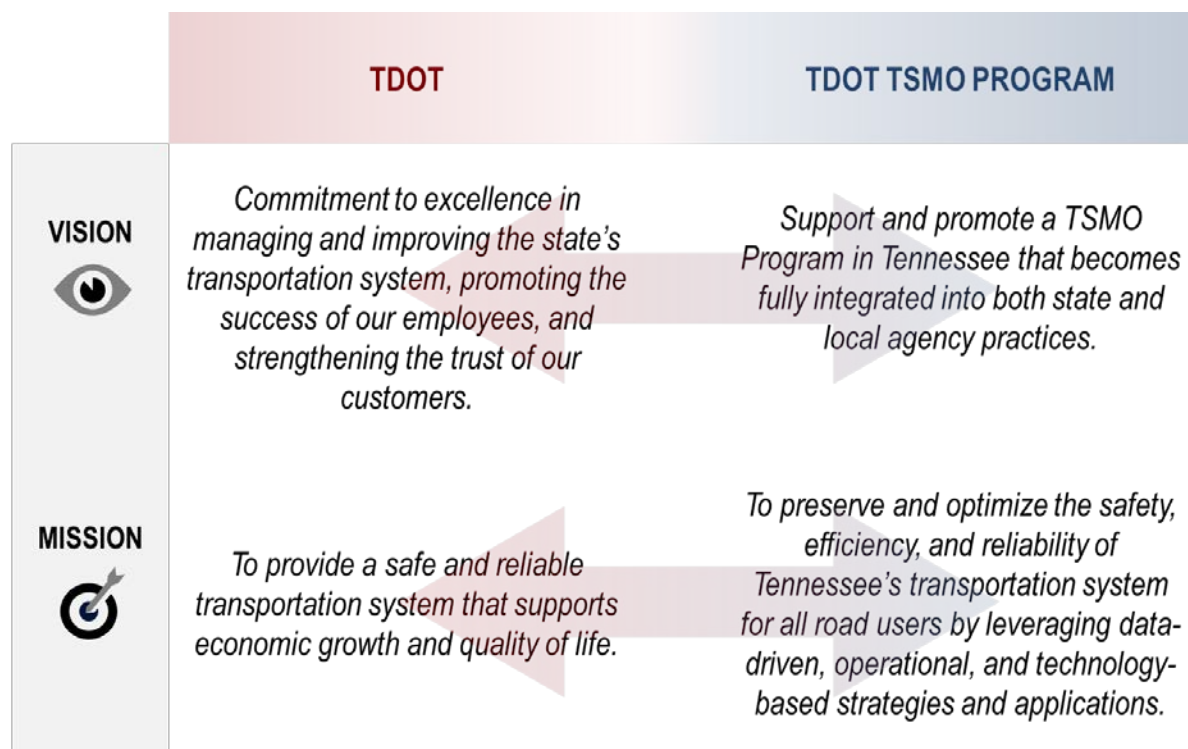
Figure 8: Alignment Between TDOT-wide and TSMO Program Strategic Direction

4.1.   TSMO Plan Connections

This Plan presents the goals and actions to advance TSMO within TDOT. Connecting and integrating TSMO with broader agency activities is essential to advancing operations and should be identified on a continuous basis. To assess potential connections, the linkages between this Plan and various internal TDOT planning efforts were identified, as shown in Figure 9. The figure shows potential connections to broader TDOT plans and programs, such as the Long-Range Plan, as well as to more specialized plans. On the left side of the figure, it shows the evolution of TDOT's TSMO program beginning with the 2017 Operations Plan and leading to the current TSMO Program Plan. Below the TSMO Plan, numerous plans and initiatives that fall under the umbrella of TSMO-related activities are listed. To the right of the TSMO Plan, other TDOT plans that could potentially interface with the TSMO program goals at some level, even if only a minor interface, are shown. Below these, broader-reaching TDOT plans are highlighted. These plans set the strategic direction for all TDOT activities and/or could overlap significantly with TSMO activities. All planning efforts should have an awareness of the TSMO program goals and processes and, vice versa, the TSMO program should have an awareness of these plans' goals and processes. This will enable TDOT to better coordinate and capture efficiencies across plans and programs, and to identify opportunities to leverage TSMO for improved safety, efficiency, and reliability in all areas.

TSMO Program Plan – connections to other plans

2017 Traffic Operations Plan → **2022 TSMO Program Plan** → **Other TDOT Plans**

- 10-Year Strategic Investment Plan
- TDOT 25-Year Long Range Transportation Policy Plan
- 4-Year State Transportation Improvement Plan (STIP)
- MPO Transportation Improvement Plans
- Strategic Highway Safety Plan (SHSP)
- Governor's Priorities

- 2019 Statewide ITS Architecture Update
- Regional ITS Architecture and Deployment Plans (various)
- ITS Strategic Plan*
- Emerging Mobility Solutions Plan (2018)
- Connected and Automated Vehicle Plan*
- Congestion Action Plans*
- Regions' Action Plans*
- Traffic Signal Modernization & Maintenance (TSM&M) Program*
- TennSmart Developments
- Operations TIM Hands-On Training (HOT)
- Highway System Access Manual Development
- Eastern Transportation Coalition Membership
- Regional Interstate Incident Management Plan

- Tennessee Environmental Procedures Manual
- Tennessee Statewide Multimodal Freight Plan
- Interstate Corridor Studies
- State Management Plan for Federal Transit Administration Programs
- Highway Safety Improvement Program (HSIP)
- Comprehensive Multimodal Program
- Emergency Preparedness (TEPP)
- Transportation Asset Management Plan (TAMP)
- Customer-Focused Government Plan
- Statewide Active Transportation Plan

* In-process or future

Figure 9: TSMO Plan Connections

4.2.   TSMO Strategic Leadership at TDOT

As part of building the foundational steps for this Plan, interviews with TDOT senior leadership were conducted, including the Commissioner, two Deputy Commissioners, seven Division Directors and Chiefs, and Regional Leadership. The goals of these interviews were to document leadership's perspective on how TDOT's current Mission, Vision, and Objectives link to TSMO principles, and help gauge the top priorities to include as the TSMO strategies and program moves forward. Paramount for the interviews was to understand the perspective on how TDOT's current philosophy and way of doing business relates to a TSMO direction for Tennessee in advancing operations.

Senior leaders reported that the TSMO term was indeed a familiar concept within TDOT but was not fully understood and increased awareness was needed. The Traffic Operations Division (TOD) is a good steward of the TSMO program and there is wide agency engagement. However, TSMO was generally associated with Intelligent Transportation System (ITS) devices and additional awareness and education would help clarify the broader TSMO strategies and applications beyond ITS. The State legislature was noted as an audience that would benefit from building additional awareness about TDOT's TSMO program objectives. Having **"TSMO Champions"** within TDOT was highlighted as a success factor for advancing TSMO.

It was general consensus while reviewing the interviews that TDOT has made great strides in advancing TSMO awareness in the State. It was noted in many interviews about how TDOT does a good job at getting everyone "**at the table**" for advancing TSMO. There is a large amount of interest in the four Congestion Action Plans currently being developed for Tennessee's four largest metropolitan areas surrounding Memphis, Nashville, Chattanooga, and Knoxville. These efforts may offer opportunities to advance TSMO awareness and integration.

Reinforcement of TDOT's Regional priorities that focus on congestion in urban areas and expanding ITS infrastructure were highlighted. TDOT's continued commitment for improving Incident Management as well as ITS infrastructure in rural regions of the State were also highlighted.

Discussions around future and expanding TSMO strategies included TDOT's use of drone technology to understand traffic flow within work zones; Electric Vehicles (EV) infrastructure needs; and future technologies such as Connected and Automated Vehicles (CAV).

4.2.1. TSMO Coordinating Committee

The TSMO CC, which began as the ITS committee, is responsible for advancing the agency's TSMO mission and vision. Committee members coordinate efforts for utilizing existing and future transportation assets to improve and preserve the safety, efficiency, and reliability of the transportation system. The committee meets quarterly to discuss and ensure the consistency of traffic operations statewide and provide strategic direction to the Region Offices and all functional areas of TDOT that will increase TSMO efforts. In addition to maintaining the TDOT TSMO Program Plan, the committee will oversee the evaluation of TSMO strategies; set priorities and initiatives; and present recommendations to top management. The committee will evaluate ongoing developments to ensure they align with other agency plans and TDOT's overall strategic goals and objectives. In October of 2020, the TSMO CC agreed upon the mission, vision, and goals for TDOT's TSMO program. As of late 2021, the TSMO CC included representation from across TDOT as shown in Table 1. All positions are TDOT except for the one noted from the Federal Highway Administration (FHWA) representation.

Table 1. TSMO Coordinating Committee Membership (2021)

TSMO Coordinating Committee Memberships (2021)	
Chair: TSMO Integration Manager	Director of Roadway Design
Director of Traffic Operations	Director of Occupational Health and Safety
Assistant Chief Engineer of Design	Director of Procurement
Assistant Chief Engineer of Program Delivery	Assistant Chief, Freight & Logistics
Director of Long-Range Planning	Regional Director of Operations (all four Regions)
Director of Strategic Transportation Investments	Director of Program Development and Administration
Director of Multimodal	Director of Strategic Planning
Director of Information Technology	Director of Community Relations
Director of Asset Management	FHWA Tennessee Division, Operations Program

5. Strengths, Challenges, and Needs

The Tennessee Department of Transportation (TDOT) conducted outreach across the Department to collect input on its statewide Transportation Systems Management and Operations (TSMO) strengths, challenges and needs through a variety of forums. These included regular project meetings with a variety of TSMO staff, the TSMO Coordinating Committee (TSMO CC) meetings, senior leadership interviews, and a series of focused Capability Maturity Model (CMM) assessments to identify priority strengths, weaknesses, and actions. **This section summarizes the statewide CMM findings**, which—in concert with the other outreach mentioned—helped inform the statewide focus areas and Headquarters' actions in this Plan.

Note that the Plan's full engagement, including engagement to TDOT Regions to follow-up on the prior 2018/2019 Regional Operations Forums and to develop Region Action Plans, is summarized in Figure 6. It is also captured in a separate Stakeholder Engagement Report. The Region Action Plans to advance TSMO, built on the outputs of these Region outreach efforts, are included in the Appendix of this Plan.

5.1. CMM Assessments

CMM assessments allow transportation agencies to self-assess their TSMO strengths, weaknesses, and capability maturity in relation to the six key dimensions: business processes, systems and technology, performance measurements, agency culture, workforce and training, and collaboration. CMM reassessments allow an agency to gauge progress and update priority actions. TDOT conducted statewide CMM assessments in 2009 and 2014. TDOT later conducted Region-focus CMMs in 2018 and 2019 at Regional Operations Forums (ROF). In early 2021, TDOT conducted a statewide CMM reassessments to identify priority areas for this Plan and identified potential action items. Participants included the TSMO CC and other key stakeholders. The TSMO CC determined that this type of reassessment should be conducted on a three-year cycle to monitor and ensure progress of the TSMO program.

The CMM scores (1–4) are collectively determined by the TDOT staff participating in the assessment. They are measures of maturity of the TSMO program dimensions. Lower scores (1–2) indicate less mature (or more ad-hoc) activities in that dimension. Higher scores (3–4) indicate more mature, institutionalized programs in that dimension. The scores are subjective and driven by the agency participants. The primary purpose is to help participants identify action items appropriate for the given level of maturity and to help identify which dimensions the agency should focus improvements on. The results of TDOT's CMM assessments over time are shown in Table 2.

Table 2: TDOT Capability Self-Assessment

	TDOT Statewide CMM Assessments		
Dimension	**2009**	**2014**	**2021**
Business Processes	1.0	1.5	2.0
Systems and Technology	2.0	2.0	2.3
Performance Measurement	2.0	2.0	1.5
Agency Culture	Not scored	2.5	2.0
Organization and Staffing	1.0	3.0	1.9
Collaboration	2.0	1.5	1.9

Over time the numerical CMM scores that assess TSMO programs have shown to decrease in maturity score while agencies actually increase in capability maturity. This phenomenon is attributed to agency staff better understanding TSMO and opportunities for advancement during CMM "reassessments" than during original CMM assessments. This highlights the subjectivity of the scores and their use as a tool to focus discussions. They are meant to help agencies determine where they should focus their efforts (lowest dimension) and what actions are appropriate for incremental advancement to the next level. Scores may also be influenced by recent events that have focused participants on a particular challenge. For instance, a major weather event that highlighted a need for greater collaboration of stakeholders occurring right before a CMM workshop might influence the scoring on that dimension that otherwise may not have happened. Generally, determining the level of maturity score by dimension identifies the dimension that should be focused on and potential first steps to advance overall program maturity.

5.1.1. Strengths and Weaknesses Identified

The key TSMO strengths and weaknesses that emerged from the 2021 CMM are summarized below. The CMM revealed that TDOT has a large number of both strengths and weaknesses in the Performance Measurement dimension. Performance measurement was also the lowest ranked CMM dimension, given a score of 1.5 (see Table 2). This indicates that performance measurement presents the greatest opportunity for significant advancement—leveraging current strengths and activities to address weaknesses and needs. This Plan takes a deeper dive into existing conditions and actions to advance performance measurement in the Performance Measurement section.

Note that at the time of publication, TDOT is evaluating some organizational improvements (known internally as EPIC) and is updating its Integrated Project Delivery (IPD) processes for project development. These updates, when finalized, may change the context since the CMM assessments were conducted for this Plan.

Performance Measurement Strengths
TDOT Data Sources, INRIX, and RITIS Datasets—In May 2020, TDOT procured comprehensive INRIX and RITIS datasets, including historical data dating back to May of 2017.[2] INRIX provides probe data and RITIS augments this with an analytics platform. This type of probe data has proven helpful in providing the department with insight on traffic conditions, especially in areas where existing Intelligent Transportation System (ITS) assets may not provide coverage. TDOT has partnered with The University

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[2]   TDOT, Probe Data Information, available at: https://www.tn.gov/content/dam/tn/tdot/traffic-engineering/Probe%20Data%20Information.pdf.

of Tennessee Knoxville (UTK) for special reporting needs using this data as well as existing data sets generated from agency owned Radar Detection Systems (RDS) infrastructure. The availability of INRIX data facilitates advanced analysis of real-time data and conditions. TDOT is making INRIX and RITIS data available to partner agencies, including training. TDOT is joining a growing list of State DOTs that are investing in probe data for real-time traffic management and operations.

Traffic Incident Management (TIM) Performance Measures (PM) Reporting—The quarterly, public-facing SmartWay reports[3] provide comprehensive incident management performance measures. Enabled by TDOT's robust Transportation Management Center (TMC) coverage throughout the State, HELP freeway service patrol, and partnership with Tennessee Highway Patrol, the department's reporting process was considered a strength. The National Cooperative Highway Research Program (NCHRP) 07-20 project, Guidance for Implementation of TIM Performance Measurement, concluded in 2014 and included TDOT's SmartWay reporting process as one of the agency case studies that highlighted peer practices and strategies[4].

Federal Highway Administration (FHWA) Performance Reporting—TDOT identifies their process for reporting department performance measures to FHWA as a strength. This includes the three categories of performance measures: Safety (PM1), Pavement and Bridge Condition (PM2), and System Condition (PM3). TDOT has a streamlined process for analyzing and reporting safety data to FHWA[5]. The department also has a Performance Measurement Working group, which can be a valuable resource in helping advance the maturity of this dimension. Regarding future target setting, the department also determined the current process as a strength. TDOT forms working groups with local Metropolitan Planning Organizations (MPO) and Transportation Planning Organizations (TPO) to present and discuss current targets and set realistic targets for the future.

Performance Measurement Weaknesses
Performance Target Setting—TDOT follows FHWA's PM3 target setting timeframes and direction for using data-driven approaches[6], which are publicly posted. TDOT also sets internal annual targets for measures related to TSMO, for example Level of Travel Time Reliability (LOTTR), in the Customer-Focused Government plan. These current practices present benefits and challenges for TSMO—in that many TSMO measures are included already, but at the same time limited by processes not designed specifically for TSMO and having varying degrees of accessibility. These targets are also considered projections, as opposed to aspirational targets set by the department, which could inform the Department of Transportation's (DOT) project selection process. TDOT could improve its approach to determining the impact of each individual roadway project on the performance measures, which may ultimately help the department understand the causal factors behind changes in performance measures. While TDOT's INRIX data and partnership with UTK on special reporting is considered a strength, there is a need to develop a more formalized, automated method of reporting and target setting.

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[3]   TDOT SmartWay Reports, https://www.tn.gov/tdot/intelligent-transportation-systems/smartway-reports.html
[4]   NCHRP 07-20 project, Guidance for Implementation of TIM Performance Measurement, http://nchrptimpm.timnetwork.org/.
[5]   TDOT Transportation Performance Management, https://www.tn.gov/tdot/strategic-planning-home/transportation-performance-management.html
[6]   TDOT State Performance Dashboard, https://www.fhwa.dot.gov/tpm/reporting/state/state.cfm?state=Tennessee

TIM Performance Measure Definitions—Other weaknesses identified involved the need to define standard definitions for TIM performance measures. For example, the CMM revealed that staff working on TIM use their own discretion and best judgment in measuring Incident Clearance Time (ICT) in absence of a standard definition. This may result in minor variations, as staff may begin and end "counting" at different moments in time. TDOT employs the standard FHWA definitions for Roadway Clearance Times (RCT) and ICT, but there are issues with the consistency in recording the information across the four Regions. Raising awareness of this issue can improve data quality and reporting. Staff resources and software updates have also created intermittent gaps in reporting.

Staffing Resources—Various challenges were identified in terms of the staffing resources that TDOT commits to performance measurement. The department does not have a division focused solely on performance measurement, analysis, and reporting. Without personnel committed to performance measurement, TDOT is not maximizing the potential impacts of performance measurement and reporting. Aside from being short-staffed on performance measurement staff, there is a lack of collaboration between Headquarters and each of the Regions when setting system performance measures. Coordination between divisions, including Traffic Operations, Strategic Transportation Investments, Strategic Planning and Long Range Planning should also be improved.

Data Silos—TDOT's operations data, which could be used for more efficient performance measurement and target setting, is located across different areas of the department. Traffic Operations owns most of the data that is used. However, other data, such as Annual Average Daily Traffic (AADT) counts, are in a separate dataset with the Long-Range Planning division.

Tennessee has met its Strategic Highway Safety Plan (SHSP) objective of integrating all written crash records into its statewide database "Tennessee Integrated Traffic Analysis Network (TITAN)."[7] TITAN is a suite of tools developed for the electronic collection, submission, and management of all traffic safety related data in Tennessee. It consists of a centralized data and document repository for public safety information managed by the Department of Safety and Homeland Security. The SHSP has integrated target measures for safety performance and established the capability to receive all crash reports in Tennessee electronically.

TDOT collects a significant amount of safety related data that is needed by commercial entities who provide in-vehicle Global Positioning Systems (GPS) messaging to drivers (vehicles and motor carriers). These data can be used to help improve overall highway safety and reduce crashes. The type of data includes a wide range of items such low-clearance bridges, weight posted bridges, high truck rollover locations, speed limits, special lane control (such as high-occupancy vehicle [HOV] lanes or truck restricted lanes), along with a range of warning locations (such as sharp curves and steep grades). The Department would like to move forward with a data portal to make access to this useful data available to others outside the agency.

The organization structure does not always promote collaboration or sharing between department divisions. At the same time, large amounts of data are collected, which are not always used or assessed, due to the lack of a formal process for its utilization.

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[7]   https://www.tn.gov/content/dam/tn/tdot/strategic/SHSP-2020.pdf.

On the topic of data management, TDOT's lack of a data governance plan was defined as a weakness. The Information Technology (IT) division is currently championing the development of a plan, but the effort will require coordination with various TDOT divisions to be successful.

Communication with the Public—TDOT determined that the department could enhance the methods in which information is disseminated to the public. An effective approach would involve various methods, where effectiveness is closely measured. This area is discussed further in the Traveler Information actions under Services and Projects in this Plan.

6. Institutional, Organizational, and Procedural Strategies

The second Strategic Highway Research Program (SHRP 2, 2006–2015) established that the agency's strength in foundational, institutional, capabilities is critical to an effective Transportation Systems Management and Operations (TSMO) program.[8] These core capabilities shaped the focus of the ensuing TSMO Capability Maturity Model (CMM) assessments, which were designed to help agencies assess their strengths and weaknesses in these areas. As the importance of these capabilities to TSMO became increasingly evident, Federal Highway Administration (FHWA) developed a guide on advancing them, using the descriptor of **"Institutional, Organizational, and Procedural" (IOP)** changes to describe these capabilities more fully.[9]

These IOP capabilities are the focus of this section, which builds on Tennessee Department of Transportation's (TDOT) current capabilities to outline strategies and actions for advancing TDOT's IOP capabilities and TSMO program as a whole. Based on TDOT's CMM assessments, leadership interviews, and Regional Operations Forums, the critical IOP capabilities that this Plan will focus on are as follows:

- Leadership, Organization, and Staffing.

- Business Processes and Planning.

- Resource Positioning and Development.

- Performance Measurement.[10]

6.1.1. Advancing IOP Capabilities at TDOT

The following sections provide background for each area of the IOP capabilities at TDOT, and detail appropriate actions to advance these capabilities. Table 3 is a high-level summary of the actions that align to advancing the goals of the TSMO program, with greater detail following the table.

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[8] Transportation Research Board, SHRP2 webpage, accessed July 19, 2021, http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Blank2.aspx.

[9] FHWA, "Advancing TSMO: Making the Business Case for Institutional, Organizational, and Procedural Changes for TSMO," 2018, https://rosap.ntl.bts.gov/view/dot/43562.

[10] Note that, while performance measurement is a foundational IOP capability, this plan is dedicating an entire separate chapter to performance measurement. During the department-wide outreach and assessments, performance measurement stood out as an area with both a lot of existing activities as well as a number of action items and needs for improvement. Therefore, it will be covered independently as an emphasis area, but with the understanding that it relates to and supports the broader program and a core IOP capability.

Table 3: TDOT IOP Action Items

Action	Stakeholders Involved	Timeframe[1]
People-1: Continue Advancing TSMO Awareness and Education.	• All TDOT staff. • Focus on TDOT areas outside of TSMO core. • TDOT partners.	Short-term, ongoing
People-2: Strengthen and Formalize Collaboration.	• TDOT Headquarters. • TDOT Regions. • Local agencies. • First responders.	Short-term
Processes-1: Integrate TSMO into Planning and Programming.	• TDOT Planning staff. • TDOT staff involved in project identification, prioritization, and development.	Medium-term
Resources-1: Identify TSMO Resource Needs.	• TDOT program managers and senior leaders.	Short-term

[1] Short-term: 1–2 years; Medium-term: 2–5 years; Long-term: Over 5 years.

6.2.   Leadership, Organization, and Staffing

This section covers the most critical IOP area for a successful TSMO program—***the people!*** —as well as the structures that facilitate staff and partners to advance agency TSMO goals—leadership and organization. All three aspects need to support TDOT's specific TSMO goals for an effective program.

6.2.1.   Leadership

As part of this Plan's development, leadership provided their perspective on how TDOT's current Mission, Vision, and Objectives link to TSMO principles, and provided their inputs on how various TSMO strategies could move forward. Leadership input generally focused on the institutionalization of the TSMO program through advancements in TDOT's IOP capabilities to support TSMO. For example, this would include better integrating TSMO into project funding and development processes or establishing training opportunities tailored to TSMO. In general, leadership expressed strong support for TSMO and highlighted several areas where TSMO can support and advance TDOT's goals and existing work (e.g., smart corridor programs, freight management). Leadership support has been widely cited as critical to TSMO advancement and associated performance improvements—and indicates that TDOT is well positioned to continue advancing its TSMO program. Leadership provided specific recommendations for actions to advance TSMO, which have been incorporated into this Plan.

6.2.2.   Organization

The Traffic Operations Division has led TDOT's TSMO program in collaboration with partners throughout the department. To-date, peer agency approaches to TSMO organization across the country fall on a spectrum from "reorganization to dedicate a TSMO division" to "TSMO is owned by everyone in the current structure" with many approaches in between. The right approach depends on the agency's context and culture, its TSMO goals, and how well its existing organization works for TSMO.

Feedback from leadership and staff indicates that TDOT's current organizational approach to TSMO is working and is the preferred direction for the agency to continue. TDOT's approach may be described as

TSMO is owned by everyone with Traffic Operations as the steward. This hybrid approach encourages active collaboration and input from all staff, while designating extra ownership with the Traffic Operations Division for monitoring and to ensure the program remains a priority. It should be noted that TDOT is in the process of an organizational realignment titled "Empowering People and Influencing Culture" (EPIC). EPIC may change the business unit responsible for monitoring and ensuring TSMO remains a priority while elevating the department's TSMO-focus.

The primary actions regarding TSMO organization at TDOT are to continue working to increase TSMO awareness, collaboration, and ownership beyond the Traffic Operations Division. Increased collaboration with partners was also highlighted (Metropolitan Planning Organizations [MPO], Transportation Planning Organizations [TPO], local agencies, transit agencies, etc.). This is an area that will also be supported by greater TSMO awareness and participation across the agencies, by ensuring that the TDOT staff interfacing with these partners can bring TSMO into the dialogue.

6.2.3. Staffing

Roles and Responsibilities

Documenting roles and responsibilities related to the organizational structure is important to successfully and efficiently implementing TSMO strategies. As detailed above, leadership and staff recommended the Traffic Operations Division (TOD) serve as the steward of the TSMO program while facilitating and increasing participation throughout TDOT. Along these lines, staff recommended that having "**TSMO Champions**" throughout the department would spur greater collaboration across TDOT. The outreach also highlighted the need to clarify and expand the role of the TSMO Coordinating Committee (TSMO CC) as a body for TSMO program direction.

This Plan begins to outline roles and responsibilities for specific actions, while intentionally leaving space for TDOT staff to determine the best ownership as they advance these actions. For every action in this Plan, a discussion of stakeholders involved and timeline is included. For the most part, these discussions identify key offices and roles within TDOT and its partners (specific individuals are not included). This is a jumping-off point for detailing roles and responsibilities for each action. In addition, the Region Action Plans in the Appendix have a dedicated space for ownership. However, these plans are designed as living documents to support advancement and such details are not always firm but, again, the plans are a starting point.

Workforce Development

Outreach indicated that TDOT is generally in a good place with their workforce. Retirement-driven turnover is a smaller concern for TDOT compared to other DOTs nationally. Retirement rates for TDOT may have already peaked in the mid-2010s. Conversely, this also means that TDOT recently may have lost some institutional knowledge from experienced employees, and that a relatively larger portion of TDOT staff is new in tenure to the Department. Nonetheless, outreach indicated that TDOT staff were generally satisfied with their workforce capabilities and trajectory.

Still, the TDOT workforce is of course subject to larger economic trends and uncertainties, such as the ongoing economic and labor impacts of the pandemic, so continuous workforce development remains important. Outreach highlighted the need for strategic hiring of staff with new skillsets related to emerging technologies (Artificial Intelligence [AI], Machine Learning, etc.) as crucial to advancing TSMO. The National Cooperative Highway Research Program (NCHRP) released a guidebook in 2018 (updated

2019) on TSMO workforce development (NCHRP 20-07 Task 408).[11] Among other guidance on TSMO workforce development, NCHRP 20-07 provides model job descriptions (Appendix D) for several TSMO positions at transportation agencies, for which agencies may not traditionally hire. These include several emerging technology positions that TDOT may be able to apply in recruiting such capabilities, including Connected and Automated Vehicle (CAV) Program Manager, AI Specialist, and several TSMO data related positions.

TDOT, like many other agencies, also faces challenges in recruiting, hiring, and retaining staff for the Transportation Management Center (TMC) and HELP programs. Here, a National Operations Center of Excellence (NOCoE) 2019 study provides valuable insights. The study, "TSMO Paraprofessional Workforce Development," introduces the term "paraprofessional" which speaks to the importance of roles within an agency that directly support and are critical to TSMO, but generally work under supervision by a licensed professional in the engineering field.[12] The study discusses the need to elevate, develop, and retain these roles within DOTs. It recommends a comprehensive evaluation of these positions within an agency, including their critical roles, available training programs, recruitment sources (college and university programs), and career trajectories and retention strategies.

6.2.4. Action People-1: Continue Advancing TSMO Awareness and Education

This action will continue the advancement of TSMO awareness and education at TDOT and with its partners.

Background

TDOT has built a strong foundation of TSMO knowledge and awareness. However, in a field like TSMO that is evolving on several fronts (technology, best practices, etc.), continuing education is key to success and to being prepared for tomorrow's challenges. In addition, efforts to increase TSMO knowledge across the department in units beyond the core TSMO activities will help further improve agency-wide coordination, efficiency, and performance.

Stakeholders Involved and Timeline

TSMO awareness and education is important for all TDOT employees and partners. A greater focus on staff and partners further removed from core TSMO activities may be warranted at this point in TDOT's TSMO advancement. However, continuing education for all employees is essential.

Roadmap to Advance (Incremental Steps)

- Develop a toolbox of resources to expand awareness and applications of TSMO strategies and solutions.

- Investigate opportunities for TSMO trainings for existing and new staff across the department, and leverage TDOT's Learning Network.

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[11] NCHRP, 20-07 Task 408 Transportation Systems Management and Operations (TSMO) Workforce Guidebook, Original November 2018 updated March 2019, accessed at: Transportation Systems Management and Operations (TSMO) Workforce Guidebook (transportationops.org).

[12] NOCoE, "TSMO Paraprofessional Workforce Development," 2019.

- Introduce TSMO guidance to help broader agency staff see their TSMO role (their "connection"). Expand TSMO expertise in each Division, not just Traffic Operations.

- Encourage an open mindset throughout the agency to look for opportunities to advance TSMO (a TSMO mindset) through key TDOT processes such as planning, project identification, prioritization, and development.

- Increase awareness of the TSMO program and objectives among the Tennessee State Legislature. For example, create a video or other materials for TDOT senior leaders to share with the Legislators.

- Explore recruitment strategies for emerging skill needs such as CAV-related skills and AI (see referenced NCHRP study).

- Evaluate roles, recruitment, retention, and career trajectories for TSMO paraprofessionals (see referenced NOCoE white paper).

6.2.5. Action People-2: Strengthen and Formalize Collaboration

This action will strengthen and formalize both internal and external collaboration on TSMO issues.

Background

Strong coordination with internal and external partners underpins the success of almost all TSMO strategies. Here, TDOT again has a good foundation and will want to strategically direct staff resources and time and continue building these partnerships. Key relationships for this stage include Regions and local partners. Expanding and clarifying the role of the established TDOT Coordinating Committee as a leader for agency TSMO coordination will help bolster and track these efforts.

Stakeholders Involved and Timeline

Stakeholders include staff who will be the key points of contact for these relationships within Headquarters, Regions, and local agencies. Points of contact will often be managers of operations activities but may also include planning leads at MPOs/TPOs, first responders, and more.

Roadmap to Advance (Incremental Steps)

- Increase and formalize collaboration between TDOT Regions, and between Headquarters and individual Regions necessary to further mainstream TSMO within TDOT. Place emphasis on having everybody "at the table" for advancing TSMO.

- Collaborate with partners (MPOs, TPOs, local agencies, transit agencies, etc.) to maximize the benefits of TSMO (e.g., inviting partners to relevant recurring meetings, and attending partner meetings). A focus on collaboration will encourage integrated approaches and prevent fragmentation.

- Document and formalize collaboration processes to help share processes with new staff, and to use as a basis for any needed improvements/adaptations.

- Expand and clarify the role of the TSMO Coordinating Committee. Track running "action lists" to encourage engagement from the committee.

6.3. *Business Processes and Planning*

Integrating TSMO considerations into existing institutional processes is key to improving overall system safety, reliability and efficiency while controlling costs. Ensuring that TSMO is considered early in project planning and development is one of the most critical activities in this area. Often this requires agencies to assess and revise the project development process to include early identification of TSMO applications and solutions in each stage of the project, from conceptualizing to planning through construction. Figure 10 demonstrates the cost of proactively versus reactively planning for operations in project development.
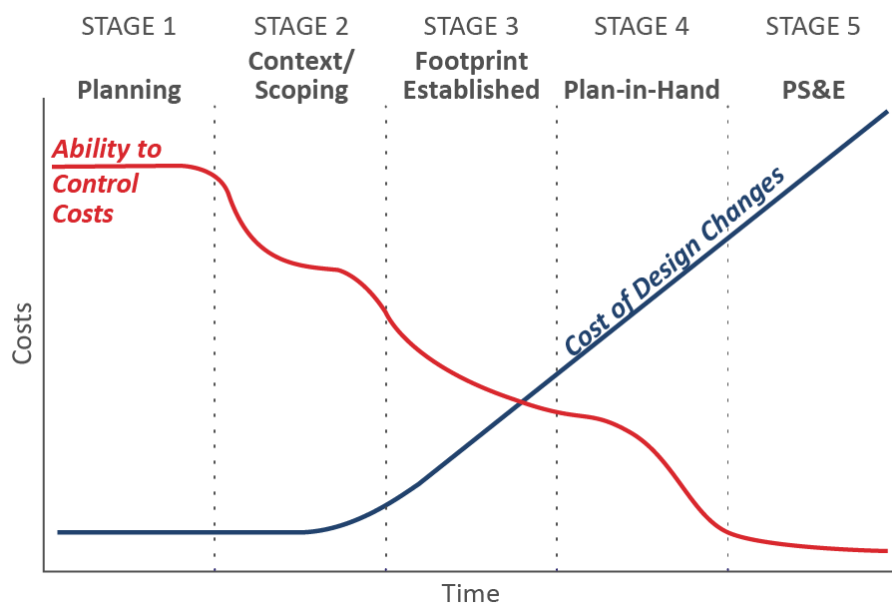
Figure 10: Cost of Proactively Versus Retroactively Planning for Operations

6.3.1. Project Delivery Network

At the time of this Plan, TDOT is in the process of developing updated Project Delivery Network (PDN) Guidance, with the update currently in draft format. The Traffic Operations Division (TOD) is working to incorporate specific steps where TSMO considerations need to occur in the PDN guidance document. By implementing these steps TSMO will become institutionalized in the project development process. Upon finalization of the PDN, TDOT may want to evaluate this Plan for any needed updates to best align the two.

TDOT's Project Delivery Network is organized into a Planning stage followed by Stages 1–4:

- Planning.

- Stage 1: Context/Scoping.

- Stage 2: Footprint Established.

- Stage 3: Plan-in-Hand.

- Stage 4: Plans, Specifications and Estimates (PS&E).

Each stage is broken into specific tasks that are coded to TDOT disciplines. The TOD currently has two defined tasks in the Planning stage and one each in Stages 2–4. The current definition of these tasks is largely focused on Intelligent Transportation Systems (ITS), signals, and lighting. The TOD is advancing recommendations to integrate broader TSMO considerations into these tasks as follows. Bringing TSMO and a broader operations perspective into this process, especially in the early stages, will help TDOT more efficiently plan for and allocate resources that can meet multiple department-wide goals, and help avoid the need to retrofit projects when needs come up later. As an example of a broader TSMO perspective, integrating TSMO would aim to include an assessment of ITS, signal, lighting, access management, and pavement marking needs for bicyclists and pedestrians, in coordination with Multimodal Planning's review during the Planning Stage.

A summary of how TSMO plans to integrate with the relevant Project Delivery Network stages is shown below.

- **Planning stage: Conduct Initial Traffic Operations and TSMO Review.**

  - Conduct TSMO Alignment and Operations Review. This is meant to encourage an early assessment of the operations needs of a project so that scopes, schedules, and budgets are aligned. This includes a cross discipline team from TDOT and local maintaining agencies.

- **Planning stage: Develop Scope and Warrants—Define TSMO Scope Items.**

  - Define TSMO scope items and assess TSMO warrant needs (in parallel with existing Traffic Operations task to Develop Scope and Warrants for ITS, signals, lighting, access management, pavement markings, etc.). This includes preparing a TSMO budget and coordinating with other TDOT efforts such as statewide safety plans, freight plans, etc. to identify opportunities to add TSMO elements to support these collaborative efforts.

- **Stage 2—Footprint Established: Prepare ITS, Signals, Pavement Marking, and Lighting Sheets.**

- **Stage 3—Plan-in-Hand: Complete Signal, Lighting, Pavement Marking, and ITS Device Design.**

- **Stage 4—PS&E: Finalize Signal, Lighting, Pavement Marking, and ITS Construction Documents.**

6.3.2.   Action Processes-1: Integrate TSMO into Planning and Programming

This action will integrate TSMO into key TDOT planning and programming processes.

Background

To advance the maturity of TSMO activities from ad-hoc (e.g., CMM Level 1: Performed) to higher maturity levels (CMM levels 2–4: Managed, Integrated, and Optimized), it is essential to begin the process of formally integrating TSMO into key planning and programming processes. This will allow TDOT to leverage the benefits and cost-effectiveness of TSMO to achieve agency goals and performance targets in a proactive and coordinated manner.

Stakeholders Involved

Key stakeholders include TDOT planning staff and staff who manage and participate in the PDN process and other project identification, prioritization, and development efforts.

Roadmap to Advance (incremental Steps)

- Investigate and develop processes that would include early identification of TSMO strategies and applications prior to planning stages of projects.

- Continue work to incorporate TSMO in the PDN process.

- Increase TSMO awareness among planning and project development staff and offices (i.e., TSMO checklist to include TSMO strategies earlier in the process).

- Institutionalize the connection between ITS Strategic Planning and the TSMO Program.

- Assess prioritization processes and tools to ensure measures to appropriately rate TSMO in relation to traditional projects—and suggest revisions to balance out if not.

- Explore funding opportunities and processes for TSMO within TDOT, evaluate opportunities to integrate TSMO. This would be led by TOD staff once TDOT has completed its in-progress organizational realignment titled "Empowering People and Influencing Culture" (EPIC) and updated Integrated Project Delivery (IPD) efforts.

6.4. Resource Positioning and Development

Defining the technical and financial resources available and required to support TSMO strategies is necessary in accomplishing the TSMO Plan goals. Exploring available resources and documenting the specific needs of TSMO strategies, services, and projects is the first step to matching resources to goals. The TSMO program could further advance by identifying other opportunities for sustainable funding, for example looking to federalize more programmatic portions as TDOT currently does with Transportation Management Center (TMC) Operations, HELP (Safety Service Patrol) Operations, and ITS Maintenance. There are opportunities to expand TSMO programs to more formal funding sources. For example, the Traffic Signal Modernization & Maintenance (TSM&M) Program, discussed in the Arterial Traffic Signal Management section, would be an excellent candidate for more formal funding streams.

6.4.1. Action Resources-1: Identify TSMO Resource Needs

This action will identify TSMO resource needs and potential sources of funding and other resources.

Background

Securing resources is an essential but often harder aspect of advancing any program or goal. Since TSMO strategies tend to be relatively low cost, quick to implement, and have high benefit/cost ratios, they generally receive ad-hoc, unplanned funding that becomes available. However, securing some level of reliable, dedicated annual funding is immensely helpful to improving the effectiveness of TSMO programs and overall transportation system performance. It allows the agency to more strategically plan for TSMO deployments that meet critical needs. The first step is identifying resources needed to meet current TSMO program goals as well as potential sources of funding and resources for TSMO.

Stakeholders Involved

This action will involve senior TDOT leaders, program managers, and staff responsible for resource allocation. TDOT's TSMO Champions will also be involved to advocate for the relative benefits and costs of TSMO and present the business case for these recommendations.

Roadmap to Success (Incremental Steps)

- Explore and document opportunities for TSMO funding, including Federal grant funding.

- Identify available and needed resources to promote and support the TSMO Plan.

- Develop a plan or strategy for pursuing funding/resource opportunities to meet the identified resource needs.

7. Performance Measurement

During the Capability Maturity Model (CMM) self-assessments, Tennessee Department of Transportation (TDOT) staff identified performance measurement as an area advancing many current activities, but with room for improvement. For this reason, and because the right performance measurement approach is critical to advancing Transportation Systems Management and Operations (TSMO), this Plan takes a deeper dive into performance measurement at TDOT.

7.1.   Existing Conditions

TDOT currently tracks performance related to TSMO through programs that reflects the broad scope of TSMO. The key programs here are:

- TDOT Performance Measurement Framework.

- Federal Highway Administration (FHWA) Transportation Performance Measurement (TPM) Program, with additional reporting in:

  - TDOT's Highway Safety Improvement Program (HSIP).

  - Tennessee's Strategic Highway Safety Plan (SHSP).

  - TDOT's Transportation Asset Management Plan (TAMP).

  - Plans from Metropolitan Planning Organizations (MPO) and Transportation Planning Organizations (TPO).

- Customer-Focused Government Plan.

- SmartWay Reports.

- Daily Traffic Reports and Intelligent Transportation Systems (ITS) Health Reporting from the Traffic Operations Division (TOD).

- Special Reporting.

- Long Range Transportation Plan *(future updates of the Plan will include TSMO-related performance measures).*

These programs, and the performance measures they track, are summarized below.

7.1.1.   TDOT Performance Measurement Framework

The TDOT Performance Measurement Framework includes five key performance categories, as shown in Figure 11, to enable a balanced assessment of organizational performance and guide performance

measurement across the agency.[13] TDOT's Strategic Planning Office manages TDOT's Performance Measurement Framework.
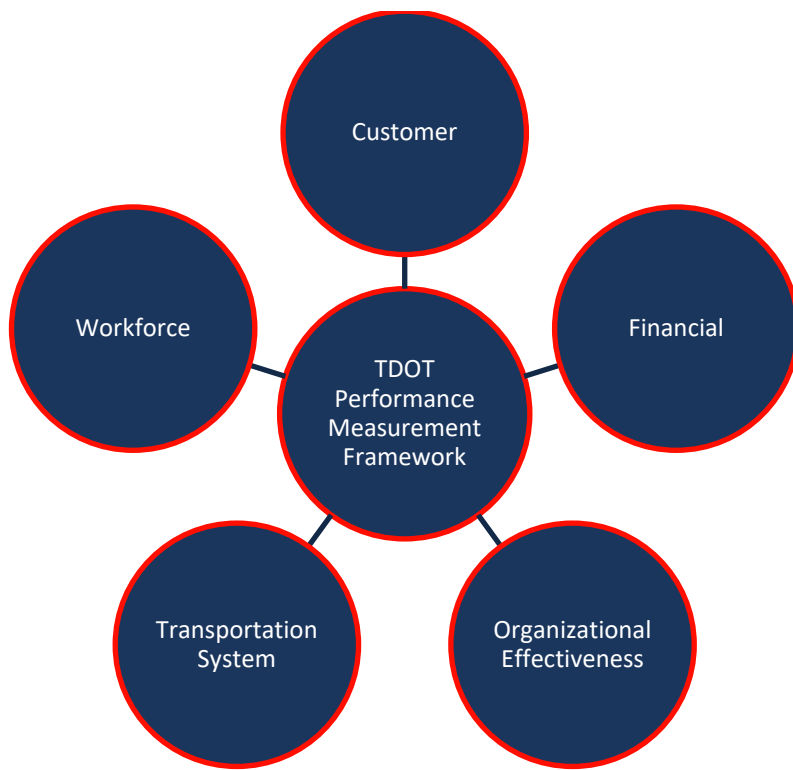
Figure 11: TDOT Performance Measurement Framework—Performance Categories

7.1.2. FHWA Transportation Performance Management

There are three groups of performance measures required by FHWA's TPM program, of which PM3 is most closely associated with TSMO strategies and applications. They are:

- PM1—Safety.

- PM2—Pavement and Bridge Condition.

- PM3—System Condition.

Figure 12 illustrates the FHWA's TPM dashboard for TDOT.[14]

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[13] TDOT Performance Measurement and Analysis, available at: https://www.tn.gov/tdot/strategic-planning-home/strategic-planning-performance-measurement-and-analysis.html.

[14] FHWA's TPM dashboard for TDOT, available at: https://www.fhwa.dot.gov/tpm/reporting/state/state.cfm?state=Tennessee.

State Performance Dashboard - Tennessee

Highway Safety

1,005.4

Number of Fatalities
Five-year average

Learn more about Highway Safety

Highway Infrastructure Condition

39.5%

Bridges in Good Condition
National Highway System

Learn more about Highway Infrastructure Condition

Highway Reliability

1.35

Truck Travel Time Reliability Index
Interstate Highways

Learn more about Highway Reliability

Emissions Reductions

363.399

NOx Emissions (kg/day) Reduced
through CMAQ projects, 4-yr cumulative

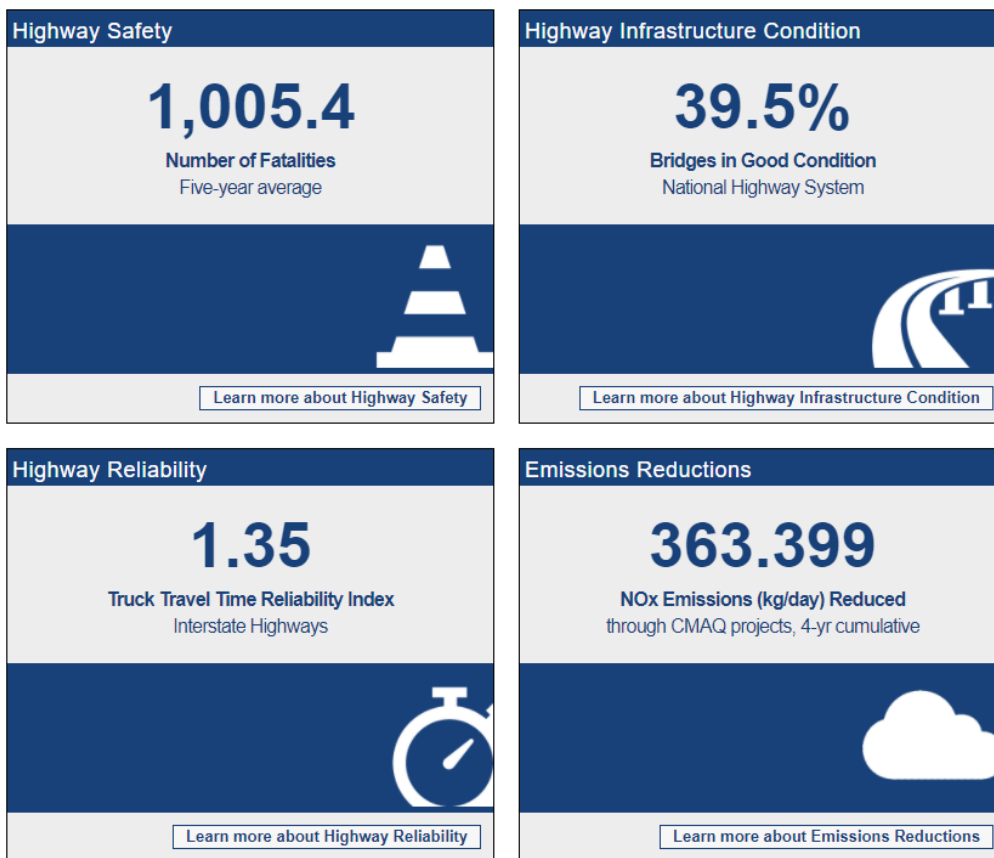Learn more about Emissions Reductions

Figure 12: State Performance Dashboard—Tennessee

(Source: FHWA TPM, State Performance Dashboard—Tennessee)

Additional performance measures are collected by TDOT for each category in FHWA's TPM program as detailed below. The Bridge and Pavement Condition PM2 targets are specifically stated in TDOT's TAMP, which is managed by the Asset Management Division.

Performance Measure 1 (PM1)—Safety

- Number of fatalities (5-year rolling average).

- Rate of fatalities per 100 million Vehicle Miles Traveled (5-year annual average).

- Number of serious injuries (5-year annual average).

- Rate of serious injuries per 100 million Vehicle Miles Traveled (5-year annual average).

- Number of Nonmotorized Fatalities and Nonmotorized Serious Injuries (5-year annual average).

Performance Measure 2 (PM2)—Pavement and Bridge Condition

- Percentage of National Highway System (NHS) Bridges by Deck Area in Good Condition.

- Percentage of NHS Bridges by Deck Area in Poor Condition.

- Percentage of Interstate Pavements in Good Condition.

- Percentage of Interstate Pavements in Poor Condition.

- Percentage of Non-Interstate NHS Pavements in Good Condition.

- Percentage of Non-Interstate NHS Pavements in Poor Condition.

Performance Measure 3 (PM3)—System Condition

- Percent of Person-Miles Traveled on the Interstate that are Reliable.

- Percent of Person-Miles Traveled on the Non-Interstate NHS that are Reliable.

- Truck Travel Time Reliability Index.

- Annual Hours of Peak Hour Excessive Delay per Capita (specific to Memphis and Knoxville starting in 2022).

- Percent of Non-Single Occupancy Vehicle Travel (specific to Memphis and Knoxville starting in 2022).

- Total Emissions Reduction (specific to Knoxville and Memphis).

7.1.3. Customer-Focused Government Plan

TDOT's Customer-Focused Government (CFG) Plan includes reporting on the agency's key operational goals and associated Key Performance Indicators (KPI). The KPIs are reported on annual or quarterly basis and include performance measures such as percentage of Interstate Highway reliable person-miles traveled and average roadway clearance time, among others.

7.1.4. SmartWay Reports

TDOT's four Traffic Management Centers (Nashville, Knoxville, Chattanooga, and Memphis) use SmartWay reporting to collect and report Traffic Incident Management (TIM) activity. Through the database and other tracking, each region publishes a quarterly report on incident management performance measures. These reports are published on TDOT's SmartWay Reports page, both for each region and statewide.[15]

Figure 13 below, from the 2020 Statewide, 3rd Quarter report, displays the "Lane Blockage Clearance Times Overall" TIM performance measure.[16] These reports also include:

- Incident managed year-to-date.

- Incidents by detection source.

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[15] TDOT SmartWay Reports, available at: https://www.tn.gov/tdot/intelligent-transportation-systems/smartway-reports.html.

[16] TDOT 2020 Statewide, 3rd Quarter Report, available at: https://www.tn.gov/content/dam/tn/tdot/intelligent-transportation-systems/2020-3rd-quarter-reports/Statewide%202020%203rd%20Quarter%20Report.pdf.

- Total roadway incidents.

- Lane blockage clearance times—overall, urban, and rural.

- HELP services provided.

- Dynamic Message Sign (DMS) usage.

- Events affecting traffic this quarter.

- Travel lane blockage events.

Lane Blockage Clearance Times Overall
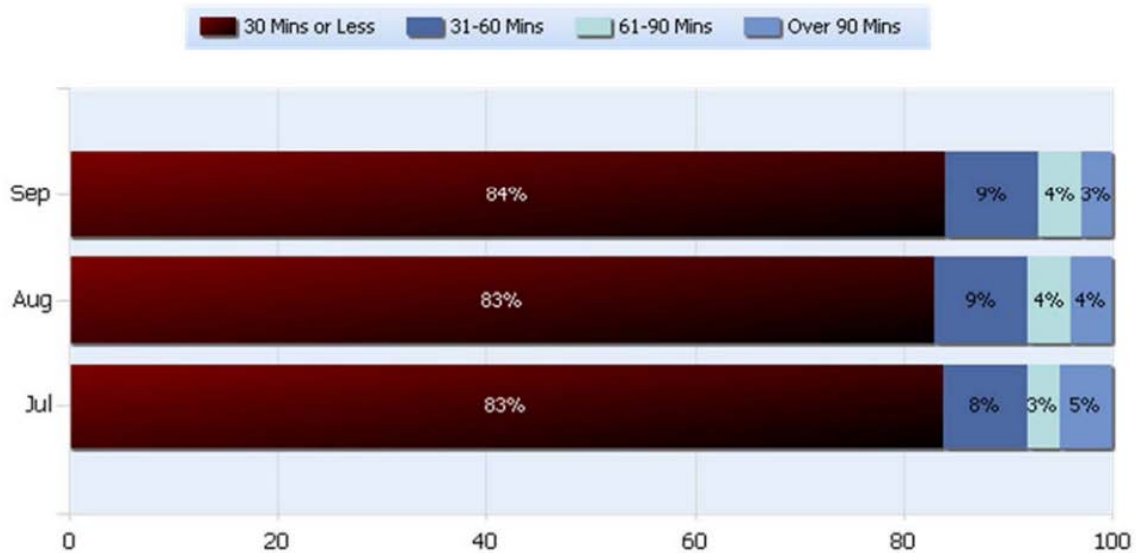
Figure 13: Lane Blockage Clearance Times Overall

(Source: TDOT SmartWay Reports, Statewide: 2020, 3rd Quarter)

TIM performance data has allowed TDOT to expand its relationships with urban areas and partner agencies. Having detailed data also helped TDOT justify the TIM program to decision-makers, as well as funding and expansion of the HELP program. Secondary crash data has helped TDOT support the effectiveness of the department's Protect the Queue campaign.[17]

7.1.5. Daily Traffic Reports and ITS Health Reporting

The TOD provides weekly traffic reports to provide a snapshot of the daily health of the ITS system. This helps in fulfilling TDOT's ITS maintenance contracts, since there are performance elements integrated

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[17] TDOT Protect the Queue campaign, available at: https://www.tn.gov/tdot/traffic-operations-division/transportation-management-office/protect-the-queue.html.

into these contracts. Data is pulled directly from the State's ITS infrastructure and is intended to provide a picture of conditions across Tennessee's four metro areas. Reports are not publicly available.

7.1.6. Special Reporting Support: UTK

TDOT's TOD also collaborates with University of Tennessee Knoxville's (UTK) Department of Civil and Environmental Engineering for special reporting activities. In the past, these have encompassed specific projects or events, to gain a deeper understanding of their impacts on Tennessee's transportation system. With access to TDOT's INRIX datasets as well as existing data sets generated from agency owned Radar Detection Systems (RDS) infrastructure, UTK can conduct comprehensive analyses on traffic conditions, including delay costs, buffer time indexes, and travel time reliability. TDOT has recently leveraged this partnership for evaluating the effects of the COVID-19 recovery on the transportation network.

7.2. Opportunities to Advance

The 2021 CMM self-assessment process identified four key actions to advance Performance Measurement of the TSMO program. This section will discuss each of these, along with a roadmap for advancement. Table 4 summarizes each action item, including the stakeholders involved and approximate timeframe to accomplish the actions.

Table 4: TDOT Performance Measurement Action Items

Action	Stakeholders Involved		Timeframe[1]
PerfM-1: Develop a Data Governance Process.	•	Information Technology (IT) Division.	Long-term
	•	All TDOT staff.	
	•	Third-party data providers.	
PerfM-2: Expand TDOT's Performance Measurement Framework.	•	Strategic Planning Division.	Medium-term
	•	Traffic Operations Division.	
	•	All TDOT staff.	
	•	The Public.	
PerfM-3: Create a Centralized Repository of Operations Data.	•	IT Division.	Long-term
	•	All TDOT Divisions.	
PerfM-4: Define Staff Roles and Responsibilities.	•	Strategic Planning Division.	Long-term
	•	Traffic Operations Division.	
	•	The Public.	

[1] Short-term: 1–2 years; Medium-term: 2–5 years; Long-term: Over 5 years.

7.2.1.   Action PerfM-1: Develop a Data Governance Process

This action will develop a data governance process including advancing a data management plan for TDOT's Traffic Operations Division.

Background

Data governance is the establishment of criteria and requirements for data: their quality, management, policies, business processes; and risk management for handling data.[18] Data management is a structured approach to managing the collection and storage of data. A data governance plan provides the framework for an organization to improve its data governance, defining roles and responsibilities, policies, procedures, and workplans to move forward with.

State DOTs collect large amounts of data, as part of their performance monitoring and reporting process, as well as through other essential functions. Developing a data governance plan can improve communication and collaboration between Department of Transportation (DOT) staff, develop a data driven approach to demonstrate value of roadway improvements, and improve awareness of program operations, helping to anticipate potential issues and benefits.

During the CMM assessment stakeholders identified data governance as an area that could benefit from additional work. TDOT is collecting vast amounts of data, and those data streams (collected and real-time) will continue to grow with current ITS devices, crowdsourced data, future Connected and Automated Vehicle (CAV) data streams, and personal smart device streams and applications. TDOT's IT group is spearheading the organization of data sources and processes. The needed action is to complete a data governance plan with agencywide understanding of responsibilities. This will hold especially true to advance TSMO data sources and uses.

Stakeholders Involved and Timeline

TDOT's current data governance plan is being championed by the IT Division, making them a major stakeholder in this action item. However, the TOD can proceed with an internal data governance process to understand their current capabilities and improve the performance measurement process for TSMO. This plan would support and integrate into the IT Division's larger data governance process. For a successful plan for TSMO, it is important to engage all divisions and understand their roles and responsibilities in relation to data governance and performance measurement. TDOT also collects data from other third-party providers or organizations. These may include probe data, such as from RITIS or INRIX, crowdsourced data such as WAZE, as well as data provided by MPOs and TPOs. Third-party data providers would be a stakeholder in the development of a data governance plan, as TDOT would need to understand the potential of this type of data within the department. Developing a comprehensive TDOT data governance plan is considered a long-term task.

Roadmap to Advance (Incremental Steps)

- The first step is for TDOT's TOD to coordinate with the IT Division to understand progress made to date on the agency-wide data governance effort.

- Create a **Data Governance Advisory Committee**, that includes at a minimum the IT Division and the TOD. A committee is helpful in developing a data governance plan, as they can evaluate and

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[18]   FHWA, Data Governance, available at: https://www.fhwa.dot.gov/datagov/.

inform the progress from a broader agency perspective. In some instances, data governance committees have members from top-level management.[19]

- Considering TDOT's reorganization (EPIC), strategic **staffing** is an effective tool as well. During the process of developing a data governance plan, TDOT may benefit from creating new positions and/or hiring individuals who will focus on data governance.

- Complete a **data governance plan** with agency-wide understanding of responsibilities, including but not limited to TSMO data sources and uses. Investigate legal structures related to TSMO (specifically related to fiber optics).

- Where possible, TDOT should explore **funding** opportunities to support their data governance efforts. Related funding priorities may include safety and emergency response, transportation asset management, and transportation performance management.[20]

- Throughout this process, **leadership communication** can be crucial for justifying the purpose and benefit of a data governance plan, as they relate to the specific organizational goals. This can come in the form of providing executive summaries for TDOT leadership.

7.2.2. Action PerfM-2: Expand TDOT's Performance Measurement Framework

This action works to expand TDOT's performance measurement framework and develop targeted metrics to mature the understanding of the top-level TSMO program metrics (including PM3).

Background

TDOT's comprehensive reporting of the FHWA TPM metrics (PM1 Safety, PM2 Pavement and Bridge Condition, PM3 System Performance), as well as data available from both INRIX and the State's ITS assets, was considered a strength. However, many overarching weaknesses were identified regarding how TDOT incorporates these performance measures into other functions of the DOT. This action item arose from TDOT's desire to develop a granular understanding of system performance measures, in turn informing department decisions. From a TSMO-perspective, PM3[21] measures should be emphasized.

This approach has been defined by FHWA literature as "Performance-based Planning and Programming," where a State DOT's performance management drives short and long-term policies and investments. Benefits of improved performance-based planning and programming include improved investment decision-making, improved return on investments and resource allocation, improved system performance, and increased accountability and transparency.[22]

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[19] FHWA, Data Governance & Data Management, available at:
https://www.gis.fhwa.dot.gov/reports/GIS_Data_Governance_and_Data_Management_Case_Studies.pdf.

[20] FHWA, Data Governance and Data Management, State Examples, 2019 AASHTO GIS-T Symposium, available at: https://gis-t.transportation.org/wp-content/uploads/sites/51/2019/04/GIS-and-Data-Governance-Peer-Exchange-GIST2019.pdf.

[21] TDOT, System Performance Measures, PM3, available at: https://www.tn.gov/tdot/strategic-planning-home/transportation-performance-management/system-performance-measures.html

[22] FHWA, Performance-Based Planning and Programming Guidebook, available at:
https://www.transit.dot.gov/sites/fta.dot.gov/files/Performance_Based_Planning_and_Programming_Guidebook.pdf.

In 2013, FHWA published a "Performance-Based Planning and Programming Guidebook" as an important resource for State DOTs as they reorganize their performance management structure. The document details a framework for performance-based planning and programming and defines best practices.

Stakeholders Involved and Timeline
Expanding TDOT's approach to system performance measurement would require a top-to-bottom evaluation, including all the department's divisions. It is crucial for all divisions to understand their role within a larger performance measurement framework. TDOT's Strategic Planning Office, where performance measurement functions are currently housed, would play a significant role. The TOD would also be largely involved, as the division is responsible for much of the data that is collected and reported. The public is also an important stakeholder in the performance measurement process, as public engagement is crucial for identifying the issues travelers are most interested in.

Several strengths have already been identified related to this action. TDOT's reporting to FHWA is streamlined, the data collection process is efficient, and the stakeholder engagement process for target-setting is effective. Therefore, the development of a more robust performance measurement framework can be considered a medium-term task.

Roadmap to Advance (Incremental Steps)
An aggressive approach to performance reporting and management should be taken by TDOT TOD in several areas.

- Define Performance Measures in Accordance with National Standards and Guidance. Much work has been done at the national level to ensure consistency in TSMO performance measures, especially regarding TIM and work zones. Measures used by TDOT, such as incident clearance time and other components of the "incident timeline," should continue to use the national definitions.

- Expand Performance Reporting Content Beyond the Current SmartWay Reports.

  – The performance of key facilities, by direction of travel, should be monitored in addition to regionwide coverage.

  – Outcome measures—those related to travel time performance—should be reported. The bottom line for TSMO programs is the effect they have on travelers in terms of congestion they encounter and the safety they experience. Outcome measures include those related to travel time reliability. Performance measures for incidents, weather, work zones, and demand (traffic volumes) should accompany the outcome measures.

  – Performance trends should continue to be highlighted to TDOT leadership annually.

- Establish an ongoing TSMO Project Evaluation Program. The data compiled for expanded performance reporting can also be used to conduct evaluations of completed TSMO projects. Evaluations should follow the most recent guidance on conducting before/after analyses.

Case Studies

For additional information, please see the overview of FHWA guidance on performance-based planning as well as a case study on the performance measures used to track and manage Texas' most congestion roadways, in the Appendix.

- Develop a Process for Setting and Updating TSMO Performance Targets. Targets should be set for both short-term and long-term time horizons. The short-term targets should be developed consistent with the statewide PM3 targets. Long-term targets should be consistent with agency established targets for overall congestion and reliability. Targets can be set using simple extrapolation of past trends, but long-term targets may require some form of model forecasting.

- Include Comprehensive Review of the TSMO Performance Management Component when the TSMO Strategic Plan is updated. If goals and objectives are changed in future Strategic Plans, performance measures and targets need to be updated so they can mark progress in meeting the new goals and objectives.

- Define and prioritize segments of TDOT's statewide network. TDOT should start by identifying facilities to focus on, followed by individual segments and parallel facilities. Safety and congestion performance measures, followed by other metrics, such as weather and work zones, should be tracked and evaluated.

7.2.3.   Action PerfM-3: Create a Centralized Repository of Operations Data

This action will create a centralized repository of operations data used for performance measurement, available for all TDOT divisions.

Background

The first action item discusses the process of developing an organizational Data Governance Plan or improving overall data governance policies and procedures. One of the crucial aspects of this process is the improvement of the accessibility of data. This can be accomplished through the development of a centralized data repository. The action item seeks to develop a centralized data repository specifically for data used for performance measurement.

Benefits of a centralized data repository are well-known among departments of transportation and other organizations. Having a centralized location for data enables better use of existing data and facilitates the incorporation of new data sources, whether data sharing occurs internally or externally. A centralized data repository can also improve the consistency and efficiency of data usage across different programs. Various divisions would easily access performance measurement data, which can include data on safety, reliability, or infrastructure condition.

Stakeholders Involved and Timeline

TDOT's IT Division is a primary stakeholder. They are responsible for the department's information resources and would most likely be needed for the development and integration of a centralized repository. As the responsible party, they would ensure that the repository is following the appropriate policies and procedures, as well as conduct future maintenance efforts. More broadly, all TDOT divisions would need to be engaged and consulted in the development of a centralized data repository, as they would ultimately transition their data into the integrated location and use it to pull information as needed.

TDOT identified various data silos across the organization as an area in need of improvement. Initial steps have not been taken yet to develop a centralized data repository with a focus on performance measurement data. This action item is considered a long-term task.

Roadmap to Advance (Incremental Steps)

FHWA's Geographic Information System (GIS) in Transportation program exists for the purpose of documenting the knowledge transfer of GIS skills, best practices, and technical resources among State, regional, and local transportation organizations.[23] Although this action item, Action PerfM-3, is not directly related to GIS, the development of a centralized data repository is commonly documented as a best practice in the process of improving an organization's GIS capabilities and could be used as model.

Case Study

For more insights on this action, please see the case study on the Iowa DOT's Open Data Portal in the Appendix.

In a 2017 newsletter, FHWA's GIS in Transportation documented several State DOT best practices for data access and management. One of these best practices highlighted the Iowa DOT's development of an open data portal, as well as the policies and changes that occurred.

7.2.4. Action PerfM-4: Define Staff Roles and Responsibilities

This action will define staff roles and responsibilities to put a greater focus on operations performance measure reporting and dashboarding.

Background

Effective reporting by a State DOT improves interdepartmental coordination, partnerships, and public engagement. TDOT currently reports performance measures through a handful of channels. However, State DOTs have begun producing their own comprehensive performance dashboard. They will generally display the federally required Performance Measures (PM), as well as additional DOT-established performance measures. A key characteristic of these dashboards is the accessibility and transparency in which the performance measures are presented to the public.

Stakeholders Involved and Timeline

TDOT's Strategic Planning Office is currently in charge of the department's performance measurement and analysis, including the three required PMs by FHWA's TPM program. They would be the largest stakeholder in the development of a performance dashboard for TDOT, as they would most likely produce and host the public-facing dashboard. However, other divisions within TDOT also collect data related to performance measures that could potentially be included in a performance dashboard. For instance, the ITS program, housed within the TOD, operates TDOT's SmartWay. SmartWay collects robust data on a variety of TIM performance measures. For this reason, the TOD is considered a stakeholder in the development of a performance dashboard for TDOT. In the case of any performance dashboard, or other public-facing reporting system, the public is also a stakeholder; it is important to provide performance measures transparently to the public.

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[23] FHWA, GIS In Transportation, Home, available at: https://www.gis.fhwa.dot.gov/default.asp.

TDOT's current capabilities for measuring and internally reporting performance measures are robust. The next step involves developing and maintaining a dashboard for external reporting. This action item is considered a long-term task.

Roadmap to Advance (Incremental Steps)

Several State DOTs have invested in and developed public-facing performance "dashboards." The FHWA State Performance Dashboard and Reports page, which displays the performance measures reported by all State DOTs, also provides links to each State's Performance Dashboard. These dashboards vary in detail, some of which report, at a high-level, performance measures that are collected by the DOT, and others are interactive reporting tools. Although this action item considers the latter option, an important first step may include identifying TDOT staffing to help in creating 'scorecards' that detail how the DOT is currently operating. Case studies from three DOTs (Georgia, Maryland, and Washington State), provided in the Appendix, illustrate examples of efficient performance measurement reporting, as well as the range of reporting capabilities that can be developed—from scorecards to interactive dashboards.

Case Study

For more insight on this action, please see the case studies on the Georgia, Maryland, and Washington State DOTs performance measurement programs in the Appendix.

8.   Services and Projects

This section outlines a set of technical strategies—that is, specific transportation services and projects—that are recommended to help meet Tennessee Department of Transportation's (TDOT) Transportation Systems Management and Operations (TSMO) program goals and objectives. Service areas and projects were identified by the core team and the coordinating committee that would advance TSMO in the State. These services and projects are organized into the following categories, which reflect TDOT's near- and midterm priority areas for TSMO advancement:

- Intelligent Transportation Systems (ITS).

- Traffic Incident Management (TIM).

- Traveler Information (TI).

- Corridor Management (CM).

- Arterial Traffic Signal Management (ATSM).

- Communications Infrastructure (CI).

- Connected and Automated Vehicles (CAV).

- Additional Areas to Advance Operations.

The below sections provide background for each of the service and project areas and details an approach to advancing TSMO for each area. Table 5 is a high-level summary of the actions that align to advancing the goals of the TSMO program.

Table 5: TDOT Services and Projects Action Items

Action	Stakeholders Involved	Timeframe[1]
ITS-1: Expand Rural ITS.	• Traffic Operations Division (TOD). • Information Technology (IT) Division. • Regions. • Procurement Division.	Medium-term
TIM-1: Expand and Customize the Service Patrol Program.	• TOD - particularly Transportation Management Office (TMO). • TN Department of Safety and Homeland Security (TDOSHS). • Regions. • First responders.	Medium-term
TIM-2: Advance the Existing Statewide/Regional TIM Committees.	• TOD—particularly TMO. • TDOSHS. • Regions. • First responders.	Short-term

Action	Stakeholders Involved	Timeframe[1]
TI-1: Explore Improvements in Rural Traveler Information.	• TOD. • IT Division. • Regions.	Medium-term to long-term
CM-1: Identify and Document Corridor Level TSMO Advancements.	• TOD. • Long Range Planning Division. • Regions. • Local agencies along corridor.	Short-term
CM-2: Document TSMO Lessons Learned from the 2021 I-40 Bridge Closure.	• TOD. • External and internal partners from I-40 response, as needed.	Short-term
ATSM-1: Continue the TSM&M Program.	• TOD. • Tennessee Traffic Signal Users Group (TTSUG).	Medium-term
CI-1: Assess and Expand the State's Communications Network.	• TOD. • IT Division. • ITS Technology Working Group. • Transportation Management Center (TMC) staff.	Medium-term to long-term
CAV-1: Support and Advance CAV Actions for TSMO.	• TOD. • Roadway Design Division. • Asset Management Division. • IT Division. • Long Range Planning Division. • Legal Division. • Regions.	Short-term
CAV-2: Document a CAV Plan for TDOT.	• TOD. • Roadway Design Division. • Asset Management Division. • IT Division. • Long Range Planning Division. • Legal Division. • Regions.	Short-term

[1] Short-term: 1–2 years; Medium-term: 2–5 years; Long-term: Over 5 years.

8.1. ITS

8.1.1. Existing Conditions

ITS devices and applications are the technological foundation for many TSMO strategies. At TDOT, the ITS Office is under the TOD and is responsible for the planning, design, and deployment of ITS projects, in addition to the maintenance and upgrade of ITS SmartWay networks. The ITS Office is also responsible for the maintenance of ITS Architectures and Systems Engineering Analyses to ensure constructability and compatibility of designed ITS projects with TDOT's TSMO Program Plan.

ITS Architectures

TDOT has Statewide and Regional ITS architectures that help determine ITS needs. The TDOT Statewide ITS Architecture was updated in 2019 in coordination with the Regional ITS Architectures.[24] The interface between the statewide and regional ITS architectures is crucial to ensure that:

- The transportation network is seamlessly managed across the State.

- There is consistency between ITS projects deployed in the area.

- There is conformance between Regional, Statewide, and the national Architectures.

Regional ITS Architectures have been developed for 11 metropolitan planning areas throughout Tennessee, as shown in Table 6 below.

Table 6: Regional ITS Architectures in Tennessee

Region	Latest ITS Architecture Update
Bristol	2017
Chattanooga	2017[1]
Clarksville	2020
Cleveland	2017
Jackson	2015
Johnson City	2015[1]
Kingsport	2017
Knoxville	2021
Lakeway	2017
Memphis	2019
Nashville	2010[1]

[1] 2021 update ongoing.

While TDOT's architectures cover both urban and rural areas of the State, ITS projects in urban areas are typically prioritized over rural areas. As per directive from the Tennessee Governor's Office, there is a need for ITS infrastructure expansion in rural areas. For example, Closed-Circuit Television (CCTV) cameras and sensors to monitor traffic and roadway conditions; message boards to communicate traveler information; and safety warning systems to alert drivers on route characteristics (height restrictions, speed, curvature, etc.).

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[24] Tennessee Statewide Intelligent Transportation Systems Architecture, 2019. https://www.tn.gov/content/dam/tn/tdot/intelligent-transportation-systems/rpt_tn_statewide_its_final_revised_20190806.pdf.

SmartWay

TDOT has a fully integrated intelligent transportation system, known as TDOT SmartWay, providing real-time information to motorists via web-based systems and roadway message signs. SmartWay covers each of the four TDOT Regions, including Memphis, Nashville, Chattanooga, and Knoxville. The SmartWay system is managed through the TMCs located at each of the Regions and provides information on: TDOT highway construction activities; lane closures due to construction or crashes; weather related information like flooding or ice; and other roadway events that have been reported through crowdsourced systems like Waze. The SmartWay system collects and analyzes roadway data and information from the Tennessee Highway Patrol (THP) Computer-Aided Dispatch (CAD) system, traffic cameras and other roadway sensors for its reporting. In the near future, TDOT will apply Decision Support Systems (DSS) and Artificial Intelligence (AI) approaches to manage traffic along the I-24 Corridor in Nashville.

Procurement

Procurement processes of ITS is often more reactive (occurs when needed) rather than proactive (strategic and well thought out in advance). The key players procuring ITS systems are the TOD, IT Division, and Procurement and Contracts Division. There are opportunities for both rural and urban ITS procurement methods to be faster and simpler.

8.1.2. Action ITS-1: Expand Rural ITS

This action works to implement and institutionalize a process to expand rural ITS deployments.

Background

There are gaps of ITS infrastructure and coverage in the rural areas. Additional CCTV cameras, message boards, roadway and traffic detection systems, and other ITS deployments are needed to meet safety, mobility, and reliability needs in rural areas. Such deployments will also help advance rural TIM and traveler information. With additional ITS deployments, TDOT's ability to collect data, monitor the system, detect incidents, disseminate data, and communicate with the public will increase.

Stakeholders Involved and Timeline

ITS procurements are currently managed by the TOD and the IT Division in liaison with TDOT Regions. It is recommended to include the Procurement and Contracts Division as a key stakeholder for this action to help optimize the procurement process. The timeline for this action is medium-term but extends to long-term as ITS deployment projects are seen as a continuing investment for TDOT.

Roadmap to Advance (Incremental Steps)

The main steps to advance this action includes:

- Develop and maintain a Statewide ITS Deployment Plan to identify ITS gaps and needs in rural areas.

  – Identify a list of projects that reflects emerging ITS priorities and needs, especially in rural areas. Define a formal process for project identification and continuous update of the ITS Deployment Plan to reflect changing ITS needs.

  – Mature TSMO operations within TMCs by defining new ways of using technology by first defining priorities of desired capabilities to build and determine how to incorporate these capabilities into the project identification process of the ITS Deployment Plan.

- Conduct peer scans to understand what procurement methods are being used for ITS technology projects by other agencies. Consider innovative contracting processes such as On-Call, or Design-Build delivery.

- Continue to support TMCs and emphasize a data-driven approach to identifying needs/projects.

- Advance collaboration between the TOD, IT Division, and Procurement and Contracts Division to procure ITS projects strategically and efficiently.

- Identify sources of funding, including Federal grants to implement rural ITS projects (e.g., Infrastructure for Rebuilding America [INFRA] grant for I-40 Smart Fiber Project).

- Search for outreach/collaboration opportunities with the Regions to emphasize rural ITS, like the collaboration efforts to expand rural ITS projects through the Coronavirus Aid, Relief, and Economic Security Act (CARES act).

8.2. Traffic Incident Management

8.2.1. Existing Conditions

TDOT has a robust TIM program for urban regions in Tennessee. Each of the four TDOT Regions has an Incident Management Plan that effectively prepares responders to manage incidents along key Interstates. Each TDOT Region also performs the Federal Highway Administration (FHWA) TIM self-assessment annually, to assess their TIM capabilities and identify actions to advance. The department operates four regional TMCs in Nashville, Knoxville, Chattanooga, and Memphis covering a total of 342 miles of roadway. All four TMCs operate 24/7. The TMCs are critical for identifying and monitoring incidents and coordinating with first responders and the public. TDOT also implemented the Protect the Queue (PTQ) campaign in 2013 to help clear roadways as soon as possible after an incident and to alert drivers to the slow-moving traffic ahead.

HELP Program

Since 1999, TDOT has operated the HELP program, which works in partnership with emergency responders and other TDOT units as part of the highway incident response team. HELP trucks are readily available on Tennessee's most traveled highways in Chattanooga, Knoxville, Memphis, and Nashville. They help provide quicker incident response and clearance time, with the goal of reducing congestion, improving safety, and assisting motorists in distress after incidents. During the first 20 years of the program, HELP provided an impressive 2.5 million services, as detailed in Table 7 below and has significantly improved mobility and safety during incidents.[25]

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[25] HELP Program Statistics, available at: https://www.tn.gov/content/dam/tn/tdot/intelligent-transportation-systems/HELP%20DATA%2007_99%20THRU%2003_31_2019.pdf.

Table 7. HELP Program Statistics (1999–2019)

Total HELP services provided by each region from July 1999 through March 2019				
Knoxville	**Chattanooga**	**Nashville**	**Memphis**	**Statewide**
490,469	581,832	834,583	638,457	2,545,341

Key HELP services by type and region				
Type of Service	**Knoxville**	**Chattanooga**	**Nashville**	**Memphis**
Provided traffic control	60,238	195,793	241,961	49,658
Tagged abandon vehicles	48,390	34,327	89,422	104,839
Changed tire	40,821	28,246	71,021	87,342
Provided fuel	36,623	28,654	49,047	71,729
Relocated from travel lanes	16,024	23,274	50,287	24,149
Debris removal from lanes	36,411	26,627	34,740	27,342
Provided first aid	1,400	1,516	1,275	1,894

Challenges

These response capabilities, however, are not as mature in rural areas of the State and has been identified as an important area of improvement as part of advancing TSMO goals. TIM in rural areas is handled in large part by local agencies and there are inconsistencies in the management and clearance of these incidents. TDOT's Maintenance, Construction, and Operations staff are key players in incident management response in rural freeway locations. Various TIM training courses have helped to empower staff and provide an understanding of their role. No matter the time of day or night, these responders often respond beyond the current urban HELP coverage areas and into the rural coverage areas. During major incidents, HELP staff will go beyond urban coverage areas and take on their role as part of the National Incident Management System (NIMS) Incident Command System when they arrive on-scene. Expanding these service patrol services in rural areas will help fill the need for more resources (equipment and personnel) to better manage incidents that occur in rural areas. Additional technology infrastructure and HELP coverage area expansion will help advance incident response and communications in the rural coverage areas.

8.2.2.   Action TIM-1: Expand and Customize the Service Patrol Program

This action works to expand and customizes the service patrol program to rural interstates.

Background

Currently, TDOT's HELP program includes HELP trucks patrolling major Interstates within the four metropolitan areas of the State. The HELP program has proved to be successful in improving incident response, management, and clearance, and in providing safer conditions to responders and motorists. TDOT could expand a similar safety service patrol program onto rural Interstates to realize increased safety benefits statewide. This expansion could focus on the unique challenges faced on rural Interstates (e.g., limited communications, lack of technology infrastructure, greater statewide consistency, etc.) and to address any current challenges faced by local agencies in responding to and clearing rural incidents.

Stakeholders Involved and Timeline

For the rural safety service patrol program to be successful, collaboration and coordination between multiple agencies is required. An approach to determine the plans, procedures, and guidelines that best

respond to incidents in rural settings is needed along with defining roles and responsibilities. The TDOT TOD, particularly the Transportation Management Office, is the main stakeholder leading this action. Another key stakeholder is the Tennessee Department of Safety and Homeland Security, which has entered an interagency memorandum of understanding (MOU) with TDOT to work together to ensure public safety, promote safe and orderly traffic flow, protect the safety of emergency responders, and restore the roadway to full capacity as soon as possible following an incident. Other stakeholders include TDOT Regions and their Regional Incident Management coordinators, local agencies, Tennessee Highway Patrol, and first responders (law enforcement, firefighters, emergency personnel, towing, etc.). These stakeholders can provide input and/or resources to create a robust rural TIM program. This action is considered a medium-term task.

Roadmap to Advance (Incremental Steps)
The main steps to advance this action include:

- Continue to assess traffic incidents (number, type, conditions, cause factors) along rural Interstates to determine and **prioritize** the corridors along which the rural HELP program should expand in.

  - E.g., Region 2 Fog Zone, Region 2 I-24 through Dade (GA) and Marion County.

  - Assess incident occurrences throughout rural areas of the State.

- Assess the existing rural TIM procedures, policies, plans, and resources and conduct a gap analysis to determine how the rural HELP program could help advance rural TIM.

- Assess best practices and lessons learned from implementing TIM within Tennessee and from peer States.

- Retool TIM training to include multiple levels of instruction from introductory to advanced in coordination with the Regions.

  - Determine training needs for rural HELP operators and stakeholders.

  - Provide Hands-on-Training (HOT) to rural stakeholders.

- Develop a safety service patrol program to rural interstates, in collaboration with all stakeholders identified, including assigned routes, hours of operations, roles and responsibilities, etc. ("Incident Commanders").

  - Identify and define the scope for a pilot project for a rural safety service patrol program.

- Determine the HELP truck resource needs (truck drivers, tools, and equipment) to assist with incident management unique to rural response. Examples of equipment are traffic cones, traffic control signs, emergency and work lights, radio communications, etc.

- Develop cost estimates based on resource needs and identify sources of funding.

- Assess and define when responses should be outsourced versus handling in-house by evaluating relative costs and resources needed.

- Develop and document a statewide approach for rural TIM based on previous steps.

8.2.3.   Action TIM-2: Advance the Existing Statewide/Regional TIM Committees

Background

There is an opportunity to build upon TDOT's existing statewide and regional TIM coordination forums to increase coordination with local agencies and first responders. Better engagement with these stakeholders can increase safety and mobility in rural areas via faster and safer incident clearance in all areas of the State.

Stakeholders Involved and Timeline

The key stakeholders for this action overlap with stakeholders identified for Action TIM-1, above. The TDOT TOD, particularly the Transportation Management Office, is the main stakeholder leading this action. Other stakeholders include the Tennessee Department of Safety, TDOT Regions and their Regional Incident Management coordinators, local agencies, and first responders (law enforcement, firefighters, emergency personnel, towing, etc.).

Roadmap to Advance (Incremental Steps)

The main steps to advance this action include:

- Coordinate with existing TDOT groups or forums for coordinating TIM (previous TDOT and THP Steering Committee) to discuss expanding participation by local agencies and first responders; jointly determine a vision and plan for this coordination.

  - Assess and identify the needed staff to relaunch and eventually institutionalize this committee (considering staff turnover) (e.g., Identifying a Statewide TIM Coordinator).

  - Evaluate approaches for reinvigorating this coordination after the pandemic and create contingency communication channels for virtual coordination.

- Conduct outreach to Regions, local agencies, and first responders, jointly determine and commit to a forum, frequency, and objective for collaboration efforts.

- Identify leads from Regions and key partners to participate in this forum ("Incident Commanders").

- Consider more formalized forms of collaboration such as multiagency collaboration and data sharing through MOUs or plans and procedures.

- Utilize the new and expanded TIM committee to maintain the State's Interstate Incident Management Plans. [26]

8.3.   Traveler Information

8.3.1.   Existing Conditions

Traveler information is a key component of many TDOT TSMO strategies, such as TIM, special event management, work zone management, and more. A traveler information system follows a simple

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[26] Regional Interstate Incident Management Plans, available at: https://www.tn.gov/tdot/traffic-operations-division/transportation-management-office/interstate-incident-management-plan.html..https://www.tn.gov/tdot/traffic-operations-division/transportation-management-office/interstate-incident-management-plan.html.

architecture of data collection, data processing, and data dissemination. Rural traveler information planning should be coordinated with rural ITS device deployments, rural TIM and HELP lite programs, route diversion, and rural communications infrastructure projects. TDOT currently uses the following traveler information technologies:

Dynamic Message Signs

TDOT uses roadside Dynamic Message Signs (DMS) to provide traveler information to motorists on incidents, alternative route options, travel times, construction updates, public service announcements (PSA), and alerts. There are 183 DMSs located within the State's four urban areas and in some rural areas across the State. The DMSs are controlled by the TMC operators who are responsible for generating and posting the relevant messages. Figure 14 provides an example of a DMS conveying lane closure information along I-24 between Nashville and Chattanooga.
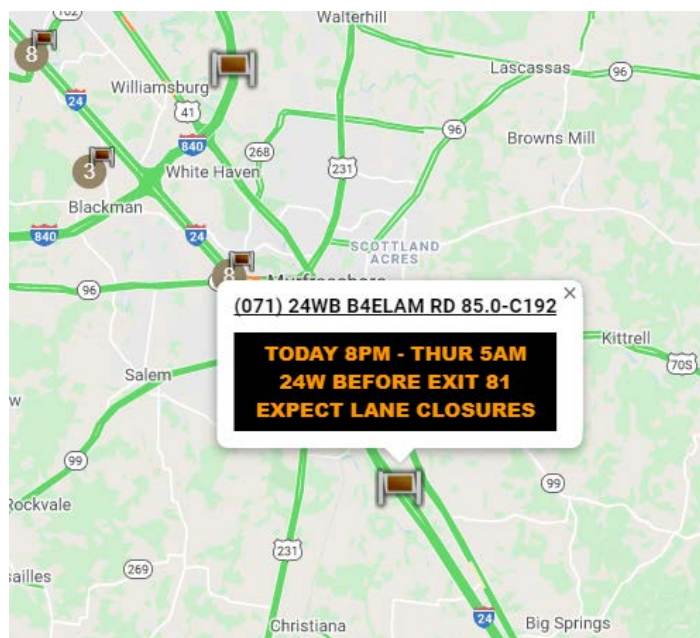

Figure 14: I-24 DMS on Lane Closures

Highway Advisory Radio (HAR)

HAR provides prerecorded traveler information to highway users in their vehicles through the AM radio receiver. HAR is provided across the State but works well in certain regions and not very well in others, because the topography or a location is prone to interference making it impossible to send clear messages to the public. It is envisioned that the use of HAR will decrease in the future with an increase in connectivity technology, especially within urban settings.

Tennessee 511 (TN511)

TN511 provides road and travel conditions information as well as updates on weather conditions from the National Weather Service.[27] It provides traffic information in the five neighboring States, including Georgia, North Carolina, Virginia, Kentucky, and Mississippi. The TN511 could be accessed online or by

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[27]   https://www.tn.gov/tdot/welcome-to-tennessee-511.

dialing 511 from a cellular or landline phone. Traffic Operations is undertaking a project called "Future of Motorist Information" that will study and evaluate options for the motorist info program.

SmartWay

The SmartWay system is TDOT's advanced traveler information platform.[28] It includes a web interface that provides real-time traffic information on Tennessee's highway system. Up-to-date information on highway incidents, construction activities, events, rest areas, road weather conditions, traffic information and speed data are published. In addition, streaming from TDOT's cameras and messages from overhead DMS are displayed. The SmartWay website can be viewed on desktop or smart devices.

Challenges

Accurate real-time information, ITS, and communication infrastructure are required to expand the current effective traveler information system. Rural areas in Tennessee have limited coverage in terms of infrastructure and that limits the amount, format, and accuracy of information that travelers receive. Another challenge is that available traveler information might not be accessible to all people, specifically those who do not have access to the Internet or a smartphone.

8.3.2.   Action TI-1: Explore Improvements in Rural Traveler Information

This task will explore opportunities to improve access to accurate real-time traveler information in rural areas.

Background

Having access to accurate real-time traveler information is crucial to make pre-trip decisions such as departure time and route choice, and in-route decisions especially when incidents occur. This action captures the opportunity for TDOT to advance its management of the Interstate and freeway system within rural Tennessee by providing the public with accurate and timely information needed for trip planning. The foundation of this action is the availability of an extensive technology and communication infrastructure that would help

> **Case Study**
>
> *For more help with this action, please see the case study on TDOT's response to the I-40 bridge closure in the Appendix.*

collect and disseminate information (including traffic incident information, travel times, construction updates, weather updates, and more) to the public. This action also addresses how accessible is traveler information for people living in rural areas. TDOT's SmartWay is a robust traveler information platform that requires Internet connectivity and smart devices, which may not be available to lower-income users without access to smartphones. Additionally, the data sources contributing to rural areas are not as robust, limiting its applicability.

Stakeholders Involved and Timeline

Since this action is based on the provision of ITS and communications infrastructure, TDOT TOD and IT Division are identified as the main stakeholders. TDOT Regions also play an important role in implementing the action as they develop the Regional ITS Architectures and understand the ITS gaps, needs and challenges. The private sector is also identified as a stakeholder as TDOT will continue to explore partnership opportunities for third-party traveler information. This action is considered as a

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28   https://smartway.tn.gov/.

medium-term to long-term action as ITS deployment and communications projects which will enable this action are seen as a continued investment for TDOT.

Roadmap to Advance (Incremental Steps)
The main steps to advance this action item include:

- Advance collaboration within the agency (between Traffic Operations, IT, Procurement) and with TDOT Regions to identify strategic and small scope ITS project "quick-wins" that could help improve rural traveler information.

- Identify sources of funding, including Federal grants to implement rural ITS and communication projects to advance traveler information. Coordinate rural traveler information planning with rural ITS, rural TIM initiatives, route diversion, and rural communications infrastructure projects.

    – Evaluation/plan for mobile DMS boards for traveler information.

- Expand upon private sector partnerships with crowdsourced data providers (e.g., Waze) and freight traveler information (Drivewyze) for traveler information services, especially in areas with limited ITS deployments.

    – Deepen connections with these providers to learn more about how they use TDOT traveler information. Discuss future needs.

- Consider advanced ways to disseminate traveler information (e.g., planned road work and closures) through web-based and smartphone apps as well as more traditional ways to ensure the entire population has access to the traveler information. Near future opportunities could be traveler information through connected vehicle data streams or the INRIX HELP tool.

- Evaluate the future of the 511 system to determine TDOT's plan moving forward. This should include a consideration of emerging technologies, such as possible ways to link 511 calls to crowdsourced data providers, and methods for improving coordination with locals on plans for traveler information and related areas (TIM and ITS).

- Determine TDOT's plan moving forward for traveler information programs. Need to evaluate this in consideration of emerging technologies versus current DOT owned 511 and HAR systems.

8.4. Corridor Management

8.4.1. Existing Conditions

As part of ongoing congestion management efforts, TDOT has been increasingly implementing corridor management programs to better manage congestion, reliability, and safety from a TSMO mindset—evaluating management and operations from a corridor perspective and identifying opportunities to implement new technologies with high benefit-to-cost ratios. Recent examples of this include Congestion Action Plans (CAP) for Tennessee's major metropolitan areas. These address technologies on key corridors and multimodal systems, assess Active Traffic Management (ATM) approaches such as traffic signal coordination, connected vehicle needs, and more sophisticated data processing, modeling, and analytics. The CAPs also involved substantial TDOT and local partner outreach as well as data analysis to inform recommendations.

TDOT's Highway System Access Manual (HSAM), developed in January of 2021, provides guidance on implementing corridor management agreements, focusing on the access management, land use regulation, and agreements necessary for corridor management, as opposed to technology. As a tool for planners or local jurisdictions seeking to improve corridor access management, the HSAM provides best practices of corridor management agreements, as well as guidance on key steps for corridor identification, implementation, and modal land development regulations.

8.4.2. Action CM-1: Identify and Document Corridor Level TSMO Advancements

This task will identify and document lessons learned from corridor level approaches and opportunities to further advance TSMO applications.

Background

Corridor management includes freeway and arterial management for TDOT and their partners. When assessing corridor level approaches, technology deployments, as well as land development regulations and access management, should be considered at the planning stage.

Stakeholders Involved and Timeline

Key stakeholders for this action include:

- TDOT TOD

- TDOT Long Range Planning.

- TDOT Regions (leadership and Region Traffic Engineers [RTE]).

- Local agencies along the corridor at hand.

This action is considered a short-term action, as it will be most beneficial to quickly capture and identify lessons learned from recent corridor management strategies.

Roadmap to Advance (Incremental Steps)

- Expand and promote corridor management agreement usage, in collaboration with TDOT Long Range Planning and agencies along the corridor at hand.

- Expand TSMO connections in long range planning and Strategic Transportation Investments Division (STID) planning initiation.

- Evaluate CAP methodology and formalize this approach/process for greater future use.

- Formalize coordination with Regional Traffic Engineers (RTE) and leadership from Regions/local agencies on bottleneck analysis and pulling INRIX data.

- Educate Regions and local agencies on Corridor Management Agreements (CMAs).

- Evaluate/collect TSMO lessons learned from I-24 Smart Corridor to apply to other corridors in Tennessee.

- Document success of existing corridor management/I-24 partnerships to help build additional partnerships with local agencies along future corridor management sites.

- Continue to support the expansion of TSM&M program and local agency partnerships—and work to have it added to the three-year Highway Plan. Emphasis should be placed on underserved arterials parallel to Interstates.

- Explore opportunities to incorporate Transportation Demand Management strategies into corridor management approaches.

8.4.3. Action CM-2: Document TSMO Lessons Learned from the 2021 I-40 Bridge Closure

This task will explore lessons learned from the 2021 I-40 bridge closure and document opportunities to further advance TSMO strategies.

Background

In May of 2021, the I-40 Hernando de Soto Bridge was closed after a routine inspection revealed a large crack on one of its crucial beams. As a vital connection between Tennessee and Arkansas, the closure was disruptive for both passenger and freight vehicles traveling throughout the region. TDOT, collaborating with nearby agencies, implemented various operational strategies to mitigate the closure, including adjusted lane configurations and data sharing agreements that allowed for response plans that could be altered on a day-to-day basis. The improvements were supported by TDOT's ITS systems and technology; DMSs, real-time video feeds, and TDOT's SmartWay system delivered crucial messages to motorists, informing them of the bridge closure, alternate routes, and travel times. These successes, along with repairs and inspections, allowed TDOT to reopen the bridge in approximately 84 days.

Stakeholders Involved and Timeline

This action will be led by TOD and may involve additional input and assessments from all internal and external partners involved in the I-40 bridge closure response. This action is considered a short-term action, as it will be most beneficial to quickly capture and identify lessons learned.

Roadmap to Advance (Incremental Steps)

- Document lessons learned as a framework for implementing the response strategies in future operational scenarios. In particular, document the data driven approach to optimize operations and the impact on reduced traveler's delay. Assess and document how collaboration and partnerships were strengthened due to the event and the impacts and approaches due to the relative longer-term nature of this event. Document the coordination approaches between maintenance forces concerning the availability of mobile message board sharing and placement, and the coordination with crowdsourced data providers that assisted in the response. Elements that can be documented from the lessons learned include:

  - Review of staffing needs and bandwidth needs for responding to major events.

  - Develop and document formal formats and processes for debriefs and reports.

  - Identify approach and steps for formally working with crowdsourced data providers. Establish and document relationships, points of contact, and contact information.

- Expand rural deployments of fiber along I-40 to fill in the coverage gaps.

- Assess corridor management needs (and potential main detour points) and incorporate into more formal processes of identifying/procuring necessary assets (message boards and other devices) for rural areas.

- Assess current diversion plans with an attention to coordination with local officials (may lead to a TIM action).

- Improve Headquarters-to-Regions coordination on incident response plan and diversions plan.

8.5. Arterial Traffic Signal Management

8.5.1. Existing Conditions

Local agencies, as opposed to TDOT, own and are responsible for traffic signals in Tennessee. However, TDOT supports and collaborates with local agencies for the operations, maintenance, and modernization of the traffic signals on State Routes. These areas can be a challenge for local agencies, especially in small and rural communities that have limited funding and resources available. Rural areas are often not eligible for certain Federal funds, such as Congestion Mitigation Air Quality (CMAQ) funds.

TDOT's Traffic Operations Division has helped address these challenges by launching the Traffic Signal Modernization and Maintenance (TSM&M) Program. This program offers State-funded grants to local agencies to help communities improve local traffic signal maintenance and modernize existing traffic signal equipment. A project selection process evaluates several factors, including the age of current equipment, economic status of the jurisdiction, and project costs and then provides grant funding for signal improvements. In the program's pilot year, Fiscal Year 2019–20, TDOT received 162 applications and selected 14 projects, 12 of which are in economically distressed or at-risk counties. Most of these projects focused on equipment upgrades, in addition to traffic signal retiming and controller replacements. The level of interest and success of the TSM&M both illustrates TDOT's momentum in this area as well as the remaining large need for traffic signal improvements and management support in the State.

8.5.2. Action ATSM-1: Continue the TSM&M Program

This task will support advancing the TSM&M Program by documenting success stories and explore opportunities to expand available funds.

Background

The TSM&M has been a successful program—delivering low-cost signal improvements that have been proven to be a cost-effective way to increase safety, mobility, and reliability. The program strategically invests limited resources in areas of high need. The target communities in Year 1 have populations of 2,500 or less in incorporated areas and counties. Future years may focus on different size communities to help equitably invest available funds. TSM&M is organized into two programs—one focused on modernization and one focused on maintenance. TDOT plans to continue and expand the size and scope of this program. It is critical to build on this momentum and capture TSM&M success stories to illustrate how low-cost TSMO strategies such as this can deliver large benefits.

TDOT Transportation Systems Management and Operations (TSMO)
Program Plan

Stakeholders Involved and Timeline

In association with the TSM&M efforts, TDOT established the Tennessee Traffic Signal Users Group (TTSUG) in 2016. TTSUG's Steering Committee is comprised of TDOT traffic signal experts, FHWA representatives, local agencies, academics, and American Council of Engineering Companies (ACEC) consultants. Over 220 local agencies have joined the TTSUG. This group will continue to be critical in guiding the TSM&M progress and convening experts and local stakeholders. The TDOT TOD's collaboration with the TTSUG as well as its leadership and management of the TSM&M within TDOT is key to advancing this program. This action is a short-term action that would be expected to continue into at least the medium-term (two to five years) but evolve in implementation as technology and Tennessee's needs evolve.

Roadmap to Advance (Incremental Steps)

- Continue supporting and advancing the TSM&M and TTSUG, leveraging this program and forum to advance knowledge of and collaboration around traffic signal operations, modernization, and applications for safety, efficiency, reliability and workforce training.

  – At the TDOT Headquarters level, identify priority projects and dedicated funding so that they are ready for implementation.

  – Document the prioritization process.

- Document TSM&M progress and success to show cost-effectiveness of these strategic traffic signal investments for key TDOT goals. Highlight these results to make the business case for growing the TSM&M and, more broadly, the benefits of the TDOT TSMO program. This is a short-term action, with input from the TSMO Coordinating Committee (TSMO CC).

  – Year 1 program created a year completion document for senior management. Continue this process for future TSM&M activities. Formalize this documentation process so that reports are provided each year.

  – Document how these projects can be implemented quickly and result in near-term benefits.

  – Gather feedback from locals as this will be a key part of documenting the benefits.

- Align staffing with the three-year vision for the program. Ensure staffing levels match the program goals.

- Work towards getting this program formally into the three-year Highway Program Plan. Goal should be to have TSM&M as a funded line item.

- Preventative Maintenance Inspections and Inventory (PMII)—Evaluate the successes and challenges of Year 1 and capture lessons learned for future years.

  – Formalize the program and included it in the three-year, Tennessee State Transportation Improvement Program.

  – Continue documenting and communicating the success and impact of this program. Identify any shelf-ready projects where Headquarters should encourage locals that might be eligible for projects to be ready to request assistance when resources become available.

8.6. Communications Infrastructure

8.6.1. Existing Conditions

Communications infrastructure is an important priority for Tennessee. Communications infrastructure, such as a fiber optic network, is necessary to set the foundation for numerous advanced TSMO strategies as well as future technologies such as connected and automated vehicles.

Fiber Optics

TDOT is actively working on deploying communications infrastructure along Interstates to enable connectivity to the States' four TMCs. TDOT has installed 394 miles of fiber optics to-date and has four funded projects underway that will continue the strategic buildout of the fiber optic network on I-40, from Arkansas to North Carolina. These projects total to approximately 245 miles of fiber optic deployment. Figure 15 below shows the project area for one of these projects: 143 miles of fiber optics that will be installed as part of an INFRA grant awarded to TDOT in 2020 for the I-40 Smart Fiber Project. This component of the project will help to fill in the communications infrastructure gaps between Memphis and Nashville, 95 percent of which are designated as rural areas.

Figure 15: I-40 Smart Fiber Project Area

Still, TDOT's fiber optic network has significant needs to meet the demands of today and the future. The existing network has been built incrementally as part of individual roadway projects and does not fully connect some areas of the State. The State lacks a fiber optic network deployment plan to fully build out a statewide system. TDOT needs to develop a single vision for a comprehensive statewide fiber optic communication network. Currently within the agency, there is not a single role, group or division that owns the fiber buildout and identifying this single point of cohesion is a necessary first step.

Broadband

Despite statewide efforts to fund broadband expansion projects, much investment is still needed to buildout the communication infrastructure in rural areas of Tennessee. According to the Federal Communications Commission's (FCC) 2019 Broadband Deployment Report, nearly one-fourth of rural Tennesseans lack access to broadband. The current I-40 Smart Fiber project is a great example of how TDOT could support rural broadband expansion, yet there is a need for continued investment to realize a fully connected statewide network.

8.6.2. Action CI-1: Assess and Expand the State's Communications Network

This task will assess and support expanding the State's communications network with a focus on rural areas.

Background

As noted, Tennessee is currently working to expand and connect its communications network, but there is a need for a coordinated approach and for greater rural expansion. This action seeks to facilitate proactive coordination with an emphasis on rural build-out. A TSMO strategy can help TDOT proactively identify low-cost opportunities to install fiber optic cables, or at a minimum, empty conduit, as part of ongoing or future projects. While fiber optic cables may not be necessary for a specific roadway project, the additional cost to install it where roadwork is already being conducted is minimal compared to initiating a standalone fiber optic expansion project. Institutionalized TSMO processes can help TDOT cost-effectively build out a statewide fiber optic communications network.

Additionally, this action addresses the need to formalize a single point of contact within TDOT to assess and manage communications network expansion. This would be a good first step to help concentrate efforts on addressing the communications gaps in the rural areas.

Stakeholders Involved and Timeline

All fiber-related projects are currently managed out of the TOD. The IT Division has expressed a strong desire to be involved in fiber-related projects, specifically in terms of technology specifications and long-term maintenance. Both divisions are important stakeholders, and it is recommended to add the ITS Technology Working Group as a key stakeholder as well. The ITS Technology Working group is currently tasked with identifying the technology needs for the SmartWay networks in Tennessee. The fiber network expansion efforts could naturally fall into this realm of responsibility. An additional benefit is that members of this group already include representatives from TMC Operations, IT (Headquarters and TMC), and TOD (ITS, Traffic Engineering, and Transportation Management).

While an inventory of existing fiber assets already exists within the agency, developing a strategic approach for providing the necessary infrastructure, along with the longer-term operations and maintenance resources, is considered a medium-term task.

Roadmap to Advance (Incremental Steps)

The main steps to advance this action item include:

- Formalize a group within the agency to manage communications network expansion with clearly defined roles and responsibilities.

- Determine current and future fiber network needs specifically within rural areas of Tennessee.

- Consider long-term operations and maintenance requirements.

- Investigate grant funding sources and explore partnerships to support broadband investment.

- Develop a statewide fiber network deployment plan to increase awareness around fiber network expansion efforts and guide the planning, deployment, and integration of a statewide system.

8.7. Connected and Automated Vehicles

8.7.1. Existing Conditions

CAV have the potential to, generally, transform the transportation system and, specifically, transform the implementation of TSMO strategies. TDOT has been proactive in learning about the potential impacts and applications of CAV for transportation in Tennessee. In 2018, TDOT developed an Emerging Mobility Solutions Plan as a companion to its 25-Year Long-Range Transportation Policy Plan. Among other emerging technologies, this plan covers a comprehensive state-of-the-practice on CAV technologies and identifies challenges, opportunities, and best practices for TDOT. This includes an assessment of existing CAV deployments, including those that utilize Dedicated Short-Range Communication (DSRC) technology for wireless short-range communication, and how advancements in communications, such as 5G cellular, may impact future applications. In 2019, TDOT advanced its organizational and staff knowledge of CAVs by conducting Connected Vehicle (CV) technology trainings and developing a set of CV system design considerations for a

Figure 16: TDOT Emerging Mobility Solutions Plan (2018)

Roadside Unit (RSU) deployment to disseminate Signal Phase and Timing (SPaT), traveler information, and other messages to connected vehicles.

It is important to note that the FCC has recently issued a notice of proposed rulemaking (ET Docket No. 19-138) that would require ITS RSUs operating in the 5.895–5.925 GHz ITS dedicated band to transition from DSRC technology to the sole usage of Cellular Vehicle-to-Everything (C-V2X) technology. TDOT remains committed to CAV technologies due to their ability to improve safety and traffic operations on the roadways. Considering potential changes at the national level, TDOT is actively monitoring national updates in this area and evaluating how TDOT can best respond to any changes. TDOT is also issuing interim guidance to its staff as needed.

Outside TDOT, other Tennessee stakeholders are also advancing CAV technology and applications. Notably, the University of Tennessee at Chattanooga (UTC) built a 1.25-mile Smart City Corridor in downtown Chattanooga, outfitted with fiber optics, cameras, Light Detection and Ranging (LIDAR), Radio Detection and Ranging (RADAR), air quality sensors, traffic controllers, DSRC, 5G cellular, and Wi-Fi.[29] The corridor is being used for a variety of research, including CV and Vehicle-to-Infrastructure (V2I) applications.

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[29] https://www.utc.edu/research/center-for-urban-informatics-and-progress/testbed.
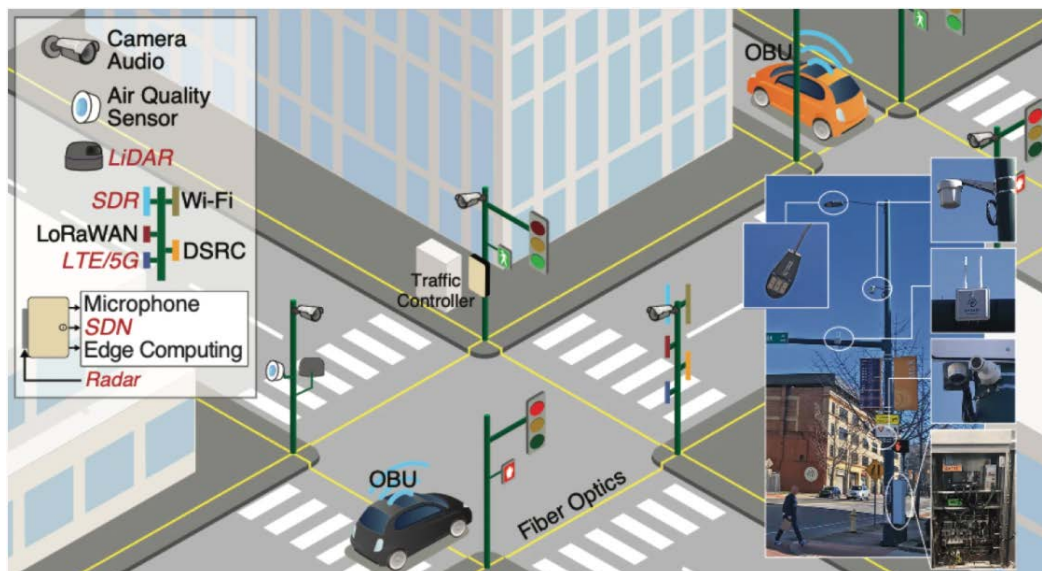
Figure 17: University of Tennessee at Chattanooga Smart City Corridor Illustration

(Source: UTC)

8.7.2. Action CAV-1: Support and Advance CAV Actions for TSMO

This task work will support and advance actions from the 2018 TDOT Emerging Mobility Solutions Plan that leverage CAV actions for TSMO

Background

The 2018 TDOT Emerging Mobility Solutions Plan identified a range of challenges, opportunities, and best practices for advancing and leveraging CAV technology for Tennessee. While this plan is currently a few years old, many of these recommendations are still relevant and would be beneficial to revisit and advance. Some recommendations from this plan that prescribe actions related to TSMO have been pulled in the roadmap to advance below.

TDOT has expanded the Traffic Signal Modernization Program (TSMP) to TSM&M and added a component to support local agencies by providing inspections to address the most pressing needs for equipment that is not functioning. As of 2021, Year 1 of this program is active for agencies with a population of 2,500 or less.

In anticipation of a CAV future, TDOT has updated standards for pavement markings to include six-inch line widths, contrast markings, and retro reflectivity standards.

Stakeholders Involved and Timeline

CAV technology will have impacts across disciplines in TDOT and Tennessee. Initially, involving TDOT stakeholders across engineering, including traffic operations, roadway design, and asset management as well as TDOT staff in policy, planning, legal, Information Technology, and data analytics. The specific set of stakeholders to involve will likely vary depending on the specific topic. Coordination with the Regions and local agencies is also key, to determine which CAV TSMO applications they believe will be priorities for their systems and communities. This set of actions is considered near-term as CAV technology is continuing to evolve quickly.

Roadmap to Advance (Incremental Steps)

Recommendations that prescribe key CAV actions related to TSMO include:

- Coordinate with stakeholders to implement communication streams on advancing CAV technologies within the Department of Transportation (DOT).

- Establish hierarchy of ITS and CAV roles and responsibilities with TDOT.

- Equip Government fleet vehicles to support testing, data collection and learning.

- Identify and implement pilot projects, utilize U.S. Department of Transportation (U.S. DOT) resources such as the open-source V2X Hub message handler and the CAV Support Service equipment loan and help desk program.[30]

- Plan for and invest in consistent and well-maintained lane markings, signage, signal phase and timing information, and more granular and accurate information related to work zones.

  – Improve pavement markings to support L1–L3 automated vehicles in the short term.

  – Ensure resources are secured for the increased maintenance needs for the more robust pavement markings (for example six-inch line widths, contrast markings, and retro reflectivity standards).

- Continue advancing the TSM&M program to assist local agencies in optimizing signal field equipment.

  – Prepare CAV Readiness assessments at TDOT and with stakeholders (potentially via TennSmart).

  – Conduct awareness building training for local agencies receiving CMAQ training to upgrade controllers.

  – TDOT has a DSRC manual that needs to be updated to reflect to current environment and applications/guidance. Ensure consistency on CAV signal infrastructure deployments.

- Eliminate unnecessary operational and maintenance practices.

  – E.g., Evaluate the TDOT approach for reducing infrastructure requirements by leveraging private sector applications and connectivity solutions. For instance, crowdsourced data, sent directly to smartphones, can help replace old traveler information systems such as HAR, and connected vehicle applications can send roadside traveler information directly to vehicles.

- Develop and execute CAV training.

  – Take advantage of U.S. DOT training programs.[31]

  – Collaborate with academic and economic development partners to identify available workforce development trainings that TDOT could participate in.

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[30] https://www.pcb.its.dot.gov/CV_deployer_resources.aspx.

[31] Ibid.

- Create a TDOT or interagency working group to support data sharing and management needs. Assess, plan for, and build out data management platform needs to support CAV.

- Continue to build on SPaT challenge deployments as CAV will continue to be integrated into signal infrastructure. Track the number of controllers equipped with CAV/SPaT functionality.

- In addition to the 2018 Emerging Mobility Plan, revisit the 2019 TDOT Connected Vehicle System Design Considerations for RSU deployments to identify near-term next steps and continued focus on building the necessary platforms for a TDOT CAV future.

8.7.3. Action CAV-2: Document a CAV Plan for TDOT

This task will document a CAV Plan for TDOT and provide clarity to the TDOT owner or group for CAV strategy, CAV-related projects, and partnerships.

Background

Given the interdisciplinary impacts and rapidly evolving nature of CAV technology, clarifying communication channels, knowledge repositories, and leadership will help TDOT navigate more efficiently. Building partnerships will be key to leveraging CAVs for TSMO applications and having defined points of contact will help facilitate collaboration. CAV efforts should be championed by the TOD going beyond DSRC/C-V2X aspects of deployment. The Division should maintain a roadmap of the physical and digital infrastructure.

Stakeholders Involved and Timeline

Similar to action CAV-1, this action will involve TDOT stakeholders across engineering, including Traffic Operations, Roadway Design, and Asset Management as well as TDOT staff in policy, planning, Legal, Information Technology, data analytics. Coordination with the Regions and local agencies will also be key. This is considered a near-term action that would evolve along with CAVs and TDOT's work.

Roadmap to Advance (Incremental Steps)

- Coordinate with existing interdisciplinary TDOT groups, such as the TSMO CC and TDOT leadership, to determine a process for: identifying, evaluating, and implementing a CAV owner or group at TDOT.

- Conduct outreach to the Regions, local partners, and State universities to identify priority CAV TSMO applications, needs, and opportunities to collaborate.

- Develop a TDOT CAV Readiness Plan/Assessment documenting the strategy, roles, responsibilities, and partners to advance a TDOT CAV Vision.

- Establish TDOT use cases and needs, leading to where and how TDOT will deploy these technologies.

- Define and document the relationships with the local agencies that own and operate signals.

- Advance TDOT's Credential Management System—by formalizing processes with local partner agencies. Use the I-24 Smart Corridor in Nashville and the SPaT challenge as examples with process set up.

8.8.   Additional areas to Advance Operations

The below section captures inputs in the discussions regarding forward looking areas that TDOT recognizes as being part of the TSMO discussion and program, and has current efforts to advance. By noting these elements in the Program Plan, the areas will be considered in future iterations and revisions to the Plan.

a. Electric Vehicle (EV) infrastructure

- Tennessee recently finalized a deal with Ford in Memphis to build EV infrastructure.

- Work with our partners at Tennessee Department of Environmental Conservation (working to promote EV infrastructure through a deployment project).

- Evaluate needs for deploying EV infrastructure.

- Advance TDOT's understanding of the role in planning and deploying EV infrastructure, and ensure the needed resources are dedicated.

- Take a leadership role to coordinate within TDOT and with partners to determine/document roles and responsibilities to advance EV infrastructure planning.

b. Access Management

- Develop policies for TDOT's Highway System Access Manual (HSAM).

- Promote HSAM in more TDOT projects.

- Promote research projects that evaluate access management strategies.

c. Transit and Ped/Bike infrastructure

- Partner with the Multimodal division to promote transit and bike/ped strategies for TSMO.

- Coordinate the TSMO program with the Active Transportation Planning activities.

d. Software and Artificial Intelligence (AI)

- Continue to explore how to leverage AI to increase automation of traffic management strategies with particular emphasis on Decision Support Systems.

- Explore applications and support of edge computing and machine learning.

- Coordinate TSMO and software needs to mature coordination with TDOT's IT office. Expand the current work in defining roles and responsibilities of the TSMO program and the IT office. Be sure to consult with TDOT's network architect to ensure compliance.

- Continue coordinating with IT and the Asset Management Division on Asset Management System software.

e. Parking (new topic)

- This topic would cover the following: truck parking, notifying public of parking availability, curbside management.

f. Mobility as a Service (MaaS)/Mobility on Demand (MoD) MaaS/MOD (new topic)

- Explore the role of TSMO in relation to MaaS/MOD and the integration between them.

8.9.   Regions: TSMO Action Plans

In 2018–2019, TDOT conducted three-day TSMO Regional Operations Forums (ROF) in each of the four Regions. These forums provided TSMO awareness building, peer presentations, trainings, and facilitated discussions of regional TSMO strengths, weaknesses, and action items.

As part of the TSMO Program Plan effort, TDOT coordinated with the four Regions to revisit their ROF outputs and create TSMO action plans for each Region and gained concurrence on actions to move forward. These action plans, summarized in the Appendix, focus on near- and midterm actions that each Region plans to take to advance TSMO and meet both regional and statewide goals.

9. Plan Maintenance, Evaluation, and Reassessment

Plan maintenance ensures that the services and projects are effective at realizing progress toward the goals and targets established previously and captures mechanisms and methods for ongoing monitoring and continual improvement of Transportation Systems Management and Operations (TSMO) and the Program Plan.

As discussed earlier, in the TSMO Strategic Leadership at TDOT section, the TSMO Coordinating Committee (TSMO CC) is responsible for advancing the agency's TSMO mission, vision, and strategies. The TSMO CC charter document contains a running list of items for the committee to accomplish. As the committee meets quarterly, they ensure that progress is maintained towards the three-year cycle of updating the Capability Maturity Model (CMM) reassessments and Program Plan. While the 2017 plan was tactical in nature, the 2022 Plan seeks to institutionalize TSMO within the agency.

9.1. Actions

- Empower the TSMO Program Manager to implement the identified actions to advance operations throughout the agency.

- Continued engagement of the TSMO CC.

- Conduct CMM reassessments to evaluate progress, identify emerging priorities, and re-engage key groups.

- Regularly update this Plan as needed as a "living document".

10. Appendix

10.1. Links to TSMO Plan Connections

Links are provided below to each of the plans referenced in section 4.1, where available. Any items not included here are either ongoing or future efforts or are not publicly available. All pages were accessed in December 2021.

- 2017 Traffic Operations Plan - https://transops.s3.amazonaws.com/uploaded_files/TDOT%20Traffic%20Operations%20Plan%202017.pdf

- 10 Year Strategic Investment Plan - https://www.tn.gov/content/dam/tn/tdot/documents/10-YearSIP_022316.pdf

- TDOT 25 Year Long Range Transportation Policy Plan - https://www.tn.gov/tdot/long-range-planning-home/25-year-transportation-policy-plan.html

- 4 Year State Transportation Improvement Plan (2020-2023) - https://www.tn.gov/content/dam/tn/tdot/programdevelopment/stip-amendments/1.5.21_Tennessee%20STIP%202020-2023%20Final_R.pdf

- Strategic Highway Safety Plan (SHSP) (2020-2024) - https://www.tn.gov/content/dam/tn/tdot/strategic/SHSP-2020.pdf

- Governor's Priorities - https://www.tn.gov/transparenttn/governors-priorities.html

- 2019 Statewide ITS Architecture Update - https://www.tn.gov/content/dam/tn/tdot/intelligent-transportation-systems/rpt_tn_statewide_its_final_revised_20190806.pdf

- Regional ITS Architecture and Deployment Plans - https://www.tn.gov/tdot/intelligent-transportation-systems/regional-architecture.html

- TennSmart Developments - https://tennsmart.org/

- Highway System Access Manual Development - https://www.tn.gov/tdot/traffic-operations-division/traffic-engineering-office/operations-and-safety/access-manual.html

- Eastern Transportation Coalition Membership - https://tetcoalition.org/about-us/

- Regional Interstate Incident Management Plan - https://www.tn.gov/tdot/traffic-operations-division/transportation-management-office/interstate-incident-management-plan.html

- Environment and Planning - https://www.tn.gov/tdot/about/tdot-organizational-charts/chief-of-environment.html

TDOT Transportation Systems Management and Operations (TSMO)
Program Plan

- Tennessee Statewide Multimodal Freight Plan - https://www.tn.gov/content/dam/tn/tdot/freight-and-logistics/TDOT_FreightPlan_AMENDED_04022019.pdf

- Interstate Corridor Studies - https://www.tn.gov/tdot/government/g/planning-studies/i-55-75-26-multimodal-corridor-study.html

- State Management Plan - https://www.tn.gov/content/dam/tn/tdot/public-trans/Tennessee_State_Management_Plan_Amended_May_2016.pdf

- Highway Safety Improvement Program - https://safety.fhwa.dot.gov/hsip/reports/pdf/2020/tn.pdf

- Comprehensive Multimodal Program - https://www.tn.gov/content/dam/tn/tdot/programdevelopment/stateprograms/3.25.20_tennessee%20fiscal%20years%2021-23.pdf

- Transportation Asset Management Plan (TAMP) - https://www.tn.gov/content/dam/tn/tdot/maintenance/asset-management-office-/tamp/2019.1.0%20TAMP%20Report.Revised.8.26.2019.pdf

10.2. Performance Measurement Case Studies

10.2.1. Action PerfM-2 Case Study

FHWA Guidebook to Performance Based Planning

The Federal Highway Administration (FHWA) guidebook presents a framework for Performance Based Planning and Programming, shown in Figure 18 below. It introduces the three iterative steps of an effective framework: Planning, Programming, and Implementation and Evaluation. Within these larger steps, several crucial subsections exist, such as Strategic Direction and Analysis within the Planning phase.

Figure 18: Framework for PBPP

(Source: FHWA, Performance-Based Planning and Programming Guidebook)

The **Strategic Direction** of a State Department of Transportation (DOT) defines the overall organizational goals, or vision. At Tennessee DOT (TDOT), these relate to TDOT's Customer-Focused Government (CFG) Plan that includes reporting the agency's key operational goals and associated key performance indicators. These include various operational performance measures reported annually or quarterly, such as percentage of Interstate highway reliable person-miles traveled and average roadway clearance time. TDOT could include additional, or more specific, performance measurements. The FHWA guidebook provides recommendations on developing effective performance measures. It is important to focus on outcome-oriented goals, as opposed to policy statements or principles. This ensures that they can later be traced to measurable objectives. Figure 19, below, from the FHWA Guidebook on Performance-Based

Planning and Programming[32], illustrates the difference between policy or action statements and outcome-oriented goals.

Statements – *These may be policies, actions, or principles, but do not focus on a transportation system or community outcome*	Outcome-Oriented Goal
Prioritize safety first.	A safe transportation system.
Institute travel demand management strategies and provide alternatives to single-occupant vehicles.	Residents have multimodal choices.
Cost-effective operations strategies are preferable to highway capacity expansion.	Multi-modal transportation infrastructure and services are well-managed and optimized.
Transportation and land use decision-making should be linked.	Livable communities that provide a range of travel choices.

Figure 19: Comparison between Policy/Action Statements/Principles and Outcome-Oriented Transportation Goals

(Source: FHWA, Performance-Based Planning and Programming Guidebook)

From outcome-oriented goals, measurable objectives can be developed. FHWA refers to best practice objectives as Specific, Measurable, Agreed-Upon, Realistic, and Time-Bound (SMART). For the example of safety, a SMART goal would be to reduce pedestrian fatalities by 15 percent from 2010 level by 2018. These metrics are analyzed through the Planning **Analysis** stage, where trends and targets are identified, and strategies and investments are prioritized.

Decisions from the Planning stage inform the DOTs **Programming** process, or investment and resource allocation. Major investment plans, such as Long-Range Transportation Plans or Statewide Transportation Improvement Programs, should be developed during this stage. In the case of TDOT, the 25-Year Transportation Policy Plan serves as the long-term vision for transportation in the State.

Implementation and Evaluation is crucial for a successful performance measurement framework. This involves monitoring of actual conditions, evaluation of the effectiveness of implemented strategies, and reporting of performance measures to the public and stakeholders. Public involvement is crucial, and strategies for improvement are discussed as part of Action P-4.

Texas' Most Congested Roadways
Each year, the Texas Department of Transportation (TxDOT), in partnership with the Texas A&M Transportation Institute (TTI), develops a list of the 100 most congested road sections in the State. TTI uses INRIX data to estimate several metrics, including traffic delay, truck delay, and truck impact. The results are summarized in a comprehensive report, including the full list of 100 roadways, a list of the 10 most congested roadways, and detailed breakdowns of how the list has changed from the previous year.

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[32] FHWA, Performance-Based Planning and Programming Guidebook, available at:
https://www.transit.dot.gov/sites/fta.dot.gov/files/Performance_Based_Planning_and_Programming_Guidebook.pdf.

TTI also provides an analysis of how the delay is distributed throughout the day, and how much it can cost the State. Figure 20, below, shows the list of the 10 most congested roads in Texas in 2020.[33]

2020	County	Road Segment	From	To	2019
1	Travis	IH 35	US 290 N / SS 69	Ben White Blvd / SH 71	2
2	Harris	W Loop Fwy / IH 610	Katy Fwy / IH 10 / US 90	Southwest Fwy / IH 69 / US 59	1
3	Harris	Southwest Fwy / IH 69 / US 59	W Loop Fwy / IH 610	South Fwy / SH 288	3
4	Dallas	Woodall Rodgers Fwy / SS 366	US 75	N Beckley Ave	5
5	Harris	Eastex Fwy / IH 69 / US 59	SH 288	IH 10	4
6	Harris	N Loop W Fwy / IH 610	North Fwy / IH 45	Katy Fwy / IH 10 / US 90	11
7	Harris	Gulf Fwy / IH 45	IH 10 / US 90	S Loop E Fwy / IH 610	6
8	Dallas	Stemmons Fwy / IH 35E / US 77	John W Carpenter / SH 183	Tom Landry Fwy / IH 30	8
9	Dallas	US 75	LBJ / IH 635	Woodall Rodgers Fwy / SS 366	7
10	Harris	IH 10 / US 90	North Fwy / IH 45	Eastex Fwy / US 59	13

Figure 20: 2020 Top 10 Most Congested Roads in Texas

(Source: TTI, Texas' Most Congested Roadways)

This formalized reporting process between TTI and TxDOT has been occurring since 2009, when Texas legislature mandated the creation of this list. Most importantly, TxDOT is continuously provided with a prioritized list of segments on their statewide transportation network. With an updated list each year, the DOT can determine where to allocate investments to improve delay and other metrics.

10.2.2. Action PerfM-3 Case Study

Case Study—Iowa DOT Open Data Portal

The Iowa DOT, struggling with internal and external access to their data, decided to develop an open data portal. Their transportation data was previously located across several locations. In the process of developing the open data portal, a new, centralized data warehouse was created to house the DOT's transportation data. Another crucial step in this process was the passing of a department-wide policy of data integration, stating that the DOT, "shall incorporate spatial data into Department business practices, databases and enterprise systems in a manner that will allow integration and information sharing among staff and customers of the Department."[34] Since the launch of the open data portal, the Iowa DOT has noticed internal and external improvements in efficiency.

Some of the key takeaways that the DOT noticed during its development can be noted as relevant for TDOT as they take the first steps to develop a centralized data repository for performance measurement:

- It is important to build a foundation for data storage.

- Policy and culture are important steps. Support from key players, as well as clear policies, are crucial.

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[33] 100 Most Congested Roadways in Texas, available at:
https://static.tti.tamu.edu/tti.tamu.edu/documents/TTI-2020-9.pdf.

[34] FHWA, GIS in Transportation, Winter 2016-2017 Newsletter.

- Services should be predictable, reliable, and authoritative to avoid future data issues and performance problems.

- In developing a centralized data structure, it is equally as important to maintain the people, processes, and procedures that were involved.

10.2.3. Action PerfM-4 Case Study

Case Study—Georgia DOT, Maryland DOT, and Washington State DOT

Within the Atlanta metropolitan area, the Highway Emergency Response Operators (HERO) exists as a service to manage traffic-related incidents, focusing on clearing roads to restore normal traffic conditions. Managed by the Georgia DOT, HERO has its own mechanism of tracking and reporting performance measures on a regular basis. The HERO Program develops a monthly report, which consists of 'scorecards' that track progress across various performance measures. Figure 21, below, illustrates the scorecard for total HERO assists, comparing monthly number of assists to that of the previous year. A key step in an effective performance measurement framework is first developing an understanding of current operations before setting targeted goals, as the two other case studies illustrate.
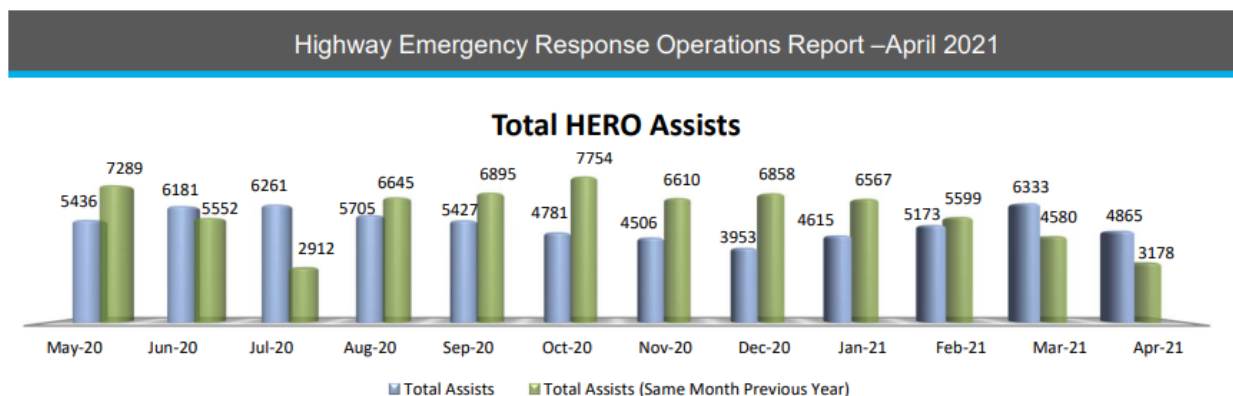
The following report outlines data for the month of April 2021. There were 4865 HERO assists in April which represents a 53.1% increase in assists compared to the data for the same month last year (2020).

Figure 21: GDOT HERO Monthly Statistics Report Sample

(Source: Georgia Navigator, Highway Emergency Response Operations Report—April 2021)

The Maryland DOT developed a Transportation Performance Measurement (TPM) dashboard for presenting the three Federal TPM performance measures—Safety, Infrastructure Condition, System Performance, Freight Movement, and Air Quality. The dashboard shows the performance measures within each of these three categories in detail, including yearly trends and future targets. Figure 22, below, presents the System Performance, Freight Movement, and Air Quality measures from the Maryland DOT dashboard. Performance measurement activities at Maryland DOT are managed by a dedicated division—the Innovative Planning and Performance Management Division (IPPD).

TPM 3: SYSTEM PERFORMANCE, FREIGHT MOVEMENT, AND AIR QUALITY

The MDOT SHA Office of Planning and Preliminary Engineering led development of system performance/reliability targets for the NHS and Freight movement using national performance management research data set (NPMRDS) version 2 data accessed on May 7, 2018 through the University of Maryland Center for Advanced Transportation Technology MAP-21 Tool. Targets for applicable urbanized area were established by work groups with MDOT SHA and metropolitan planning organization representation. The on-road mobile source emissions targets were developed by the Office of Planning and Capital Programming at the MDOT Secretary's Office in March 2018.

CONGESTION MITIGATION

MEASURE AND TARGETS	Baseline 2017	Two-Year 2019	Four-Year 2021
Percent of person-miles traveled on the **Interstate System** that are reliable	71.5%	72.1%	72.1%
Percent of person-miles traveled on the **non-Interstate NHS** that are reliable	82.0%	N/A	81.7%

TRAVEL TIME RELIABILITY

MEASURE AND TARGETS	2017	2019	2021
Truck travel time reliability index	1.87	1.87	1.88

AIR QUALITY (CMAQ)

MEASURE AND TARGETS for Urbanized Areas (as applicable)	2017	2019	2021
Annual hours of peak-hour excessive delay per capita – **Baltimore, MD**	20.2	N/A	22.6
Annual hours of peak-hour excessive delay per capita – **Washington, DC/MD/VA**	23.0	N/A	26.7
Annual hours of peak-hour excessive delay per capita – **Philadelphia, PA/DE/MD/NJ**	16.9	N/A	17.2

MEASURE AND TARGETS for Urbanized Areas (as applicable)	2016	2019	2021
Percent of non-single occupancy vehicle travel – **Baltimore, MD**	25.1%	24.8%	24.8%
Percent of non-single occupancy vehicle travel – **Washington, DC/MD/VA**	36.6%	36.9%	37.2%
Percent of non-single occupancy vehicle travel – **Philadelphia, PA/DE/MD/NJ***	27.9%	28.0%	28.1%

MEASURE AND TARGETS	2017	2019	2021
On-road mobile source emissions reduction (volatile organic compounds)	4.91	6.73	8.14
On-road mobile source emissions reduction (nitrogen oxides)	53.24	88.91	124.00

Figure 22: Maryland DOT State Highway Administration, Transportation Performance Management 3 Report

(Source: Maryland DOT State Highway Administration TPM)

The Washington State DOT does not publish a dedicated webpage for their performance dashboard. Instead, they release updated editions of The Gray Notebook, a comprehensive quarterly performance and accountability report. The report includes each of the FHWA TPM goals, as well as the DOTs statewide transportation policy goals. The specific goal is shown, whether it was met or not, and a five-year trend. Figure 23 below shows the goals and trends for Safety and Preservation, which are policy goals of Washington State DOT.

Statewide policy goal/ WSDOT performance measure	Previous period	Current period	Goal	Goal met	Five-year trend (unless noted)	Desired trend
Safety						
Rate of **traffic fatalities** per 100 million vehicle miles traveled statewide[1] (Annual measure: calendar years 2018 & 2019)	0.87	0.84	<1.00	✓		↓
Rate of **recordable incidents** for every 100 full-time WSDOT workers (Annual measure: calendar years 2019 & 2020)	4.7	4.4	<5.0	✓		↓
Preservation						
Percentage of state **highway pavement** in fair or better condition by vehicle miles traveled (Annual measure: calendar years 2018 & 2019)	91.4%[2]	92.9%[2]	≥ 90%	✓		↑
Percentage of **state bridges** in fair or better condition by bridge deck area (Annual measure: fiscal years 2019 & 2020)	92.9%	93.8%	≥ 90%	✓		↑

Figure 23: Statewide Transportation Policy Goals Dashboard

(Source: Washington State DOT, Gray Notebook, December 2020)

Along with the quarterly publishing of the Gray Notebook, Washington State DOT maintains a performance reporting gallery, which includes interactive story maps for topics covered in the Gray Notebook. For instance, the various Washington State DOT ferry routes publish quarterly reports on performance trends. The corresponding story map is updated quarterly, displaying a map of each of the ferry routes, followed by their respective ridership trends.
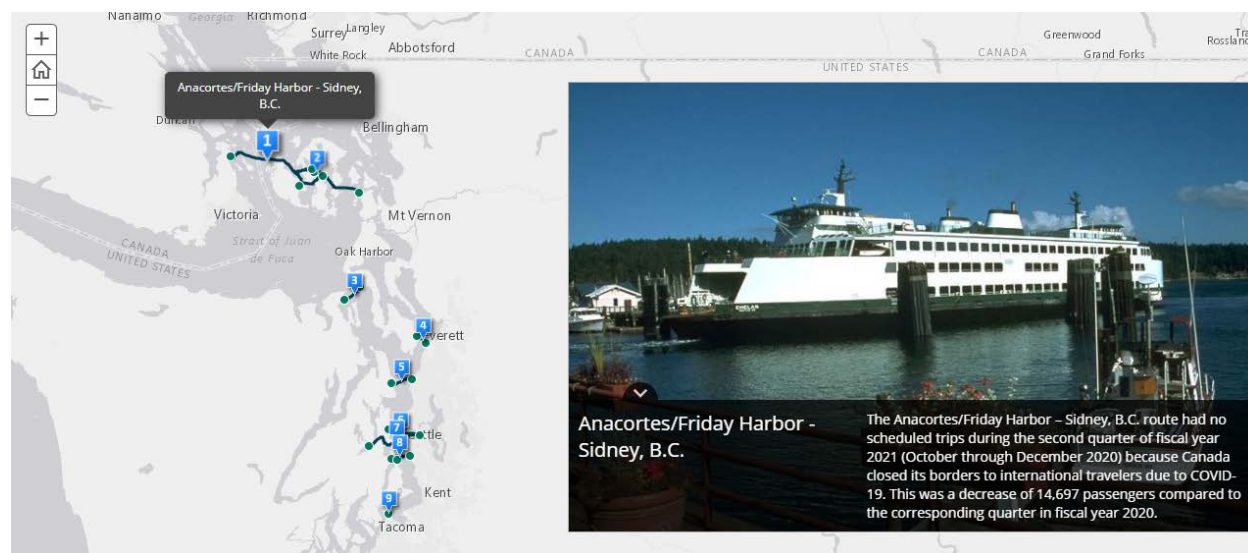

Figure 24: Washington State DOT Ferry Division Quarterly Update Example

(Source: Washington State DOT, Gray Notebook—Washington State DOT Ferries Division Quarterly Update)

Although many other State DOTs publish performance measure "dashboards," these two case studies illustrate the main principle of displaying transparent and detailed statistics. They also illustrate the range of applications for performance dashboards, as they can be dedicated webpages or quarterly reports. By considering these applications, TDOT can develop a model of a performance dashboard that best serves the department. TDOT can translate the three FHWA Performance Measures (PM), as well as the SmartWay Traffic Incident Management (TIM) PMs, into a format that is clearly presented to the public.

10.2.4. Action TI-1: Case Study

I-40 Bridge Closure Case Study

May 11th, 2021 started with a seemingly routine morning for traffic operations along the Interstate 40 corridor. For the Hernando de Soto Bridge, a crucial connection for freight and passenger vehicles between Tennessee and Arkansas, it was also time for its routine two-year inspection. That morning, the inspection revealed a large crack on one of the bridge's critical beams. The inspector immediately notified emergency services, which diverted traffic and shut down the bridge. Having avoided a potential disaster, TDOT was faced with the need to employ management and operations solutions to address the many challenges that emerged, including the disruption to the local economies, increased traffic congestion, and the prospect of long detours given the limited river crossing opportunities in the region.

TSMO and TDOT Successes

Transportation Systems Management and Operations (TSMO) strategies and solutions played an important role in TDOT's immediate response to the bridge closure. TDOT leveraged its existing assets to mitigate the effects of the bridge closure using their ITS systems and technology. TDOT evaluated travel times on detour routes to assess traffic patterns, then adjusted lane configurations and access points to optimize throughput. They deployed portable dynamic message signs (DMS) to provide greater information to travelers. TDOT also collaborated with the City of Memphis to adapt signal timing plans on key corridors to help manage the influx of additional vehicles on the arterial system.

TDOT's SmartWay system, using DMS, delivered messages to drivers informing them of the bridge closure, alternate routes, and travel times. Video streams allowed TDOT to monitor flows and queues throughout the day, understand traffic patterns, and prioritize short-term operational strategies. Staff monitored camera images for any events that could block traffic, allowing TDOT to quickly respond to incidents that would result in additional traffic congestion. TDOT also conducted analysis on traffic levels, aided by both Department owned roadside sensors and third party vehicle probe data, and provided travelers with maps showing the hotspots so that they could see when the I-55 bridge traffic was at its worst and how traffic would be rerouted. For instance, travel delay charts, such as the one shown below, were provided weekly to help travelers plan for the best time to cross the Mississippi on I-55. Minutes of extra delay were represented on a scale of 0-4, or green to red.
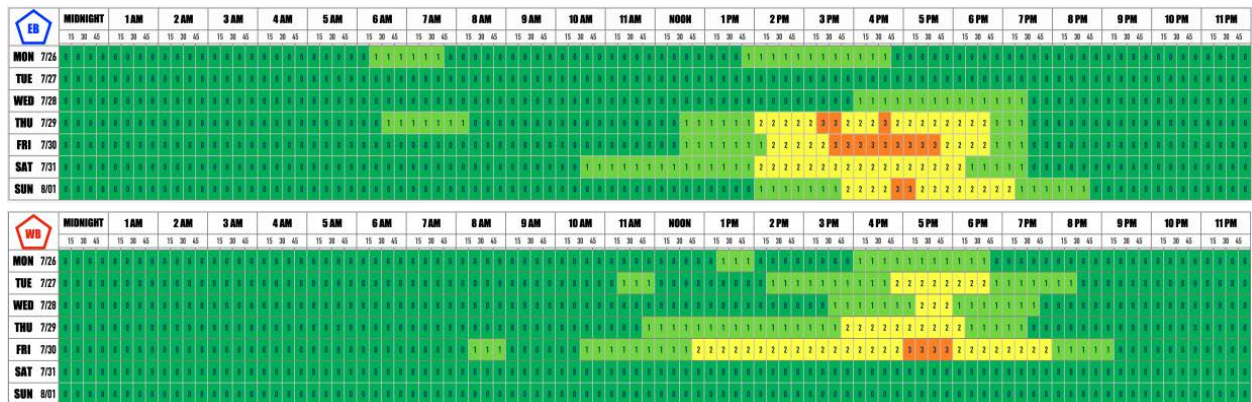

Figure 25: Est. Travel Delay Across the I-55 Mississippi River Bridge, EB and WB (July 26th - Aug 1st).

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On the I-55 detour route, TDOT utilized a data-driven approach to implement traffic improvements. The first phase of improvements involved the identification of bottlenecks and minor modifications, such as closing conflicting ramps, changing pavement markings, and using Waze closures. Complete within a few weeks, this stage was followed by larger improvements, such as ramp widening and modifications. These included a lane addition for southbound I-55, which was complete on June 13th.

The importance of existing relationships with partners highlighted the success of **collaboration** in helping mitigate the impacts of the bridge closure through sharing data streams and other resources. Through collaboration with the Arkansas Department of Transportation and other agencies, TDOT gathered needed information on resulting traffic patterns. Using traffic volumes and origin-destination data on I-40, TDOT determined where most eastbound and westbound traffic over the I-40 bridge was going to and from, which helped to determine detour routes. Collaboration with the city of Memphis and the Memphis Police Department provided feedback on the effects of I-40 to additional exits and other local traffic issues. These meetings, combined with data sharing, presented TDOT with a comprehensive picture of the impacts of the bridge closure. In addition, TDOT continuously notified third-party navigation applications (like Waze) of the new lane assignments for improved in-vehicle mapping.
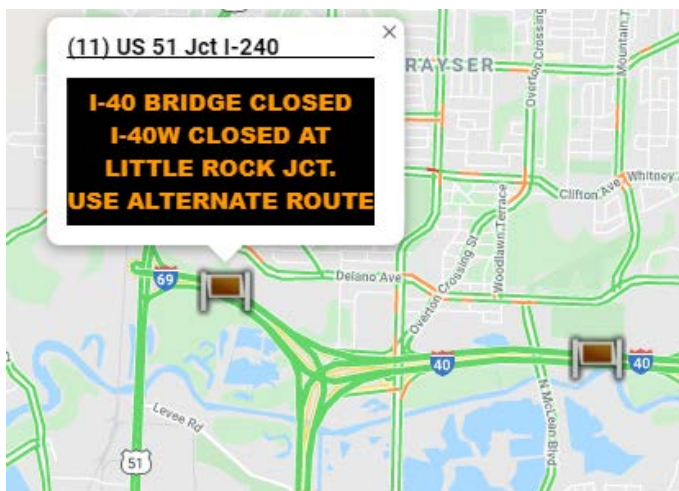
With these successes, along with expedited repairs and inspections, TDOT was able to reopen the I-40 Hernando DeSoto Bridge in 84 days. A phased approach was implemented, with eastbound lanes reopening on July 31st, followed by westbound lanes on August 2nd.

10.3. Region Action Plans

The following pages contain the Action Plans developed in concert with each Region as final outputs to the ROFs each Region participated in during the 2018/2019 timeframe.

Action No. 1: Automate work zones permitting system and include Traffic Operations in the notification and approval process.

TDOT Lead:

- _____

Action Category:

Business Processes

Timeframe:

Jan 2022–Dec 2023

Support:

- _____
- _____
- _____
- _____

Contribution to TDOT Goals:

Safety

Reliability

Steps to Accomplish Action:

1. Review current regional work zone data standards and permits, maintenance of traffic designs, and information dissemination strategies.
2. Establish regularly occurring work zone coordination meetings to coordinate on work zone activities on the Interstate and State Route system.
3. Define a framework that details information elements that can be automated within the work zone permitting system.
4. Develop a central repository of planned, real-time, and archived work zone activities in the region:
    a. Begin with Interstate and State Route system and expand to construction and utility projects.
5. Develop methods to validate work zone permits and approvals, and to flag conflicting work zones.
    a. Establish response strategies for conflicting or poorly timed work zones with clear roles and responsibilities.
6. Create a framework to share work zones data with key stakeholders including Region 1 Traffic Operations/Traffic Management Center (TMC).
7. Automate the work zone data feeds to share with stakeholders for better coordination.

Benefits:

✓ Reduce work zone related traffic delays and crashes.

✓ Streamline the work zone approval process.

✓ Improve data sharing between key stakeholders for better management and operation of the transportation system.

Measures of Success:

- Quarterly recurring work zones coordination meetings happen.
- A documented framework for automating the work zone permitting system approved by all relevant stakeholders.
- Reduction in work zone conflicts.

Resource Needs:

- Staff time
- Consultant support
- Funding for work zone system update and maintenance

Cost Estimate:

- Software: $250,000–$500,000*
- Annual Maintenance: $50,000–$100,000*

* Ohio DOT TSMO Action Plan

Potential Sources of Funding:

TBD

TN TDOT
Department of
Transportation

Action No. 2: Set specific goals and criteria to measure TSMO performance and progress.

TDOT Lead:

- _____

Action Category:

Performance Measurement

Timeframe:

Jan 2022–Dec 2022

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Define two or three of the Region's TSMO goals and targets.
2. Evaluate existing performance metrics and identify how they tie to these TSMO goals and targets.
3. Identify data needs to support measurement of the goals and targets.
4. Develop approach and acquire tools to measure performance (e.g., Regional Integrated Transportation Information System (RITIS) tool, probe data).
5. Finalize a list of agreed upon TSMO performance measures with associated data collection tools, reporting requirements (timeline and frequency), and other relevant information.
6. Develop tools and dashboards to generate performance reports (if needed).
7. Establish bi-annual reviews to identify TSMO successes and areas of improvement as well as update identified measures to move forward with.

Contribution to TDOT Goals:

- Safety
- Efficiency
- Reliability
- Workforce

Benefits:

✓ Effective and systematic process to measure and monitor TSMO advancement using available data.
✓ Improve internal and federal reporting on performance.

Measures of Success:

- Agreed upon list of TSMO goals and performance measures.

Resource Needs:

- Staff time
- Consultant support (to develop dashboard)

Cost Estimate:

$300,000–$400,000*
* Las Vegas GoMed project and Ohio DOT TSMO Action Plan

Potential Sources of Funding:

TBD

TN TDOT
Department of Transportation

Action No. 3: Improve collaboration with local agencies for signal systems, Traffic Incident Management (TIM), and Emergency Management.

TDOT Lead:

- _____

Action Category:

Collaboration

Timeframe:

Jan 2022–Dec 2022

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Leverage existing regional meetings (e.g., Region 1 quarterly meeting) to discuss collaboration for TSMO strategies including Traffic Signal Management, TIM, and Emergency Management.
2. Review existing practices in terms of line of communication, exchange of data, response strategies and processes, etc. and define two to three gaps or areas of improvement.
3. Identify training needs and frequency (considering staff turn over).
4. Assess available resources for training opportunities (e.g., webinars, tutorials).
5. Identify potential memorandum of understanding (MOU) that might be needed to institutionalize and understand roles and responsibilities, resources, etc.

Contribution to TDOT Goals:

- Safety
- Efficiency
- Reliability
- Workforce

Benefits:

- ✓ Improve coordination and response to incidents and emergency situations.
- ✓ Strengthen stakeholder relationships.
- ✓ Advance TSMO awareness and education.

Measures of Success:

- Regular coordination meetings with local agencies.
- Shared MOU between TDOT and local agencies.

Resource Needs:

- Staff time

Cost Estimate:

Low

Potential Sources of Funding:

n/a

TN TDOT
Department of
Transportation

Action No. 1: Develop a one-page memorandum of legislative talking points in coordination with the Tennessee Highway Patrol (THP) on statewide towing regulations especially as related to hazardous materials (HAZMAT) incidents.

TDOT Lead:

- _____

Action Category:

Business Processes

Timeframe:

Jan 2022–Dec 2022

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Arrange for a Traffic Incident Management (TIM) roundtable discussion meeting(s) with relevant stakeholders including towing companies to discuss current towing strengths and weaknesses in Region 2 and identify potential legislative solutions.
2. Assess and define various towing equipment needs, process of communication with towing companies, and how payment/recovery of payment for towing and recovery services occur. Prepare separate assessment for HAZMAT incidents as they will have unique criteria.
   a. Include TDOT HQ in conversations to ensure that towing issues and regulations are assessed from a statewide perspective.
3. Review and assess current policies and legislative language that may control current towing regulations.
4. Meet with THP to understand their role in advancing this action.
5. Document agreed upon talking points into a one-page information flyer that legislator can use to advance towing regulations.
6. Coordinate this effort with an ongoing TDOT research project focused on towing regulations.
7. Secure endorsement of talking points by TDOT Commissioner.

Contribution to TDOT Goals:

Safety

Reliability

Benefits:

✔ Improve coordination between TIM stakeholders.

✔ Improve the statewide towing ordinance.

✔ Improve incident response and management at regional and statewide levels.

✔ Improve the safety and operations of the transportation system during incidents.

Measures of Success:

- TIM/towing discussion meetings with relevant stakeholders.
- One-pager of legislative talking points endorsed by TDOT Commissioner.

Resource Needs:

- Staff time

Cost Estimate:

Low

Potential Sources of Funding:

n/a

Action No. 2: Develop a data governance framework to formalize how data is managed and shared.

TDOT Lead:

- _____

Action Category:

Business Processes

Timeframe:

Jan 2022–Dec 2023

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Leverage regional meetings to discuss data and data governance processes and challenges.
2. Conduct review of best practices for regional data governance.
   a. Link back to TDOT-wide data governance processes (e.g., for Traffic Operations data).
3. Develop a data governance strategy/vision.
4. Develop a data dictionary to understand the structure and content of data available.
5. Establish data standards for data integration and sharing.
6. Define roles and responsibilities for owners and stakeholders/users.
7. Document clear data governance rules, guidelines, and processes into a data governance framework.
8. Share findings with other TDOT regions.

Contribution to TDOT Goals:

- Safety
- Efficiency
- Reliability
- Workforce

Benefits:

- ✓ Improve the quality of existing and new data.
- ✓ Standardize data for easy and consistent sharing with stakeholders.
- ✓ Maintain data security, privacy, and compliance.
- ✓ Make better data-driven decisions.

Measures of Success:

- A documented assessment of data governance in the region, and what are best practices.
- A documented regional data governance framework on how to describe, store, access, and share data.

Resource Needs:

- Staff time
- Consultant support

Cost Estimate:

$250,000 for consultant support

Potential Sources of Funding:

TBD

Action No. 3: Establish debrief after action meetings after major incidents as a standard and formalized practice.

TDOT Lead:

- _____

Action Category:

Collaboration

Timeframe:

Jan 2022–Dec 2022

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Define and document what categorizes a major incident (incident that includes HAZMAT, caused by natural forces, results in long delays, injuries or fatalities, etc.)
2. Establish triggers for identifying major incidents to conduct after action meetings.
3. Engage TIM stakeholders (including incident responders, HELP, fire, police, emergency/medical services, towing companies, Metropolitan Planning Organizations (MPOs), counties, and Traffic Management Center (TMC)) to develop processes (schedule and how to document) to formalize debrief after action meetings.
4. Conduct after action meetings to share information and identify ways to mitigate deficiencies in response strategies on major incidents and improve response and management.
5. Document after action meetings and circulate with stakeholders.

Contribution to TDOT Goals:

Safety

Reliability

Benefits:

✓ Continue to enhance TIM response and management.
✓ Strengthen coordination and collaboration between TIM stakeholders.

Measures of Success:

- Formalized debrief meetings with TIM stakeholders after major incidents.

Resource Needs:

- Staff time

Cost Estimate:

Low

Potential Sources of Funding:

n/a

TN TDOT
Department of
Transportation

Action No. 1: Address bottlenecks in the region with TSMO strategies.

TDOT Lead:

- _____

Action Category:

Systems & Technology

Timeframe:

Jan 2022–Dec 2023

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Identify key bottlenecks on Nashville's highway system.
2. Prioritize bottleneck locations using data on total delay, congestion type, frequency, average and worst queue length.
3. Coordinate with other Divisions within TDOT to identify current or planned resurfacing or design projects at top priority bottleneck locations.
4. Incorporate bottleneck analysis and mitigation as part of identified resurfacing or design project scope.
5. Assess and implement TSMO strategies to address bottlenecks.
6. Include framework for before/after studies in project planning documents to evaluate success of TSMO investment.

Contribution to TDOT Goals:

- Safety
- Efficiency
- Reliability
- Workforce

Benefits:

✓ Mitigate congestion and improve safety of the transportation system.
✓ Increase awareness and education on TSMO strategies and benefits.

Measures of Success:

- A study to identify, assess, and prioritize bottlenecks in the region.
- A project list that includes TSMO solutions to address bottlenecks.
- Specify before/after studies in planning documents to document TSMO success.

Resource Needs:

- Staff time
- Consultant support
- Funding for TSMO implementation

Cost Estimate:

Cost dependent on number of projects and proposed TSMO solutions.

Potential Sources of Funding:

TBD

TN TDOT
Department of Transportation

Action No. 2: Develop a Regional TSMO Task Force including TDOT staff and external stakeholders.

TDOT Lead:

- _____

Action Category:

Organization/Workforce

Timeframe:

Jan 2022–June 2022

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Define and document the purpose of the Regional TSMO Task Force.
2. Identify internal stakeholders (cross-divisions) and external stakeholders and reach out to seek their participation.
3. Define the operating procedures of the TSMO Task Force (priorities and initiatives, meeting sequence, key roles and responsibilities, communication protocol, etc.).
4. Hold regularly occurring meetings to coordinate on tasks, to evaluate the impact of the TSMO Task Force, to replace/add members as needed, etc.
5. Continue to expand the outreach and impact of the committee to meet the regional TSMO goals and needs.

Contribution to TDOT Goals:

- Safety
- Efficiency
- Reliability
- Workforce

Benefits:

✓ Advance TSMO awareness and education.
✓ Improve communication and information sharing with stakeholders.
✓ Set TSMO priorities and initiatives for the region.
✓ Coordinate efforts to advance TSMO in the region.

Measures of Success:

- An established forum to discuss and collaborate on TSMO initiatives.
- Development of a Charter documenting regular coordination meeting schedules, roles, responsibilities, etc.

Resource Needs:

- Staff time

Cost Estimate:

Low

Potential Sources of Funding:

n/a

TN TDOT
Department of
Transportation

Action No. 3: Improve event coordination between event coordinators, TDOT, Transportation Management Center (TMC), emergency responders, and local agencies.

TDOT Lead:

- _____

Action Category:

Collaboration

Timeframe:

Jan 2022–Dec 2022

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Define special event categories that impact traffic operations.
   a. Document yearly events that routinely cause congestion.
2. Review existing practices in terms of line of communication, exchange of data, event coordination procedures, community outreach, etc.
3. Leverage lessons learned from peer exchange with Georgia DOT.
4. Formalize special events response by establishing standard operating procedures (SOP) which defines key stakeholders, tiers of response, roles and responsibilities, timing and frequency of coordination meetings and activities, emergency procedures, media/ press releases, etc.
5. Schedule and hold coordination meetings prior to major special events.
6. Schedule and hold debrief meetings to identify successes and areas of improvement.
7. Document success stories.

Contribution to TDOT Goals:

Safety

Efficiency

Reliability

Benefits:

✓ Actively manage traffic and mitigate congestion during special events.

✓ Improve safety within and near event locations.

✓ Improve coordination and response during events.

✓ Advance TSMO awareness and education.

Measures of Success:

- Established special events SOP.
- Pre and post special event coordination meetings.

Resource Needs:

- Staff time

Cost Estimate:

Low

Potential Sources of Funding:

n/a

TN TDOT Department of Transportation

Action No. 1: Expand rural Intelligent Transportation Systems (ITS) infrastructure.

TDOT Lead:

- _____

Action Category:

Systems & Technology

Timeframe:

Jan 2022–Dec 2023

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Conduct an inventory of existing ITS field devices and communication connections (fiber network) to identify gaps and priority needs.
2. Focus the inventory exercise on Jackson and rural areas of the region. Consider ITS gaps at Mississippi River crossings.
3. Identify a list of projects needed to enhance the ITS and fiber network in rural areas and prioritize them.
4. Identify funding opportunities and resources to implement the priority projects.
   a. Consider leveraging existing or planned construction projects at TDOT or other opportunities as part of local projects.
   b. Promote awareness of the Smart Fiber Grant project that will expand the fiber network and provide expansion opportunities.
5. Work with TDOT HQ and relevant partners (Metropolitan Planning Organizations (MPOs), Rural Planning Organizations (RPOs), counties) to procure and deploy ITS and communications infrastructure.

Contribution to TDOT Goals:

- Safety
- Efficiency
- Reliability
- Workforce

Benefits:

✓ Increase situational awareness in rural areas of the region.

✓ Enable real-time operations and management of the rural transportation network.

✓ Advance TSMO implementation projects in the region.

Measures of Success:

- A study to assess regional ITS inventory and gaps, focused on Jackson, rural areas, and Mississippi River crossings.
- A prioritized list of rural ITS projects with potential funding opportunities.
- Established collaboration with partners to implement ITS projects.

Resource Needs:

- Staff time
- Consultant support (for inventory and gap study)
- Funding for rural ITS deployments.

Cost Estimate (range):

- $250,000 for consultant support
- Additional costs based on the number and scope of identified rural ITS projects.

Potential Sources of Funding:

TBD

TN TDOT
Department of
Transportation

Action No. 2: Improve collaboration with Memphis Police Department (MPD), Tennessee Highway Patrol (THP), and local agencies to improve Traffic Incident Management (TIM) especially in rural areas.

TDOT Lead:

- _____

Action Category:

Collaboration

Timeframe:

Jan 2022–Dec 2022

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Review existing communication and collaboration practices with MPD, THP, and local agencies especially around TIM.
   a. Document contact lists with stakeholders.
2. Discuss priorities to advance TIM response. Engage the local county Sheriff departments and the Traffic Management Center (TMC) staff in conversations.
3. Formalize TIM response by establishing standard operating procedures (SOP) which defines key stakeholders, tiers of response, roles and responsibilities, timing and frequency of coordination meetings and activities, etc.
   a. Provide training for stakeholders on TIM.
4. Schedule and hold regular coordination meetings to review status and progress in advancing collaboration between TDOT and stakeholders.

Contribution to TDOT Goals:

Safety

Efficiency

Reliability

Benefits:

✔ Improve coordination and response to incidents.
✔ Strengthen stakeholder relationships.
✔ Advance TSMO awareness and education.

Measures of Success:

- Established SOP for TIM.
- Regular coordination meetings.

Resource Needs:

- Staff time

Cost Estimate:

Low

Potential Sources of Funding:

n/a

TN TDOT
Department of
Transportation

Action No. 3: Improve collaboration with Metropolitan Planning Organizations (MPOs)/ Transportation Planning Organizations (TPOs) to incorporate TSMO in long-range planning and at annual conferences.

TDOT Lead:

- _____

Action Category:

Collaboration

Timeframe:

Jan 2022–Dec 2022

Support:

- _____
- _____
- _____
- _____

Steps to Accomplish Action:

1. Establish routine communication with MPOs/TPOs to discuss TSMO and share TSMO success stories, lessons, and best practices.
   a. Consider and invite (as appropriate) cities and counties as stakeholders.
2. Coordinate with MPOs/TPOs to align long-range plan (LRP) goals with TDOT's TSMO Vision, Mission, and goals.
3. Support MPOs/TPOs in LRP development and include TSMO into the plan's recommendations and strategies.
4. Leverage existing regional meetings and conferences, such as the Memphis Annual Conference, and secure presentations on TDOT's TSMO program to raise awareness.

Contribution to TDOT Goals:

- Safety
- Efficiency
- Reliability
- Workforce

Benefits:

✔ Advance TSMO awareness and education at MPO/TPO level.
✔ Advance TSMO initiatives as part of regional plans.
✔ Build the TSMO culture and mindset.

Measures of Success:

- Regular coordination meetings with MPOs/TPOs.
- Incorporate TSMO in LRP.
- Add TSMO as an agenda item at key conferences/ events in the region.

Resource Needs:

- Staff time

Cost Estimate:

Low

Potential Sources of Funding:

n/a

TN TDOT
Department of
Transportation