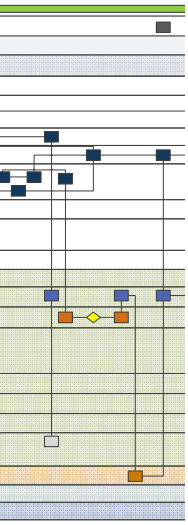
TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO)



SAN ANTONIO DISTRICT PROGRAM PLAN

March 2022

Texas Department of Transportation

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ACRONYMS AND ABBREVIATIONS

Arcadis	Arcadis U.S., Inc.
AAMPO	Alamo Area Metropolitan Planning Organization
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
ATMS	Advanced Traffic Management System
ATSPM	Automated Traffic Signal Performance Measures
CAV	Connected and Automated Vehicle
CCTV	Closed-Circuit Television
CMF	Capability Maturity Framework
CMM	Capability Maturity Model
comm	Communications
Con-Ops	Concept of Operations
COSA	City of San Antonio
CRIS	Crash Records Information System
DCC	Design Concept Conference
DDRT	District Design Review Team
DE	District Engineer
DMS	Dynamic Message Sign
DOT	Department/s of Transportation
DSRT	District Safety Review Team
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HERO	Highway Emergency Response Operator
ITS	Intelligent Transportation Systems
NPMRDS	National Performance Management Research Data Set
PDO	Property Damage Only
PDP	Project Development Process
PIO	Public Information Officer
PS&E	Plans, Specifications, & Estimates
PTI	Planning Time Index
SAPD	San Antonio Police Department
SAT	San Antonio District
SEA	Systems Engineering Analysis
SHRP2	Second Strategic Highway Research Program
SWZ	Smart Work Zone
TAC	Technical Advisory Committee
TIM	Traffic Incident Management
TM	Traffic Management
TMC	Traffic Management Center

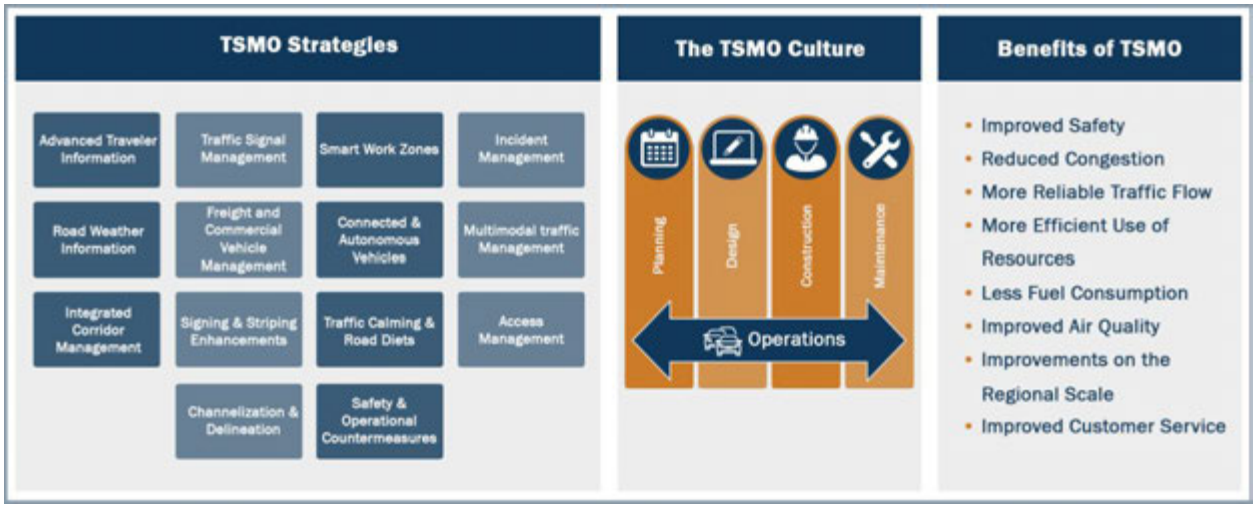
TMS	Traffic Management Systems
TP&D	Transportation Planning & Development
TRF	Traffic Division
TSM	Traffic Signal Management
TSMO	Transportation Systems Management and Operations
TSP	Transit Signal Priority
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation
UTP	Unified Transportation Program
VIA	VIA Transit
WZ	Work Zone
WZM	Work Zone Management

EXECUTIVE SUMMARY

What is TSMO?

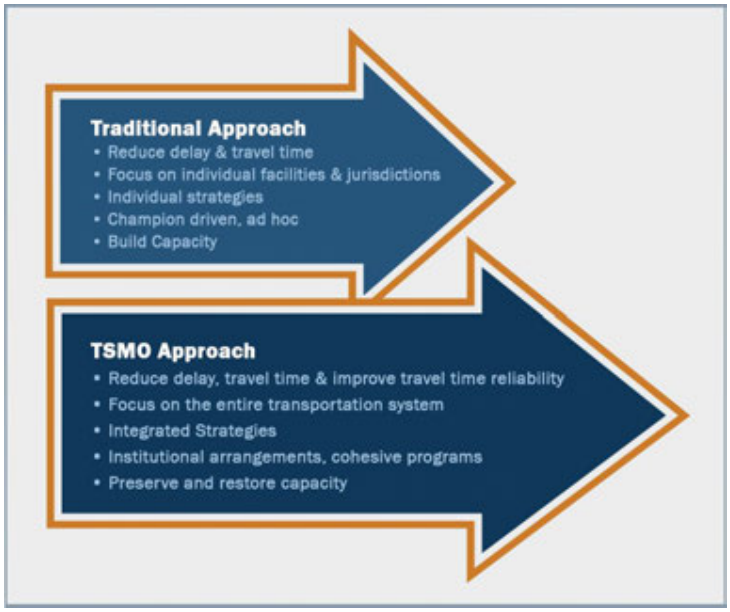
Transportation Systems Management and Operations, also known as TSMO, is a set of strategies that focus on operational improvements that can maintain and even restore the performance of the existing transportation system before additional capacity is needed. The goal of TSMO is to get the most performance out of the existing transportation system, allowing departments of transportation to stretch their funding to benefit more areas and customers.

Successful TSMO programs have adopted TSMO as a core function of the transportation agency and developed institutional arrangements and processes that promote inclusion of TSMO strategies throughout the project lifecycle of planning, design, construction, and maintenance.



The TSMO Difference

Texas Department of Transportation (TxDOT) San Antonio District (SAT; District) implements many of the above-listed TSMO solutions. However, TSMO is more than implementations of isolated, champion-driven Intelligent Transportation Systems (ITS) solutions. TSMO involves a mindset change to determine the best way to optimize the safety, mobility, and reliability of the existing transportation system with limited resources. This graphic highlights the paradigm shift that will sustain and grow TSMO within TxDOT-SAT.



TxDOT TSMO Planning Initiative

At the beginning of the TxDOT TSMO planning initiative, Chief Engineer William Hale issued two memos highlighting the importance of traffic management systems (TMS) as cost effective and efficient means to address safety, mobility, connectivity, maintenance, and emergency response across the state.

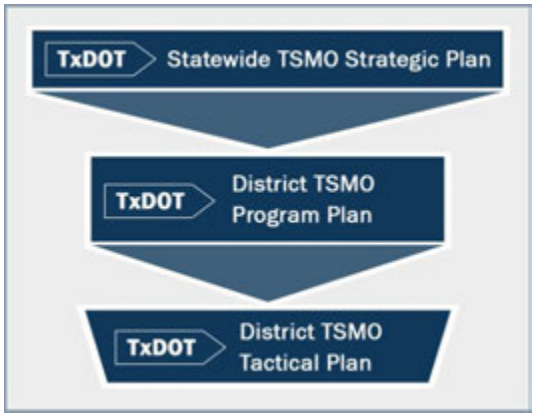
"…it is critical that Traffic Management Systems (TMS) be included on new roadway construction projects. Including TMS at the earliest stages of project development planning will maximize investments by leveraging comprehensive project construction cost at the earliest stages …"

William Hale, July 1, 2016

"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."

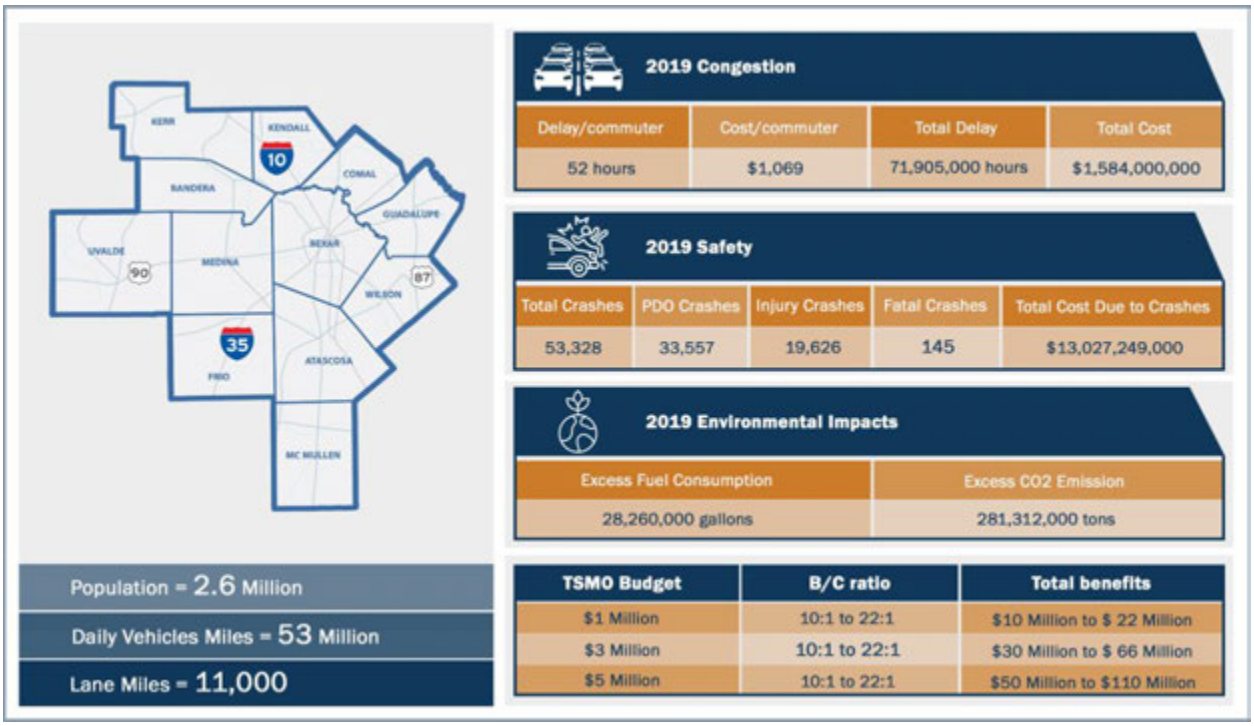
William Hale, April 7, 2017

Building on the direction provided in these memos, TRF developed a three-stage approach to TSMO adoption across the state. As part of the first stage, TRF rolled out the Statewide TSMO Strategic Plan in 2017. As part of the second stage, all TxDOT districts, including TxDOT-SAT, are developing TSMO Program Plans. Subsequently, the districts will develop TSMO Tactical Plans as necessary to address specific operational issues within each district.



Business Case For TSMO

Studies around the country have shown that TSMO deployments provide benefit-to-cost ratios (B/C Ratios) between 10:1 to 22:1. The business case summary presented here illustrates the impacts and costs associated with congestion, safety, and environment within the San Antonio region and highlights the potential benefits from TSMO deployments. The graphic on the following page highlights how hypothetical TSMO investments of $1 to $5 million would result in benefits to congestion and safety of $10 to $110 million.



TSMO Implementation

The process illustrated below was utilized to develop the TSMO program-level and operational-area-level (program-area-level) actions. The four program areas selected by the District for development of TSMO actions included traffic signal management, traffic incident management (TIM), traffic management (TM), and work zone management (WZM). The process, beginning with the District Engineer's (DE's) endorsement, included extensive engagement with the district leadership, partner agencies, and project steering committee to obtain input on existing TSMO practices, complete Capability Maturity Model (CMM) and Capability Maturity Framework (CMF) assessments, develop District-specific TSMO goals and objectives, and cocreate the TSMO actions included in this Program Plan.

The key program-level and program-area-level actions are summarized below.

Action	Lead	Support
Program-Level Actions		
Consider proven TSMO/ITS strategies during planning: - Consider including ITS/TSMO as part of access management studies. - Include ITS/TSMO during schematic development to provide better estimate of construction costs. - Develop checklists/toolbox to include ITS/TSMO strategies.	Transportation Planning & Development (TP&D)	Operations
Develop formal workflow/process that institutionalizes how work and funding needs are coordinated between TP&D, construction, operations, and maintenance. Identify roles within functional groups responsible for communication to ensure successful practices are not lost when personnel changes occur.	TP&D	All
Include TSMO activities as part of existing meetings/processes. - Discuss topics such as ITS needs, work zone (WZ) analysis, smart WZ needs and technologies, safety and operational performance measures, and traffic control funding during DSRT (Construction), DDRT (Design), and DCC (TP&D) meetings.	Operations	Construction
Identify project priorities and estimated costs for TSMO improvements that can be added to Unified Transportation Plan.	TP&D	Operations
Provide example use cases and benefits for various TSMO strategies to help justify their deployment. - Track performance measures after project completion to assess performance against expected benefits. - Use actual benefits as use cases to develop project selection criteria.	TP&D	Operations
Continuously analyze mobility (from probe data) and safety data such as speeds, travel times, and crashes to develop mobility- and safety-based performance measures. Display performance measures on shareable dashboard: - Identify bottlenecks/hotspots and develop and prioritize projects. - Utilize performance measures to enhance operations during construction by better planning for traffic control and detours. - Develop and deploy mitigations before issues become complaints. - In the interim, develop checklist to identify major construction projects to monitor performance measures.	TP&D	Operations
Establish TSMO sub-committee through Technical Advisory Committee to meet quarterly to discuss district-wide TSMO efforts, partnership opportunities, and lessons learned.	TP&D	Alamo Area Metropolitan Planning Organization (AAMPO)
Update individual job descriptions to reflect TSMO skills and capabilities, and discuss TSMO-related goals and responsibilities during onboarding.	Deputy DE, Directors	District Staff

Action	Lead	Support
Program-Level Actions		
Formalize collaboration process with partner agencies including AAMPO.	TP&D	Operations

Action	Lead	Support
Traffic Signal Management Actions		
Develop performance-based and objectives-driven traffic signal timing program in alignment with TxDOT goals and objectives.	Operations	Operations
Develop performance-based and objectives-driven traffic signal maintenance program in alignment with TxDOT goals and objectives.	Operations	Operations
Deploy automated traffic signal performance measures at all District signals.	Operations	TRF
Utilize INRIX/probe data to identify corridors to retime and to compare performance measures before/after signal-timing studies.	Operations	TP&D
Provide regional leadership and coordination to incorporate principals of active arterial management and Integrated corridor management.	Operations	City of San Antonio (COSA)
Identify required staffing levels to attain goals and objectives of signal management program.	Operations	Operations
Collaborate with AAMPO and COSA to develop regional signal timing and maintenance program that will allow consistency in signal operations and maintenance within SAT.	Operations	COSA & AAMPO
Traffic Incident Management Actions		
Address TIM during development of significant roadway projects.	Operations	TP&D
Plan for TIM during construction phase of significant roadway projects (potential discussion during DDRT), and evaluate need for project-specific TIM Plan.	Construction	Operations

Action	Lead	Support
Utilize data analytics to monitor traffic in real time: - Utilize National Performance Management Research Data Set (NPMRDS) data (speed, travel time) or data from roadside devices to identify bottlenecks and potential incidents. - Evaluate video analytics to automatically detect incidents.	Operations	TRF
Utilize NPMRDS data to supplement existing incident detection, tracking, and reporting processes to more accurately report TIM performance.	TRF	Operations
Provide regional leadership in TIM activities to: - Improve understanding of TIM and its need among partner agencies. - Increase partner agency participation in TIM program.	Operations	TIM Stakeholders
Establish TIM steering committee or task force to provide consistent, permanent leadership to TIM program. The committee comprised of leadership from fire, police, AAMPO, TxDOT, COSA, and tow providers will meet quarterly to establish TIM memoranda of understanding, policies, and practices and define priorities.	DE or Deputy DE	TIM Stakeholder Leadership
Establish recurring TIM training: - To train new staff and develop redundancy in existing staff. - For multidisciplinary TIM program participants to understand incident command structure, role of involved agencies, and applicable standards (e.g., Texas Manual on Uniform Traffic Control Devices). - To improve TIM practices based on lessons learned.	Operations	Operations
Formalize the roles and responsibilities within TIM participant agencies to carry out TIM functions.	Operations	Operations
Traffic Management Actions		
Develop data-driven, needs-based operations and maintenance budgeting process to maintain or replace TSMO (ITS/signals) assets. The process will utilize TSMO asset inventory, asset cost, information on completed/needed maintenance, and assigned asset level of service to determine operations and maintenance budget.	Operations	Operations
Explore use of macro-, meso-, and microscopic traffic analysis tools to evaluate emerging ITS/TSMO technologies.	TP&D	Operations
Update existing San Antonio Regional ITS Architecture document to be Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) 9.0 compliant. Conduct multi-agency training on ITS architecture to ensure all stakeholder agencies are	Operations	Operations

Action	Lead	Support
developing TSMO/ITS projects in compliance with architecture. - Evaluate web-based, interactive, and user-friendly version of Regional ITS Architecture that is easy to reference and update.		
Update ITS Master Implementation Plan based on revised ARC-IT 9.0 compliant Regional ITS Architecture.	Operations	Operations
Continuously analyze mobility and safety data such as speeds, travel times, and crashes to develop mobility- and safety-based performance measures (e.g., incident/equipment alerts, roadway clearance times, average speed, travel-time index). Display performance measures on Traffic Management Center (TMC) dashboard: - Identify areas on which to focus TM activities (e.g., traveler information, signal timing adjustments, incident response). - Utilize performance measures to plan for and enhance operations (e.g., WZs, special events, weather events, holidays). - In the interim, develop checklist to identify major construction projects for which to monitor performance measures.	Operations	Operations
Continuously track asset performance (e.g., percentage uptime, asset reliability, asset age vs. service life, work order tracking) against goals. - Proactively address equipment issues before issues become complaints. - Improve system reliability.	Operations	Operations
Leveraging colocation in TMC, identify ways to formalize, enhance, and extend collaboration with COSA on TM strategies (e.g., integrated corridor management).	Operations	COSA
Work Zone Management Actions		
For significant projects, evaluate use of planning-level traffic analysis (e.g, FREEVAL, QuickZone, VISSIM, DynusT) and predictive safety analysis tools to configure WZs (duration, extent, and number of lanes taken with WZ).	TP&D	Construction
For significant projects, evaluate need for and type of WZ ITS based on TxDOT Smart Work Zone Guidelines and Go/No-Go Decision Tool (LINK).	Operations	Construction
Develop Transportation Management Plan for significant project WZs, and document safety and mobility performance measures and TSMO elements: -Utilize WZM strategies listed under Table 4.1 of the Federal Highway Administration's "Developing and Implementing Transportation Management Plans for Work Zones." -Document how ITS/smart WZ elements are evaluated to improve WZ mobility, safety, and monitoring capabilities. -Document how social media, crowdsourcing, and connected vehicle technology are evaluated to improve traveler information.	Operations	Construction

Action	Lead	Support
Develop process to coordinate lane closures among multiple projects and agencies to achieve WZM objectives.	Operations	Construction
On significant projects, collect real-time and historical performance measures on travel speed, travel time, traffic volumes, queue lengths, and crashes. -Utilize performance measures to monitor WZ performance and develop safety and mobility countermeasures. -Utilize performance measures from multiple projects to continually evaluate and improve WZ policies and procedures. -Utilize historical WZ performance measures and planning-level analyses to develop WZM funding needs for upcoming projects.	TP&D	Operations
Discuss WZ safety and lessons learned in Director's, Supervisors' and DSRT meetings.	Construction	Operations
Establish periodic WZM training to: - Regularly update WZM knowledge and skills to incorporate latest industry advances within TxDOT practice. - Cross-train staff to improve understanding of all aspects of WZM. - Capture, share, and refine institutional WZ knowledge within TxDOT.	Construction	Operations
Identify ways to enhance collaboration with law enforcement during WZ activities (e.g., use of CAD data, WZ enforcement, incident response).	Operations	Construction

1 INTRODUCTION

Historically, state and local departments of transportation (DOTs) were created to deliver infrastructure capacity for the movement of people and goods. As a result, DOTs have traditionally focused their efforts and resources on the planning, design, construction, and maintenance of capital projects. This focus on delivery of capital projects has generally resulted in limited resources for the management and operations of transportation systems. Further, with capacity building lagging traffic growth in most urban areas and available funding lagging DOT funding needs, DOTs are often required to do more with less. To overcome these challenges, many DOTs are starting to embrace Transportation Systems Management and Operations (TSMO), a strategic approach that provides near-term and cost-effective solutions to improve mobility and safety while addressing customer needs.

1.1 What is TSMO?

In simple terms, TSMO is a set of strategies that focus on operational improvements that can maintain and even restore the performance of the existing transportation system before additional capacity is needed. The goal of TSMO is to get the most performance out of our existing transportation system, allowing DOTs to stretch their funding to benefit more areas and customers.

Successful TSMO programs have adopted TSMO as a core function of the transportation agency and developed institutional arrangements and processes that promote inclusion of TSMO strategies throughout the project lifecycle of planning, design, construction, and maintenance. Figure 1 summarizes the concept of TSMO.

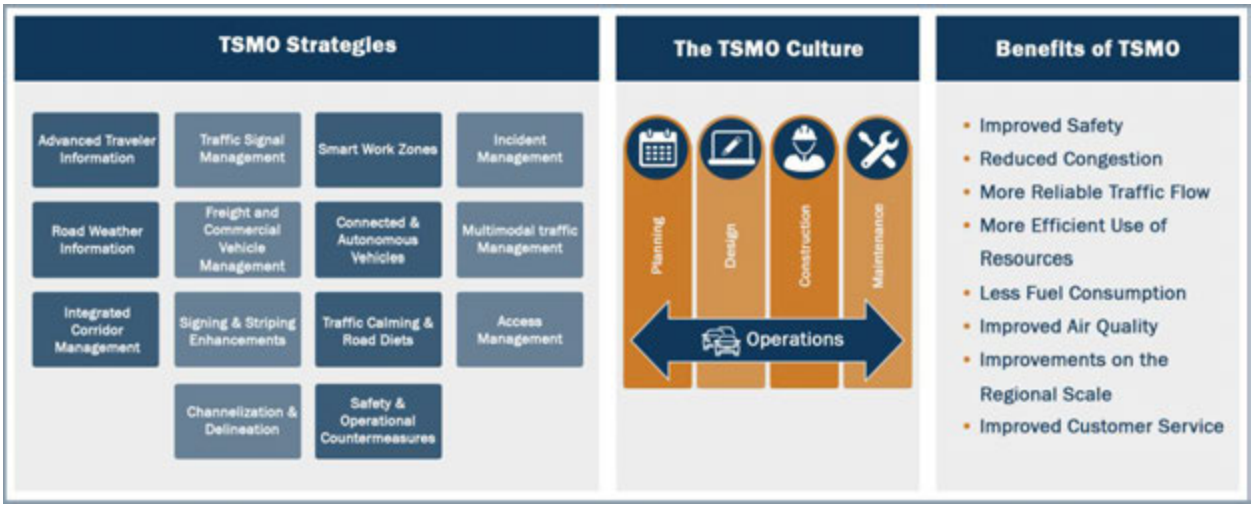


Figure 1: The Concept of TSMO

1.3 Aren't We Already Doing TSMO?

Texas Department of Transportation (TxDOT) San Antonio District (SAT; District) implements many of the TSMO solutions listed on Figure 1. However, TSMO is more than the implementations of isolated, champion-driven

Intelligent Transportation Systems (ITS) solutions. TSMO involves a mindset change to determine the best way to optimize the safety, mobility, and reliability of the existing transportation system with limited resources.

Figure 2 highlights the paradigm shift that will sustain and grow TSMO within TxDOT-SAT.

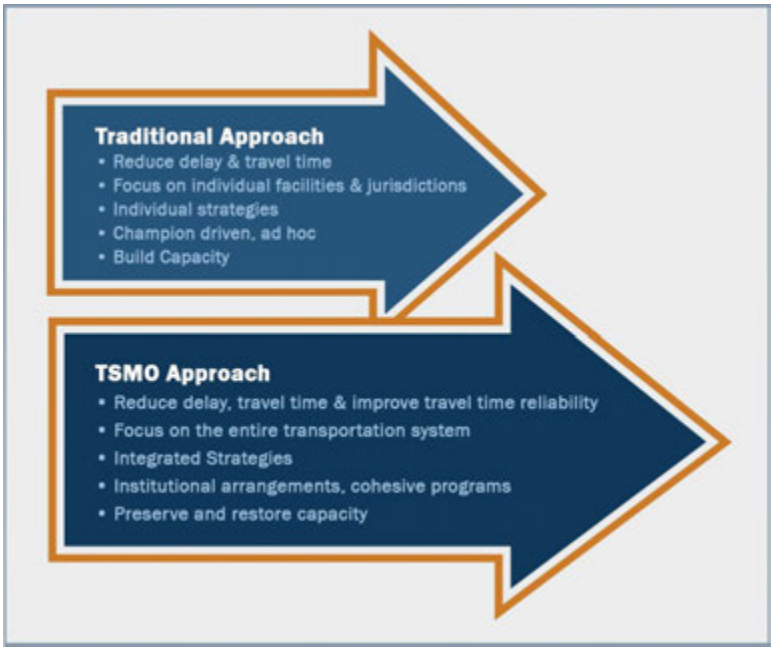


Figure 2: The TSMO Difference

1.4 Need for TSMO Planning

Research conducted as part of the Federal Highway Administration's (FHWA's) Second Strategic Highway Research Program (SHRP2) found that in most agencies, TSMO planning and budgeting have been largely limited to specific projects or initiatives and initiatives have been limited based on availability of funding and a champion to drive those initiatives. The research determined that agencies with the most effective TSMO activities were differentiated not by budgets or technical skills alone but by the existence of critical processes and institutional arrangements focused on TSMO applications. The research identified development of a TSMO Program Plan as a key action to guide organizations in advancing the institutional focus on TSMO.

1.4.1 TxDOT Division TSMO Initiative

At the beginning stages of the TxDOT TSMO initiative, Chief Engineer William Hale issued two memos highlighting the importance of traffic management systems (TMS) as cost-effective and efficient means to address safety, mobility, connectivity, maintenance, and emergency response across the state. Excerpts from these memos are provided below.

"...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 ..."

William Hale, July 1, 2016

"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."

William Hale, April 7, 2017

The TxDOT TSMO initiative (Figure 3) builds on the direction provided in these memos to develop a statewide TSMO framework and guidance. The TxDOT TSMO initiative consists of three stages. As part of the first stage, TRF rolled out the Statewide TSMO Strategic Plan in 2017. The strategic plan provided the framework and guidelines to mainstream TSMO throughout the state and recommended that each District develop a TSMO program focused on their unique needs. As part of the second stage, the Austin District in 2018 formalized its TSMO program by developing a TSMO Program Plan. In 2019 and 2020, the remaining TxDOT districts began developing their own TSMO Program Plans. As part of the third stage, the districts may develop tactical plans with specific operational focus, such as plans for work zone management (WZM), traffic incident management (TIM), traffic signal management (TSM), regional traffic management (TM), or ITS implementation.

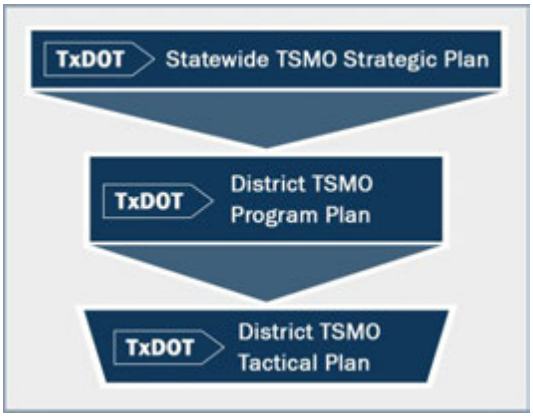


Figure 3: TxDOT TSMO Planning Initiative

1.4.2 TxDOT-SAT TSMO Initiative

In alignment with the statewide TSMO initiative, TxDOT-SAT began developing the District TSMO Program Plan in August 2019. The Program Plan development began with an endorsement from the District Engineer (DE), paving way to formalizing the District's TSMO program. Subsequently, the leadership and key leads within TxDOT and partner agencies were engaged to seek input on regional operational challenges, capabilities, and ideas for improvements. Leadership engagement within TxDOT focused on gathering input from the DE and Deputy DE, the Directors and leads representing Traffic Operations and Maintenance, Transportation Planning & Development (TP&D) and Construction functional groups, and the area engineers. Partner agency engagement focused on gathering input from leadership within the City of San Antonio (COSA), Bexar County (the County), Alamo Area Metropolitan Planning Organization (AAMPO), and VIA Transit (VIA). A TxDOT steering committee was also established to seek technical input and buy-in at various stages of the project. Appendix A provides a list of TxDOT and partner agency members that participated during the various engagement efforts. The same TxDOT and partner agency members were also engaged to conduct the Capability Maturity Model (CMM) and Capability Maturity Framework (CMF) self-assessments for the District. The input received during the leadership engagement and self-assessment stages was combined to develop draft TSMO actions to be included in the District TSMO Program Plan. This District TSMO Program Plan summarizes the District-specific TSMO goals and objectives, institutional arrangements, responsibilities, processes, and implementable action items that were developed collaboratively with the District and partner agency groups. Figure 4 summarizes the process that was utilized to develop the TxDOT-SAT TSMO Program Plan.

Figure 4: TxDOT-SAT TSMO Planning Process

1.4.3 Program Plan Format

The Program Plan document format follows a process similar to the one utilized to develop TSMO actions for the District and is as follows:

- Introduction: Introduces the concept of TSMO and discusses the need for TSMO planning.
- Business Case: Establishes a data-driven business case to support sustained investment in TSMO strategies.
- TSMO Vision, Mission, Goals & Objectives: Shares the TSMO vision and mission developed as part of the Statewide TSMO Strategic Plan and the District-specific TSMO goals and objectives developed in collaboration with the District leadership and District TSMO steering committee.
- Capability Maturity Model: Discusses the six dimensions of CMM, how TxDOT and partner agencies assessed their capability across each dimension, and opportunities to improve within each dimension. Discussion also includes a summary of CMF assessment across four program areas: TIM, WZM, TSM, and TM.
- Five-Year TSMO Implementation Plan: Summarizes TSMO actions developed based on input from District leadership, an understanding of the District's TSMO state of practice, and a review of CMM and CMF self-assessments and provides an implementation time frame.
- TSMO Tactical Plan Assessment: Evaluates the need for tactical plans, with specific operational focus such as plans for WZM, TIM, TSM, regional TM, and ITS implementation.

2 BUSINESS CASE FOR TSMO

Figure 5 summarizes the business case for TSMO within TxDOT-SAT. The figure provides impacts and costs associated with congestion, safety, and environment within the San Antonio region and highlights potential benefits from TSMO deployments. Studies around the country have shown that TSMO deployments provide benefit-to-cost ratios (B/C Ratio) between 10:1 to 22:1. The figure highlights how hypothetical TSMO

investments of $1 to $5 million would result in benefits to congestion and safety of $10 to $110 million. A more detailed discussion on the TSMO business case is provided in the paragraphs that follow.

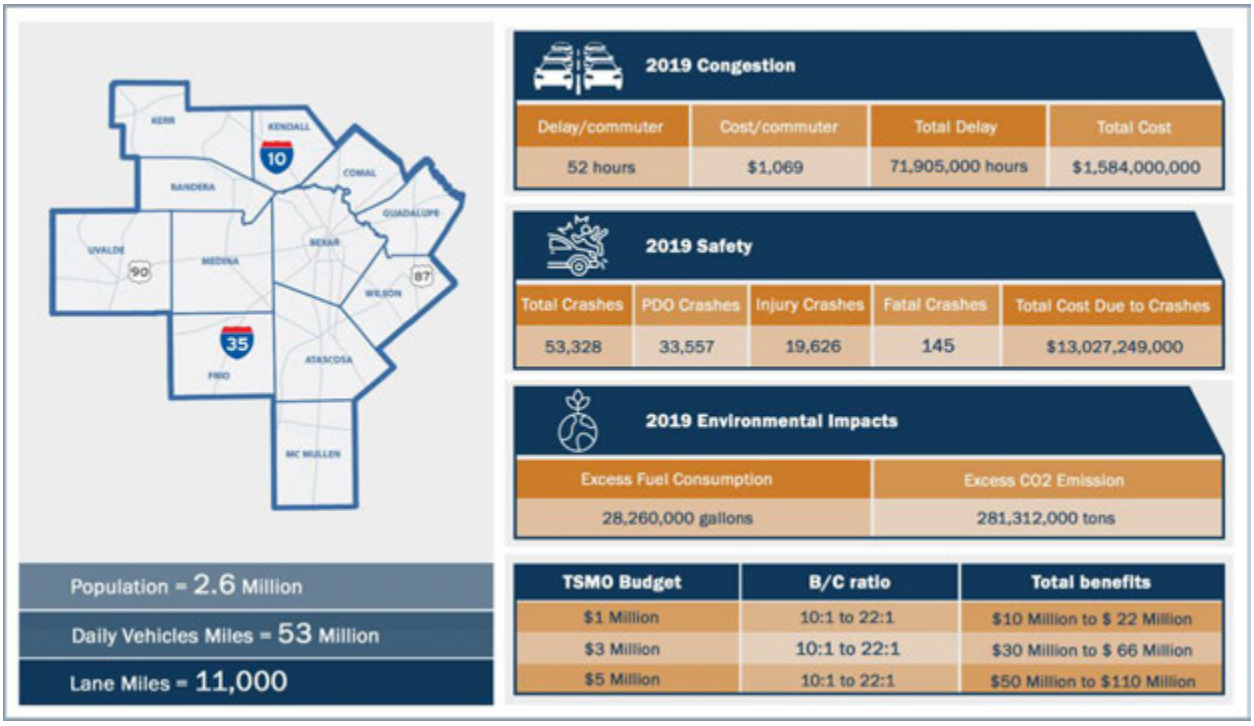


Figure 5: TxDOT-SAT TSMO Business Case Summary

2.1 Funding

2.1.1 Challenge

Texas population grew by 16 percent between 2010 and 2020 and is projected to grow by 60 percent between 2020 and 2050. While the state's population continues to grow rapidly, the available transportation system capacity continues to decrease. Additionally, many of the state's congested corridors are fully built out, and the funding necessary to expand the system capacity continues to be constrained. Figure 6 below shows the funding deficit at the statewide level and district level based on TxDOT's 2022 Unified Transportation Program (UTP).

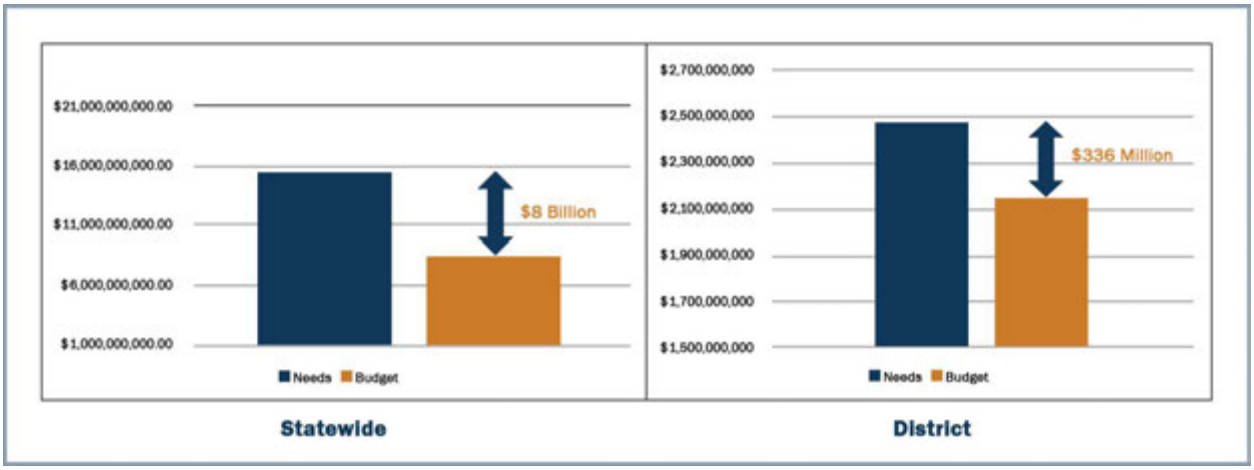


Figure 6: TxDOT Statewide and District-Level Funding Needs Vs. Budget

2.1.2 How TSMO Can Help

To address the growing capacity and funding constraints, TxDOT Division recommends transitioning a portion of funding and resources from the more expensive, long-range capacity expansion projects to cheaper, near-term TSMO deployments that focus on the management and operation of the existing transportation system. This new TSMO approach also leverages resources among regional partner agencies and the private sector to improve regional mobility at a higher benefit-cost ratio compared to capacity improvement projects.

Placing importance on TSMO strategies in long-range planning, project development, and system operations and maintenance creates a strong basis for devoting funding to these strategies. Applying a TSMO approach in the early stages of project development can help establish procedures that lead to efficient and cost-effective implementation of TSMO strategies. TSMO program planning helps develop institutional arrangements to reserve funds for system management during construction, asset management techniques, upgrades to existing ITS and signal infrastructure, workforce development, and other operational strategies.

2.2 Congestion

2.2.1 Challenge

According to TxDOT's performance dashboard, an average driver experienced more than 31 hours of delay while traveling on Texas roadways in 2019. In the same year, an average urban driver in Texas had to account for 51 percent more travel time to be 95 percent confident in reaching their destination on time.

Figure 7 summarizes the congestion statistics for the San Antonio region based on the Texas Transportation Institute's (TTI's) Urban Mobility Report. Per the report, an average driver traveling in the region experienced more than 52 hours of delay in 2019. The region also recorded a Planning Time Index (PTI) of 1.71, indicating that an average driver had to account for 71 percent more travel time during peak periods to reach their destination on time. The monetary cost of congestion was over $1,000 per commuter and $1.5 billion overall. Of the overall delay, 76 percent occurred on freeways and 24 percent on arterials.

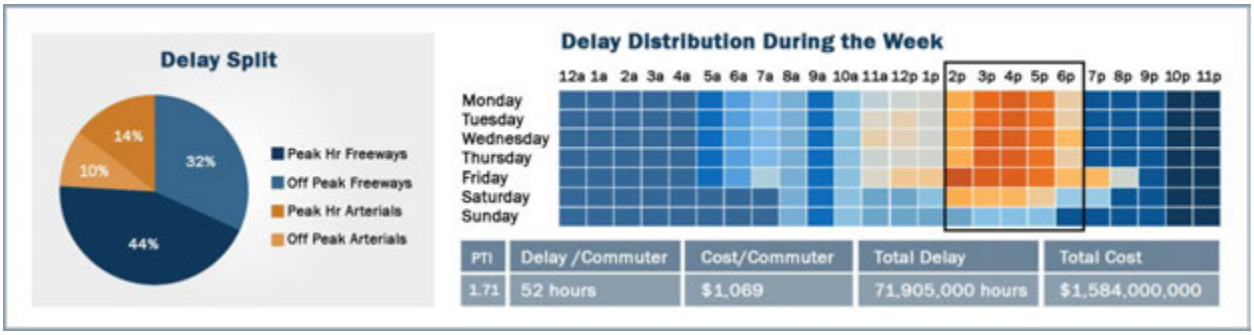


Figure 7: TxDOT-SAT 2019 Congestion Statistics

2.2.2 How TSMO Can Help

As seen in the delay split pie chart above (Figure 7), 32 percent of the regional delay occurred during off-peak conditions on freeways and 10 percent of the regional delay occurred during off-peak conditions on arterials. This indicates that the capacity improvement projects, which mainly address peak-period congestion, do not specifically target approximately 42 percent of the delay occurring in the San Antonio region. As seen on Figure 8, FHWA estimates that approximately 40 percent of the national congestion is attributable to recurring congestion (bottlenecks), while 60 percent is attributable to non-recurring congestion (e.g., traffic incidents, work zones [WZs], special events). TSMO provides robust and near-term strategies such as TIM, WZM, TSM, active TM, and road weather management to address the recurring and non-recurring congestion at a fraction of the cost of the capacity expansion projects.

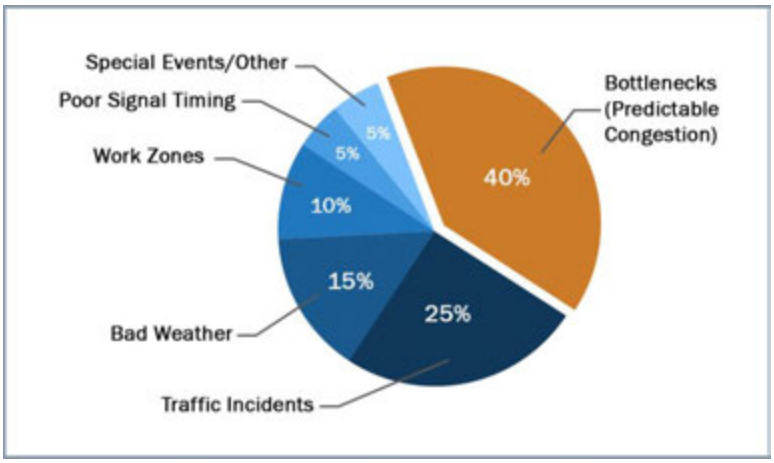


Figure 8: National Causes of Congestion by FHWA

2.3 Safety

2.3.1 Challenge

According to TxDOT's performance dashboard, there were 3,622 fatalities and 15,851 serious injuries on Texas roadways in 2019. According to TxDOT's Crash Records Information System (CRIS), the San Antonio region experienced over 140 traffic-related fatalities, 20,000 injury crashes, and 34,000 property-damage-only (PDO) crashes in 2019 (Figure 9). Of the fatal and injury crashes, almost 16,000 crashes occurred at intersections and almost 900 occurred within WZs. Of the overall crashes, 70 percent occurred on freeways and 30 percent on arterials. The total cost of crashes was more than $13 billion.

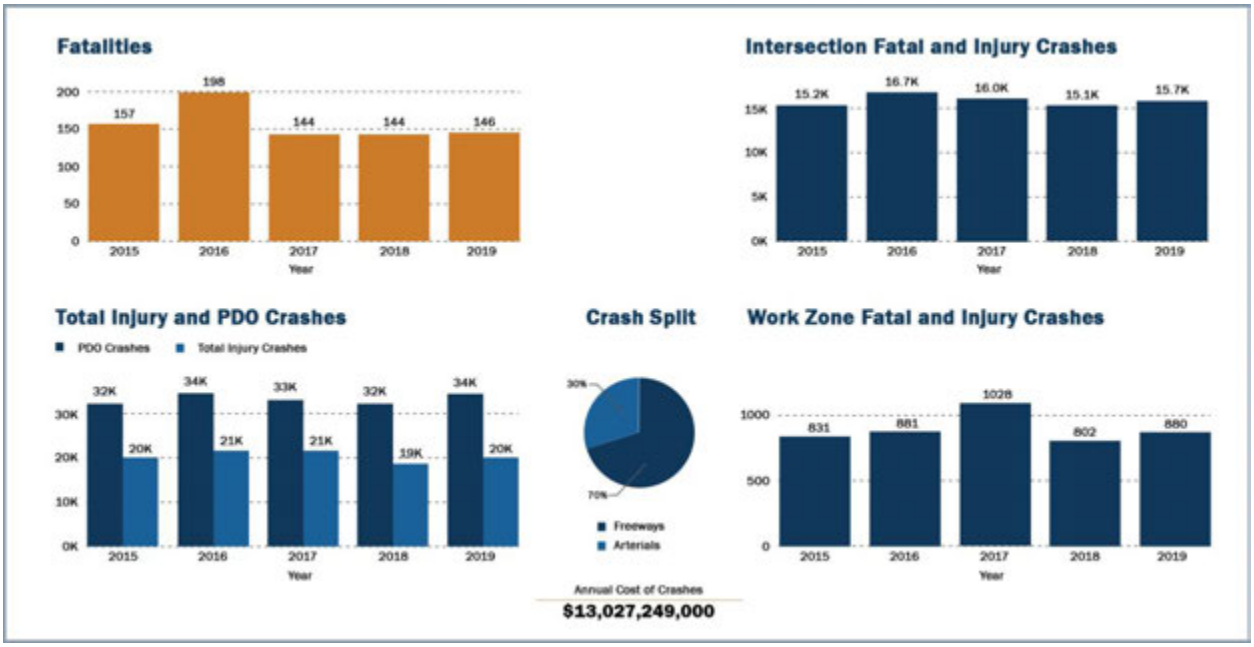


Figure 9: San Antonio Region Crash Summary

2.3.2 How TSMO Can Help

Integrating TSMO principles throughout the project development process (PDP) ensures a collaborative and data-driven approach, consideration of cost-effective and multimodal alternatives (e.g., conflict reduction, innovative intersections, ITS, multimodal facilities), evaluation of network-wide opportunities, and inclusion of operational elements during and after construction. This holistic approach to project development ensures that solutions to improve safety are evaluated and implemented throughout the project lifecycle and across the transportation network. TSMO strategies aimed at reducing non-recurring congestion and improving traveler information can improve driver expectancy and improve driver awareness of hazardous conditions. Finally, TSMO strategies can help protect those who spend time working in the roadway, including TxDOT employees and contractors, public safety officers, and emergency responders.

2.4 Mainstreaming TSMO

FHWA research has shown that agencies with the most effective TSMO activities are differentiated not by budgets or technical skills alone but by the existence of critical processes and institutional arrangements focused on TSMO applications. Therefore, mainstreaming TSMO through the modification of existing business and technical processes is an important step toward building a sustainable TSMO program within the District. TxDOT-SAT currently implements numerous processes, projects, and programs with a TSMO flavor, including TIM, Traveler Information, WZM, TSM, 4-year safety planning, and 4-year-maintenance planning. However, sometimes TSMO strategies are taken out of new projects due to funding constraints or due to being considered too late during project development. Also, sometimes TSMO strategies are not considered as an alternative to roadway widening projects due to lack of understanding of TSMO strategies and their benefits. Such projects miss out on the safety and mobility benefits provided by TSMO.

Mainstreaming TSMO through integration within the PDP (Figure 10), creation of institutional arrangements, and documentation of critical processes will ensure that TSMO is fully adopted within the District. Taking full advantage of TSMO will require the following:

Figure 10: Integrating TSMO within PDP

1. A commitment from the DE and Deputy DE to integrate the TSMO mission and vision within the District's project development and business processes.
2. A commitment from District leadership (DE, Deputy DE, and Directors) to embrace a TSMO mindset, where processes are formalized and programs and projects are developed in a data-driven, collaborative, and cost-effective manner.
3. A performance-based approach to budgeting, project selection, assessing project/program performance, and tracking and enhancing system performance.
4. Consistent funding, staffing, and training to sustain the TSMO program.
5. Utilization of a systems engineering process during the TMS project planning and deployment.
6. Leveraging existing touchpoints with partner agencies to collaborate on regionally significant TSMO implementation opportunities.

The institutional commitment to TSMO— including reorganization, staffing, and changes in processes to accommodate TSMO— are outside the control of the staff who manage the TSMO functions. Implementing these changes will require the DE and Deputy DE's support and authorization. There will need to be high-level direction to all staff that the changes needed to deploy and implement TSMO strategies are necessary and that those strategies should apply across all functional areas of the District.

3 TSMO VISION, MISSION, GOALS, AND OBJECTIVES

The San Antonio District has adopted the statewide TSMO vision, mission, and goals and has developed specific objectives to address the District-specific mobility and safety challenges.

3.1 Statewide TSMO Vision

The statewide TSMO Vision is as follows: Improve safety and mobility for all modes of transportation by integrating planning, design, operations, construction, and maintenance activities and acknowledging all opportunities for innovation.

3.2 Statewide TSMO Mission

The statewide TSMO Mission is as follows: Through innovation, collaboration, and performance-based decision-making, transportation facilities are developed, constructed, maintained, and operated cost-effectively with the end user in mind.

3.3 District-Specific TSMO Goals and Objectives

TxDOT-SAT has adopted each of the six statewide TSMO goals of safety, reliability, efficiency, customer service, collaboration, and integration. For each of these goals, the District has developed objectives in order to monitor the District's progress toward implementing the TSMO Program Plan. Measurable objectives have been set where baseline data are available to track performance. Non-measurable objectives for which baseline data are not available should be revisited with future Program Plan updates once the District has established more performance metrics. TxDOT goals and objectives are listed in Table 1.

Table 1: TxDOT-SAT TSMO Goals & Objectives

Goal	TxDOT Statewide TSMO Objectives	TxDOT-SAT TSMO Objectives
Safety 	• Reduce crashes and fatalities through continuous improvement of TMS and procedures.	• Continually develop and track safety performance measures for the transportation system. • Utilize safety performance measures to document benefits of TSMO deployments as well as to prioritize projects. • Periodically review safety data to develop systemwide safety improvements and package the improvements for implementation. • Reduce work zone related crashes. • Accurately track and reduce secondary crashes.

Goal	TxDOT Statewide TSMO Objectives	TxDOT-SAT TSMO Objectives
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.	• Continually measure travel times for on-system roadways and develop travel time reliability related performance measures (travel time index, planning time index). • Improve travel time reliability for on-system roadways by deploying TSMO strategies. • Reduce delay caused by work zones. • Reduce incident clearance times for on-system roadways. • Maintain above 90 percent TMS asset operational uptime.
Efficiency 	Implement projects that optimize existing transportation system capacity and vehicular throughput.	• Periodically review operational data to develop systemwide operational improvements and package the improvements for implementation. • Continually review traffic signal performance for operations and maintenance deficiencies and proactively address the deficiencies for improved customer service. • Prioritize the use of systems and technology-based solutions over capacity building to improve system performance. • Consider all modes of transportation in the PDP.
Customer Service 	Provide timely and accurate travel information to customers so they can make informed mobility decisions.	• Deliver traveler information related to incident detection and recovery to the public more efficiently and through multiple media. • Deliver traveler information related to closures/alternate routes to the public through multiple media. • Identify opportunities for third-party partnerships to enhance traveler information services. • Develop public facing dashboards reporting District efforts to improve system performance. • Accommodate needs of all road users, including pedestrians, bicyclists, transit and commercial vehicles.
Collaboration 	Proactively manage and operate an integrated transportation system through multi-jurisdictional coordination, internal collaboration, and cooperation between various transportation disciplines and partner agencies.	• Develop a regional TSMO committee to facilitate quarterly collaboration on TSMO initiatives. • Discuss TxDOT TSMO initiatives and collaboration opportunities during District Director's meetings. • Promote data-sharing across TxDOT functional groups and TSMO stakeholders. • Improve stakeholder participation in the monthly TIM meetings.
Integration 	Prioritize TSMO as a core objective in the agency's planning, design, construction, operations, and maintenance activities.	• Integrate TSMO within the existing District policies, plans and procedures. • Discuss TSMO opportunities during Design Concept Conference, District Design Review Team, and District Safety Review Team meetings. • Leverage regional stakeholder partnerships, including with the MPO, to identify funding opportunities for TSMO. • Deploy TMS assets as part of new construction projects. • Achieve 100 percent monitoring capabilities for all existing and proposed TMS deployments. • Conduct joint TSMO training exercises in the region.

4 CAPABILITY MATURITY MODEL AND FRAMEWORKS

4.1 Capability Maturity Model

CMM is a concept adopted from the information technology industry during the FHWA's SHRP2 research. The goal of CMM assessment is to allow agencies to identify, build consensus around, and prioritize institutional and process improvements that further TSMO objectives within the agency and region. The CMM framework, laid out as a matrix, consists of six improvement areas (often referred to as the CMM dimensions) that are evaluated across four levels of capability (Level 1 being the lowest and Level 4 being the highest). Illustrated below (Figure 11) are the six CMM dimensions, the four levels of capability, and the FHWA-recommended process of CMM assessment. The CMM assessment is not meant to be a scorecard. Its purpose is to identify opportunities for improvement and support setting goals that are achievable.

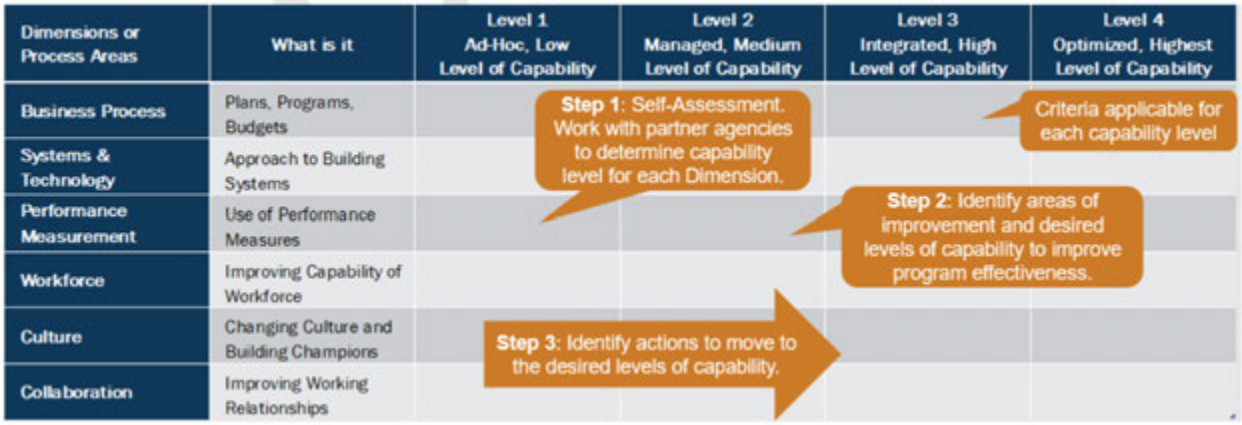


Figure 11: CMM Assessment Process

TxDOT, along with partner agencies, conducted a CMM assessment workshop to identify TSMO-related gaps and needs for TxDOT-SAT and the region. CMM assessment results from the workshop are discussed below.

4.1.1 Business Processes

Business Process dimension relates to the planning, programming, budgeting, and implementation of TSMO programs. Table 2 summarizes the FHWA-provided criteria for each Business Process capability level.

Table 2: Capability-Level Descriptions for Business Process

Dimension	Level 1	Level 2	Level 3	Level 4
Business Processes (Planning, Programming, Budgeting, Implementation)	Processes related to TSMO activities **ad hoc** and **un-integrated**	Multiyear **TSMO plan and program exists** with deficiencies, evaluation, and strategies	Programming, budgeting, and PDPs for **TSMO standardized and documented**	**Processes streamlined** and subject to **continuous improvement**

Figure 12 summarizes the results of capability assessment for the Business Process dimension. As seen on the figure, all agencies in the region ranked themselves between 1 and 2, with TxDOT ranking themselves at 1.6. Also, all agencies ranked the region at 1.1. The results indicate TxDOT and partner agencies' desire for a shift from ad-hoc implementation of TSMO projects/programs toward institutionalizing TSMO as a core function of regional agencies.

The following needs related to Business Process were discussed during the CMM workshop:

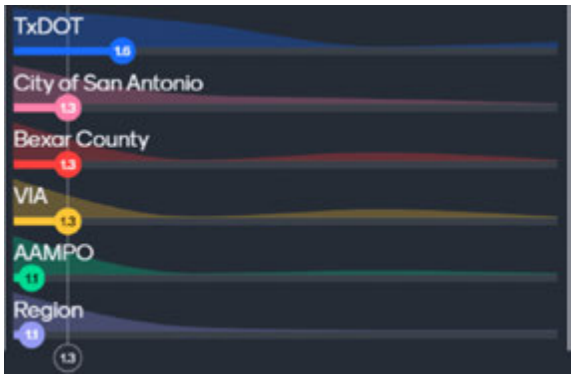


Figure 12: Business Process Assessment Results

Revised Project Delivery Process:

The PDP at TxDOT-SAT comprises six steps: Planning, Programming, Design, Construction, Operations, and Maintenance. While this process has successfully been used to develop capital projects over the years, the process also supports development of new or retrofit TSMO projects. During the workshop, TxDOT identified the opportunity to integrate operations or technology-oriented strategies throughout the existing PDP. This can be accomplished by enhancing Design Concept Conference (DCC), District Design Review Team (DDRT), and District Safety Review Team (DSRT) meeting agendas to include broader TSMO topics.

TSMO Planning:

TxDOT-SAT currently develops several multi-year plans that address TSMO aspects. These plans include the ITS Master Plan, Maintenance Plan (e.g., striping, seal coat, pavement rehabilitation) and Safety Plan. The TxDOT team discussed that these plans can be further enhanced through interdepartmental data sharing to include data-driven analysis and project prioritization and map-based dashboards for performance measurement and tracking. Additionally, improving the understanding of TSMO across functional groups and developing a TSMO strategy toolbox will allow for incorporation of TSMO strategies at the project schematic stage and through long-range planning.

Programming, Budgeting, and Funding:

Figure 13 below shows the TxDOT-SAT funding allocations based on the 2022 UTP. Although there is no dedicated funding for TSMO, the projects in Categories 1, 2, 4, 5, 7, and 12 can be good candidates in which to incorporate TSMO strategies. Adding cost-effective and near-term TSMO strategies to projects in these categories presents an opportunity to address the TxDOT-SAT funding deficit shown on Figure 6.

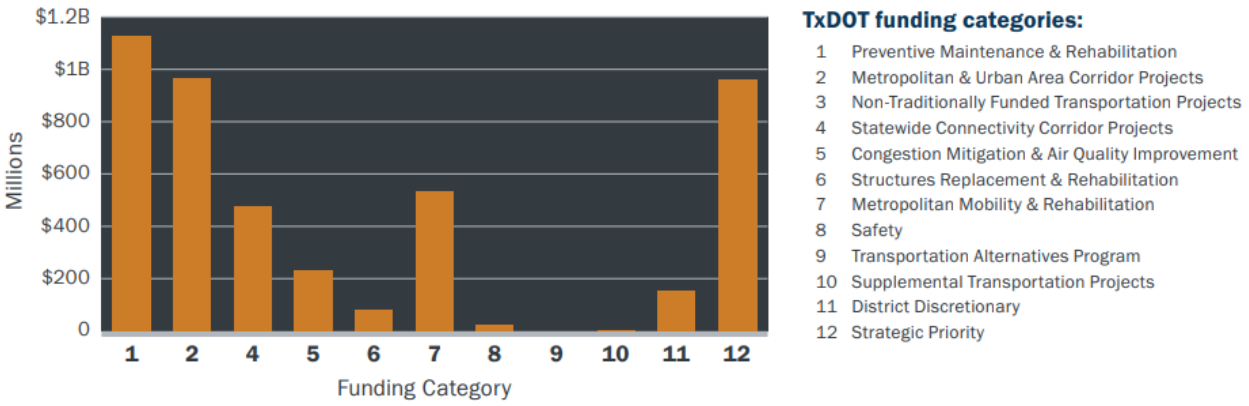


Figure 13: TxDOT-SAT Funding Allocations from 2022 UTP

During the workshop, agencies discussed creation of a dedicated and sustainable source of funding for TSMO. AAMPO mentioned the possibility of reappropriating the "Other" Transportation Improvement Program funding category to a "TSMO" category and adjusting the project scoring criteria to encourage inclusion of TSMO strategies in projects. Partner agencies also expressed interest in leveraging interagency collaboration to pursue federal funding for regional TSMO deployments.

Continuous Improvement:

TxDOT's top statewide TSMO objective is to "reduce crashes and fatalities through continuous improvement of TM systems and procedures." During the TSMO workshop, agencies discussed formalizing collaboration on TSMO initiatives through the AAMPO Technical Advisory Committee (TAC) and through regularly scheduled meetings. Agencies also discussed formalizing the process of collaboration within TransGuide during day-to-day TM activities and incident response. Documentation of these business and technical processes, their consistent application across projects and programs, and their continuous improvement will allow TxDOT to meet the statewide Road to Zero goals. Additionally, revisiting the TSMO Program Plan and CMM assessments every couple of years for minor updates and revisiting them every 5 years for major updates will ensure that TSMO is well integrated and on a path to continuous improvement within TxDOT.

4.1.2 Systems and Technology

Systems and Technology dimension relates to the use of systems engineering, systems architecture standards, interoperability, and standardization in TSMO activities. Table 3 summarizes the FHWA-provided criteria for each Systems and Technology capability level.

Table 3: Capability-Level Descriptions for Systems and Technology

Dimension	Level 1	Level 2	Level 3	Level 4
Systems and Technology (Systems Engineering, ITS standards, technology interoperability)	**Ad hoc** approaches outside systematic systems engineering	**Systems engineering employed** and consistently used for **ConOps, architecture,** and systems development	**Systems and technology standardized**, documented, and trained and new technology incorporated	**Systems and technology routinely upgraded** and utilized to improve efficiency performance

Figure 14 summarizes results of capability assessment for the Systems and Technology dimension. As seen on the figure, all agencies in the region ranked themselves between 1 and 2, with TxDOT ranking themselves at 2. Also, all agencies ranked the region at 1.2. The results indicate TxDOT and partner agencies' desire for a more consistent use of Systems Engineering and Regional ITS Architecture in developing TSMO projects to ensure that the systems being designed, developed, or procured address project and stakeholder needs, are cost effective, and assess the need for standardization and interoperability between agencies. The following needs related to Systems and Technology were discussed during the CMM workshop:

Figure 14: Systems and Technology Assessment Results

Systems Engineering Analysis Process

Systems Engineering Analysis (SEA) provides a systematic method for ITS and operations project developers to design their systems to achieve the desired operations objectives while also providing an assessment of alternative physical solutions. SEA allows developers to establish the concept of operations (Con-Ops) and perform alternatives analysis, cost analysis, technical risks analysis, and effectiveness analysis. SEA is required for all ITS projects using federal funds per Title 23 Code of Federal Regulations 940.11. All projects, not necessarily limited to federally funded projects, borrow components from the Systems Engineering process shown on Figure 15. This figure also highlights the key stages of TxDOT PDP and how they relate to the Systems Engineering process.

TxDOT projects apply a few components from the Systems Engineering process but generally begin with high-level system requirements and go straight to the Plans, Specifications, & Estimates (PS&E) stage. TxDOT engineers have an idea of the system requirements, but the requirements are generally not documented in Con-Ops and ITS architecture is seldom referenced during project development. Factors such as critical timelines to spend available funding cause engineers to expedite project design and advertise the project for construction. As a result, the SEA is often omitted during the PDP.

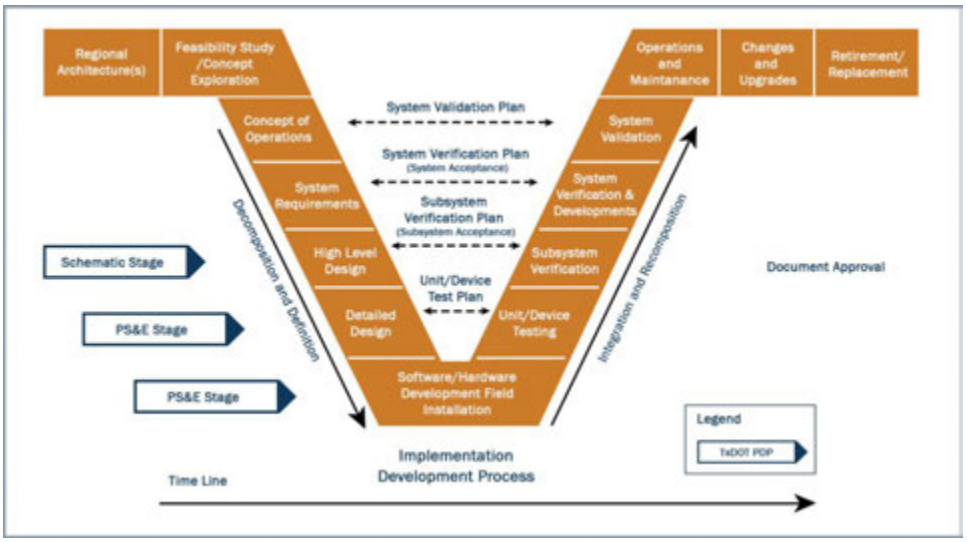


Figure 15: Systems Engineering Process

TSMO, which incorporates the "Plan to Operate" concept, encourages integration of the "Feasibility Study/Concept Exploration" phase (SEA) shown on Figure 15 within the PDP. This ensures consideration of a range of alternatives, incorporation of needs of stakeholders, incorporation of operations and maintenance costs within planning-level costs, and selection of an alternative that addresses most system needs.

Innovative Technology Vetting Process

The transportation industry is currently going through a phase of rapid innovation. New types of detection, communication, software, and connected vehicle technology as well as probe-based data are becoming available each day, putting the onus of vetting and accepting the technologies on DOT staff. Vendors market the products based on case studies that are limited in scope, and many of these technologies employ "black box" algorithms that are challenging to validate. It also becomes challenging to compare multiple technology products with similar features due to the absence of technical specifications for those applications. To mitigate these challenges, the District, in collaboration with the Traffic Division (TRF), should develop a technology vetting process and apply it in conjunction with an SEA to evaluate a range of options and select the technology application that most closely and cost effectively meets the system requirements.

Regional ITS Architecture

San Antonio Regional ITS Architecture, developed in 2003 and later updated in 2007 and 2015, systematically identified transportation needs for the region through stakeholder interviews. Regional ITS Architecture provides a framework to support project planning and the systems engineering process reflecting the regional transportation priorities and needs. It provides a systematic approach to integrate TMS and ITS in project planning. The architecture fosters stakeholder coordination and reflects the current state of ITS for the region. It ensures that the region is in conformation with the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) and meets FHWA Final Rule 940 and Federal Transit Administration (FTA) Final Policy on ITS Architecture and Standards. ITS Architecture also supports initial identification and scoping of an ITS project—the initial steps of the systems engineering process represented by the "V" model. Regional ITS Architecture identifies many agency interfaces, information exchanges, and formal agreements among the associated stakeholders in addition to their roles and responsibilities that are needed to provide the ITS services for the region.

In the 2015 update of the San Antonio Regional ITS Architecture, National ITS Architecture Version 7.0 and the associated Turbo Architecture software tool were used. The National ITS Architecture was integrated with Connected Vehicle Reference Implementation Architecture in 2017, and the resulting expanded reference framework became ARC-IT Version 8.0. ARC-IT allows transportation organizations to explore how connected and automated vehicle (CAV) services could be integrated with traditional and ITS projects. In November 2020, the ARC-IT updated to Version 9.0 with new ITS and CAV services.

ITS projects to support TxDOT-SAT TSMO strategy action item implementation should be referenced in the TxDOT-SAT Regional ITS Architecture and meet FHWA Final Rule 940 and/or FTA Final Policy on ITS Architecture and Standards if Highway Trust Fund is used for their deployment. It is recommended that the

TxDOT-SAT architecture be updated to conform to ARC-IT Version 9.0 first and then be updated periodically every 5 years to accommodate the changes in technology, to reflect the region's ITS status as new projects are being deployed, and to ensure that TxDOT-SAT's operational needs are met.

Existing and Planned Tools

All functional groups within TxDOT-SAT utilize some level of technology to assist staff with their daily work activities. TxDOT's Lonestar Advanced Traffic Management System (ATMS) is the foundational platform from which applications are launched, including accessing closed-circuit television (CCTV) camera video, providing dynamic message sign (DMS) messages, and logging incidents in the TIM module. TxDOT utilizes Centracs central system to remotely monitor and control traffic signal operations and is planning to adopt Automated Traffic Signal Performance Measures (ATSPM) to improve the maintenance and operations of traffic signals. Additionally, TxDOT recently launched their asset and network management tool, TxDOTNow, to track assets (e.g., CCTV, DMS), monitor traffic along the communication network, and identify locations where the network is bogged down. TxDOT has also instituted cybersecurity measures to combat unauthorized access to the network.

During leadership engagement, various TxDOT functional groups expressed interest in sharing tools and data across groups and utilize them to improve technical and business processes. To streamline work, functional groups expressed interest in reducing the number of programs used. Table 4 summarizes the tools and data utilized by TxDOT functional groups that could be of interest to other groups. During the CMM workshop, partner agencies and TxDOT expressed the desire to share data such as camera feeds, signal operations data, CAD data, incident situational awareness data, special and weather event data, traffic counts, public concerns, lane closures, and performance measures.

Table 4: Tools and Data Used by TxDOT-SAT

Tool or Data	Purpose
Probe Data (INRIX, Waze, Ritis, etc.)	Traffic Analysis (travel time, speed, Origin-destination)
Traffic Counts	Traffic Analysis (capacity analysis, prioritization)
Performance Measures (Delay, Travel Time)	System Performance Tracking
Travel Demand Models	Traffic Projections
Lonestar ATMS	Active traffic management
TxDOTNow	Ticketing, network monitoring and asset management
Signing and Pavement Marking Retroreflectivity	Identify and prioritize maintenance locations
Pavement Analyst (PMIS Ratings, visual condition, ride data, maps)	Identity pavement segments in need of maintenance/rehabilitation and prioritize them
TxTAP and TxMAP	Condition scores for traffic control devices and state highway system
TxDOTCONNECT	Portfolio Management, Project Development, Letting Management, Project Execution
Predictive Safety	Countermeasure development, alternatives comparison, project prioritization
Project data in spreadsheets	Countermeasure development, cost estimation
Cost Estimation Tool	Efficient estimation of planning level and detailed costs

Tool or Data	Purpose
Lane Closure Form/Data	Efficient coordination, real-time TM using a map
Dashboards with Project and Performance Data	Identify hotspots, develop countermeasures, prioritize projects, budgeting
Compass Maintenance Management System	Maintenance costs, maintenance plan
Ticketing System	Track and Prioritize traffic signal and ITS maintenance
Stockpile App	Materials inventory
GoPro	Field inspection documentation
FaceTime	Field troubleshooting collaboration
Tablet/Phone	Field documentation
Roadrunner App	Maintenance data collection, photo upload
SiteManager	Information on project (Work diary, payment, measurements)
LCP Tracker	Wage reviews
DMS	DBE goal
Primavera P6	Scheduling
ProjectWise	File storage
Scan Gun	Ability to scan information (concrete/HMA tickets)

4.1.3 Performance Measurement

Performance Measurement dimension relates to the identification of performance measures, consistent use of (big) data and analytics, and use of performance measures throughout a project lifecycle for decision-making. Table 5 summarizes the FHWA-provided criteria for each Performance Measurement capability level.

Table 5: Capability-Level Descriptions for Performance Measurement

Dimension	Level 1	Level 2	Level 3	Level 4
Performance Measures (Measures, data and analytics and utilization)	**No regular performance measurement** related to TSMO	TSMO strategies measurement largely via **outputs**, with **limited after-action analyses**	**Outcome measures identified and consistently used** for TSMO strategies improvement	**Mission-related outputs data routinely utilized** for management, reported internally and externally, and archived

Figure 16 summarizes results of capability assessment for the Performance Measurement dimension. As seen on the figure, all agencies in the region ranked themselves between 1 and 2, with TxDOT ranking themselves at 1.8. Also, all agencies ranked the region at 1.1. The results indicate TxDOT and partner agencies' desire for a greater use of data and data-driven insights throughout the project lifecycle and enhanced data sharing both within and across agencies.

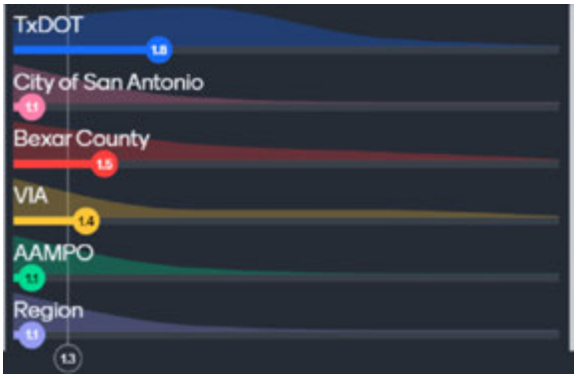


Figure 16: Performance Measurement Assessment Results

Agency Performance-Based Initiatives

TxDOT's Performance Dashboard (Link) provides insights to the public on how TxDOT is doing in relation to its seven strategic goals. Table 6 summarizes the TxDOT strategic goals and performance measures available on the statewide dashboard. TxDOT has also adopted a statewide "Road to Zero" initiative to reduce fatalities on all Texas roadways by half by 2035 and to zero by 2050. The TxDOT strategic goals and Performance Dashboard serve as a guide for the districts to develop their own performance measures to track projects and assets starting from planning through operations and maintenance.

Table 6: TxDOT Strategic Goals and Statewide Performance Measures

TxDOT Strategic Goal	Performance Measures Include
Promote Safety	Annual fatalities and fatality rate, annual serious injuries and serious injury rate, fatality emphasis areas (run off road, DUI, intersections, pedestrians, bicyclists, etc.).
Optimize System Performance	Congestion and reliability indices (urban, rural and truck), vehicle miles traveled, delay per person.
Preserve Our Assets	Bridge condition scores (statewide, national highways, non-national highways), percentage of lane miles in good or better condition.
Deliver the Right Projects	Percentage of construction contracts completed on time and on budget, savings due to innovative contracting usage (e.g., A+B bidding).
Focus on the Customer	Customer complaints closed on time, complaint type, customer service through social media.
Foster Stewardship	Transportation expenditures, DBE/HUB goal attainment.
Value Our Employees	Employee engagement score.

District-Wide Performance Measures

Chief Engineer William Hale's memo from April 2017 placed an emphasis on utilizing TMS performance measures to track and improve transportation system performance. The memo also required districts to submit their TMS status with an implementation plan for the next 12 months to TRF semiannually. As a result, TxDOT-SAT began developing quarterly TMS Status Reports with the documentation of performance measures such as asset operation uptime, incident clearance times, and TMS system coverage. Although it is not included in the report, the District does utilize probe-based travel-time data to display travel-time information to the traveling public. The District currently has limited capabilities to detect secondary incidents and relies on incident responders to report them.

Additionally, TP&D develops project-specific planning-level performance measures related to traffic operations and safety (e.g., delay, volume-to-capacity ratio, level of service, travel time, queue length, crash rate) that are used to develop transportation system improvements. The data used to develop these performance measures are usually collected on a single day during the school year. Usually, no follow-up studies (before vs. after) are conducted after the improvements are constructed to validate the planning-level performance measures.

During the CMM workshop, TxDOT participants recognized that a lot of data are being collected across functional groups in an ad-hoc manner. Streamlining data collection and sharing data and performance

measures across functional groups will improve system efficiency and save data collection costs. Also, many types of operational, safety, and maintenance data (e.g., probe data, CRIS data, Lonestar/Centracs data, Pavement Analyst, lane closures) are available at all times. These data can be brought into a single, GIS-based platform and overlayed to provide insights that could improve various TxDOT processes, including project analyses, selection, prioritization, and TM. Workshop participants, including partner agencies, recognized the need to report TSMO performance measures and quantify benefits and costs associated with TSMO projects. Doing so will allow TSMO projects to compete well with capacity improvement projects. All agencies recognized that sharing of data and performance measures across agencies will contribute to overall system performance.

4.1.4 Organization and Workforce

Organization and Workforce dimension relates to the programmatic status, organizational structure, staff development, and recruitment and retention related to TSMO. Table 7 summarizes the FHWA-provided criteria for each Organization and Workforce capability level.

Table 7: Capability-Level Descriptions for Organization and Workforce

Dimension	Level 1	Level 2	Level 3	Level 4
Organization and Workforce (Organizational structure and workforce capability development)	**Fragmented roles** based on legacy organization and available skills	Relationship among roles and units rationalized and **core staff capacities identified**	**Top-level management position and core staff for TSMO established** in central office and districts	**Professionalization and certification of operations** core capacity positions including performance incentives

Figure 17 summarizes results of capability assessment for the Organization and Workforce dimension. As seen on the figure, all agencies in the region ranked themselves between 1 and 2, with TxDOT ranking themselves at 2. Also, all agencies ranked the region at 1.2. The results indicate TxDOT and partner agencies' desire to evaluate staff capabilities and roles and responsibilities to better integrate TSMO.

Figure 17: Organization and Workforce Assessment Results

Organization Structure to Accommodate TSMO

During TxDOT leadership engagement meetings and the CMM workshop, TxDOT leadership was supportive of integrating TSMO within their organizational structure.

Figure 18 shows what TSMO integration within the District may look like. Although District leadership recognizes the benefits of having TSMO as part of their organizational structure, current resource constraints make it challenging to have staff solely focused on TSMO. As a mitigation, the District has decided to update certain job descriptions to reflect TSMO skills and capabilities and to discuss TSMO-related goals and responsibilities during staff onboarding.

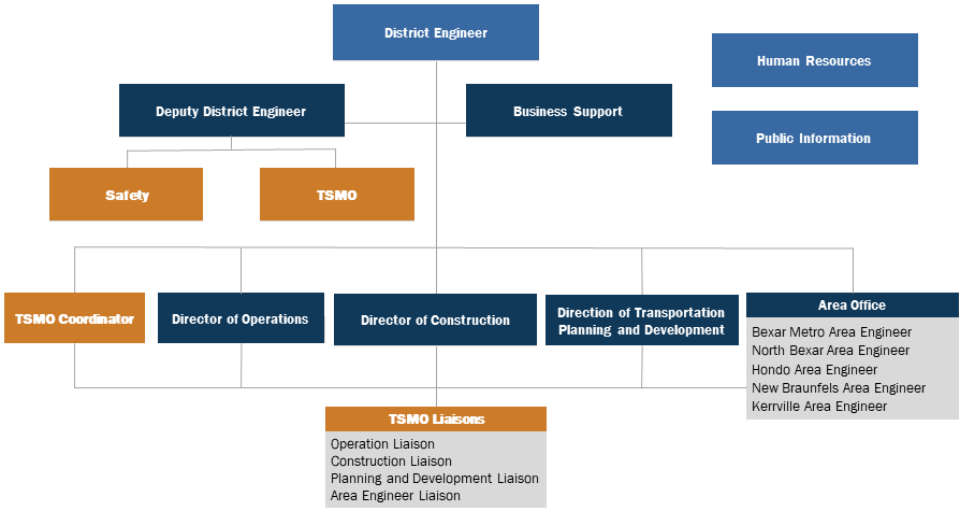


Figure 18: Organization Structure with TSMO Integration

Key TSMO Roles

As TSMO matures within the organization, key TSMO roles will need to be formalized to ensure continuous implementation of TSMO. This section describes how key roles in the region could support TSMO:

TSMO Champion:

This designation will be held by the Deputy DE. Key responsibilities will include:

- Representing TSMO activities during leadership meetings.
- Advocating for funding and resources.
- Promoting the value of TSMO activities and the high-benefit cost.

TSMO Coordinator:

This designation will be held by the TransGuide Manager. Key responsibilities will include:

- Acting as the point of contact for TSMO questions and activities internally and among partner agencies.
- Managing the development and continuous improvement of the TSMO Program Plan.

TSMO Liaisons:

This designation will be held by a key lead from each functional group and a lead representing all area offices. Key responsibilities will include:

- Embrace a TSMO mindset and identify TSMO-related opportunities while performing functions critical to their department.
- Collaborate with the TSMO Coordinator and liaisons from other functional groups to advance TSMO ideas to actionable strategies.

Staffing Plan for Recruitment and Retention

The transportation industry is evolving rapidly. As a result, many agencies are having difficulties recruiting and retaining qualified personnel. Having trained staff to carry out critical TMS, traffic engineering, and planning functions is critical to the success of TSMO within the District. Therefore, a staffing plan detailing strategies to fill immediate needs in the workforce such as positions carrying out critical TSMO functions becomes necessary. The plan should consider how TSMO can help prepare the district for the advancement of technology. Additionally, the staffing plan should consider the following strategies:

- Cross-train employees to ensure staff can transition into TSMO roles quicker.
- Provide professional development opportunities related to TSMO.
- Establish a TSMO career path, with established training requirements and goals.

4.1.5 Culture

Culture dimension relates to the technical understanding, leadership, outreach, and program legal authority related to TSMO. Table 8 summarizes the FHWA-provided criteria for each Culture capability level.

Table 8: Capability-Level Descriptions for Culture

Dimension	Level 1	Level 2	Level 3	Level 4
Culture (Technical understanding, leadership, outreach, program authority)	**Value of TSMO not widely understood** beyond champions	**Agency-wide appreciation** of the value and role of TSMO	TSMO accepted as a **formal core program**	**Explicit agency commitment to TSMO** as key strategy to achieve full range of mobility, safety, and livability

Figure 19 summarizes results of capability assessment for the Culture dimension. As seen on the figure, all agencies in the region ranked themselves between 1 and 2, with TxDOT ranking themselves at 2. Also, all agencies ranked the region at 1.1. The results indicate TxDOT and partner agencies' desire to improve the technical understanding of TSMO and agency-wide appreciation of the role TSMO can play in improving regional traffic mobility and safety.

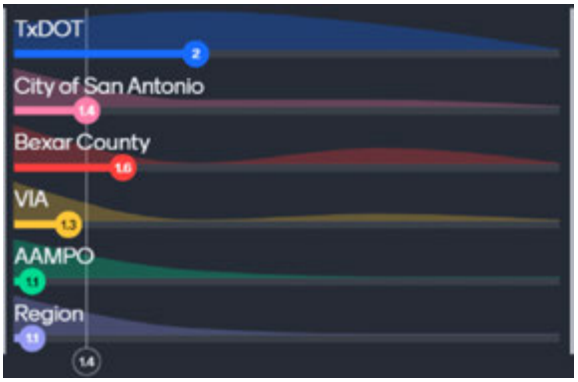


Figure 19: Culture Assessment Results

TSMO culture within the District can be enhanced in a similar way regarding how the District has enhanced the safety culture. The TSMO program within the District is endorsed by the DE and is being led by the Deputy DE (TSMO Champion) and TransGuide Manager (TSMO Coordinator). These leaders can encourage every District staff member to review the TSMO Program Plan and attend TSMO outreach events within the District and at TxDOT-sponsored conferences to improve their understanding of TSMO.

The District leadership and staff can consider the following strategies to enhance TSMO culture within the District:

- Share TSMO opportunities, accomplishments, and lessons learned within meetings.
- Include TSMO discussions within existing Director's, DCC, DDRT, and DSRT meetings.
- Continue distribution of the monthly TSMO Voice newsletter with TSMO case studies.
- Develop an annual report, sharing advancement of TSMO within the District and highlighting key staff members for their TSMO-related successes.

4.1.6 Collaboration

Collaboration dimension relates to the working relationships and partnerships between TxDOT and partner agencies, public safety agencies, and the private sector in relation to TSMO. Table 9 summarizes the FHWA-provided criteria for each Collaboration capability level.

Table 9: Capability-Level Descriptions for Collaboration

Dimension	Level 1	Level 2	Level 3	Level 4
Collaboration (Partnerships among levels of government and with public safety agencies and private sector)	**Relationships on informal**, infrequent, and personal basis	**Regular collaboration** at regional level	Collaborative interagency adjustment of roles/ responsibilities by **formal interagency agreements**	High level of operations **coordination institutionalized among key players**—public and private

Figure 20 summarizes results of capability assessment for the Collaboration dimension. As seen on the figure, all agencies in the region ranked themselves between 1 and 3, with TxDOT ranking themselves highest, at 2.9. Also, all agencies ranked the region at 1.9. The results reflect TxDOT and partner agencies' belief of having strong longstanding working relationships that streamline collaboration across agencies.

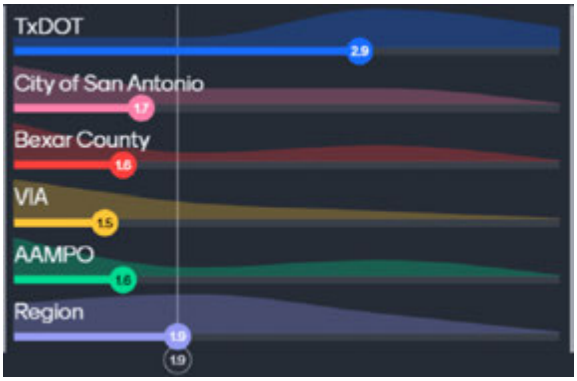


Figure 20: Collaboration Assessment Results

Internal Partnerships

Many of the senior leadership within TxDOT-SAT, such as the Deputy DE, functional group directors, and the TransGuide manager, have been with the District for a long time and have established strong working relationships with each other. These relationships, along with some institutionalized activities such as monthly Director's meetings and DCC, DDRT, and DSRT meetings, form the basis for strong collaboration throughout traditional project development. However, the District is staff constrained and lacks the depth of staff beyond the leadership level. As a result, when people get busy and are unable to attend certain meetings, the opportunity to provide input on TSMO opportunities is lost. Additionally, most of the collaboration beyond the project development, including collaboration within the functional groups, occurs on an ad-hoc basis.

Some opportunities to formalize the internal collaboration in the TSMO context include:

- Add a discussion of TSMO opportunities to the existing Director's, DCC, DDRT, and DSRT meetings.
- Obtain input from traffic operations staff during planning, design, construction, and maintenance phases to ensure TSMO opportunities are considered.
- Through collaboration between Operations and TP&D groups, develop performance measures for TSMO projects to allow them to compete with traditional project types during project selection.
- Through collaboration within the Operations and Maintenance group, explore the use of technology to make the maintenance process more effective and efficient.
- Through collaboration between Operations and Construction, ensure the consideration of appropriate smart work zone (SWZ) technology and detour signal timing within regionally significant projects.
- Through collaboration within the Operations group, establish funding needs for proactive management of traffic signals through a data-driven process.

External Partnerships

Similar to TxDOT-SAT, many of the senior leadership within partner agencies have been working in similar capacity in the San Antonio region for a long time and have established strong working relationships with each other. Collaboration across agencies typically occurs in an ad-hoc manner. Some examples of interagency collaboration include collaboration between TxDOT, COSA, and Bexar County on Highway Safety Improvement Program projects to improve roadways and signals and collaboration between TxDOT and VIA to implement Park and Ride along US 281. Some opportunities to formalize the internal collaboration in the TSMO context include:

- Formalizing the process of interagency collaboration through the AAMPO TAC meeting.
- Formalizing the process of collaboration during incident response and special events.
- Formalizing the process of collaboration during day-to-day TM activities.

4.2 Capability Maturity Framework

Based on the success of CMM across the country, the FHWA adapted the CMM approach to develop specific CMFs for individual TSMO applications (also called program areas), including TIM, TSM, WZM, planned special events, TM, and road weather management. Tailored capability frameworks allow agencies and stakeholders to focus on specific capability improvement needs within each program area.

TxDOT-SAT determined the four program areas discussed in paragraphs below to be the most critical for regional mobility and safety. Discussed below is the existing state of practice for TxDOT-SAT in these program areas and case studies that were discussed in conjunction with CMF self-assessments to develop actions for the program areas. The actions are detailed in the Five-Year TSMO Implementation Plan section (Section 5).

4.2.1 *Traffic Signal Management*

TSM involves the planning, design, integration, maintenance, and proactive operation of a traffic signal system. It is one of the most cost-effective TSMO strategies to improve movement of people and goods while making our streets safer and trips more reliable.

TxDOT-SAT currently operates approximately 450 traffic signals. Approximately 50 percent of the signals currently have 4G communications (comm) and are connected to the Centracs central system. TxDOT uses Econolite Cobalt controllers to control the signalized intersections and a mix of radar (approximately 60 percent) and video (approximately 40 percent) to detect vehicles. Three major corridors currently run coordination plans: Pat Booker Road, Farm-to-Market Road 3009, and State Highway 16. TxDOT does not currently operate traffic responsive or adaptive signal operation and does not collect performance measures such as ATSPM. The signal timing adjustments or equipment repairs are conducted once the issue is observed in the field or a request is received from the public. The request is tracked through completion by using the ticketing system TxDOTnow. TxDOT-managed corridors currently do not operate Transit Signal Priority (TSP).

TxDOT is in the process of modernizing the signal system by implementing cabinet upgrades and comm at signals. As part of this project, comm has been provided to more than 50 percent of the signals and all signals will have comm within the next 2 years. The District also plans to increase the usage of Centracs and adopt ATSPM to proactively maintain and operate signals. Additionally, the TxDOTnow program will incorporate features to track assets and inventory performance and perform asset management. Table 10 provides examples of how agencies across the country have utilized TSMO principles to enhance traffic signal/arterial management. These examples, along with CMF assessment results and discussions with TxDOT leadership, were utilized to develop the traffic signal management program area recommendations presented in Table 15.

Table 10: TSMO Applications for Traffic Signal Management

Case Study 1: Denver Regional Council of Government's (DRCOG) Traffic Operations Program (LINK) Extent: 3500 traffic signals across 32 jurisdictions in Denver Metro Program Components: 1. Capital improvement program: providing signal and communications equipment 2. Traffic signal timing program: Implementing signal timing improvements to demonstrate the benefits of the capital improvements. Funding: CMAQ Benefits: Benefit-cost ratio of 7.0

Case Study 2: FDOT (District 4) and Palm Beach County Active Arterial Management (LINK)

Extent: 76 traffic signals across three corridors

Project Components:

1. Actively monitor, manage and improve arterial operations utilizing 38 CCTVs, 30 BlueTOAD devices and remote command of traffic signals.
2. Deploy signal timing plans in response to incidents along I-95
3. Develop performance measures while accounting for costs of equipment/devices, operations and maintenance, Traffic Management Center operators, central signal software and INRIX subscription. Benefits calculations accounted for cost of travel time savings, crash reductions and energy savings.

Funding: FDOT and Palm Beach County

Benefits: Benefit-cost Ratio of 10.0

Case Study 3: Traffic Signal Retiming Program, North Central Texas Council of Governments (LINK)

Extent: 400 plus signals retimed as part of Phase 1

Project Components:

1. Collect and analyze traffic data, develop and optimize traffic models, create signal timing plans and field deploy the signal timing plans
2. Collect and report before-after performance measures.

Funding: CMAQ

Benefits: 7.3 percent reduction in travel time, 31.1 percent reduction in number of stops, 14.3 percent reduction in fuel consumption and 4.9 percent reduction in emissions; approximately $25.7 million in annual savings.

4.2.2 Traffic Incident Management

TIM is a planned and coordinated program to detect, respond to, and remove traffic incidents and restore traffic capacity as safely and quickly as possible. TIM reduces travel delay and non-recurring congestion and improves responder and traveler safety. Effective incident management helps address approximately 25 percent of all traffic congestion and reduces secondary incidents, which account for approximately 20 percent of all incidents.

TxDOT-SAT has been conducting TIM since the early 2000s. The first San Antonio region Traffic Incident Management Plan was published in May 2002, providing incident response, site management, and incident clearance recommendations. In August 2015, the Enhanced Traffic Incident Management ConOps document was published. This document further detailed the San Antonio region's TIM program, goals, objectives, needs, and recommended improvements.

TransGuide serves as the point of contact for all stakeholders (TxDOT, COSA, VIA, and the San Antonio Police Department [SAPD]) during incidents. During an incident, TransGuide operators utilize cameras throughout the region to provide incident information (e.g., video feeds) to first responders and to facilitate incident response. Operators also post travel-time and detour information on the DMSs and log incident details within Lonestar ATMS. TxDOT's main responsibilities during an incident are to manage extended traffic control and to participate in command of the incident. Through the Highway Emergency Response Operator (HERO) Program, TxDOT assists incident management by providing help to motorists and traffic responders. COSA is responsible for adjusting signal timing for the affected area and any alternate routes during incidents. The City also funds and controls incident clearance within city limits through its contracts with four towing companies. Outside city

boundaries, TxDOT-SAT, counties, and other municipalities within the District are responsible for conducting incident clearance.

A police dispatch stationed at TransGuide coordinates incident response between TxDOT and SAPD. Primary SAPD responsibilities include law enforcement at the incident scene, traffic control, accident investigation, and unified command of the situation. If there is a fire, spill, or injury, SAPD calls the fire department to command the scene. In San Antonio, SAPD is also responsible for coordinating with the towing contractor to arrange the necessary services. Primary fire responsibilities include injury response, traffic safety, and command of any type of spill. The fire departments attend to any injuries first and block the affected lanes with fire trucks.

TxDOT and stakeholders recognize the importance of a coordinated response to traffic incidents and therefore have implemented a TIM program that is constantly improving. As part of the program, TxDOT leads monthly TIM meetings to discuss important TIM needs and issues and solutions to improve incident response. Table 11 provides examples of how agencies across the country have utilized TSMO principles to enhance TIM. These examples, along with CMF assessment results and discussions with TxDOT leadership, were utilized to develop the TIM program area recommendations presented in Table 15.

Table 11: TSMO Applications for Traffic Incident Management

Case Study 1: Waycare Incident Management Platform Deployment at Southern Nevada Traffic Management Center (TMC) (LINK) Extent: Southern Nevada region Project Components: 1. Real-time sharing of incident information across four agencies housed at the TMC and to the public. The information used to be siloed across various software platforms used by the agencies. 2. Live map showing active incidents, congestion, queues, construction zones, road closures, location of highway patrol, service patrol and maintenance drivers. 3. Incident alerts on all devices, including incident location, a 20-second looped GIF, geofenced CCTV footage, insights on current road conditions, as well as relevant notes. Benefits: 12-minute reduction in incident response time; greater context of incident details prior to arriving on the scene; reduction in secondary crashes.
Case Study 2: TMC-based Active Incident Monitoring and Management, Denver, CO (LINK) Extent: Metro Denver area including Colorado Department of Transportation (CDOT) roadways Project Components: 1. The City uses “live” travel time and vehicular volume data and CCTV cameras to detect and verify incidents as well as bottlenecks, queuing and diversion routes. 2. The City and CDOT work together to activate incident related messaging on DMS signs and deploy signal timing changes to address congestion and travel time increase due to congestion. 3. The City and CDOT actively monitor and manage the incident through the TMC, which includes use of cameras and travel time/volume data to iteratively adjust signal timing on diversion routes. Benefits: 67 percent reduction in travel time on diversion routes.

Case Study 3: Real-Time Incident Management Dashboard, Bellevue, Washington (LINK)
Extent: City of Bellevue
Project Components:

1. The City developed a map-based dashboard integrating real-time 911 dispatch data (incident location, type, time) and CCTV cameras at traffic signals.
2. The dashboard map displays incident alerts near traffic signals, allows filtering of calls, and viewing and archiving of CCTV footage.
3. The engineers utilize the dashboard to verify, monitor and respond to incidents. Incident response includes signal timing adjustments, public notifications, incident analysis and countermeasures development.

Benefits: 10-15 minutes saved in incident investigations; up to 50 percent reduction in incident clearance time; reduced travel delays and improved safety of traveling public and responders.

4.2.3 *Traffic Management*

TM is the efficient management of traffic by application of the appropriate policies, strategies, and actions to mitigate any potential impacts resulting from the intensity, timing, and/or location of travel and to enhance mobility on transportation facilities. Effective TM reduces travel delay, reduces recurring and non-recurring congestion, and improves safety.

TxDOT conducts the regional TM activities through the TransGuide Traffic Management Center (TMC). Some of these activities include providing traveler information through DMSs, utilizing CCTVs for traffic monitoring, and coordinating special events, incidents, and emergency response. A major renovation of the TransGuide TMC was recently completed, renovating the main operations room and replacing obsolete consoles, video walls, and other technology. With the renovation, the COSA traffic operations staff has moved into the main operations room to join SAPD and VIA dispatchers and the TxDOT traffic operations staff. This colocation of TxDOT and COSA operations staff will help improve coordination, collaboration, and overall TM efforts.

TxDOT-SAT first developed the San Antonio Regional ITS Architecture in 2003. Since then, the architecture has been updated in 2007 and 2015. The National ITS Architecture v7.0 utilized during the 2015 update has been updated to ARC-IT v9.0. Therefore, TxDOT plans to update the San Antonio Regional ITS Architecture to be ARC-IT v9.0 compliant in 2022.

TxDOT-SAT's most recent ITS Master Plan was developed in 2017, providing a 5-year roadmap for developing the on-system ITS for major corridors within the San Antonio region. Active TM, integrated corridor management, active demand management, and Advanced Traveler Information System are among the service packages recommended in the plan. TxDOT plans to update the plan in 2022.

As part of the network monitoring initiative from TRF, TxDOT-SAT prepares quarterly TMS Reports that describe the existing ITS, gaps and needs, and implementation plans to address those gaps. Table 12 provides examples of how agencies across the country have utilized TSMO principles to enhance TM. These examples, along with CMF assessment results and discussions with TxDOT leadership, were utilized to develop the TM program area recommendations presented in Table 15.

Table 12: TSMO Applications for Traffic Management

Case Study 1: FDOT District 5 Integrated Corridor Management (LINK) **Extent:** Florida Department of Transportation District 5 **Project Components:** 1. FDOT District 5 freeway personnel and Active Arterial Management personnel work side-by-side to ensure an integrated approach to operations throughout the region. 2. ICM includes a wide variety of strategies such as traffic signal management through remote control and ATSPM, signal preemption and priority, ramp metering, traveler information (511, DMS, WAZE), incident management, dynamic shoulder running, information management, etc. **Benefits:** up to 10:1.
Case Study 2: Arizona DOT Needs Based Maintenance Budget (LINK) **Extent:** All of ADOT **Project Components:** 1. Determination of TSMO (CCTV, DMS, signals, lighting, ITS, signing, striping, etc.) maintenance needs based on a data-driven, performance centered approach as opposed to the one based on historical perspective (budget allocation based on what was accomplished last year). 2. ADOT staff collects inventories, assigns Level of Service grades, and enters data into a Needs Based Budget model for analysis and budget allocation. 3. Real-time Tableau-based performance measures and dashboards are available to make decisions based on the most recent data and to track progress towards targets. **Benefits:** Limited maintenance funds are allocated more efficiently.
Case Study 3: Georgia DOT Connected Data Platform (LINK) **Extent:** All GDOT **Project Components:** 1. The project will build a platform that aggregates data from multiple departments and eliminates the need to use multiple software. 2. The map-based platform will aggregate, quality check and develop performance measures for data such as crashes, incidents, ITS/signal devices, traffic, weather, fleet, etc. 3. The platform will provide automated alerts, on-screen monitoring, performance measure dashboards and reports. **Benefits:** Improve decision making accuracy and efficiency.

4.2.4 Work Zone Management

WZM entails the management of traffic during construction to minimize traffic delays, maintain motorist and worker safety, complete construction in a timely manner, and maintain access for businesses and residents. WZM is necessary to ensure construction projects progress without adversely affecting the safety and mobility of construction workers and the traveling public.

The construction group oversees and manages construction activities (freeway/arterial construction, signal construction, landscaping, rehabilitation) throughout the District for on-system roadways. TxDOT Design Guidebook includes construction-related design requirements, including requirements for ITS and WZs. TxDOT also has Special Specifications (6000 series) that apply to ITS items. Currently, the WZ details developed during the project do not always include consideration of SWZ elements. On large projects where safety concerns are raised, TxDOT engages TTI to monitor performance measures and to develop countermeasures.

The budget for traffic control during construction is generally included in the project budget during design. If additional funding is necessary for traffic control improvements during construction, a change order funded by Category 1 funds may be utilized. Addition of SWZ elements during the design phase will ensure their inclusion during construction.

Frontage roads and on-system roadways generally serve as alternate routes during construction. Signal timing changes to accommodate the needs of detour traffic are generally not developed or maintained by TxDOT over the duration of construction.

The District requires agencies and contractors to submit Lane Closure Forms to inform where the planned lane closures will be. The forms are not always received by the District, affecting TM through the construction areas. The District Public Information Officer (PIO) sends out a list of all closures planned by TxDOT every Friday to all partner agencies within the District.

Table 13 provides examples of how agencies across the country have utilized TSMO principles to enhance WZM. These examples, along with CMF assessment results and discussions with TxDOT leadership, were utilized to develop the WZM program area recommendations presented in Table 15.

Table 13: TSMO Applications for Traffic Incident Management

Case Study 1: My35 Waco Construction Work Zone (LINK) **Extent:** Texas Department of Transportation I-35 Waco **Project Components:** 1. ITS such as CCTVs, end-of-queue warning systems, comparative travel time signs. 2. Project website with a map displaying real-time traffic conditions, incidents, delays, pedestrian crossing locations and CCTV streams **Benefits:** Surrounding Waco community and traveling public benefit from comprehensive approach to traveler information.
Case Study 2: AZTech Smarter Work Zone (LINK) **Extent:** Phoenix Metro **Project Components:** Arizona DOT, Maricopa County DOT and Maricopa MPO partnered to deploy three technology and data driven solutions to address work zone mobility and safety: 1. Deployed SWZ applications such as queue warning, traveler information (travel times, detours) and speed limit compliance across the state on both freeways and arterials. 2. Developed a database that collects and processes construction data from multiple agencies and disseminates the information through AZ 511. 3. Developed an in-vehicle connected vehicle app that utilizes 5.9 GHZ wireless communications to provide freight vehicles work zone related alerts and warnings. **Benefits:** Reduced travel times, increased speed compliance and no fatalities or worker safety issues during SWZ deployment.

Case Study 3: Comprehensive Work Zone Management Program (LINK)

Extent: All of Iowa DOT

Project Components:

1. To determine which highway projects require additional work zone management attention, developed Traffic Critical Projects (TCP) process and added it within the Design Manual.
2. Added countermeasures such as traffic operations treatments, SWZ equipment and work zone TIM plans to the Design Manual.
3. Partnered with Iowa State University on real-time performance monitoring, developed a database to store work zone data, disseminated situational data to engineers and law enforcement, and developed a specification for requiring smart arrow boards (GPS + modem) on construction projects.

Benefits: Advanced Iowa DOT's TSMO capability maturity through the development of policy and procedures.

5 FIVE-YEAR TSMO IMPLEMENTATION PLAN

This section includes a prioritized implementation plan for advancing TSMO in the San Antonio District over the next 5 years. The action items included in Tables 14 and 15 are the outcome of the comprehensive TxDOT and partner agency engagement process discussed earlier where the leadership and key leads from TxDOT and partner agencies were engaged multiple times over the course of the project to cocreate the TSMO actions. This approach ensures that the action items listed below are properly vetted and that there is TxDOT support for them, making the actions implementable. Table 14 provides program-level, CMM-based TSMO actions, and Table 15 provides program-area-level, CMF-based TSMO actions. These tables provide the following information for each action item.

- **ID:** An identifier for each recommended action item, organized by CMM capability dimension: Business Processes (BP), Systems & Technology (ST), Performance Measurement (PM), Culture (CU), Organization & Workforce (OW), and Collaboration (CO).
- **Action:** Brief description of the action and associated steps.
- **Lead:** Identification of the department or agency that will take ownership of the action and lead its implementation.
- **Support:** Identification of the department or agency that will support the implementation of the action.
- **Cost:** An estimate of the level of fiscal resources TxDOT would need to commit to implement the action.
- **Impact:** An estimate of the magnitude of improvement as a result of implementing the action.
- **Time Frame:** The time frame in which an action is likely to be implemented.
- **Measure of Success:** Identification of how the progress and completion of an action will be tracked.

While all action items listed below could potentially be implemented within the next 5 years, no funding is currently allocated for any of these action items unless otherwise specifically stated in this plan. Action items will be implemented as District resources permit.

Table 14: TxDOT-SAT Program-Level TSMO Action Items

ID	Action	Lead	Support	Cost	Impact	Timeframe	Measure of Success
Year 1 - 2 Actions							
BP-01	Consider proven TSMO/ITS Strategies during planning: - Consider including ITS/TSMO as part of access management studies. - Include ITS/TSMO during schematic development to provide better estimate of construction costs. - Develop checklists/toolbox to include ITS/TSMO strategies.	TP&D	Operations	$	★★★★	1-2 years	Yes/No
BP-03	Develop a formal workflow/process that institutionalizes how work and funding needs are coordinated between TP&D, Construction, Operations, and Maintenance. Identify roles within functional groups responsible for the communication to ensure successful practices are not lost when personnel changes occur.	TP&D	All	$	★★★	1-2 years	Yes/No
BP-04	Include TSMO activities as part of existing meetings/processes instead of adding to the number of meetings/processes: - Discuss topics such as ITS needs, WZ analysis, smart WZ needs and technologies, safety and operational performance measures, and traffic control funding during DSRT (Construction), DDRT (Design), and DCC (TP&D) meetings.	Operations	Construction	$	★★★★	1-2 years	Yes/No
CU-01	Identify ways to embed TSMO in the District's culture, e.g., start certain meetings with a TSMO Moment, recognize staff for bringing TSMO ideas to projects, establish TSMO roles and responsibilities.	Deputy DE	All	$	★★★	1-2 years	Yes/No
OW-02	Evaluate training and development of existing staff/retention of staff (data scientists, software developers, or technology experts) to continue to leverage data and technology to enhance DOT Business Processes.	Deputy DE	All	$$	★★★★	1-2 years	% Complete
Year 3 - 5 Actions							
BP-06	Identify project priorities and estimated costs for TSMO improvements that can be added to the Unified Transportation Plan over the next 10 years.	TP&D	Operations	$	★★★★	3-5 years	% Complete
BP-08	Institutionalize the use of Regional ITS Architecture and Systems Engineering processes during planning of ITS/TSMO projects.	Operations	TP&D	$$	★★★	3-5 years	Yes/No
ST-02	Track complaints/issues from initial documentation to resolution: - Institutionalize the use of the TxDOT ticketing system (ServiceNow) for tracking issues, discussions, resolutions, and turnaround time.	Operations	Area Engineers	$	★★★	3-5 years	Yes/No
PM-02	Continuously analyze mobility (from probe data) and safety data such as speeds, travel times, and crashes to develop mobility- and safety-based performance measures. Display performance measures on a shareable dashboard: - Identify bottlenecks/hotspots and develop and prioritize projects. - Utilize performance measures to enhance operations during construction for regionally significant corridors.	TP&D	Operations	$$	★★★	3-5 years	% Complete
PM-03	Develop a dashboard to visually overlay on the map the maintenance activities. This helps identify potential conflicts in implementation time frames for seal coat plan, striping plan, 4-year safety plan, volumes, construction, etc.	TP&D	Maintenance	$$	★★★★	3-5 years	% Complete
CU-02	Establish through TAC a TSMO sub-committee that meets quarterly to discuss district-wide TSMO efforts, partnership opportunities, and lessons learned.	TP&D	Alamo Area MPO	$	★★★★	3-5 years	Yes/No
OW-03	Update individual job descriptions to reflect TSMO skills and capabilities and discuss TSMO-related goals and responsibilities during onboarding.	Deputy DE, Directors	District Staff	$	★★★	3-5 years	% Complete
BP-02	Develop a program to plan for and continuously track maintenance activities: - Routinely collect asset (e.g., pavement condition, guardrail, seal coat, ITS) information to develop and maintain a comprehensive inventory. - Track maintenance activities and completion status. - Develop asset lifecycle cost models to identify maintenance funding needs for maintenance and area offices. - Develop tools/platform to efficiently inventory assets (e.g., signs), perform asset assessment (e.g., guardrail condition), inform maintenance/replacement costs, and track work orders.	Maintenance Division	Maintenance	$$$	★★★★	3-5 years	% Complete

ID	Action	Lead	Support	Cost	Impact	Timeframe	Measure of Success
BP-05	Identify ways to incorporate standalone TSMO projects within the District's annual budget.	TP&D	Operations	$	★★★	3-5 years	Yes/No
BP-07	Review the TSMO Program Plan and CMM/CMF assessments for minor updates every 2 years.	Operations	All	$	★★	3-5 years	Yes/No
ST-01	Identify a way to reduce the number of programs being used and improve information/data sharing between programs.	IMD	Operations	$$$	★★★	3-5 years	% Complete
PM-01	Provide example use cases and benefits for various TSMO strategies to help justify their deployment: - Track performance measures after project completion to assess performance against expected benefits. - Use actual benefits as use cases to develop project selection criteria.	TP&D	Operations	$$	★★★	3-5 years	% Complete
CU-03	Communicate benefits and outcomes of TSMO to various external stakeholders, including policymakers, the media, and others.	Operations	PIO	$	★★	3-5 years	Yes/No
OW-01	Emphasize need for TSMO focus, similar to Safety, through a change in organization structure. Example: TSMO Coordinator under Deputy DE; TSMO facilitators within each functional group.	Deputy DE	All	$$	★★★★	3-5 years	Yes/No
CO-01	Formalize the process of collaboration with partner agencies including the AAMPO.	TP&D	Operations	$	★★★★	3-5 years	Yes/No
CO-02	Improve collaboration between Bexar County, VIA, COSA, and TxDOT to: - Share data and performance measures such as video feeds, volumes, speeds, travel times, signal timings, crashes, benefit-cost analysis, dashboards, etc.	TP&D	Bexar County, Alamo Area MPO, VIA, COSA	$$	★★★	3-5 years	Yes/No

Table 15: TxDOT-SAT Program-Area-Level TSMO Action Items

ID	Action	Lead	Support	Cost	Impact	Timeframe	Measure of Success
Traffic Signal Management							
Year 1 - 2 Actions							
ST-01	Provide communications to 100 percent of District signals.	Operations	TRF	$$	★★★★	1-2 years	% Complete
ST-03	Expand Centracs license to provide connectivity to 100 percent of District signals.	Operations	Operations	$$	★★★★	1-2 years	% Complete
ST-04	Deploy ATSPM pilots to evaluate district-wide deployment.	Operations	TRF	$$	★★★	1-2 years	Yes/No
Year 3 - 5 Actions							
BP-1	Develop a performance-based and objectives-driven traffic signal timing program in alignment with TxDOT goals and objectives.	Operations	Operations	$	★★★	3-5 years	% Complete
BP-5	Identify ways to verify contractors maintaining signal timing and detection during construction.	Operations	Operations	$	★★★	3-5 years	Yes/No
ST-07	Evaluate portable traffic signals for TM during construction. - Provide communications to portable traffic signals from TMC during construction projects to enable remote timing adjustments	Operations	Construction	$	★★★	3-5 years	Yes/No
PM-01	Utilize INRIX/probe data to identify corridors to retime and to compare performance measures before/after signal timing studies.	Operations	TP&D	$$	★★★	3-5 years	Yes/No
BP-2	Develop a performance-based and objectives-driven traffic signal maintenance program in alignment with TxDOT goals and objectives.	Operations	Operations	$$	★★★	3-5 years	% Complete
BP-3	Document detection layout and requirements to enable ATSPMs.	TRF	Operations	$	★★★	3-5 years	Yes/No

ID	Action	Lead	Support	Cost	Impact	Timeframe	Measure of Success
BP-4	Document existing guidelines for signal turn-on, flashing yellow arrow deployment, vehicle and pedestrian change intervals, need for coordination, standardized cycles lengths, and other timing parameters, etc.	Operations	Operations	$	★★★	3-5 years	Yes/No
ST-02	Upgrade controllers to ensure high-resolution data capability (to collect ATSPMs).	Operations	TRF	$$	★★★★	3-5 years	% Complete
ST-05	Deploy ATSPM at all District signals.	Operations	TRF	$$$	★★★★	3-5 years	% Complete
ST-06	Deploy an asset management system for traffic signals to ensure aging or antiquated controller and communications technologies are replaced based on projected end-of-life information or regular upgrade cycles. Also track failures based on manufacturers, makes, and models.	Operations	TRF	$$$	★★★★	3-5 years	Yes/No
PM-02	Develop ATSPM-based reporting for regionally significant corridors and track performance measures monthly for continuous improvement of signal operations and maintenance.	Operations	Operations	$$	★★★	3-5 years	% Complete
CU-01	Provide regional leadership and coordination to incorporate principals of active arterial management and integrated corridor management.	Operations	COSA	$	★★★★	3-5 years	Yes/No
OW-01	Identify required staffing levels to attain goals and objectives of signal management program.	Operations	Operations	$	★★★	3-5 years	Yes/No
OW-02	Identify training needs for the signal operations staff based on goals and objectives of the signal management program, which may include considerations for emerging technologies in signal management.	Operations	Operations	$$	★★★	3-5 years	Yes/No
CO-01	Enhance signal operations in the region by: - Improving agency coordination on signal timing efforts across the district. - Performing region-wide coordination/retiming of signals. - Exploring expansion of TSP coverage and enhancements to TSP system. - Leveraging ATSPMs and central systems to better track/enhance signal performance across agencies and sharing performance measures.	Operations	COSA & AAMPO	$$$	★★★★	3-5 years	Yes/No
CO-02	Collaborate with AAMPO and COSA to develop a regional signal timing and maintenance program that will allow consistency in signal operations and maintenance within the San Antonio District.	Operations	COSA & AAMPO	$$$	★★★★	3-5 years	Yes/No
Traffic Incident Management							
Year 1 - 2 Actions							
BP-01	Apply data-driven analysis of historical data (e.g., speed, crash, HERO operations) to conduct HERO route planning, staging, and resource allocation.	Operations	COSA	$$	★★★	1-2 years	Yes/No
BP-02	Utilize HERO performance measures to build a data-driven business case to sustain and obtain additional funding (if necessary) for the program in the future.	Operations	TP&D	$	★★★★	1-2 years	Yes/No
CO-01	Collaborate with COSA and all TIM partners to develop data-sharing policies, including view access of CCTV cameras.	Operations	Operations	$	★★★	1-2 years	Yes/No
Year 3 - 5 Actions							
BP-05	Plan for TIM during the construction phase of significant roadway projects (potential discussion during DDRT) and evaluate the need for a project-specific Traffic Incident Management Plan.	Construction	Operations	$	★★★	3-5 years	Yes/No
ST-01	Evaluate video analytics to automatically detect incidents.	Operations	TRF	$$	★★★	3-5 years	Yes/No
CU-01	Provide regional leadership in TIM activities to: - Improve the understanding of TIM and its need among partner agencies. - Increase partner agency participation in the TIM program.	Operations	TIM Stakeholders	$$	★★★	3-5 years	Yes/No

ID	Action	Lead	Support	Cost	Impact	Timeframe	Measure of Success
OW-01	Establish a TIM Steering Committee or Task Force to provide consistent, permanent leadership to the TIM program. The committee comprised of leadership from fire, police, AAMPO, TxDOT, COSA, and tow providers will meet quarterly to establish TIM memoranda of understanding, policies, and practices and define priorities.	DE or Deputy DE	TIM Stakeholder Leadership	$$	★★★	3-5 years	Yes/No
BP-03	Apply for federal grants to pilot test emerging technologies with potential to enhance TIM.	Operations	TRF	$$	★★★	3-5 years	Yes/No
BP-06	Identify district-wide diversion routes and develop the ability to quickly deploy signal timing changes in response to incidents.	Operations	Operations	$$	★★★	3-5 years	% Complete
ST-02	Deploy a platform where all agencies can share real-time incident data. - Evaluate platforms that can integrate with Lonestar and ingest multiple data sources such as NPMRDS data, crowdsourced data, in-vehicle data and roadside device data. - Integrate Police CAD data into Lonestar to receive incident alerts. - Automate reporting of roadway clearance and incident clearance times.	TRF	Operations	$$$	★★★★	3-5 years	% Complete
PM-01	Utilize NPMRDS data to supplement existing incident detection, tracking, and reporting processes to more accurately report TIM performance.	TRF	Operations	$$	★★★	3-5 years	Yes/No
PM-02	Develop interactive dashboards that track performance measures such as roadway clearance time, incident clearance time, and secondary crashes.	TRF	Operations	$$	★★★	3-5 years	Yes/No
OW-02	Establish an Incident Management Coordinator position that would serve as the main contact and communications hub for TIM activities and would be responsible for development, maintenance, and implementation of operational policies, manuals, and standard operating procedures.	Operations	Operations	$$	★★★	3-5 years	Yes/No
OW-03	Establish recurring TIM training: - To train new staff and develop redundancy in existing staff. - For multidisciplinary TIM program participants to understand the incident command structure, role of involved agencies, and applicable standards (e.g., Texas Manual on Uniform Traffic Control Devices). - To improve TIM practices based on lessons learned.	Operations	Operations	$$	★★★	3-5 years	% Complete
OW-04	Formalize the roles and responsibilities within TIM participant agencies to carry out TIM functions.	Operations	Operations	$$	★★★	3-5 years	Yes/No
Traffic Management							
Year 1 - 2 Actions							
ST-03	Update the existing San Antonio Regional ITS Architecture document to be ARC-IT 9.0 compliant. Conduct multi-agency training on ITS Architecture to ensure all stakeholder agencies are developing TSMO/ITS projects in compliance with the Architecture: - Evaluate a web-based, interactive, and user-friendly version of the Regional ITS Architecture that is easy to reference and update.	Operations	Operations	$$	★★★	1-2 years	Yes/No
ST-04	Update the ITS Master Implementation Plan based on the revised ARC-IT 9.0 compliant Regional ITS Architecture.	Operations	Operations	$$	★★★	1-2 years	Yes/No
Year 3 - 5 Actions							
CO-01	Leveraging colocation in the TMC, identify ways to formalize, enhance, and extend collaboration with COSA on TM strategies (e.g., integrated corridor management).	Operations	COSA	$$	★★★	3-5 years	Yes/No
BP-2	Develop a data-driven, needs-based operations and maintenance budgeting process to maintain or replace TSMO (ITS/signals) assets. The process will utilize TSMO asset inventory, asset cost, information on completed/needed maintenance, and assigned asset level of service to determine the operations and maintenance budget.	Operations	Operations	$$$	★★★★	3-5 years	% Complete
BP-3	Evaluate the need for a performance-based preventative maintenance and inspection program that would complement the statewide Skyline contract to facilitate needs-based maintenance.	Operations	Operations	$$	★★★	3-5 years	% Complete

ID	Action	Lead	Support	Cost	Impact	Timeframe	Measure of Success
BP-4	Evaluate the need for a platform that aggregates TSMO-related information (signals/ITS assets, crashes, INRIX, WAZE) from various departments/sources and develops alerts and actionable insights to inform real-time TM decisions.	TRF	Operations	$$$	★★★★	3-5 years	Yes/No
BP-5	Explore partnerships with partner agencies and private companies to share communications networks.	Operations	COSA	$	★★★	3-5 years	Yes/No
ST-01	Develop the needs and requirements for applications of active TM strategies (e.g., integrated corridor management, high-occupancy-vehicle use monitoring, ATSPM) to test freeway and arterial emerging technologies. Identify a corridor on which to evaluate the technologies.	TRF	Operations	$$	★★★	3-5 years	% Complete
ST-02	Explore the use of macro-, meso-, and microscopic traffic analysis tools to evaluate emerging ITS/TSMO technologies.	TP&D	Operations	$$	★★★	3-5 years	Yes/No
PM-01	Continuously analyze mobility and safety data such as speeds, travel times, and crashes to develop mobility- and safety-based performance measures (e.g., incident/equipment alerts, roadway clearance times, average speed, travel-time index). Display performance measures on a TMC dashboard: - Identify areas on which to focus TM activities (e.g., traveler information, signal timing adjustments, incident response). - Utilize performance measures to plan for and enhance operations (e.g., WZs, special events, weather events, holidays). - In the interim, develop a checklist to identify major construction projects to monitor performance measures on.	Operations	Operations	$$	★★★	3-5 years	% Complete
PM-02	Continuously track asset performance (e.g., percentage uptime, asset reliability, asset age vs. service life, work-order tracking) against goals: - Proactively address equipment issues before issues become complaints. - Improve system reliability.	Operations	Operations	$$	★★★	3-5 years	% Complete
CU-01	Identify ways to promote travel behavior changes through TM activities (e.g., promote alternate routes, carpooling, transit use, wearing seat belts, changing work schedule).	TRF	Operations	$	★★★	3-5 years	Yes/No
PM-01	Evaluate training and development of existing staff/retention of staff (data scientists, software developers, or technology experts) to continue to leverage data and technology in TM activities. Establish procedures to ensure knowledge is not lost when personnel transition into new roles.	Operations	Operations	$$	★★★	3-5 years	Yes/No
CO-02	Explore partnerships with private application developers to share traveler information data with them (e.g., share construction data with Google/Waze).	TRF	Operations	$$	★★★	3-5 years	Yes/No
CO-03	Expand the mobility and safety dashboards to the regional level, integrating data from regional partners and providing access to the partners.	TRF	Operations	$$$	★★★★	3-5 years	% Complete
Work Zone Management							
Year 1 - 2 Actions							
BP-01	For significant projects, evaluate the use of planning-level traffic analysis (e.g., FREEVAL, QuickZone, VISSIM, DynusT) and predictive safety analysis tools to configure WZs (duration, extent, and number of lanes taken with WZ).	TP&D	Construction	$$	★★★	1-2 years	Yes/No
BP-02	For significant projects, evaluate the need for and type of WZ ITS based on the TxDOT Smart Work Zone Guidelines and Go/No-Go Decision Tool (LINK).	Operations	Construction	$	★★★	1-2 years	Yes/No
BP-04	Develop a Transportation Management Plan for significant project WZs, and document safety and mobility performance measures and TSMO elements: - Utilize WZM strategies listed under Table 4.1 of FHWA's "Developing and Implementing Transportation Management Plans for Work Zones." - Document how ITS/SWZ elements are evaluated to improve WZ mobility, safety, and monitoring capabilities. - Document how social media, crowdsourcing, and connected vehicle technology are evaluated to improve traveler information.	Operations	Construction	$$	★★★	1-2 years	Yes/No
BP-05	Develop a process to coordinate lane closures among multiple projects and agencies to achieve WZM objectives.	Operations	Construction	$$	★★★	1-2 years	Yes/No

ID	Action	Lead	Support	Cost	Impact	Timeframe	Measure of Success
ST-02	During project design, assess whether the application of existing technologies to manage traffic and measure system performance would enhance WZ operations and safety.	TP&D	Operations	$	★★★	1-2 years	Yes/No
OW-02	Establish a TSMO Liaison position representing the Construction group.	Construction	Operations	$	★★★	1-2 years	Yes/No
CO-01	Identify ways to enhance collaboration with law enforcement during WZ activities (e.g., use of CAD data, WZ enforcement, incident response).	Operations	Construction	$$	★★★	1-2 years	Yes/No
Year 3 - 5 Actions							
BP-07	For significant projects, evaluate integration of incident management through WZs.	Operations	Operations	$	★★★	3-5 years	Yes/No
PM-02	On significant projects, collect real-time and historical performance measures on travel speed, travel time, traffic volumes, queue lengths, and crashes: - Utilize performance measures to monitor WZ performance and to develop safety and mobility countermeasures. - Utilize performance measures from multiple projects to continually evaluate and improve WZ policies and procedures. - Utilize historical WZ performance measures and planning-level analyses to develop WZM funding needs for upcoming projects.	TP&D	Operations	$$	★★★	3-5 years	% Complete
BP-03	Institutionalize the process to evaluate innovative contracting alternatives (e.g., A+B bidding, incentive/disincentive clauses, design-build) for WZM.	Construction	Operations	$	★★★	3-5 years	Yes/No
BP-06	Explore the use of federal pilot and pooled-fund projects to evaluate new and emerging WZM strategies.	Operations	TRF	$$	★★★	3-5 years	Yes/No
ST-01	Include the assessment of new technologies, procedures, and strategies for WZM as a step during project design stage.	TP&D	Operations	$$	★★★	3-5 years	Yes/No
ST-03	Develop a map-based platform to plan for and coordinate construction-related activities. The platform will: - Provide information on TxDOT and partner agency planned/ongoing construction, signals, ITS, and other assets (location of HERO, EMS, police, and fire vehicles) to allow coordination of construction activity, accurate detour information, and seamless coordination between TMC staff, inspectors, contractors, and functional groups. - Real-time and historical performance measures and dashboards on travel speed, travel time, traffic volumes, queue lengths, and crashes. - Third-party data such as INRIX, Waze, and Google data. - An online Lane Closure Form to allow easy entry of construction activity through computer/mobile devices. - Daily email/text alerts on construction activity. - Formalize the process of lane-closure coordination through TMC/Operations and Maintenance staff by designating them to receive Lane Closure Forms or phone notifications of planned closures. - Allow field verification and enforcement of lane closures.	TRF	Operations	$$$	★★★★	3-5 years	% Complete
PM-01	Define safety- and mobility-based performance measures and performance measurement goals for ongoing mobility and safety evaluations and improvements within WZs.	TP&D	Operations	$$	★★★	3-5 years	Yes/No
CU-01	Discuss WZ safety and lessons learned in Director's and Supervisors' meetings.	Construction	Operations	$	★★★	3-5 years	Yes/No
CU-02	For significant projects, document and share with relevant staff/stakeholders the WZM successes and improvement opportunities to develop actions for future projects.	Construction	Operations	$	★★★	3-5 years	Yes/No
OW-01	Establish a periodic WZM training to: - Regularly update WZM knowledge and skills to incorporate latest industry advances within the TxDOT practice. - Cross-train staff to improve understanding of all aspects of WZM. - Capture, share, and refine institutional WZ knowledge within TxDOT.	Construction	Operations	$$	★★★	3-5 years	% Complete
CO-02	Collaborate with partner agencies (e.g., COSA, Bexar County, VIA) on coordination of construction projects and sharing data that may help address construction impacts.	Operations	Construction	$$	★★★	3-5 years	Yes/No
CO-03	Identify ways to enhance collaboration with private sector and stakeholders during WZ activities: - Document input and resulting countermeasures because of concerns from affected public, businesses, schools, EMS. - Provide regular construction updates via social media platforms/project websites. - Utilize enhanced ways to obtains input from stakeholders (encourage input from social media, platforms such as MetroQuest).	Operations	Construction	$$	★★★	3-5 years	% Complete

6 TSMO TACTICAL PLAN ASSESSMENT

Tactical plans build upon the higher-level recommendations provided in a TSMO Program Plan related to specific services, projects, and programs and provide more detailed recommendations and actions to operationalize them. Tactical plans include discussion and analysis of existing conditions, needs and gaps, opportunities and challenges, recommendations including responsibilities and staffing, and a more detailed cost estimate for implementation. Examples of tactical plans created by TxDOT-SAT include the 2017 ITS Master Plan, 2015 Regional ITS Architecture, and 2015 Incident Management Concept of Operations.

6.1 Tactical Plan Criteria

Tactical criteria were developed by the TRF using qualitative descriptors with the intent that, as tactical plans advance to implementation, quantitative analyses will be performed (e.g., cost estimates, benefit-cost ratios, funding sources, detailed schedules). Criteria for tactical plans applied at the strategic plan level are as follows:

- Alignment with TxDOT-SAT TSMO goals
- Stakeholder partnerships necessary for implementation.
- Anticipated initial and ongoing costs.
- Level of District staff effort.
- Expected return on investment.

6.2 Tactical Plan Components

The following components will be included in each tactical plan:

- Documentation, discussion, and analysis of existing conditions, including existing processes, systems, roles, and responsibilities.
- Identification of gaps and development of needs based on tactical plan objectives.
- Discussion of institutional and technical challenges in addition to opportunities to support TSMO advancement developed in conjunction with stakeholders.
- Recommendations related to enhancement of activities or addition of new activities to advance TSMO elements.
- Budgetary requirements and schedule for implementation.
- Performance measures to track progress of the proposed activities.

6.3 Recommended Tactical Plans

TSMO tactical plans recommended for TxDOT-SAT are summarized in Table 16.

Table 16: TxDOT-SAT TSMO Tactical Plan Recommendations

Tactical Plan	Supported District TSMO Goals						Lead	Support	Cost	Impact
	Safety	Reliability	Efficiency	Customer Service	Collaboration	Integration				
Regional ITS Architecture Update					X	X	Operations	COSA, Bexar County, VIA, AAMPO	$$	★★★
ITS Master Plan Update	X	X	X		X	X	Operations	COSA, Bexar County, VIA, AAMPO	$$	★★★
Traffic Incident Management Plan	X	X	X	X	X		Operations	COSA, Bexar County, VIA, First Responders, AAMPO	$$	★★★★
Traffic Signal Management Plan	X	X	X	X	X	X	Operations	COSA, Bexar County, VIA, AAMPO	$$	★★★
Data Collection and Performance Measurement Plan	X	X	X	X	X		TP&D	Operations, COSA, AAMPO	$$	★★★
Traffic Management Center Service Layer Plan	X	X	X	X	X	X	Operations	COSA	$$	★★★

7 REFERENCES

- Texas Transportation Plan 2050.
- TxDOT Transportation Systems Management & Operations.
- TxDOT (2018) Transportation Systems Management and Operations (TSMO) Statewide Strategic Plan.
- TxDOT (2018) Performance Dashboard.
- TxDOT (2022) Unified Transportation Program
- San Antonio (2015) Regional ITS Architecture
- San Antonio (2015) Traffic Incident Management Concept of Operations
- TxDOT-SAT District (2017) ITS Master Plan
- Federal Highway Administration (2017) Developing and Sustaining a Transportation Systems Management & Operations Mission for Your Organization: A Primer for Program Planning (FHWA-HOP-17-017).
- FHWA (2020) Capability Maturity Frameworks Overview
- US DOT (2021) Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)
- FHWA (2015) Transportation Systems Management and Operations Benefit-Cost Analysis Compendium.

APPENDIX A

List of TxDOT and Partner Agency Members

TxDOT San Antonio District TSMO Stakeholder List

TxDOT San Antonio District

Executive Leadership				
	Gina E. Gallegos, P.E.	District Engineer	(210) 615-1110	Gina.Gallegos@txdot.gov
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	Jessica Castiglione, P.E.	Director of Transportation Operations	(210) 615-6222	Jessica.Castiglione@txdot.gov
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Partner Agencies

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	Allison Blazosky, AICP	Regional Transportation Planner	(210) 230-6911	blazosky@alamoareampo.org
Bexar County				
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TxDOT San Antonio District TSMO Stakeholder List

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VIA Metropolitan Transit

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