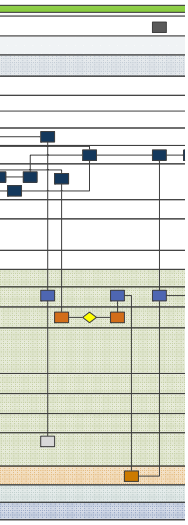
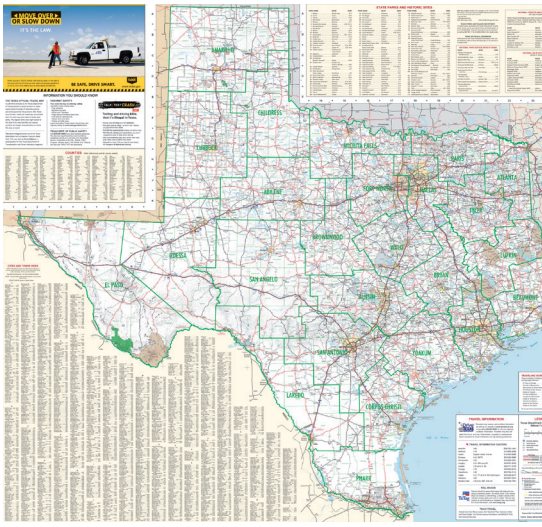
TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO)





STATEWIDE STRATEGIC PLAN

July 2018

Texas Department of Transportation

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List of Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADM	Active Demand Management
ATSPM	Automated Traffic Signal Performance Measure
CAV	Connected and Autonomous Vehicle
CMAQ	Congestion Mitigation and Air Quality
CMM	Capability Maturity Model
COG	Council of Governments
CTECC	Combined Transportation, Emergency & Communications Center
FAST Act	Fixing America's Surface Transportation Act
FHWA	Federal Highway Administration
IMD	Information Management Division
ITS	Intelligent Transportation Systems
MAP-21	Moving Ahead for Progress in the 21st Century Act
MPO	Metropolitan Planning Organization
NOCoE	National Operations Center of Excellence
SEA	Systems Engineering Analysis
SHRP2	Second Strategic Highway Research Program First Responder Training
STP	Surface Transportation Program
TIM	Traffic Incident Management
TMC	Traffic Management Center
TMS	Traffic Management Systems
TPP	Transportation Planning and Programming Division
TRF	Traffic Operations Division
TSMO	Transportation Systems Management and Operations
TTP	Texas Transportation Plan
TxDOT	Texas Department of Transportation
UTP	Unified Transportation Plan
VMT	Vehicle Miles Traveled

Executive Summary

Texas' metropolitan cities are among the most congested locations in the nation. Rural areas also have seen an increase in vehicles on the roadways—most notably, freight and commercial vehicles. With vehicle miles traveled (VMT) continually increasing, congestion throughout Texas is expected to get worse with the current pace of infrastructure development. To maximize mobility using the available transportation funding, the Texas Department of Transportation (TxDOT) is implementing a Transportation Systems Management and Operations (TSMO) program statewide. A TSMO planning initiative in Texas will improve the project delivery process by integrating mobility-focused solutions throughout planning, design, construction, operations, and maintenance. By collaborating with partner agencies and implementing data-driven decisions, the transportation network will be safer and more efficient, and will improve reliability for travelers of all modes.

TSMO activities will be institutionalized in TxDOT through the TSMO planning initiative, which will formalize and improve existing processes, institutional arrangements, and responsibilities. This will enable mobility strategies such as traffic incident management (TIM), road weather management, or enhanced signing and striping. It will support Traffic Management Systems (TMS), a priority identified in Chief Engineer Bill Hale's memo from April 2017. The memo identifies TMS performance metrics that metro districts are required to track and urban and rural districts are encouraged to consider:

- Asset uptime
- Incident clearance time
- Travel time reliability
- TMS system coverage completion

Due to the large size of Texas' transportation network, TxDOT is implementing a three-pronged approach for the TSMO planning initiative: a statewide strategic plan, district program plans, and district tactical plans (e.g. mobility service layers, projects, programs, etc.), as shown in the example organizational structure in Figure 1. The Statewide TSMO Strategic Plan will provide guidance on how TSMO will be conducted throughout the state. Districts or geographic regions will use the Statewide TSMO Strategic Plan as the framework to develop their own TSMO programs to meet their unique needs, one output of which is a District TSMO Program Plan. Depending on the needs of each district, tactical plans may be developed to provide additional details and protocols for how certain mobility strategies (such as incident management, work zone management, etc.), project deployment, and transportation improvement programs will be conducted. These three components will provide actionable guidance to implement TSMO activities across the state and integrate management and operations into the fabric of the organization to maximize the potential efficiencies.

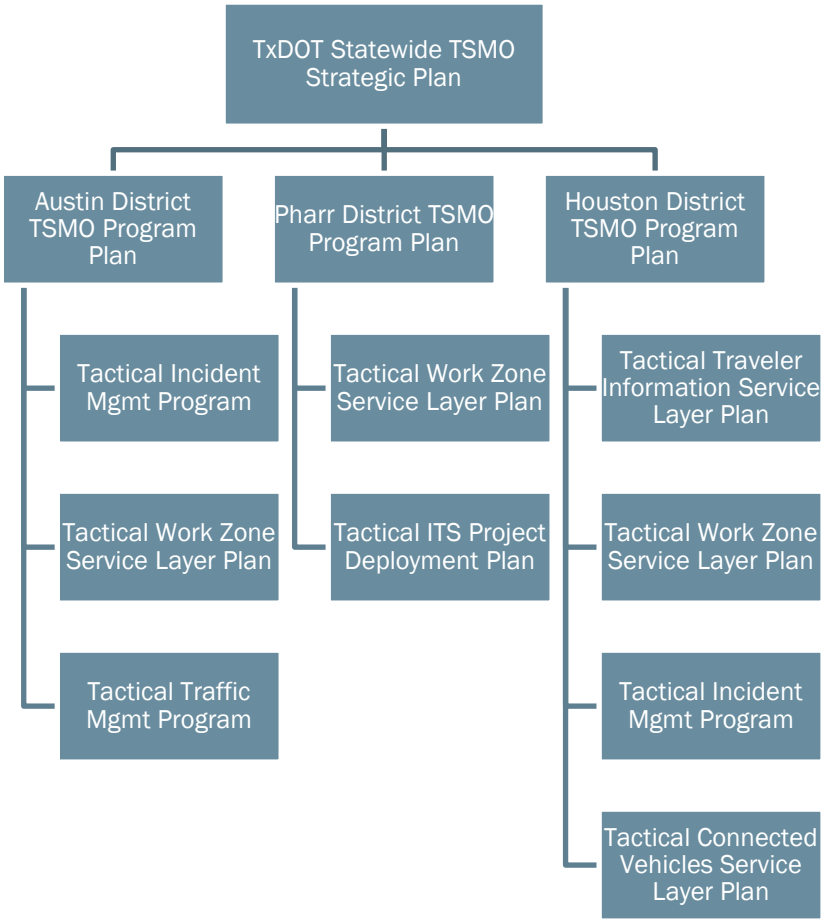


Figure 1: TxDOT TSMO Program Components

This structure aligns with guidance from the Federal Highway Administration's (FHWA) "Developing and Sustaining a Transportation Systems Management and Operations Mission for Your Organization: A Primer for Program Planning." The primer identifies strategic, programmatic, and tactical elements of TSMO program planning that are needed to mainstream activities into the organization.

The purpose of the TxDOT Statewide TSMO Strategic Plan is to:

- Provide background information and a business case regarding the value of TSMO
- Provide a framework and guidance for districts and/or regions to develop a district- or region-specific TSMO Program Plan
- Identify central support available from the TxDOT divisions

The TxDOT Statewide TSMO Strategic Plan includes a business case for TSMO; statewide mission, vision, and goals statements; an introduction to how mobility strategies benefit the TSMO program; and the statewide TSMO strategy.

The statewide TSMO strategy highlights the following six TSMO program dimensions:

- Business processes
- Systems and technology
- Performance measurement
- Culture
- Organization and workforce
- Collaboration

These TSMO program dimensions were chosen because they categorize key areas that affect TSMO activities within an agency and they align with agency organizational structures and industry standards.

Introduction

TxDOT is initiating a statewide TSMO planning initiative. TSMO is an approach to improve mobility for all modes of transportation by integrating planning and design with operations and maintenance to holistically manage the transportation network and optimize existing and future infrastructure. Initially, TxDOT leadership recognized a need for performance-based planning as a way to meet the mobility needs of the state using a cost-effective, targeted approach to funding projects. TSMO takes these techniques a step further by integrating innovation and collaboration throughout the entire project delivery process.

While TxDOT has made improvements to operations, safety, and mobility strategies prior to this, the TSMO planning initiative will institutionalize these efforts through documentation, organized arrangement and specific responsibilities. It is new to TxDOT in that it will identify specific needs, focusing on the end user, to improve mobility at a regional level and implement cost-efficient solutions to address those needs. An established TSMO program establishes the prioritization of mobility solutions on projects through technology or other innovative techniques. It integrates operations and management strategies throughout the entire project delivery process through coordination and collaboration of stakeholders to address the end users' needs. The FHWA supports TSMO as a means to meet the performance measurement requirements originally identified in the Moving Ahead for Progress in the 21st Century Act (MAP-21) and further in the Fixing America's Surface Transportation (FAST) Act, in addition to the many other benefits.

MAP-21 defines TSMO as "integrated strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal cross-jurisdictional systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system." (https://ops.fhwa.dot.gov/plan4ops/focus_areas/integrating/operations_strategies.htm)

TxDOT TSMO Planning Initiative Structure

The TxDOT TSMO planning initiative is comprised of three components: a Statewide TSMO Strategic Plan, TSMO District Program Plans, and potential tactical plans, as shown in the organization diagram in Figure 1. In "Developing and Sustaining a Transportation Systems Management and Operations Mission for Your Organization: A Primer for Program Planning" by FHWA, these three components are identified as critical elements to advancing TSMO and integrating it within an agency.

The purpose of the Statewide TSMO Strategic Plan is to set the framework and guidelines for how TSMO will be conducted throughout the state. It also will include information on how centralized support will be provided to the districts to develop and maintain their TSMO programs. District TSMO Program Plans will be developed for individual districts or regions,

depending on the needs of the area and local available knowledge of TSMO. A metropolitan planning organization (MPO) or council of governments (COG) also may lead an initiative to develop a local TSMO program that may encompass multiple TxDOT districts and include local agencies. Each TSMO Program Plan will provide detail on the district or regional TSMO responsibilities, business processes, and action items for implementation. Tactical plans will be developed as needed for each district or region. Each tactical plan will outline how specific mobility strategies will be implemented and provide a high level of detail for the procedures of each strategy. Example tactical plans include incident management, ITS in work zones, or traffic signal management. This hierarchical approach was taken due to the large geographic size of Texas—each district and region has individual needs that cannot be effectively outlined in a single document. Additionally, TxDOT has a de-centralized agency structure, where most of the decisions occur at a district-level, so it is necessary that the districts and regions develop TSMO programs based on their specific strengths and challenges.

Development of the TxDOT Statewide TSMO Strategic Plan

To develop the TxDOT Statewide TSMO Strategic Plan, an approach was established to gather feedback and engage leaders and stakeholders at multiple milestones. Information was gathered through a state-of-the-practice exercise, multiple outreach events, and a statewide survey.

The State-of-the-Practice Report was developed to understand what agencies around the country were implementing for TSMO programs and to gather best practices for the TxDOT TSMO planning initiative. A literature review of the following types of documents was conducted:

- State and local agency TSMO plans
- Guidance developed by the FHWA, the American Association of State Highway and Transportation Officials (AASHTO), and other national experts
- TxDOT and local agency TSMO or TSMO-related documents

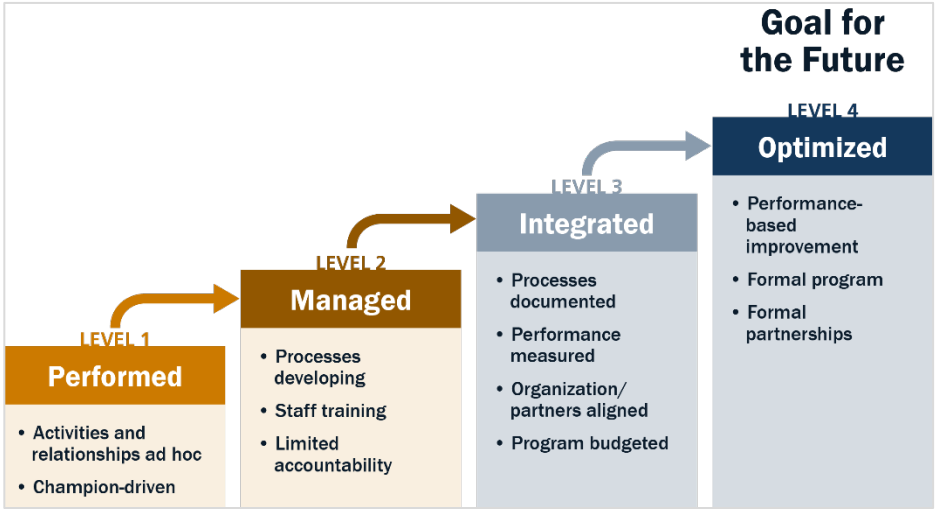
The findings from the State-of-the-Practice Report were used to gain an understanding of national TSMO activities and to determine the state of TSMO within Texas prior to the outreach events.

Outreach events were held across the state between October 2016 and January 2017, with more than 256 attendees from more than 80 different national, state, and regional agencies. The purpose of the outreach events was to inform stakeholders of the TxDOT TSMO planning initiative, provide training on the benefits of TSMO, and gather feedback through a capability maturity model (CMM) assessment. A CMM is a methodology, originally developed in the software engineering industry, to evaluate an organization's progress toward developing a specific program.

For TSMO, there are six capability dimensions, defined by AASHTO, at which TSMO activities are evaluated:

- Business processes
- Systems and technology
- Performance measurement
- Culture
- Organization and workforce
- Collaboration

To develop the CMM, individuals rate their own organizations for each TSMO dimension using the levels of maturity shown in Figure 2. Level 1, Performed, means the TSMO capability dimension is completed on an ad-hoc basis and one or two individuals champion the activity without integrating with the team. Level 2, Managed, may involve more individuals on a team performing the activity and beginning to integrate into other processes; however, there is little accountability for achieving performance measures. At Level 3, Integrated, the TSMO capability dimension is part of a more formalized process and budgets are coordinated around the activity. When an organization has achieved Level 4, Optimized, the TSMO capability dimension is continuously improved based on performance measures and activities are organized with local partners.



Source: Creating an Effective Program to Advance Transportation System Management and Operations, FHWA Jan 2012

Figure 2. CMM Levels of Maturity

At least one representative from each division, district, and agency that attended an outreach event completed a CMM assessment. After all of the outreach events had concluded, the results of the CMM assessments were compiled to understand the state's and local agencies' level of maturity in TSMO. Overall, most state and local agencies rated themselves between Level 1 and Level 2 in all TSMO capability dimensions; however, some of the metro districts rated themselves higher for some of the TSMO capability dimensions.

Based on the CMM assessments and additional comments received during the outreach events, recommendations were made to include certain elements in the TxDOT Statewide

TSMO Strategic Plan, as well as action items that must be completed in each TSMO program dimension to advance a statewide TSMO program. In May of 2017, the recommendations for the TxDOT Statewide TSMO Strategic Plan were summarized and distributed to all outreach event attendees. To continue the effort of gathering feedback throughout this process, stakeholders were asked to provide input on Strategic Plan recommendations via an online survey. Most survey respondents reported that the elements recommended to be included in the TxDOT Statewide TSMO Strategic Plan were relevant to them. The comments received for the open-answer questions reaffirmed that the proposed content addressed their needs.

Simultaneous to the TSMO program development, a TMS initiative has been led by the Information Management Division (IMD) in collaboration with the Traffic Operations Division (TRF), to enhance intelligent transportation systems (ITS) along state roadways. Construction and maintenance efforts are strongly encouraged to include TMS and operational improvements in projects. It is essential that districts begin planning and budgeting for TMS going forward to ensure TMS is included in future projects to improve roadway system operations. TMS will complement the TSMO initiative, as they both work to improve system operations, with TMS focusing specifically on ITS infrastructure. The TxDOT Statewide TSMO Strategic Plan was developed based on input TRF and IMD received through their TSMO Program and TMS efforts.

Business Case for TSMO

According to the Texas Transportation Plan (TTP) 2040, the population of Texas is expected to reach 45 million by 2040. This rapid growth leads to an increase in daily VMT, and historically, improvements to transportation infrastructure have not expanded at the same rate as demand. The results of this inconsistency are significant increases in delay and reduction in reliability. Many of the metropolitan areas in Texas are among the most congested cities in the nation, including Houston, Dallas, Fort Worth, and Austin (Texas Department of Transportation, 2015). In rural areas, with the increase in an aging population needing transportation alternatives and the increasing number of heavy vehicles due to oil and gas production, mobility challenges are prevalent throughout the state (Texas Department of Transportation, Transportation Planning and Programming Division, 2012).

With inadequate funding available, state and local agencies have learned to do more with less, yet it is a continual struggle to keep up with increasing demand. TSMO is an effective approach to planning for and delivering projects using innovative and efficient strategies. TSMO helps agencies provide safe, reliable, efficient, and sustainable mobility for all users for the following reasons:

1. TSMO initiatives lead to the effective use of available funding. Implementing innovative, technology-based solutions can add capacity at a lower cost than building more lane miles.

2. TSMO programs are efficient, conserving agency dollars by encouraging different disciplines and stakeholders to work through challenges together before projects are constructed.
3. Data-driven mobility strategies are funded to provide measurable results to share with the general public and agency leadership.
4. Implementing performance-based mobility strategies leads to effective projects by leveraging TSMO business processes that target the areas of greatest need in transportation systems.
5. A TSMO approach to improve system reliability prioritizes solutions that realize immediate results.
6. Through the integration of all aspects of the project delivery process, projects are planned, designed, constructed, and operated efficiently, improving mobility for all modes of transportation.
7. By improving mobility and reliability, safety is improved by reducing the likelihood of secondary crashes. Less delay caused by crashes and other incidents leads to improvements in mobility.

Mobility Strategies Enabled Through TSMO

TSMO activities enable the implementation of mobility strategies such as work zone management, traffic incident management, or innovative signing and striping. These strategies have been implemented in Texas for years. The TSMO planning initiative will develop processes and institutional arrangements that raise the priority of these strategies and integrate them with other activities to be more effective.

Identifying Needs

FHWA defines congestion in terms of recurring or non-recurring congestion. The national causes of congestion, shown in Figure 3, are the same issues that Texas faces. Understanding the causes of congestion is key to evaluating the needs and identifying solutions that address those items specifically.

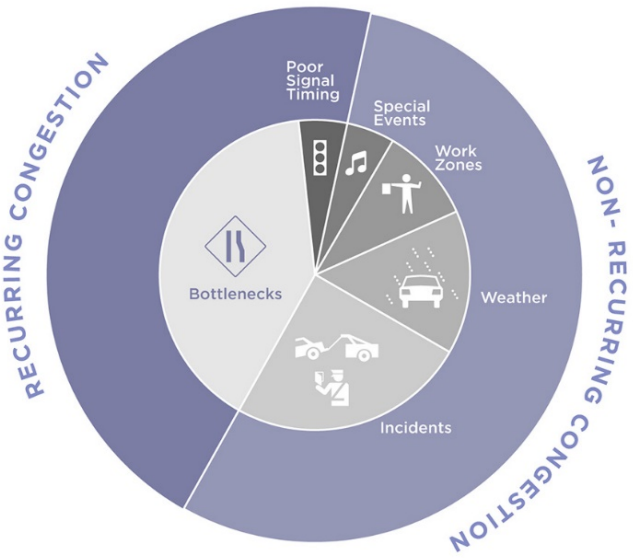


Figure 3: National Causes of Congestion

Source: https://ops.fhwa.dot.gov/publications/fhwahop14034/ch1.htm?]

Similar to the overall TSMO assessment using the CMM framework, FHWA has developed an assessment for each of these mobility challenges using the CMM model to identify opportunities and action items that can improve an agency's capabilities. The FHWA CMM frameworks are described in further detail at: https://ops.fhwa.dot.gov/tsmoframeworktool/cmf_overview.htm

Using TSMO to Address Needs

The plans and processes of the TSMO planning initiative establish opportunities to prioritize operations and ITS solutions to improve congestion and safety. The graphic shown in Figure 4 represents of how common problems can be addressed by using TSMO approaches to coordinate multiple traffic operations techniques and improve the end-user's travel experience.

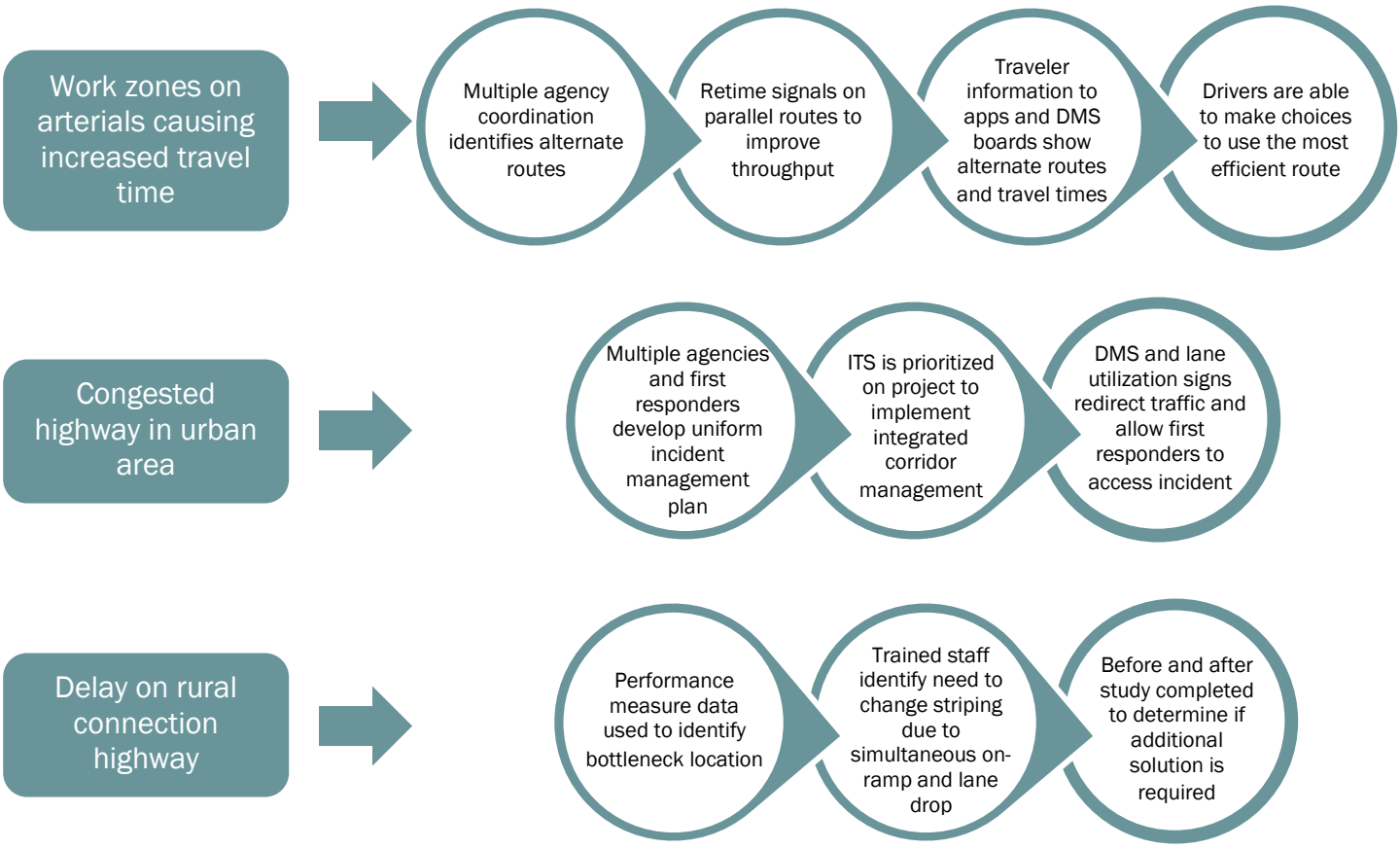


Figure 4: TSMO Mobility Improvement Examples

TSMO applies to technology-independent enhancements such as; traffic calming measures, channelization improvements, and signage/striping improvements. Mobility enhancements like this could be optimal for rural areas or locations that don't have ITS infrastructure.

Current Progress

TxDOT currently has many operations and safety initiatives in progress, listed below, that should be integrated into TSMO processes. It is important to remember that this is not an all-inclusive list, but includes examples of initiatives that would be mutually beneficial to coordinate for TSMO planning activities. Each district should consider how to incorporate these into program plans, as well as other existing activities to improve success of the TSMO planning initiative.

Traffic Management Systems: An emphasis has been placed on transitioning transportation funding and resources from conventional capacity-adding methods to a focus on managing and operating the transportation network through investing in technology and TMS, as well as leveraging resources among regional partner agencies and private sector data providers. Chief Engineer Bill Hale's Memo from July 1, 2016, states "… it is critical that Traffic Management Systems (TMS) be included on new roadway construction projects. Including

TMS at the earliest stages of project development planning will maximize investments by leveraging comprehensive project construction cost at the earliest stages when TMS can be included for a fraction of total project cost." Furthermore, in Chief Engineer Bill Hale's Memo from April 7, 2017, he states "Each district will be expected to ensure (1) TMS is included in each project's planning, development, design, construction, maintenance and operation, and (2) provide specific TMS projects where gaps exist between typical road and bridge projects… TRF will also provide Transportation Systems Management and Operations (TSM&O) guidance for the districts." Both memos are included as Appendix A. TSMO integrates TMS into the planning, design, and construction of new and improved facilities to achieve this objective. Through TSMO institutional arrangements and processes, TMS is supported in conventional construction, asset management techniques, upgrades to existing infrastructure, workforce resources, and other operational strategies.

Freight Mobility Plan: The *Texas Freight Mobility Plan* identifies challenges, investment strategies, policies, and data to improve freight safety and mobility. Opportunities as part of statewide freight projects have begun to be identified in the *Texas Freight Mobility Plan* to implement TMS or ITS devices. For more information on the *Texas Freight Mobility Plan*, refer to: http://ftp.dot.state.tx.us/pub/txdot/move-texas-freight/studies/freight-mobility/2017/plan.pdf.

Traffic Incident Management: The TRF recently hired a Statewide TIM Coordinator to work with all the districts to establish best practices for incident response, after-action reviews, etc. The TIM Coordinator is organizing the delivery of FHWA's second Strategic Highway Research Program (SHRP2) First Responder Training to first responders. The Statewide TIM Coordinator also can support TSMO collaboration activities, including between first responders and project staff.

Smart Work Zones: The Work Zone ITS Standards are under development to implement smart solutions in work zones statewide. Several strategies are being reviewed for advance traveler information, incident management, and speed monitoring. Along with the Work Zone ITS Standards, guidelines will be created to explain when and how to use the standards and how to maintain ITS operations in work zones. By considering the cost of work zone ITS strategies early in the project development process, through implementation of the TSMO business process, funding for work zone ITS can be allocated and prioritized.

Drive Texas: TxDOT supports the travel information website, www.drivetexas.org, which provides highway condition information to the public. This website is valuable for construction and traffic information; however, it is also a great resource during adverse weather. Based on this information, travelers can make route planning decisions prior to beginning their journeys. This supports TSMO objectives to consider the user experience and provide traveler information.

Information Management Division Initiatives: IMD is supporting the development of a Traffic Information System Dashboard that will help staff monitor traffic conditions. This will help all districts dynamically react to special events and other challenges to improve travel reliability. By integrating this system with existing technology, it will institutionalize improving operations dynamically and optimizing available capacity.

IMD will pilot automated traffic signal performance measures (ATSPM) in several districts. This will help districts identify signal timing issues to resolve them faster. The districts could use this information to integrate with maintenance and ticketing processes through TSMO collaboration activities.

IMD supports many other operations statewide with emerging technology and strategic resource planning, including:

- Network monitoring prototype
- Asset management
- Fiber mapping and fiber asset management
- End-of-life network equipment upgrades
- Lonestar redundancy
- Improvements to traveler information
- 4G cellular deployment
- Video sharing
- Advanced traffic signal performance measures
- Modernize portfolio and project management
- Data lake
- Sharing data between agencies
- TMS drill-down metrics through Tableau

Special Event Management: TxDOT has recently developed statewide standard operating procedures, released by Chief Engineer Bill Hale in May 2018, for the use of dynamic messaging for special events based on the projected number of people to attend the event. This formalized guidance further promotes proactively planning for special events. Furthermore, TxDOT can collaborate through outreach to the public and event planners to encourage active transportation and transit when attending events.

Texas Clear Lanes: TxDOT's Texas Clear Lanes (www.texasclearlanes.com) has identified congested facilities and supports projects to address gridlock across the state. Texas is funding these projects through two statewide propositions to provide $1.3 billion to metro areas to address congestion. A TSMO approach to these projects can help this funding go farther and build institutional best practices.

District Specific Solutions with Statewide Expansion Potential:

- TxDOT initiated a vendor-managed regional Traffic Management Center (TMC) at the Combined Transportation, Emergency & Communications Center (CTECC) to augment existing staff in managing Austin's transportation system.
- Connect-Smart consists of a technology platform that integrates TSMO and an Active Demand Management (ADM) with multi-modal demand/mobility management through a mobile app platform.
- Connected Freight Corridors project is a collaborative effort funded through federal and state programs to improve safety and congestion management to deploy connected vehicles and infrastructure. Additional information can be found here: https://www.txdot.gov/inside-txdot/division/traffic/freight-corridors.html

Statewide TSMO Vision, Mission, Goals, and Objectives

The following mission, vision, goals, and objectives are from the TxDOT Statewide TSMO Strategic Plan. Districts may add specific interests or additional details when developing district TSMO program plans.

Statewide TSMO Vision

Improve safety and mobility for all modes of transportation by integrating planning, design, operations, construction, and maintenance activities and acknowledging all opportunities for innovation.

Statewide TSMO Mission

Through innovation, collaboration, and performance-based decision making, transportation facilities are developed, constructed, maintained, and operated cost-effectively, with the end user in mind.

Statewide TSMO Goals and Objectives

The goals and objectives for the statewide TSMO planning initiative identified in Table 1 are based on the TxDOT agency goals and objectives.

Table 1: Statewide TSMO Goals and Objectives

Goal	Objective
Safety	Reduce crashes and fatalities through continuous improvement of traffic management systems and procedures.
Reliability	Optimize travel times on transportation systems in critical corridors to ensure travelers are reaching their destinations in the amount of time they expected for the journey.
Efficiency	Implement projects that optimize existing transportation system capacity and throughput.
Customer Service	Provide timely and accurate travel information to customers so they can make informed mobility decisions.
Collaboration	Proactively manage and operate an integrated transportation system through multi-jurisdictional coordination, internal collaboration, and cooperation between various transportation disciplines and partner agencies.
Integration	Prioritize TSMO as a core objective in the agency's planning, design, construction, operations, and maintenance activities.

Statewide TSMO Program Strategy

The Statewide TSMO Program Strategy is divided into six components that align with the following TSMO program dimensions:

- Business processes
- Systems and technology
- Performance measurement
- Culture
- Organization and workforce
- Collaboration

Although these dimensions are divided for the purposes of this document, they are interrelated and depend on each other to succeed. Each subsection below provides the following information specific to the TSMO program dimensions:

- Guidance information on how districts and/or regions will conduct TSMO programs locally
- Specific guidance for how centralized support will be provided to the districts and/or regions

(Note: for the purposes of this report, the term “district” refers to both TxDOT districts and other agencies divided into geographic regions.)

The districts will be responsible for the planning and implementation of local TSMO activities. TRF will provide overall leadership and policy management of the statewide TSMO program, relying on coordination with other units and divisions to carry out the objectives of the program.

Business Processes

Business processes include all of the planning, budgeting, procurement, and process development that is required for TSMO programs. To be implemented, TSMO activities and initiatives must be supported financially and institutionally. Protocols and procedures are necessary for TSMO to become ingrained in agency culture.

Based on the results of the 2016-2017 CMM, processes and financial support are not in place to ensure TSMO is incorporated into day-to-day operations for the development and delivery of projects. To develop a successful TSMO program district-wide, the following action items related to Business Processes need to be completed:

- **Planning**—Using a needs-based, data-driven approach, mobility-focused projects will be identified, as well as opportunities to include mobility strategies in existing projects. These projects will be included in long-term planning efforts, including the Unified Transportation Plan (UTP). Project scopes must be developed to align with the performance-based planning requirements that guide project selection criteria and funding distributions in the UTP.

- **Programming**—Districts will develop a budget for TSMO efforts that includes funding for mobility-focused projects and implementing mobility strategies in existing projects. Per the Chief Engineer's memo from April 2017, funding for TMS is expected to be included in each project's planning, development, design, construction, maintenance, and operation. Consideration also will need to be given for training, staffing, data acquisition, or any additional engineering resources required.

  When applying for federal grants funding, districts will include information regarding the TSMO program and the resulting data-driven decision making. TSMO activities can be funded through the Congestion Mitigation and Air Quality (CMAQ) Improvement Program, the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program, and Surface Transportation Program (STP). There are additional funding opportunities through federal technology grants that could be leveraged to deploy emerging technology-based mobility solutions.

- **Process Development**—Existing processes for project delivery will be revised to consider TSMO and other efforts outlined in this TSMO Program Plan. Similarly, an evaluation of existing project development manuals will be reviewed and revised to address the changes in protocol. As a resource for considering innovative ideas, a TSMO evaluation tool is being developed to assist districts in determining how TSMO can be applied to projects to improve mobility during conceptualization, planning, design, construction, operation, management, and maintenance. The use of the tool

can be scaled according to project size, but it will be a valuable resource to encourage a TSMO culture in the organization.

- **Continuous Improvement**—As districts continue to implement TSMO practices, revisions to the TSMO Program Plan will be made so continuous improvement and optimization of business processes can occur. Regular assessments will be completed to determine what has been successful and what resources are needed to overcome challenges.

Table 2, below, summarizes the district responsibilities for the Business Processes dimension.

Table 2: District Responsibilities for Business Processes

District Responsibilities	Objective	Evaluation Metric	Timeframe
	Identify list of operation-based projects & budget for the next 10 years to include in UTP.	Send projects and budget to TRF for TSMO tracking purposes.	1–2 years
	Identify list of projects & budget where operations/ITS solutions can be added over the next 10 years to include in UTP.	Send projects and budget to TRF for TSMO tracking purposes.	1–2 years
	Develop template language for project scopes to align with performance-based planning requirements.	Implement scoping language in projects.	1 year
	Develop budget for training, staffing, data acquisition, or other resources.	Send budget to TRF for TSMO tracking purposes.	1–2 years
	Revise project delivery process to include TSMO activities & TSMO tool.	Include project delivery process in TSMO Program Plan.	1–2 years
	Review/revise project manuals/protocols to include TSMO activities & TSMO tool.	Implement revised project manuals/protocols.	1–2 years
	Develop TSMO Program Plan, including plan for re-assessment.	Send TSMO Program Plan to TRF for TSMO tracking purposes.	1–2 years

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To sustain the districts with their individual TSMO programs, the following centralized support will be provided to assist with planning and leadership of the TSMO initiative:

- **Coordination**—TRF will coordinate with the Transportation Planning and Programming Division (TPP) to provide guidance to the districts for including mobility-focused projects or additional funding for mobility strategies on existing projects in the UTP.

- **Funding Support**—TRF will support the districts' efforts to obtain federal grants to fund TSMO-specific projects or mobility strategies on existing projects. This may include technical expertise, providing statewide best practice information, or developing statewide standard practices.
- **Policy and Procedural Documentation**—TRF will lead an effort to develop TSMO policy or similar procedural documentation. This will highlight the support from executive leadership and the necessity of the initiative throughout the state.

- **Continuous Improvement**—As necessary, the TxDOT Statewide TSMO Strategic Plan will be updated by TRF in response to changes to the agency's mission, vision, and strategic goals. TRF also will support districts in developing and maintaining their TSMO program plans. This may include re-evaluating statewide, regional, or district-level CMM assessments to identify where action items can be enhanced. The Culture dimension section of the TxDOT Statewide TSMO Strategic Plan describes the roles in the central office and districts required to support the TSMO program.

Table 3, below, summarizes the support from divisions for the Business Processes dimension.

Table 3: Central Office Responsibilities for Business Processes

Central Office Responsibilities	Objective	Evaluation Metric	Timeframe
	Develop guidance on including/funding operations/ITS projects in UTP.	Send UTP guidance to districts.	1 year
	Develop TSMO policy.	Send TSMO policy to districts.	6 months–1 year
	Review and revise TSMO Strategic Plan regularly.	Send revised TSMO Strategic Plan to districts.	Biennial review
	Maintain the overall statewide TSMO plan, comprised of the statewide strategic plan and the regional plans.	Maintain all TSMO plans online	Continuous

Systems and Technology

Appropriate planning, construction, operations, and maintenance of systems and technology ensures that the operational needs of an agency are met. By developing standard protocols and an iterative data management process, transportation solutions can be effective in enhancing mobility.

The 2016-2017 CMM indicated a need for faster procurement and upgrade processes, statewide software standards, and a platform to share data. To develop a successful TSMO program district-wide, the following action items related to Systems and Technology need to be completed:

- **Regional Architecture**—Districts will develop a systematic approach to planning, defining, and integrating an ITS architecture to accommodate regional needs. This can be done in coordination with the statewide requirements for including TMS on all projects. Per the Chief Engineer's memo from July 2016, all new roadway construction projects should include infrastructure that supports TMS, including the underground conduit that supports a fiber optic-based communications network. The Chief Engineer's memo from April 2017 requires that TMS be included in each project's planning, development, design, construction, maintenance, and operation. Specific TMS projects must be identified where gaps exist between typical road and bridge projects. The regional architecture should be updated at regular intervals, and no less than every five years.

- **Systems Engineering**—Districts will develop processes to implement the federally required systems engineering analysis (SEA). Training on the SEA, provided by FHWA or TRF, may be necessary for new staff.

- **Emerging Technology**—With new types of detectors, communication, and connected vehicle technology becoming available each day, a vetting process needs to be developed. The current device acceptance process will be re-evaluated regularly based on agency needs, industry standardization, and type of device.

- **Interoperability**—Districts will continue to coordinate with partner agencies (including local agencies, tolling agencies, neighboring districts, etc.) to support interoperability of systems, potentially through a statewide data sharing platform or existing memoranda of understanding. This will allow agencies to access data for supporting analyses and performance measures. IMD and TRF are working on projects to support interoperability between districts. These divisions should be included in interoperability activities to provide guidance and technical support.

Table 4, below, summarizes the district responsibilities for the Systems and Technology dimension.

Table 4: District Responsibilities for Systems and Technology

District Responsibilities	Objective	Evaluation Metric	Timeframe
	Develop and/or update regional architecture (update no less than every five years).	Send regional architecture to TRF for TSMO tracking purposes.	3 years
	Implement SEA process on projects as necessary.	Include SEA process in project delivery process in TSMO Program Plan.	1–2 years
	Consider re-evaluating current ITS processes based on emerging technology.	Include plan for considering re-evaluating ITS processes in TSMO Program Plan.	1–2 years

Collaborate with IMD and TRF to establish formal agreements to share data with partner agencies.	Send formal questionnaire to TRF to facilitate their execution	Continuous

When managing systems and technology, there are many considerations to evaluate. TRF and other central offices are available to provide technical expertise and statewide management support as follows:

- **Technical Support**—TRF and IMD will provide technical support and guidance, including, but not limited to, the following TMS challenges: system coverage, planning for expansion or upgrades, systems engineering, and ITS deployments in the field. They also can provide input on best practices for regional ITS architectures and concepts of operations. TRF may consider revising the approach to the development of regional ITS architectures to standardize practices across the state. TRF and IMD will continue to provide support for statewide software and technologies.

- **Standards and Specifications Development**—TRF will lead the development of statewide construction specifications and standards for ITS equipment. A standard statewide data platform or standards and specifications for sharing data also would help with multi-agency interoperability and to improve efficiency. This can be done with an iterative process—adding additional resources and stakeholders after initial concepts are proven.

- **Procurement**—TRF will develop procurement procedures to address the common procurement challenges faced by the districts. Purchasing ITS hardware often is subject to statewide procurement procedures that are not always well suited for the special characteristics of ITS systems and software, and the technology lifecycles. TRF also will manage statewide procurements and blanket purchase orders. An approved vendor product list will be maintained to facilitate purchasing ITS elements on construction projects, reducing the time needed to obtain the products, and overcoming the challenge of continually maintaining and updating specifications.

- **Statewide Management**—TxDOT central offices will develop and maintain statewide technology solutions for various needs, such as asset management, network management, software management and upgrades, and performance measurement. They also will support the implementation of statewide mobility strategies, such as incident management, data analytics, or intelligent work zones.

- **Cyber Security**—In an effort to protect assets and technology systems, a plan to improve cyber security of all TxDOT networks will be developed. The centralized offices will evaluate existing threats, implement protocols to protect existing technologies, and develop a strategy to assess and protect new assets.

- **Connected and Autonomous Vehicles (CAV)**—A statewide plan will be developed for how connected vehicle technology will be implemented throughout the state of Texas. Employing an incremental approach to implement emerging technology, the

plan should be responsive to industry capabilities. The plan should be updated on an annual basis to continue to provide information on relevant technologies.

Table 5, below, summarizes support from centralized divisions for the Systems and Technology dimension.

Table 5: Central Office Responsibilities for Systems and Technology

	Objective	Evaluation Metric	Timeframe
Central Office Responsibilities	Develop statewide data management and analysis platform.	Implement data management platform statewide.	2 years—scalable
	Develop statewide procurement procedures, including approved product vendor list.	Send statewide procurement procedures to districts.	Continuous
	Access cyber security threats and establish security protocols.	Implement security protocols statewide.	2 years—scalable
	Develop statewide connected and autonomous vehicle guidance/plan.	Send CAV guidance/plan to districts.	1 year

Performance Measurement

Performance measures are used to evaluate the effectiveness of mobility strategies and whether additional changes need to be made to achieve mobility goals. They are essential for making the business case for TSMO to decision makers and the public, and for gauging program success. Furthermore, monitoring performance measures regularly allows the program to be constantly improved and advances institutional continuous improvement.

Based on the 2016-2017 CMM, districts need specific definitions of performance measures to track, a better understanding of how to use them to make decisions, and the ability to automate the process to reduce employee workload. To develop a successful TSMO program district-wide, the following action items related to Performance Measurement need to be completed:

- Measures Definition—Districts will identify what their needs are for performance measurement management, considering state and federal reporting requirements (i.e., MAP-21/FAST Act), MPO project selection funding requirements, regional initiatives, or project requirements (i.e., TIM). Per Chief Engineer Bill Hale's April 2017 memo, districts are required to track and report the following performance measures: TMS asset operation uptime, incident clearance times, travel time reliability, and TMS system coverage. Definitions of these performance measures can be found in Appendix B. Districts should review these requirements, as well as needs to improve regional mobility when developing measures definitions.

- Measures Utilization Strategy—In coordination with defining the performance measures, districts will develop a strategy to determine reporting frequency,

coordination with other divisions, output functions, and other protocols. Districts may use performance measures for internal purposes, such as advocating for mobility strategies, and for external purposes, such as providing traveler information. Data can be used for accountability to understand if strategies are successful or need additional technical support and will be integrated into the planning process and evaluation of TSMO.

- **Data Acquisition**—Districts will identify what data already are available and what data will need to be acquired. ITS or third-party vendors may need to be contracted to meet the districts' needs.

Table 6 summarizes district responsibilities for the Performance Measurement dimension.

Table 6: District Responsibilities for Performance Measurement

District Responsibilities	Objective	Evaluation Metric	Timeframe
	Develop measures definitions, utilization strategy, and data acquisition plan for district-specific performance measures.	Include measures definitions, utilization strategy, and data acquisition plan in TSMO Program Plan.	1–2 years
	Monitor performance measures regularly.	Provide summary of status of achieving performance measures objectives at Statewide TSMO Meeting.	Continuous

Reporting and monitoring performance measures is a major role of the TMS initiative. Support from centralized divisions will include:

- **Measures Definition**—TRF, in coordination with IMD, will promote the development of a standard set of performance measures that have a common definition statewide and are consistent with the MAP-21 requirements, as well as the performance-based planning requirements that guide project selection criteria and funding distributions in the UTP.

- **Measures Utilization Strategy**—The Central Office will maintain and revise accountability and reporting policies, as necessary. Existing and potential statewide technology solutions for performance measurement and reporting will be developed and maintained by centralized divisions.

- **Data Acquisition**—TRF will evaluate the potential of statewide private sector data and connected vehicle data acquisition.

Table 7 summarizes support from centralized divisions for the Performance Measurement dimension.

Table 7: Central Office Responsibilities for Performance Measurement

	Objective	Evaluation Metric	Timeframe
Central Office Responsibilities	Develop measures definitions, utilization strategy, and data acquisition plan for statewide performance measures.	Provide statewide performance measures definitions to all districts.	1–2 years
	Verify and consolidate districts' performance measure strategy into statewide platform dashboard.	Share consolidated district performance strategies with all districts.	1–2 years

Organization and Workforce

Technically qualified staff and an organizational structure that unites TSMO activities into an integrated project delivery approach are key to supporting effective TSMO solutions. Through training, identifying TSMO responsibilities, and building relationships across teams, TSMO functions will be engrained in an agency's day-to-day work efforts.

Based on the 2016-2017 CMM, to institutionalize a TSMO program, districts need formal training, revised position responsibilities, and guidance on recruitment and development of current employees to assist with TSMO activities. To develop a successful TSMO program district-wide, the following action items related to Organization and Workforce need to be completed:

- **Training**—Districts will participate in training provided by centralized divisions, FHWA, or other national experts. Districts also may coordinate with agency partners to participate or develop training. Potential training topics include benefits of TSMO, applications and case studies of mobility strategies, or emerging technology.

- **Organizational Development**—A review of the organizational structure will be completed to determine which roles will take on TSMO activities and what new positions or core capabilities need to be developed to support the program. Rearranging the organizational structure may be necessary to promote collaboration between teams and provide project authority. It is important to take into consideration all roles/responsibilities throughout the district when identifying TSMO responsibilities to improve engagement in TSMO activities. This should be done in coordination with the TSMO champion(s) to share expertise and lessons learned from other agencies. Additionally, a strategy for providing adequate staffing, recruitment, and succession will be developed.

Table 8, below, summarizes the district responsibilities for the Organization and Workforce dimension.

Table 8: District Responsibilities for Organization and Workforce

District Responsibilities	Objective	Evaluation Metric	Timeframe
	Develop TSMO training plan.	Include training plan in TSMO Program Plan.	1–2 years
	Review and revise agency structure to accommodate TSMO activities.	Include revised agency structure in TSMO Program Plan.	1–2 years
	Develop staffing plan, including revised position responsibilities, recruitment, and succession, to accommodate TSMO activities.	Include staffing plan in TSMO Program Plan.	1–2 years

A majority of the organization and workforce decisions lie with the districts; however, central offices will provide training and resources to the districts as needed. Support from centralized divisions will include:

- **Training**—TRF will develop or provide access to training for districts and partner agencies. Training may be facilitated as a stand-alone activity, through multi-district meetings (e.g., Statewide ITS Meeting), or at conferences.

  TRF also is engaged with national forums, including the National Operations Center of Excellence (NOCoE), Transportation Research Board (TRB), AASHTO, and others. These organizations can be resources to the districts and provide insight on best practices from around the country.

- **Organizational Development**—Centralized offices will assist the districts with identifying core capabilities and developing job descriptions to support TSMO activities with respect to both technical and managerial roles. This also may include reviewing all project delivery responsibilities to identify where the integration of TSMO activities can be included.

Table 9 summarizes the Central Office responsibilities for the Organization and Workforce dimension.

Table 9: Central Office Responsibilities for Organization and Workforce

Central Office Responsibilities	Objective	Evaluation Metric	Timeframe
	Provide TSMO training opportunities to districts.	Provide training biannually.	Continuous

Culture

The culture of an organization represents the values and beliefs that lead to certain decisions being made. Through a business case or outreach opportunities, TSMO messaging can be communicated to others inside and outside of the agency to gain support.

Respondents in the 2016-2017 CMM identified a need for local TSMO champions, advocacy on projects, development of new processes, and a business case encouraging executive leadership in TSMO. To develop a successful TSMO program district-wide, the following action items related to Culture need to be completed:

- Outreach—Because the concepts will be new to most people in an agency, it is important to seek out opportunities to discuss the value of TSMO. Districts will take advantage of opportunities, such as regularly scheduled multi-disciplinary meetings, to share information using statewide resources such as presentations or handouts. Training, internal campaigns, and newsletters also will help develop commitment and advocates for the TSMO program. These are great opportunities not only to engage the transportation planners and engineers who will be directly involved with TSMO activities, but also other staff within an agency so that it is understood why certain strategies or projects are prioritized over others. These outreach opportunities will be organized in a district-level engagement plan. As part of the development of a district program plan, districts will customize the business case from the TxDOT Statewide TSMO Strategic Plan to meet their unique needs. It also may be revised to speak to different audiences, such as executive leadership, implementers, or the general public. This is a powerful tool to succinctly describe the value and potential benefits for prioritizing mobility strategies and to communicate directly to the audience's core values.

- Leadership—Districts will engage a TSMO coordinator to be a leader and a connection to other resources for technical expertise. The TSMO coordinator will encourage thoughtful discussion, advocate for innovative ideas on projects, and be a point of contact to centralized TxDOT divisions for support. This position would be held by an available staff member from the district, potentially the Statewide ITS Leadership Committee representative or designee. Potential responsibilities for the TSMO coordinator include:
    - be available as the point of contact for TSMO questions
    - organize regional TSMO committee meetings
    - lead tactical planning activities

  Districts also will identify a TSMO champion to show support for the initiative from management and to advocate for TSMO to a wide range of audiences, including both internally and with TxDOT's partner agencies. This would be an administration-level district staff member who will enable the coordinator to effectively support staff members, and who will seek out opportunities to grow and develop the TSMO approach.

Potential responsibilities for the TSMO champion include:

- advocate for TSMO activities during executive and/or leadership meetings
- lead requests for resources and funding to support TSMO activities
- communicate value of mobility strategies and successful TSMO activities

Table 10 summarizes the district responsibilities for the Culture dimension.

Table 10: District Responsibilities for Culture

District Responsibilities	Objective	Evaluation Metric	Timeframe
	Develop TSMO engagement plan.	Include engagement plan in TSMO Program Plan.	1–2 years
	Customize TSMO business case to meet individual district needs.	Include business case in TSMO Program Plan.	1–2 years
	Identify TSMO coordinator.	Send TSMO coordinator name to TRF for TSMO tracking purposes.	3–6 months
	Identify TSMO champion.	Send TSMO champion name to TRF for TSMO tracking purposes.	3–6 months

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To promote the benefits of TSMO statewide and provide unified messaging, TRF will provide resources to the districts. Support from centralized divisions will include:

- **Outreach**—TRF will facilitate TSMO learning opportunities internally or offered by national organizations, such as the FHWA. TRF will identify and take advantage of opportunities to engage agency staff of all backgrounds into discussions about TSMO at meetings, conferences, and other collaborative work efforts. Resources for district communication and engagement regarding TSMO will be developed. This may include, but is not limited to, a short presentation, handouts, or case studies of successful TSMO activities. These resources will be available for any district to leverage and customize as necessary. The business case developed in the TxDOT Statewide TSMO Strategic Plan will be distributed to highlight the distinctive payoffs from highly cost-effective and innovative TSMO solutions.

- **Leadership**—Centralized divisions will promote TSMO concepts as a multi-discipline activity involving planning, design, construction, maintenance, traffic operations, and others. This may involve providing a forum for senior management to collaborate and learn about the benefits of TSMO to help them advocate for it in their districts or divisions. Central divisions will identify a TSMO coordinator to support the statewide TSMO activities and provide guidance to the districts. The list of divisions that require a TSMO coordinator will be determined by TRF and may include information management, transportation planning and programming, maintenance, and others.

Table 11 summarizes the centralized office responsibilities for the Culture dimension.

Table 11: Central Office Responsibilities for Culture

	Objective	Evaluation Metric	Timeframe
Central Office Responsibilities	Develop engagement plan for advocating for TSMO.	Implement engagement plan statewide.	6–9 months
	Develop standard format for case studies.	Send case study template to districts.	9-12 months
	Develop engagement resources (presentations, handouts, etc.) for districts.	Send engagement resources to districts.	6 months
	Divisions determined by TRF will identify a TSMO coordinator.	Send TSMO champion name to TRF for tracking purposes.	3-6 months

Collaboration

The effectiveness of TSMO activities depends on the ability of divisions, districts, partner agencies, and other stakeholders to work together. Taking advantage of opportunities to build internal and external relationships will help with communication and overcoming challenges in the future.

Throughout Texas, interagency partnerships are in place, but more organization is needed to collaborate, engage stakeholders, and develop official agreements for projects. To develop a successful TSMO program district-wide, the following action items related to Collaboration need to be completed:

- Internal District Stakeholders—Districts will develop processes to find opportunities to encourage collaboration between multiple district units (i.e., design, construction, traffic, maintenance) to identify project challenges as early as possible. This may be done through regularly scheduled meetings, scoping meetings, project reviews, or other opportunities that fit the district's needs. Districts also may consider developing an internal TSMO working group to establish formal meeting opportunities. This could also be an opportunity to engage divisions, such as TRF or IMD, to provide technical support or guidance.

- Public Agencies and MPOs—A review of available long-term planning documents or TSMO plans produced by partner agencies will be completed to identify where

regional TSMO efforts can support existing goals. Agencies will work together to identify roles and responsibilities for executing action items. To encourage collaboration between public agencies and MPOs, a Regional TSMO subcommittee will be established and model the format of the statewide ITS meeting. This will be an opportunity to make agreements for collaborating on projects, planning efforts, and sharing data. It also may be valuable to include first responders and other traffic incident management responders.

- **Public-Private Partnerships**—It is becoming increasingly common for companies to promote mobility as a service or provide transportation data. Districts will develop a plan to cultivate strategic relationships with private companies to collaborate on tasks such as incident management or traffic management center staffing, to provide access to data and analytics, or to provide alternative mobility solutions (i.e., ride hailing services).

Table 12 summarizes the district responsibilities for the Collaboration dimension.

Table 12: District Responsibilities for Collaboration

District Responsibilities	Objective	Evaluation Metric	Timeframe
	Include internal collaboration in revised project delivery process.	Include project delivery process in TSMO Program Plan.	1–2 years
	Establish opportunity to engage internal stakeholders, including division support, such as district TSMO working group.	Schedule consistent internal meeting or other opportunity.	12–18 months
	Attend and participate in Statewide TSMO Meeting.	Attend Statewide TSMO Meeting.	Continuous
	Review planning documents and evaluate where TSMO can support planning objectives.	Include planning document evaluation in TSMO Program Plan.	1–2 years
	Establish Regional TSMO subcommittee with internal and external stakeholders.	Attend Regional TSMO subcommittee meetings.	Continuous

The TxDOT central offices will be a liaison between multiple organizations to help connect districts to the resources they need. Support from centralized divisions will include:

- **Organize Statewide Meetings**—A statewide TSMO meeting will be initiated to discuss district TSMO activities and share best practices, similar to the existing Statewide ITS Meeting format. TRF will organize the meeting and may coordinate with the Statewide ITS Meeting to leverage traffic engineers' availability. Presentations also will be made by centralized divisions to deliver strategic direction, present updates on statewide initiatives and technology, and gather information from the districts. The regional

TSMO subcommittees may choose to present on progress and current initiatives during this meeting. Traffic Management Section regional representatives should frequently engage district staff to identify areas the district may need support.

- **Coordination**—TRF will support districts through the coordination of multiple districts, partner agencies, and private companies. This may include evaluating formal agreements, developing unified performance measures, or developing technology for sharing data to execute mobility strategies.

Table 13 summarizes the central office responsibilities for the Collaboration dimension.

Table 13: Central Office Responsibilities for Collaboration

Central Office Responsibilities	Objective	Evaluation Metric	Timeframe
	Initiate a Statewide TSMO Meeting, including district and division representatives.	Hold regular Statewide TSMO Meetings.	3–6 months
	Traffic Management Section regional representatives will provide support to districts in their region.	Discuss strengths/weaknesses at regional ITS meetings.	Ongoing

References

Strategic Highway Research Program (SHRP2). (2014). *Gap Filling Project 6: Business Case Primer Communicating the Value of Transportation Systems Management and Operations.* Washington, D.C.: Transportation Research Board.

Texas Department of Transportation. (2015). *Texas Transportation Plan 2040.* Austin, TX: Texas Department of Transportation.

Texas Department of Transportation, Transportation Planning and Programming. (2017). *2017 Unified Transportation Program (UTP).* Austin, TX: Texas Department of Transportation.

Texas Department of Transportation, Transportation Planning and Programming Division. (2012). *The Texas Rural Transportation Plan.* Austin, TX: Texas Department of Transportation.

APPENDIX A: TxDOT District TSMO Program Plan Table of Contents

TxDOT District TSMO Program Plan Table of Contents

The following outlines a common Table of Contents to be used for district and/or regional TSMO plans. Any modifications to the Table of Contents will require approval of the statewide TSMO committee. The goal is to maintain a common look and feel for the TSMO plans, which will be developed regionally, with multiple contributors.

1. Executive Summary
2. Introduction
3. Business Case for TSMO Summary
   A. Potential business case topics: funding, congestion, safety, mainstreaming TSMO
4. TSMO Mission, Vision, Goals, and Objectives
   A. Statewide TSMO Vision
   B. Statewide TSMO Mission
   C. District-specific TSMO Goals and Objectives
5. Capability Maturity Model
6. Mobility Challenges and Strategies
7. Program Plan Format
8. Capability Components
   A. Business Processes
      i. Revised project delivery process to include TSMO activities and TSMO tool
      ii. Planning for TSMO
      iii. Programming, Budgeting, & Funding
      iv. Continuous improvement
   B. Systems & Technology
      i. Systems Engineering Analysis Process
      ii. Process to Vet Innovative Technology
      iii. Regional ITS architecture
      iv. Existing and Planned Tools
   C. Performance Measurement
      i. Agency Performance-Based Initiatives
      ii. District-Wide (or Project Specific) Performance Measures
      iii. Regional Performance-Based Initiatives
      iv. Measures definitions
      v. TMS Status Report required performance measures
      vi. Utilization strategy
      vii. Data acquisition plan
   D. Organization & Workforce
      i. Revise organization structure to accommodate TSMO
      ii. Key TSMO Roles
      iii. Staffing plan for recruitment, retention, and revised position responsibilities to accommodate TSMO activities
      iv. Training plan
   E. Culture
      i. Engagement Opportunities
   F. Collaboration

i. Procedures/plan with internal partners (HQ, design, maintenance, traffic, structures, etc.) & how to include in the project delivery process
ii. Procedures with External Partners (COGs, cities, counties, etc.) including study of where TSMO can support planning objectives
iii. Procedures/plan with other districts to coordinate projects, operations, ITS management
iv. Plan for developing public-private partnerships and strategic alliances

9. TSMO Tactical Plan Assessment
   A. Tactical Plan Criteria
   B. Tactical Plan Components
   C. Recommended Tactical Plans
10. TSMO Implementation Plan
   A. Schedule, tasks, identified leads for each TSMO task in each district
11. References
12. Appendices

APPENDIX B: TxDOT Chief Engineer's Memos

Texas Department of Transportation

MEMO

July 1, 2016

To: District Engineers

From: William L. Hale, P.E.
Chief Engineer

Subject: Traffic Management Systems in Construction Projects

As TxDOT moves ahead with the goals of reducing congestion and enhancing safety, it is critical that Traffic Management Systems (TMS) be included on new roadway construction projects. Including TMS at earliest stages of project development planning will maximize investments by leveraging comprehensive project construction cost at the earliest stages when TMS can be included for a fraction of total project cost.

Freeway TMS typically includes Dynamic Message Signs (DMS), Closed Circuit Television (CCTV) Cameras, Traffic Sensor Systems and the telecommunications networks connecting the field devices to the Transportation Operations Center (TOC). Additional TMS devices that are installed due to specific needs include High Water Detection Systems, Wrong Way Driver detection and warning systems, Over Height Detection and Warning Systems and others.

It is critical that roadway construction projects include the fiber optic based communications during construction. Fiber optic cable is the recommended communications mode for Traffic Management for many reasons as described below:

- Capacity – Fiber has greater capacity than wireless technologies. Reliability – Fiber is more reliable than wireless due to its contained environment.
- Redundancy – Fiber is the optimal method to provide network redundancy with TMS field equipment as a best practice under all circumstances and especially for unforeseen emergency situations. Additionally, TMS fiber can enhance ability for metro traffic management centers to support other centers during emergency situations.
- Cost – Although initial capital cost for wireless may be lower, fiber has several cost benefits:
    - No recurring utility/power costs or licensing.
    - Reduced maintenance costs as noted in Reliability.
    - Cost – TxDOT can install fiber on state right-of-way during initial construction for its own use usually at a lower cost than a utility will pay for a right-of-way and fiber installation for lease to TxDOT.

The optimum time to install the underground conduit that will support the fiber networks on state right of way is during roadway construction and reconstruction projects, when the nature of the work already requires significant disturbance of the right of way. The conduit installation should be part of the construction phasing. Where reconstruction projects are planned for roadway segments with

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existing Traffic Management Systems, a plan for the temporary operation of the equipment during construction should be included in the construction plans.

If you have any questions on TMS during project development, please contact Carol T. Rawson (TRF) (512) 416-3200.

CC: Carol T. Rawson, P.E., Director, Traffic Operations Division
C. Michael Lee, P.E., Director, Maintenance Division
Mark A. Marek, P.E., Director of Engineering & Safety Operations
Lauren D. Garduño, P.E., Director of Project Planning & Development
Randy C. Hopmann, P.E., Director of District Operations
Darran Anderson, Director of Strategy and Innovation
Rene Garcia, P.E., Director, Design Division
Gregg A. Freeby, P.E., Bridge Division Direction

Texas Department of Transportation

MEMO

April 7, 2017

To: District Engineers

From: William L. Hale, P.E.
Chief Engineer

Subject: Statewide Procedures for Traffic Management Systems

The Traffic Operations Division (TRF) is working to upgrade and coordinate the state's Traffic Management System (TMS). With the Information Management Division (IMD) we are looking to improve technology, processes and procedures, and help all districts implement state-of-the-art TMS practices.

A strategic statewide TMS that includes strong Intelligent Transportation System (ITS) practices and traffic signal operations provides the most cost effective means to address safety, congestion, mobility, connectivity, maintenance and emergency response available. Operating the state roadway system in the most efficient manner is expected.

TRF has outlined a common set of objectives for the Districts. Over the coming months, IMD and Traffic will be working with each district to determine the approach and investments needed to meet these objectives. Each district will be expected to ensure (1) TMS is included in each project's planning, development, design, construction, maintenance and operation, and (2) provide specific TMS projects where gaps exist between typical road and bridge projects. Funding for these efforts is expected to be included as an element of each project in the selection process of the Unified Transportation Program.

TMS procedures will be discussed in next week's Engineering Operations and Quarterly Senior Leadership meeting (April 11-13, 2017), and the upcoming Directors of Operations Meeting (April 24-26, 2017).

Please contact Michael Chacon, 512-965-3073 if you have questions.

Attachment

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Statewide Procedures for Traffic Management Systems

The Texas Department of Transportation is currently outlining statewide procedures for future implementation and upgrades to Traffic Management Systems (TMS), which includes Intelligent Transportation Systems (ITS) and Traffic Signal operations across the state on-system roadways.

The Traffic Operations Division (TRF) will take the lead in introducing and coordinating these procedures, and Information Management Division (IMD) will support the Districts by assisting with technology solutions for District needs. The Districts have the responsibility of local implementation of these TMS procedures.

The Metro Districts and El Paso will be the focus of these TMS implementation and upgrade procedures. The procedures will later be expanded based on lessons learned and adapted to Urban and Rural Districts.

Traffic Management Systems

TMS has been proven to improve mobility and safety, and is widely recognized as having high return on investment. Per the Chief Engineer's memo from July 2016, ITS needs must continue to be considered early in project development, design, and construction.

As the department increases investments for congestion relief, it is imperative that TMS and operational improvements complement the construction and maintenance program efforts. This includes ensuring TMS planning is involved in the early stages of project development and design, and adequately preserving these systems during construction. In addition, as technology and data continue to evolve, it is critical to ensure this information and infrastructure is secure, meets industry best practices, and is prepared for future innovations in transportation.

There is large variation in traffic management performance across the state. Some Districts have adopted leading best practices, and some Districts have gaps in performance due to limited resources or prioritization among other efforts. To achieve a level of uniformity and implementation, the Districts working with TRF and IMD, are expected to plan and implement TMS efforts from FY 2017-2019 to achieve the following goals and improvements:

1. Equipment maintenance and asset management: Ensure 90%+ equipment is operational including feasible areas under construction; implement asset and network management

2. System coverage and planning for innovation and expansion: Prioritize, plan, execute projects through UTP process to increase ITS coverage and network connectivity on all interstates and other key roadways on the state system; Prepare the system for future innovations in infrastructure
3. Incident Management: Collect incident clearance data, set targets, and continuously improve incident management processes in collaboration with regional partners
4. Work zone management: Minimize adverse impact of work zones on the public (in terms of crashes or delays), use "smart" technologies, and improve planning and operation of work zones in ongoing construction and maintenance activities
5. Communicating with public through Dynamic Message Signs (DMS) and media: Improve travel time reliability and proactively provide public effective traffic info on-road, online, at home (through DMS and media, sharing with partners, and private sector)
6. Implement strategies to improve traffic flow: Where feasible, expand use of Active Transportation Demand Management (ATDM) and increase integration of Signals and ITS network to manage flow across on-system highways and arterials

While each District has a different starting point, TRF has outlined a common set of objectives for the Districts. Each District can define their own best approach and investments needed to meet these objectives. This includes ensuring TMS is included in the early stages of project development, planning and design, and that district projects adequately preserve systems during construction.

Districts can learn from each other by sharing best practices, how to plan projects to include TMS where appropriate, fund, implement Traffic Management improvements. TRF will facilitate best practice sharing, and IMD will support common technological solutions across districts. In the future, TRF will also provide Transportation Systems Management and Operations (TSM&O) guidance for the Districts. The Administration will regularly review the performance of TMS in TRF and the Districts.

TRF will begin the introduction of these TMS procedures in the upcoming Quarterly Senior Leadership meeting (Apr 11-13, 2017), and the upcoming Directors of Operations Meeting (April 24-26, 2017). With District input and review, performance metrics will be rolled out in the Engineering Operations dashboard initially using data from the Metro Districts and El Paso. As part of the upcoming FY 2018 update of the Unified Transportation Program (UTP), TRF Division will work with Metro Districts and El Paso to compile funding needs for FY 2018-2019 to ensure Traffic Management needs are fully considered.

New Information Technology solutions by IMD to support Districts' traffic management needs are being piloted with Districts in FY 2017, and will be expanded going forward. In meetings with the ITS and Operations District staff, TRF will continue to facilitate best-practice sharing across Districts, and TRF and the Districts will review progress of implementing these procedures to report back to Administration.

Based on District, TRF and Administration input, the following 4 metrics will be reviewed as a pilot in FY 2017.

- TMS asset operational uptime to measure how Districts maintain their traffic management equipment, is the most critical metric to improve in the short-term
- Incident clearance times to measure mobility on our system, driven by District incident management processes in collaboration with regional partners
- Level of travel time reliability, an FHWA MAP-21 recommendation, to measure impact on the public from traffic management strategies applied to on-system roads e.g. work zone management, DMS, etc.
- TMS system coverage to measure and understand what portion of on-system roadways are adequately covered with ITS equipment and communications, or where coverage needs to be expanded

IMD has been tasked with leading the aggregation of data across Districts for Engineering Operations and ADM dashboards. IMD will work with the Metro and El Paso Districts and TRF to address gaps in systems, with the goal to have full data across these metrics established by the end of FY 2017. Additional data or analyses may be used by Districts to demonstrate progress or improve performance.

As part of the District interviews conducted, several technology solutions have been identified as a priority need for Districts to improve Traffic Management systems and operations. IMD will lead the implementation of the following technology solutions to meet District needs.

- Asset management system: IMD will prototype a software with Forth Worth District in FY17 to set up processes to track asset details, manage repairs, and support better planning and use of maintenance funds.
- Network monitoring and management: IMD will prototype a system with Austin District and TRF's Cedar Park facility in FY17 to monitor the traffic management network to diagnose and troubleshoot ITS or Signal connectivity issues and manage network connections. Solutions to improve the network monitoring will also incorporate IMD's recommendations for improving security of the traffic management network infrastructure.
- Data analytics: IMD will define analytical tools for traffic management operations and planning using historical or real-time traffic data. These may include use of existing tools or new complex approaches such as simulation of traffic situations, in collaboration with the research community and private sector.
- Resource Requirements: IMD will advise ADM on a continuing basis of the technology and monetary resources needed to upgrade and implement TMS technology both at the statewide level as well as the individual district level.

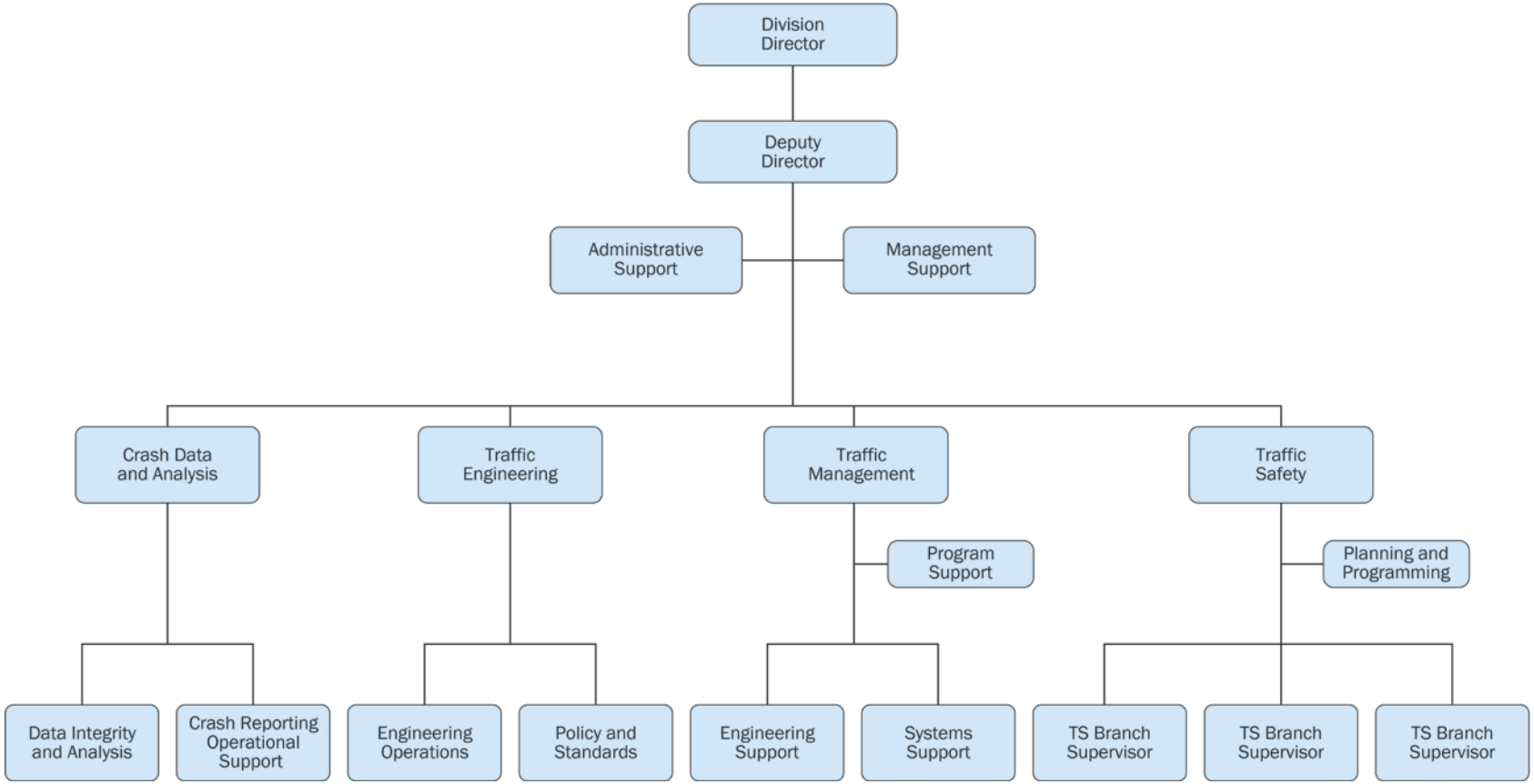
These solutions will help improve system performance and reliability, reduce time or risk of manual efforts in the field, and help Districts best allocate their resources. District are requested to work with TRF and IMD to provide feedback on how these common technology solutions can be adopted to meet the Districts' needs and industry best practices. The goal is to expand these solutions to other Districts as appropriate in FY 2018-2019.

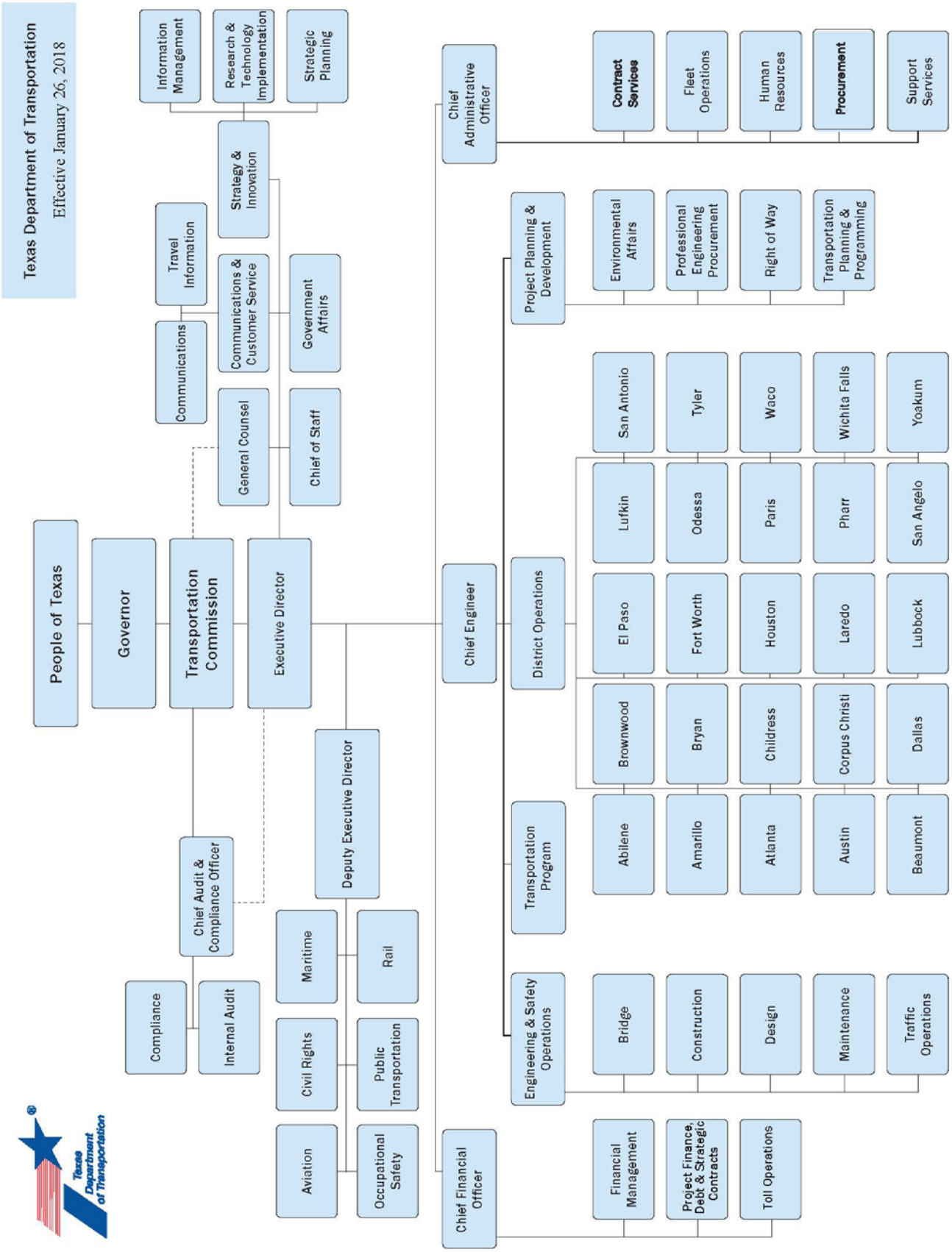
Initially, each Metro District and El Paso will submit the current status of their TMS and upgrade/implementation plans for the next twelve months to TRF on September 1, 2017 and March 1, 2018. TRF will compile these status reports and annual plan reports for the Chief Engineer on October 1, 2017 and April 1, 2018. TRF will provide a format for these reports.

For any questions related to the TMS upgrades and implementation, or performance metrics, please contact Michael Chacon, Traffic Operations Division Director. For any questions around the technology solutions, please contact Cassie Jordan, IMD Section Director for Strategy and Portfolio Management.

APPENDIX C: 2018 TxDOT Organizational Charts

Traffic Operations Division




Texas Department of Transportation
Effective January 26, 2018
People of Texas
Governor
Transportation Commission
Executive Director
Chief Audit & Compliance Officer
Compliance
Internal Audit
Communications
Travel Information
Communications & Customer Service
General Counsel
Strategy & Innovation
Information Management
Research & Technology Implementation
Strategic Planning
Government Affairs
Chief of Staff
Deputy Executive Director
Maritime
Rail
Civil Rights
Public Transportation
Aviation
Occupational Safety
Chief Engineer
Project Planning & Development
Environmental Affairs
Professional Engineering Procurement
Right of Way
Transportation Planning & Programming
District Operations
San Antonio
Tyler
Waco
Wichita Falls
Yoakum
Lufkin
Odessa
Paris
Pharr
San Angelo
El Paso
Fort Worth
Houston
Laredo
Lubbock
Brownwood
Bryan
Childress
Corpus Christi
Dallas
Abilene
Amarillo
Atlanta
Austin
Beaumont
Transportation Program
Engineering & Safety Operations
Bridge
Construction
Design
Maintenance
Traffic Operations
Chief Financial Officer
Financial Management
Project Finance, Debt & Strategic Contracts
Toll Operations
Chief Administrative Officer
Contract Services
Fleet Operations
Human Resources
Procurement
Support Services
Texas Department of Transportation

APPENDIX D: TSMO Evaluation

TSMO Evaluation

As part of Work Authorization #10 to develop statewide transportation systems management and operations (TSMO) guidance for the Texas Department of Transportation (TxDOT), Atkins was tasked with developing a TSMO Evaluation. The purpose of the TSMO Evaluation is to provide project managers with questions early in the project delivery process to encourage a holistic and innovative approach to project development. Project managers will answer questions regarding the project in planning or scoping phases to determine if any mobility solutions or TSMO activities can be incorporated to improve effectiveness and efficiency of the project, or future projects.

In Work Authorization #10, the TSMO Evaluation was scoped to be a standalone application provided to TxDOT. During the development of the Statewide TSMO Strategic Plan, the project team learned about the Modernize Portfolio and Project Management (MPPM) initiative to incorporate over 40 different project development systems to a single platform. With MPPM being a perfect example of a TSMO activity, the team agreed that incorporating the TSMO Evaluation with MPPM would be advantageous to both parties. It provides an opportunity to enhance project development activities using a platform that is already integrated into TxDOT procedures. The TSMO Evaluation is expected to be more widely accepted if it is smoothly integrated with the regular project development workflow.

The following document provides questions and background information to be used for the TSMO Evaluation as part of the MPPM initiative.

COORDINATION & COLLABORATION:
The purpose of the coordination and collaboration section is to provide project managers with directions on which stakeholders should be involved in the project delivery process based on the facility. By having the right representatives in discussions early on, it promotes project acceptance, diversity of ideas for solving problems, and allows different teams to voice their concerns prior to design.

1. Coordinate with required stakeholders to complete the evaluation, based on the type of facility, using the following table:

Stakeholders	Freeways	Arterials	Collectors	Local Streets
Planning division	✓	✓	✓	✓
Incident manager	✓	✓		
District engineer	✓	✓	✓	
Traffic operations/ management center	✓	✓		
Project managers of adjacent projects	✓	✓		

Stakeholders	Freeways	Arterials	Collectors	Local Streets
Public information offices	✓	✓		
Special events manager	✓	✓		
Federal Highway Administration	✓			
Cities and counties	✓	✓	✓	✓
Transit agencies	✓	✓	✓	✓
School districts	✓	✓	✓	✓
Metropolitan planning organizations (MPO) or councils of governments (COG)	✓	✓	✓	
Law enforcement	✓	✓		
Local businesses	✓	✓	✓	✓

SAFETY:

The safety section of the TSMO Evaluation requires the project manager to use available crash data or reports to identify safety issues within the project area. The project manager can make recommendations to include within the scope to improve safety on the project and during construction. Using available crash data will help stakeholders understand the need for improvements and implement solutions to directly address the project challenges.

1. Is there a safety problem in the project area, as documented through historic crash data, road safety audit, previous studies etc.?
    a. If yes, what are the potential countermeasures?
    b. Are there recurring crash patterns that indicate trends or a systematic crash problem at this location?
2. Are the following safety elements adequate? Do they need to be added/upgraded to meet current standards or address safety problems? If so, please provide additional details.
    a. Roadway surface skid resistance and drainage
    b. Guardrail
    c. Safety edge
    d. Super-elevation or crown
    e. Pavement markings, signing, and delineation
    f. Advance warning signs
    g. Button reflectors and guardrail reflectors
    h. Sight distance
3. Which of the following smart work zone safety measures must be included in the scope of the project?
    a. Real-time traveler information
    b. Temporary queue warning
    c. Performance measurement
    d. Entering/exiting construction vehicle notification
    e. Other (please provide details)

OPERATIONS:

The purpose of the operations section is to provide project managers with an opportunity to improve the operations and mobility of a facility. By leveraging the Federal Highway Administration's threshold for poor mobility, the project manager can determine the types and scale of potential solutions required. Using operations data will also help develop the business case for recommendations and develop an understanding for the project's needs. A mobility toolbox was created for TxDOT to provide project managers with ideas for improving mobility on projects. It includes strategies and solutions for all types of facilities to be recommended and scaled based on the project. The operations section also includes questions regarding traffic incident management and work zone management; two initiatives becoming increasingly important on construction projects for TxDOT for the value and service they provide for travelers.

1. Is there an operations problem in the project area based on the travel time reliability performance measures? Is the Level of Travel Time Reliability (LOTTR) or the Peak Hour Travel Time Ration (PHTTR) greater than 1.5? LOTTR of 1.5 or greater is determined by FHWA to be not reliable.
    a. If yes, can any of the strategies from the mobility toolbox be used to mitigate the congestion issues? If so, how?
2. Has a traffic incident management (TIM) plan been developed for operations during construction? What coordination is required to maintain incident management during construction?
    a. If a TIM plan has not yet been developed, if on a freeway or arterial facility, would it be valuable the project and can one be developed within the scope of the project?
    b. If a TIM plan has not and will not be developed, could the following TIM activities be included within the scope of the project:
        i. Courtesy patrol (new or coordinate with existing)
        ii. Traffic diversion plans and trailblazing
        iii. Data collection and integration
        iv. Traveler information
3. Has a work zone management plan been developed for operations during construction?
    a. If not, have the following zone management strategies been considered to minimize adverse impact of work zone on the public during project construction:
        i. Dynamically managed work zones
        ii. Temporary queue warning systems
        iii. Traveler information
4. Can improvements related to how the roadway integrates with existing roadway be incorporated into the project? For example, lane utilization, merge/diverge, etc.

TECHNOLOGY:

The purpose of the technology section is to ensure that technology is appropriately considered and included in projects. Through the Traffic Management System (TMS) initiative, TxDOT recognizes the value of systems and technology to effectively operate and manage the transportation network. The technology section of the TSMO Evaluation uses guidance from Chief Engineer Bill Hale's memos, (1) Statewide Procedures for Traffic Management Systems in Construction Projects dated July 1, 2016 and (2) Statewide Procedures for Traffic Management Systems dated April 7, 2017, to encourage project managers to consider including TMS in the project scope.

1. Is there an innovation or technology solution that can help improve system safety, operations, and reliability?
2. Are any improvements needed to ensure maintenance and asset management equipment maintains operation during construction and after project completion?
3. Is there an opportunity to include TMS improvements within the project to improve ITS coverage and network connectivity?
4. Can any ITS technology or applications be included within project scope to monitor performance measures?
5. Are there any existing ITS infrastructure/devices within the project limits? Can they be operated better to provide benefit during construction and afterward?
6. Is the project implementing or replacing new ITS infrastructure/devices?
    a. Will the Systems Engineering Analysis (SEA) process need to be initiated for this project?

PROJECT CLOSEOUT:

The project closeout section is expected to be completed after the design stages are complete in order to document which recommendations from the previous sections were implemented. If recommendations were not implemented, they may not have been funded and it is valuable to understand if an additional project should be developed to develop the recommendation or if it should be included on a future project. These recommendations can be queried at a later date to help develop projects or justify a business case for funding.

1. Which recommendations were implemented?
2. If some recommendations were not implemented, why not?
3. If recommendations were not implemented, should they be added to a critical project list to be included in a future project? Why or why not?
    a. Should any of the recommendations be advanced on its own or considered next time on a future project?

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