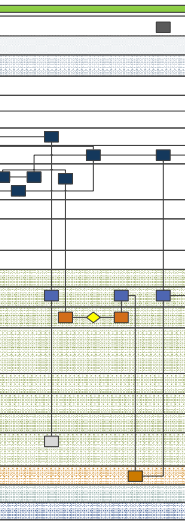
TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO)



CORPUS CHRISTI DISTRICT PROGRAM PLAN

December 2022

Texas Department of Transportation

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ACRONYMS AND ABBREVIATIONS

ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
ATMS	Advanced Traffic Management System
ATSPM	Automated Traffic Signal Performance Measures
BCR	Benefit-Cost Ratio
BP	Business Processes
CCMPO	Corpus Christi Metropolitan Planning Organization
CCRTA	Corpus Christi Regional Transportation Authority
CCTV	Closed-Circuit Television
CMF	Capability Maturity Framework
CMM	Capability Maturity Model
CO	Collaboration
COCC	City of Corpus Christi
Con-Ops	Concept of Operations
CRIS	Crash Records Information System
CRP	Corpus Christi District
CU	Culture
DCC	Design Concept Conference
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
ITS	Intelligent Transportation Systems
OW	Organization & Workforce
PDO	Property Damage Only
PDP	Project Development Process
PM	Performance Measurement
RWM	Road Weather Management
SEA	Systems Engineering Analysis
SHRP2	Second Strategic Highway Research Program
ST	Systems & Technology
SWZ	Smart Work Zone
TIM	Traffic Incident Management
TMC	Traffic Management Center
TMS	Traffic Management Systems
TP&D	Transportation Planning & Development
TRF	Traffic Safety Division

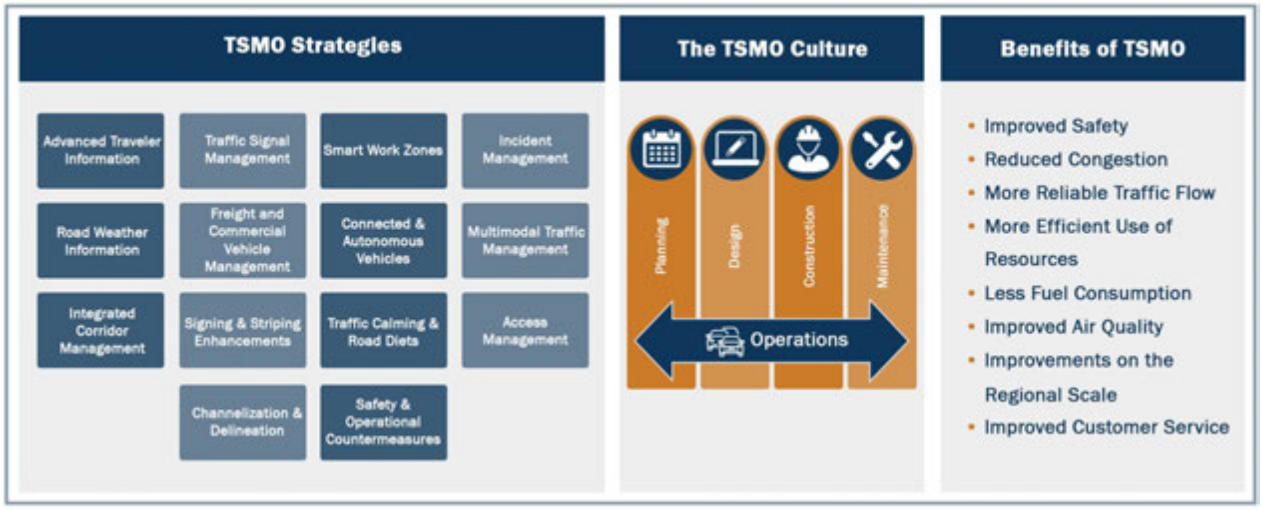
TSM	Traffic Signal Management
TSMO	Transportation Systems Management and Operations
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation
UTP	Unified Transportation Program
WZ	Work Zone
WZM	Work Zone Management

EXECUTIVE SUMMARY

What is TSMO?

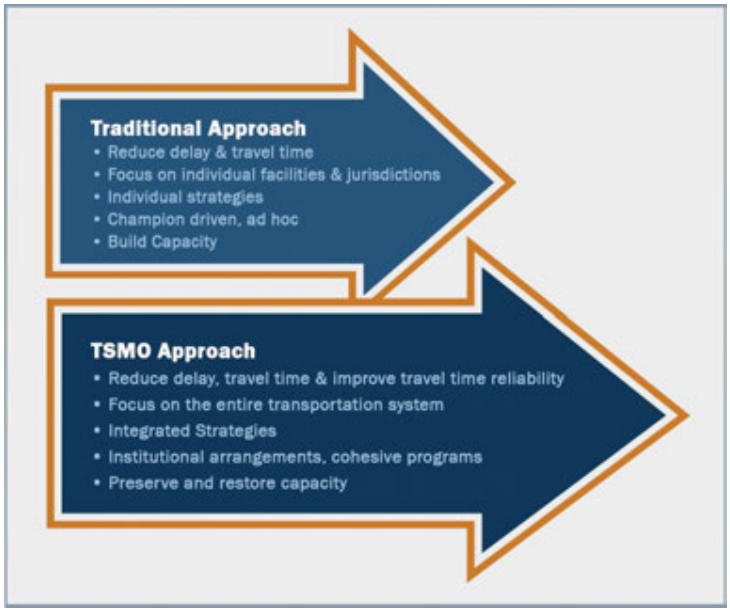
Transportation Systems Management and Operations, also known as TSMO, is a set of strategies that focus on operational improvements that can maintain and even restore the performance of the existing transportation system before additional capacity is needed. The goal of TSMO is to get the most performance 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

The Texas Department of Transportation (TxDOT) Corpus Christi District (CRP; District) implements many of the above-listed TSMO solutions. However, TSMO is more than implementation 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 the district.



TxDOT TSMO Planning Initiative

Executive Director Marc Williams issued a memo 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.

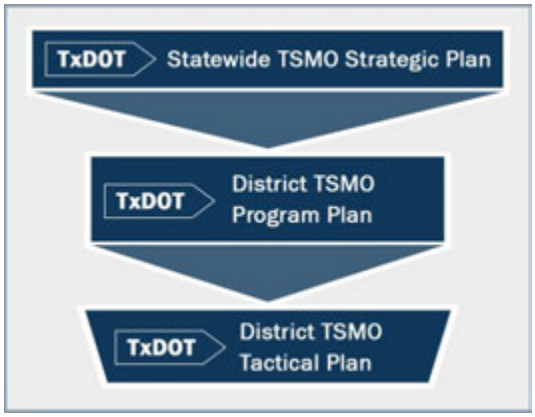
"…it is imperative that Traffic Management Systems (TMS) and operational improvements complement construction and maintenance program efforts. This includes ensuring that TMS is considered throughout the project lifecycle from inception through construction…."

Marc Williams, June 29, 2022

"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."

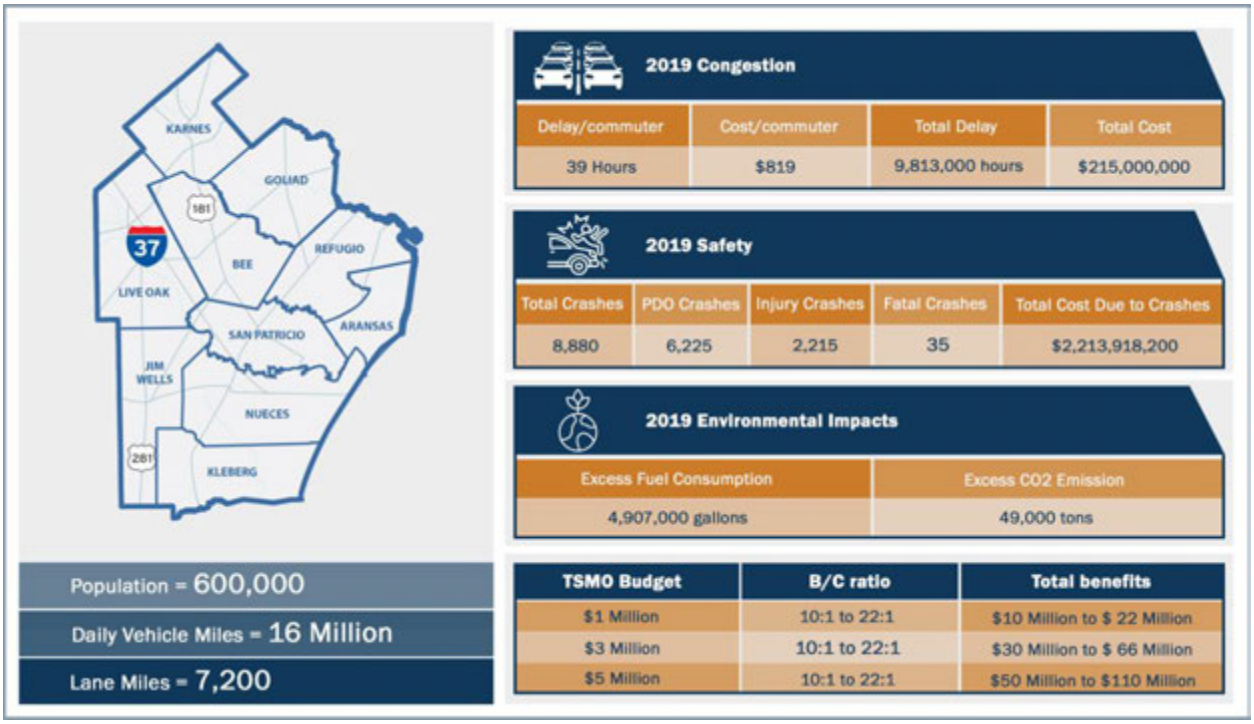
Marc Williams, June 29, 2022

TxDOT's Traffic Safety Division (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-CRP, 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-cost ratio (BCR) between 10:1 to 22:1. The business case summary presented here illustrates the impacts and costs associated with congestion, safety, and the environment within the Corpus Christi 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 (TSM), traffic incident management (TIM), road weather management (RWM), and work zone (WZ) management (WZM). The process, beginning with the District Engineer's (DE's) endorsement, included extensive engagement with District leadership, partner agencies, and a 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 incorporating TSMO/ITS strategies during planning.	Transportation Planning & Development (TP&D)	Traffic Operations
Enhance maintenance planning and tracking activities by utilizing systematic processes.	Maintenance	Maintenance
Develop a formal process that institutionalizes how project development and funding needs for TSMO projects are coordinated between TP&D, Construction, and Operations and Maintenance.	TP&D	All
Incorporate TSMO discussions as part of existing meetings such as District Directors' meetings.	Traffic Operations	All
Identify ways to incorporate TSMO priorities into existing and planned projects within the District's annual budget.	TP&D	Traffic Operations
Monitor ongoing system developments and update the Regional ITS Architecture to reflect changing needs.	Traffic Operations	TP&D
Continuously analyze mobility (speeds and travel times) and safety data (crashes) to develop mobility- and safety-based performance measures.	TP&D/Traffic Operations	Area Engineers
Share use cases of various TSMO strategies to help better understand their benefits and justify future deployments.	TP&D/Traffic Operations	Area Engineers
Evaluate training and development of existing staff to perform specialized functions related to data and technology to enhance TxDOT business processes.	Deputy DE	All
Perform outreach efforts to inform staff on how TSMO will better help them do their jobs.	Deputy DE	All
Formalize the process of collaboration with partner agencies including the CCMPO.	TP&D	Traffic Operations

Action	Lead	Support
Traffic Signal Management Actions		
Develop a TSM plan that identifies needs and strategies to operate, maintain, and upgrade the traffic signal system. - Establish goals that are aligned to TxDOT and the region. - Formalize/develop traffic signal timing and maintenance programs. - Determine funding streams, the level of collaboration, and training requirements.	Traffic Operations	Traffic Operations and City of Corpus Christi (COCC)
Include a discussion about construction signal retiming and maintenance during the project design meeting, pre-construction meeting, and District Safety Review Team meeting for significant projects. - Verify appropriate signal timing is implemented during construction.	Traffic Operations	Construction, Area Engineers
Provide communications to 100 percent of District signals and acquire traffic signal central management system licenses to monitor and control all District signals.	Traffic Operations	TRF
Pilot-test technologies to improve traffic signal operations (automated traffic signal performance measures [ATSPM], traffic responsive signals, adaptive systems, connected vehicles).	Traffic Operations	TRF
Standardize detection layouts for ATSPM implementation. - Detector placement determines which kinds of performance measures could be collected.	Traffic Operations	TRF
Deploy an asset management system for traffic signals (e.g., ATMS.now). - Have information on existing assets. - Ensure traffic signal assets are maintained in good condition.	Traffic Operations	TRF
Utilize INRIX/probe data to obtain traffic signal performance measures. - Conduct before/after performance measure comparison.	Traffic Operations	TP&D
Utilize an ATSPM pilot to develop ATSPM-based reporting for regionally significant corridors, and track performance measures for continuous improvement of signal operations.	Traffic Operations	Traffic Operations

Action	Lead	Support
Develop a recurring staff training program. - Create staff redundancy by cross-training on skills and job functions. - Training should include existing and emerging technology related to the traffic signal system (detection, diamond intersections, troubleshooting signals, fiber-optics management, and ITS assets).	Traffic Operations	Traffic Operations
Identify ways to communicate benefits, outcomes, and needs to various internal and external stakeholders, including policy makers, the media, and others. - Share benefits from signal timing at Directors' and supervisors' meetings. - Leverage social media to share information (e.g., Twitter, Facebook).	Traffic Operations	TRF
Establish regular meetings (e.g., quarterly meetings) with partner agencies to collaborate on TSM.	Traffic Operations	COCC, Nueces County, Corpus Christi Metropolitan Planning Organization (CCMPO), Corpus Christi Regional Transportation Authority (CCRTA)
Develop a formal process of sharing traffic-signal-related data (e.g., timing data, traffic counts, video feeds) with partner agencies.	Traffic Operations	COCC
Traffic Incident Management Actions		
Establish a working group to manage the District's wrong-way driving system. - Identify stakeholders. - Establish the role of each stakeholder. - Regularly discuss District needs.	Traffic Operations	Traffic Operations
Develop a District TIM handbook. - Document how the TIM program should function. - Identify agencies and stakeholders and the roles and responsibilities of each party.	Traffic Operations	TRF
Consider addressing TIM impacts prior to the final design of significant roadway projects. - The Project Development Process Manual (July 2019) requires consideration of TIM as a TSMO strategy.	Traffic Operations	Traffic Operations, Construction, COCC

Action	Lead	Support
Review any existing interagency agreements and determine the need for updates or additional agreements. - Address interagency TIM issues. - Additional agreements may include data-sharing agreements, roles/responsibilities of agencies, notification procedures, and joint operating procedures.	Traffic Operations	TP&D
Evaluate Emergency Operation Center enhancements to support: - TIM. - Active traffic monitoring. - TSM.	Traffic Operations	Traffic Operations
Utilize probe data sources (such as RITIS/INRIX) for incident detection, tracking, and reporting.	TRF	Traffic Operations
Establish continuous tracking of performance measures for the wrong-way driving system.	Traffic Operations	TRF
Establish reoccurring, consistent, and evolving TIM training for all stakeholders: - to train new staff and develop redundancy in existing staff. - for multidisciplinary TIM program participants to understand the incident command structure, roles of involved agencies, and applicable standards (e.g., Texas Manual on Uniform Traffic Control Devices). - to improve TIM practices based on lessons learned.	Traffic Operations	Traffic Operations
Establish the roles and responsibilities within TxDOT and TIM stakeholders to carry out TIM functions. - Helps define current TIM activities and where each partner fits into the lifecycle of a typical traffic incident.	Traffic Operations	COCC, Nueces County
Share lessons learned, benefits, and outcomes from traffic incident responses with stakeholders and TxDOT leadership.	Traffic Operations	Traffic Operations
Collaborate with all TIM partners to develop data-sharing policies, including access to closed-circuit television cameras.	Traffic Operations	COCC, Nueces County, CCMPO, CCRTA

Action	Lead	Support
Road Weather Management Actions		
Evaluate RWM needs, and establish multi-year RWM funding to address those needs. Collaborate with CCMPO to identify funding streams available to support RWM-related operational and maintenance activities.	Traffic Operations	CCMPO
For significant weather events, utilize information from “after action” reviews to discuss and document challenges, lessons learned, and opportunities. Document/update RWM procedures as needed.	Traffic Operations	Traffic Operations
Formalize the process of obtaining weather data from the National Weather Service and how it will be utilized in resource planning/forecasting. - Evaluate the applicability of the Federal Highway Administration (FHWA) Pathfinder initiative to the RWM activities within the District.	Maintenance	TRF
Develop a process to be utilized by TxDOT (Operations, Maintenance), partner agencies, and first responders for coordinated response during a significant weather event.	Maintenance	COCC, Nueces County, CCMPO, CCRTA
Identify alternate corridors that complement current designated evacuation routes to facilitate efficient and safer evacuation. - Helps identify corridor needs (capacity or operational improvements) for road weather master planning. - Improve communication to the public on all alternate corridors for evacuation.	Traffic Operations	COCC, Nueces County, CCMPO, CCRTA
Evaluate technology solutions to facilitate the advisory (e.g., traveler information) and control (e.g., road closure) functions during RWM.	Traffic Operations	TRF
Develop a dashboard that provides historical and real-time performance measures related to weather events. - Historical performance measures to plan for future events. - Real-time performance measures for event response.	Traffic Operations	TRF

Action	Lead	Support
Provide reoccurring RWM training to TxDOT staff, and conduct biannual RWM exercises with partner agencies and first responders. - Enhance capabilities in areas of operations and maintenance - Cross-train staff to ensure availability for critical functions	Traffic Operations	Traffic Operations, COCC, Nueces County
Discuss RWM lessons learned, process improvements, needs, and plans during leadership meetings to maintain support for RWM activities.	Traffic Operations	Traffic Operations, COCC, Nueces County
Enhance collaboration with partner agencies, first responders, and the private sector to plan for and respond to significant weather events. - Meet periodically with partner agencies and first responders to discuss RWM policies, plans, strategies, and data needs. - Collaborate with the private sector (e.g., news organizations, Waze) on sharing RWM-related data.	Traffic Operations	COCC, Nueces County, CCMPO, CCRTA
Work Zone Management Actions		
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
Develop Transportation Management Plans for significant projects, and document mobility and safety performance measures: - Utilize WZM strategies in FHWA's "Developing and Implementing Transportation Management Plans for Work Zones." - Document how ITS/smart work zone (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.	Traffic Operations	Construction
For significant projects, evaluate the need for and type of WZ ITS based on TxDOT SWZ guidelines and the Go/No-Go Decision Tool.	Traffic Operations	Construction

Action	Lead 	Support 
Develop a process to coordinate lane closures among multiple projects and agencies to achieve WZM objectives. - Avoid conflicting project road closures. - Compile all lane-closure data in one central database. - Share WZ data with the public, media, and transportation-focused businesses.	Traffic Operations	Construction
Assess whether the application of existing and/or new technologies to manage traffic and measure system performance would enhance WZ operations and safety. - Potential addition to the Design Concept Conference.	TP&D	Traffic Operations
Pilot-test SWZ technologies to identify use cases and mainstream SWZ deployments.	Traffic Operations	Construction
Define safety- and mobility-based goals and performance measures to inform continuous improvements within WZs. - Utilize planning-level analysis. - Utilize historical WZ data.	TP&D	Traffic Operations
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.	Traffic Operations	TP&D
Establish periodic WZM training to: - train District staff on the Division's SWZ guidelines. - regularly update WZM knowledge and skills to incorporate the 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	Traffic Operations

Action	Lead 	Support 
Discuss WZ safety and lessons learned in supervisors' and construction meetings. - Helps create awareness and garner support for WZM from within TxDOT.	Construction	Traffic Operations
Identify ways to enhance collaboration with the private sector and stakeholders during WZ activities. - Document input and resulting countermeasures because of concerns from the affected public, businesses, schools, and emergency medical services. - Provide regular construction updates via social media platforms/project websites. - Utilize enhanced ways to obtain input from stakeholders (encourage input from social media platforms such as MetroQuest).	Traffic Operations	Construction
Collaborate with partner agencies on coordination of construction projects and sharing data that may help address construction impacts.	Traffic Operations	Construction, COCC, Nueces County, CCMPO, CCRTA
Identify ways to enhance collaboration with law enforcement during WZ activities (e.g., use of CAD data, WZ enforcement, incident response).	Traffic 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 an 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.

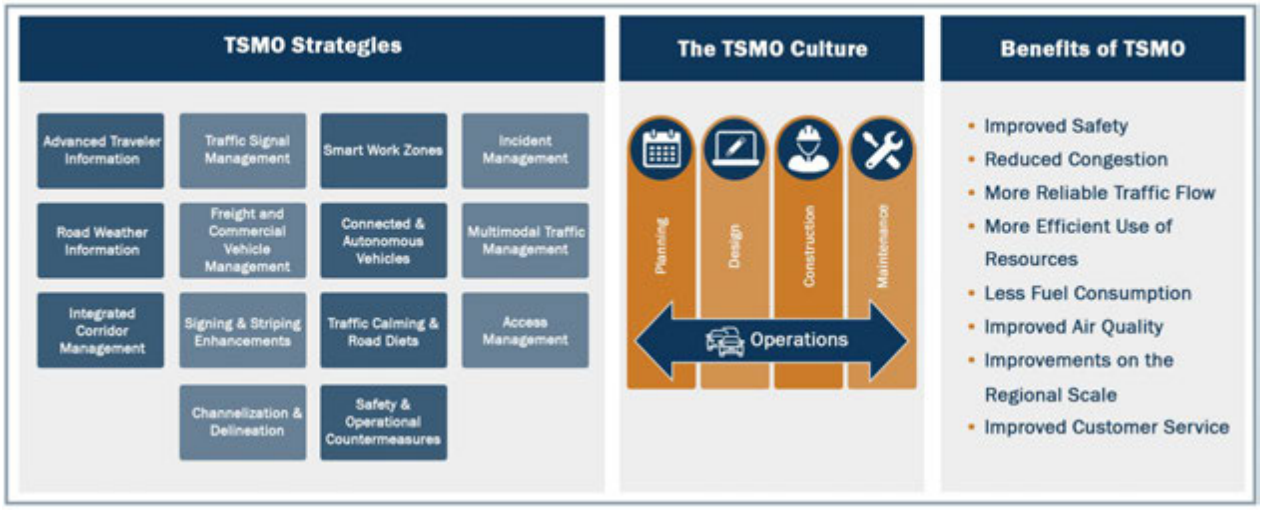


Figure 1: The Concept of TSMO

1.2 Aren't We Already Doing TSMO?

The Texas Department of Transportation (TxDOT) Corpus Christi District (CRP; 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-CRP.

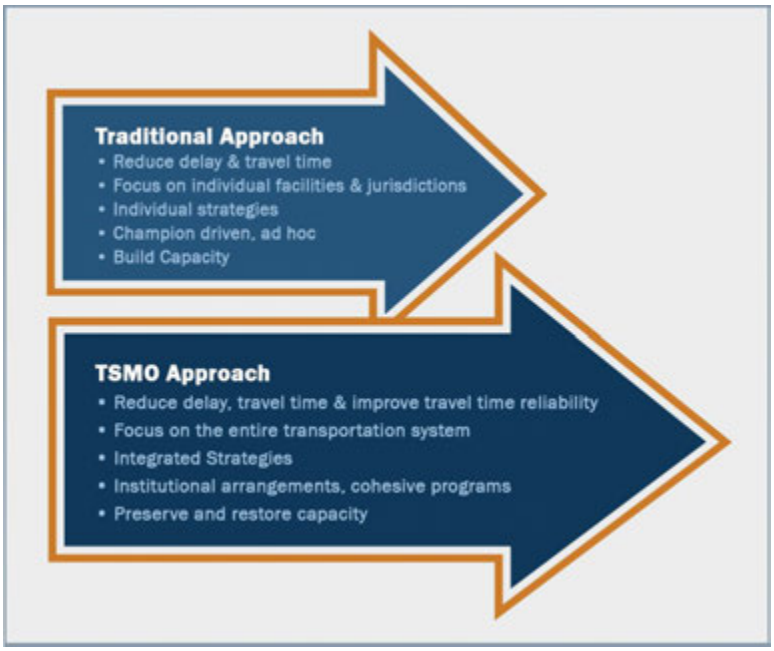


Figure 2: The TSMO Difference

1.3 Need for TSMO Planning

Research conducted as part of the Federal Highway Administration's (FHWA's) Second Strategic Highway Research Program (SHRP2) revealed that in most agencies, TSMO planning and budgeting have been largely limited to specific projects or initiatives and initiatives have been limited based on the availability of funding and a champion to drive those initiatives. The research indicated 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 the development of a TSMO Program Plan as a key action to guide organizations in advancing the institutional focus on TSMO.

1.3.1 TxDOT Division TSMO Initiative

Executive Director Marc Williams issued a memo 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 the memo are provided below.

"…it is imperative that Traffic Management Systems (TMS) and operational improvements complement construction and maintenance program efforts. This includes ensuring that TMS is considered throughout the project lifecycle from inception through construction…."

Marc Williams, June 29, 2022

"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."

Marc Williams, June 29, 2022

The TxDOT TSMO initiative (Figure 3) developed a statewide TSMO framework and guidance. The TxDOT TSMO initiative consists of three stages. As part of the first stage, TxDOT's Traffic Safety Division (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 traffic signal management (TSM), traffic incident management (TIM), road weather management (RWM), and work zone (WZ) management (WZM) or ITS implementation.

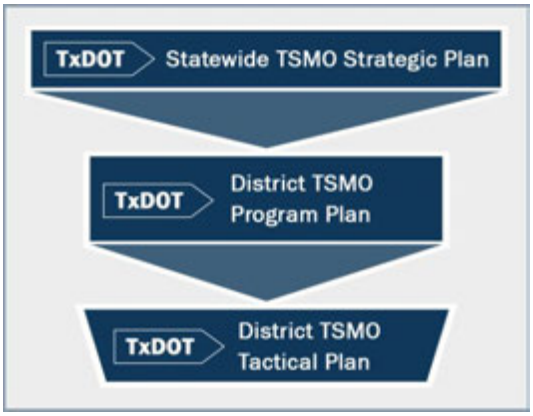


Figure 3: TxDOT TSMO Planning Initiative

1.3.2 TxDOT-CRP TSMO Initiative

In alignment with the statewide TSMO initiative, TxDOT-CRP began developing the District TSMO Program Plan in April 2020. The Program Plan development began with an endorsement from the District Engineer (DE), paving the 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 Corpus Christi (COCC), Nueces County, Corpus Christi Metropolitan Planning Organization (CCMPO), and Corpus Christi Regional Transportation Authority (CCRTA). 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-CRP TSMO Program Plan.

Figure 4: TxDOT-CRP TSMO Planning Process

1.3.3 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 for TSMO: Establishes a data-driven business case to support sustained investment in TSMO strategies.
- TSMO Vision, Mission, Goals, and 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 District leadership and the District TSMO steering committee.
- Capability Maturity Model and Frameworks: 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 RWM.
- 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 RWM, and ITS implementation.

2 BUSINESS CASE FOR TSMO

Figure 5 summarizes the business case for TSMO within TxDOT-CRP. The figure provides impacts and costs associated with congestion, safety, and the environment within the Corpus Christi region and highlights potential benefits from TSMO deployments. Studies around the country have shown that TSMO deployments provide benefit-cost ratio (BCR) 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.

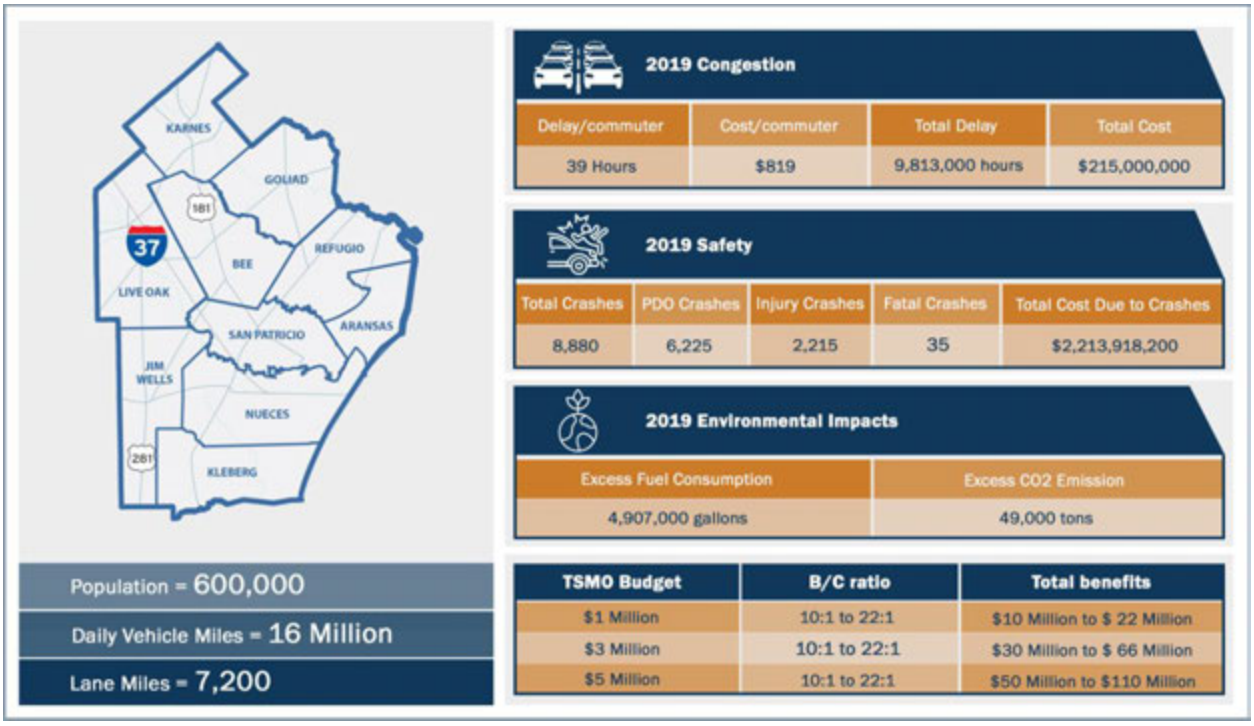


Figure 5: TxDOT-CRP TSMO Business Case Summary

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 shows the funding deficit at the statewide level and district level based on TxDOT's 2022 Unified Transportation Program (UTP). It is important to note that the actual needs are much greater than what is documented in the fiscally constrained UTP. As a result, the budget shortfall in reality is greater than what is shown.

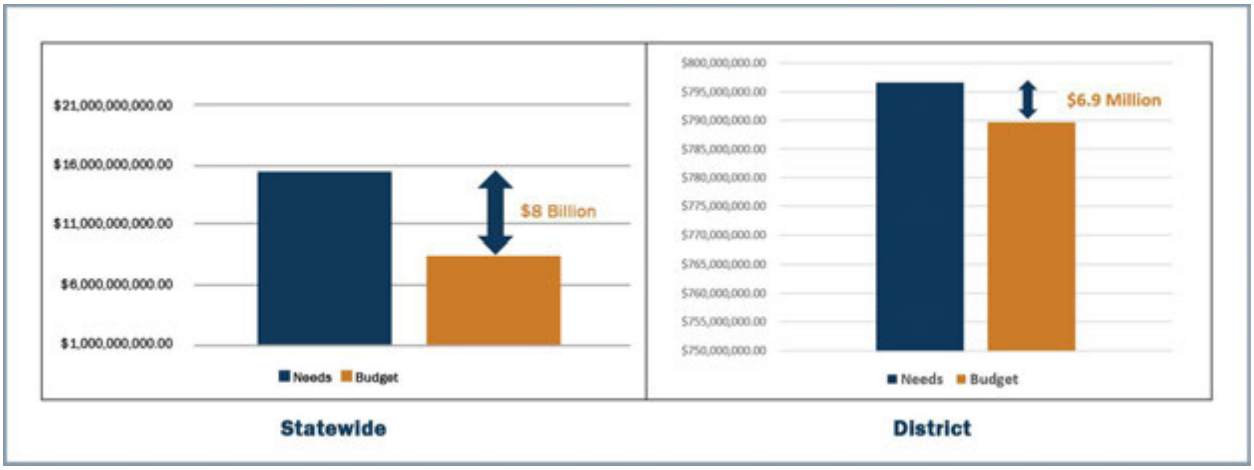


Figure 6: TxDOT Statewide and District-Level Funding Needs Vs. Budget

2.1.2 How TSMO Can Help

To address the growing capacity and funding constraints, TxDOT 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 BCR 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 Corpus Christi 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 39 hours of delay in 2019. The region also recorded a planning time index of 1.15, indicating that an average driver had to account for 15 percent more travel time during peak periods to reach their

destination on time. The monetary cost of congestion was over $800 per commuter per year and $215 Million overall. Of the overall delay, 78 percent occurred on freeways and 22 percent on arterials.

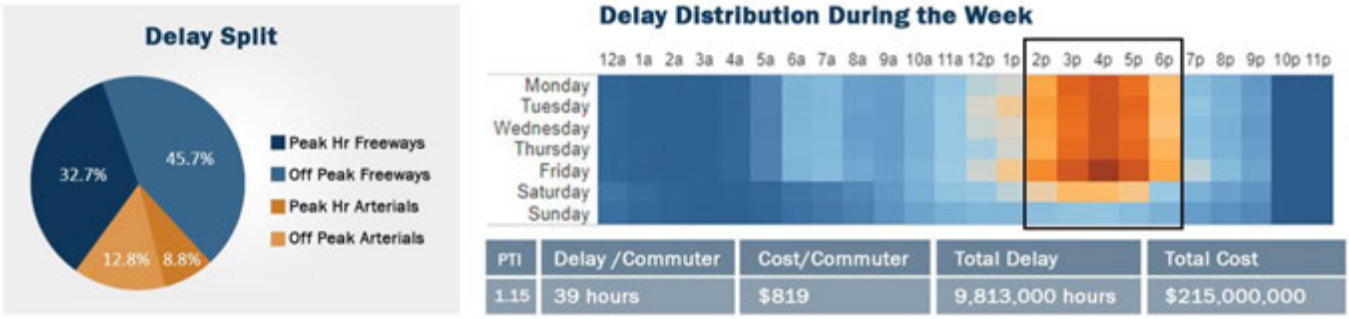


Figure 7: TxDOT-CRP 2019 Congestion Statistics

2.2.2 How TSMO Can Help

As seen in the delay split pie chart above (Figure 7), 45.7 percent of the regional delay occurred during off-peak conditions on freeways and 12.8 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 58.5 percent of the delay occurring in the Corpus Christi 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, WZs, special events). TSMO provides robust and near-term strategies such as TIM, WZM, TSM, and active RWM to address the recurring and non-recurring congestion at a fraction of the cost of the capacity expansion projects.

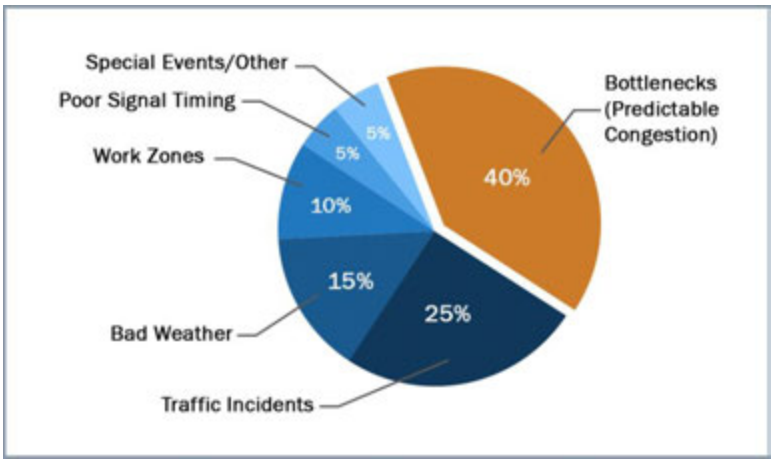


Figure 8: National Causes of Congestion by FHWA

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 Corpus Christi region experienced 37 traffic-related fatalities, 2,215 injury crashes, and 6,225 property-damage-only (PDO) crashes in 2019 (Figure 9). Of the fatal and injury crashes, almost 666 crashes occurred at intersections and

almost 203 occurred within WZs. Of the overall crashes, 12 percent occurred on freeways and 88 percent on arterials. The total cost of crashes was more than $2 billion.

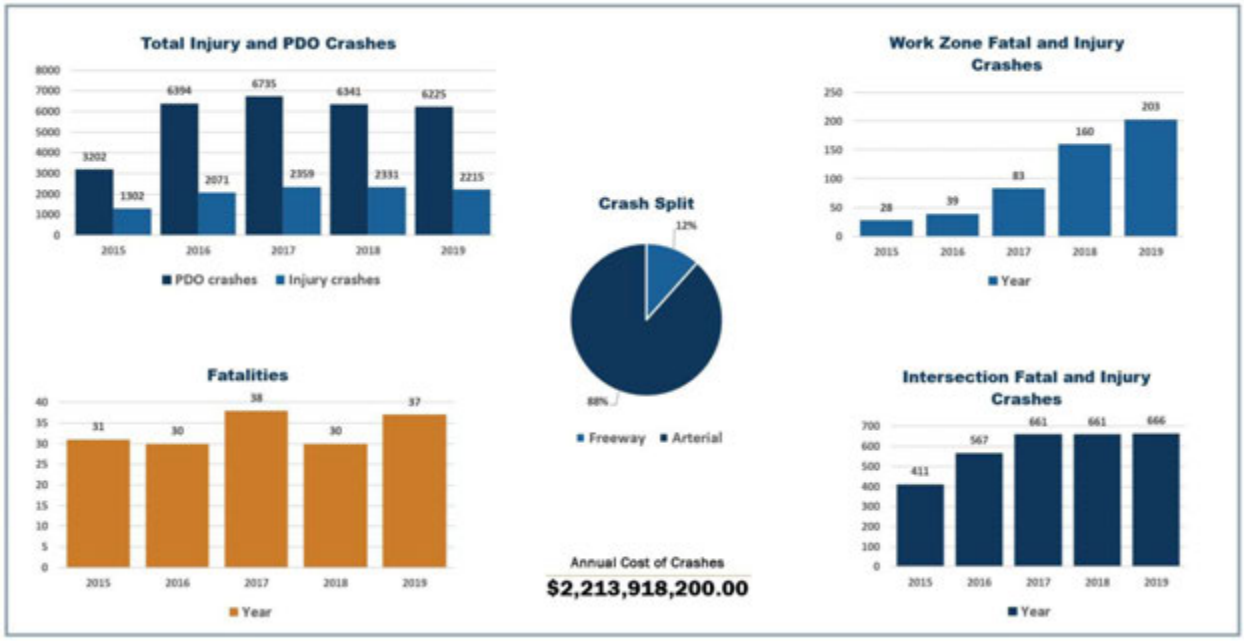


Figure 9: Corpus Christi Region Crash Summary

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 alternatives (e.g., conflict reduction, ITS), 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 on roadways, 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. The

TxDOT-CRP District currently implements numerous processes, projects, and programs with TSMO elements, including ITS, traveler information, WZM, wrong-way driving, 4-year safety planning, and 4-year-maintenance planning. The TxDOT-CRP District aims to incorporate additional TSMO strategies into its operations by improving the understanding of TSMO and its benefits.

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 in which 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, selecting projects, 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 TMS project planning and deployment.
6. Leveraging existing touchpoints with partner agencies to collaborate on regionally significant TSMO implementation opportunities.

The institutional commitments 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 Corpus Christi District has adopted the statewide TSMO vision, mission, and goals and has developed specific objectives to address 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-CRP 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-CRP TSMO Goals and Objectives

Goal	TxDOT Statewide TSMO Objectives	TxDOT CRP 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 and to prioritize projects. • Periodically review safety data to develop systemwide safety improvements, and package the improvements for implementation. • Reduce WZ-related crashes.

Goal	TxDOT Statewide TSMO Objectives	TxDOT CRP TSMO Objectives
Reliability 		
Efficiency 	Implement projects that optimize existing transportation system capacity and vehicular throughput.	
Customer Service 		
Collaboration 	Proactively manage and operate an integrated transportation system through multi-jurisdictional coordination, internal collaboration, and cooperation between various transportation disciplines and partner agencies.	• Discuss TxDOT TSMO initiatives and collaboration opportunities during District Director's meetings. • Promote data sharing across TxDOT functional groups and TSMO stakeholders. • Participate in periodic meetings with TSMO stakeholders to collaborate on TSMO initiatives.
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, Design Review, and District Safety Review Team meetings. • Leverage regional stakeholder partnerships, including with the CCMPO, 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.

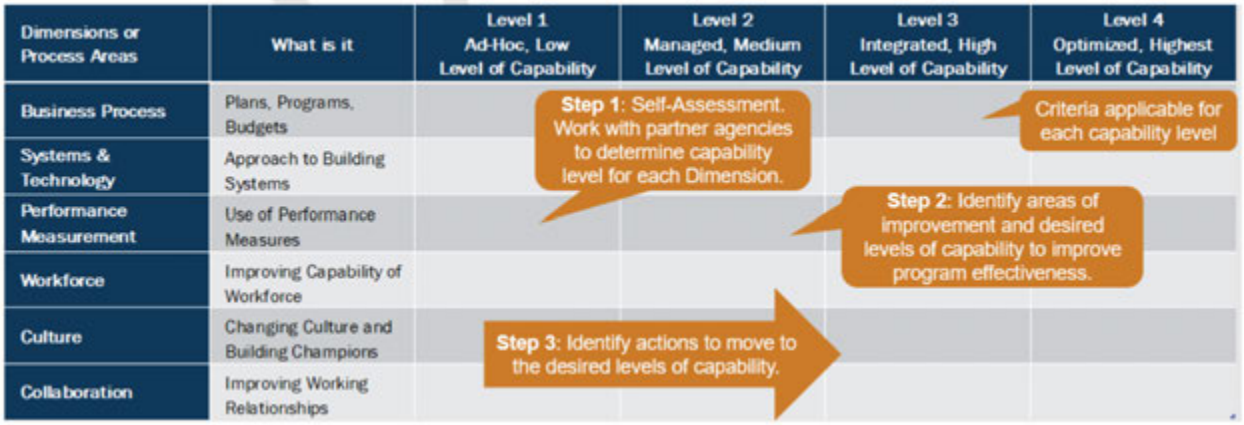


Figure 11: CMM Assessment Process

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

4.1.1 Business Processes

The 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 4
Business Processes (Planning, programming, budgeting, implementation)				**Processes streamlined** and subject to **continuous improvement**

Figure 12 summarizes the results of the capability assessment for the Business Process dimension. As seen on the figure, the majority of participants ranked themselves at Level 1 or 2. The results indicate TxDOT's 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:

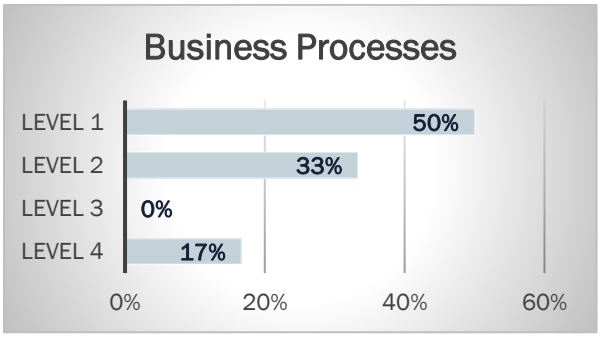


Figure 12: Business Process Assessment Results

Revised Project Delivery Process:

The PDP at TxDOT-CRP 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), Design Review, and District Safety Review Team (DSRT) meeting agendas to include broader TSMO topics.

TSMO Planning:

TxDOT-CRP currently develops several multi-year plans that address aspects of TSMO. 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 shows TxDOT-CRP funding allocations based on the 2022 UTP. Although there is no dedicated funding for TSMO, the projects in Categories 1, 2, 4, 7, and 10 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-CRP funding deficit shown on Figure 6.

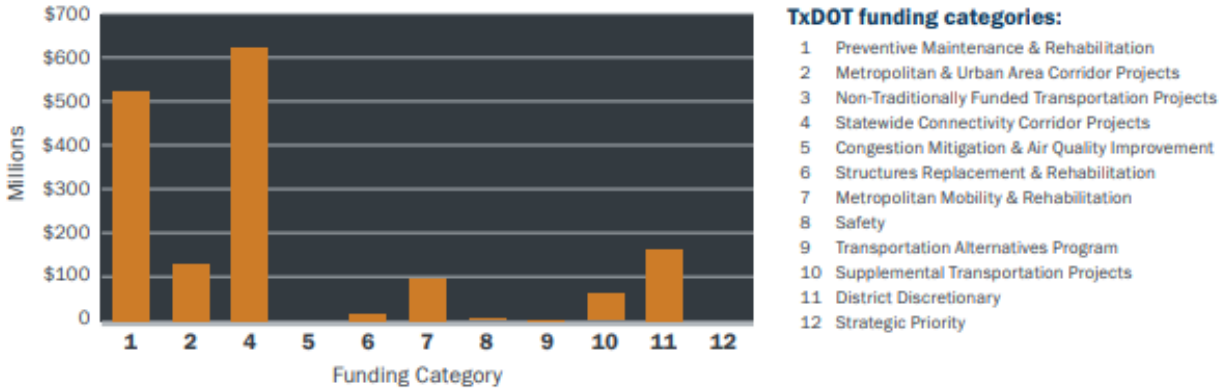


Figure 13: TxDOT-CRP Funding Allocations from 2022 UTP

Continuous Improvement:

TxDOT's top statewide TSMO objective is to "reduce crashes and fatalities through continuous improvement of Traffic Management (TM) systems and procedures." During the TSMO workshop, the TxDOT-CRP District discussed the needs for a more integrated multi-year plan for budgeting. This plan should include standardized processes to ensure all District needs are addressed and align with statewide initiatives and budgets. TxDOT-CRP District's ITS Master Plan is a good example of an integrated multi-year plan that provides a pipeline of ITS needs to support mobility and safety.

4.1.2 Systems and Technology

The 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 4
Systems and Technology (Systems engineering, ITS standards, technology interoperability)				**Systems and technology routinely upgraded** and utilized to improve efficiency performance

Figure 14 summarizes the results of the capability assessment for the Systems and Technology dimension. As seen on the figure, the majority of participants ranked themselves at Level 3. To reach Level 4, TxDOT is aiming for more consistent use of systems engineering and Regional ITS Architecture in developing TSMO projects to ensure that systems and technology tools are routinely being upgraded and utilized to address project and

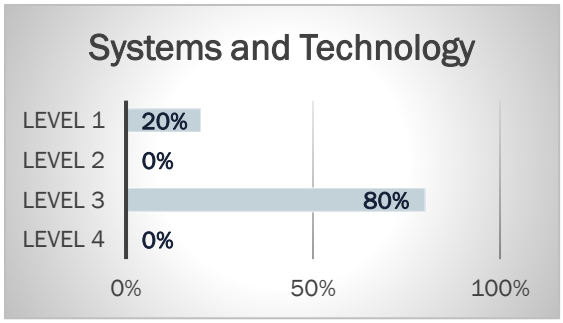


Figure 14: Systems and Technology Assessment Results

stakeholder needs. The following needs related to Systems and Technology were discussed during the CMM workshop.

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 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.

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 stakeholder needs, incorporation of operations and maintenance costs within planning-level costs, and selection of an alternative that addresses most system needs.

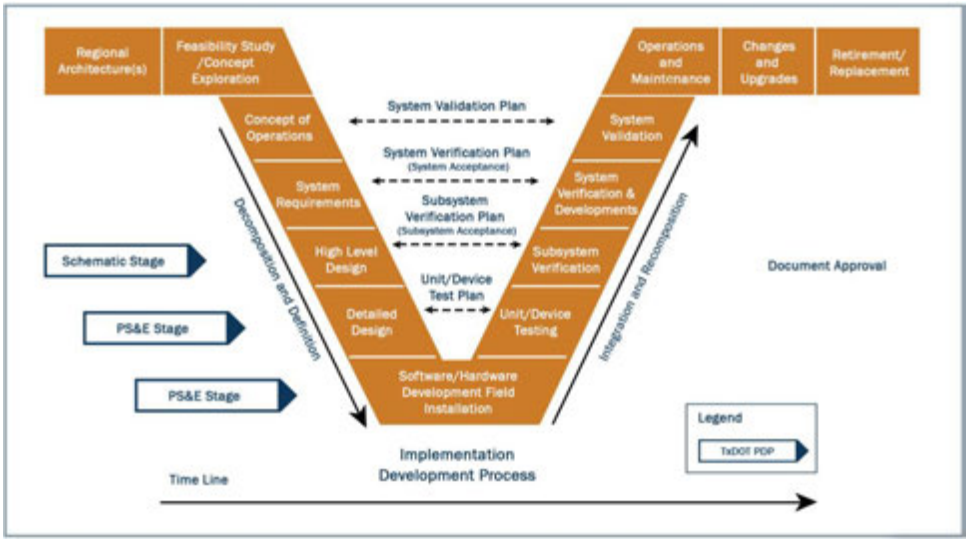


Figure 15: Systems Engineering Process

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 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

Corpus Christi Regional ITS Architecture was developed in 2003. As the update to the document is currently in progress, it will systematically identify 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 in providing ITS services for the region.

ITS projects to support TxDOT-CRP TSMO strategy action item implementation will be referenced in the TxDOT-CRP Regional ITS Architecture and meet FHWA Final Rule 940 and/or FTA Final Policy on ITS Architecture and Standards if the Highway Trust Fund is used for their deployment. Upon completion of the current update, it is recommended that the TxDOT-CRP architecture be updated every 5 years to accommodate changes in technology, to reflect the region's ITS status as new projects are being deployed, and to ensure that TxDOT-CRP's operational needs are met.

Existing and Planned Tools

All sections within TxDOT-CRP 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 and providing dynamic message sign (DMS) messages. TxDOT utilizes Centracs and ATMS.now central systems 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 sections expressed interest in sharing tools and data across groups and utilizing them to improve technical and business processes. To streamline work, sections expressed interest in reducing the number of programs used. Table 4 summarizes the tools and data utilized

by TxDOT sections that could be of interest to other groups. Partner agencies and TxDOT expressed the desire to share data such as camera feeds, signal operations data, traffic counts, public concerns, lane closures, and performance measures.

Table 4: Tools and Data Used by TxDOT-CRP

Tool or Data	Purpose
Probe Data (e.g., INRIX, Streetlight)	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)	Identify pavement segments in need of maintenance/rehabilitation and prioritize them
TxTAP and TxMAP	Evaluate traffic control devices and determine needs and maintenance priorities
TxDOTCONNECT	Portfolio management, project development, letting management, project execution
Project data in spreadsheets	Countermeasure development, cost estimation
GIS apps and dashboards	Identify hotspots, develop countermeasures, prioritize projects, budgeting
Compass Maintenance Management System	Maintenance costs, maintenance plan
Tablet/phone	Field documentation
SiteManager	Information on project (work diary, payment, measurements)
Primavera P6	Scheduling
ProjectWise	File storage
Veoci	Cloud-based emergency management system

4.1.3 Performance Measurement

The Performance Measurement dimension relates to the identification of performance measures, consistent use of 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 4
Performance Measurement (Measures data, analytics, and utilization)				**Mission-related outputs data routinely utilized** for management, reported internally and externally, and archived

Figure 16 summarizes the results of the capability assessment for the Performance Measurement dimension. As seen on the figure, all of the participants ranked themselves between Level 1 and Level 2. The results indicate TxDOT's desire for greater use of data and data-driven insights throughout the project lifecycle and enhanced data sharing both within and across partner agencies.

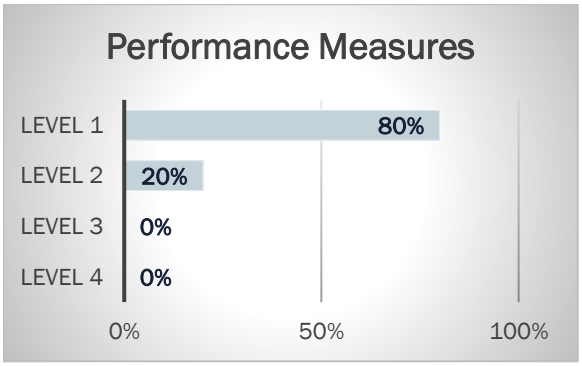


Figure 16: Performance Measurement Assessment Results

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 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 (e.g., run off road, DUI, intersections, pedestrians, bicyclists).
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, Disadvantaged Business Enterprise/Underutilized Business goal attainment.
Value Our Employees	Employee engagement score.

District-Wide Performance Measures

Executive Director Marc Williams's memo from June 2022 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-CRP has been developing biannual TMS Status Reports with documentation of performance measures such as asset operation uptime, incident clearance times, and TMS system coverage.

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 data, Centracs data, Pavement Analyst, and 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

The 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 4
Organization and Workforce (Organizational structure and workforce capability development)				**Professionalization and certification of Operations** core capacity positions including performance incentives

Figure 17 summarizes the results of the capability assessment for the Organization and Workforce dimension. As seen on the figure, all participants ranked themselves at Level 2. The results indicate TxDOT's desire to evaluate staff capabilities and roles and responsibilities to better integrate TSMO within the District. To reach Level 3, TxDOT is aiming to establish a top-level management position and core staff to support the facilitation of TSMO activities in the District.

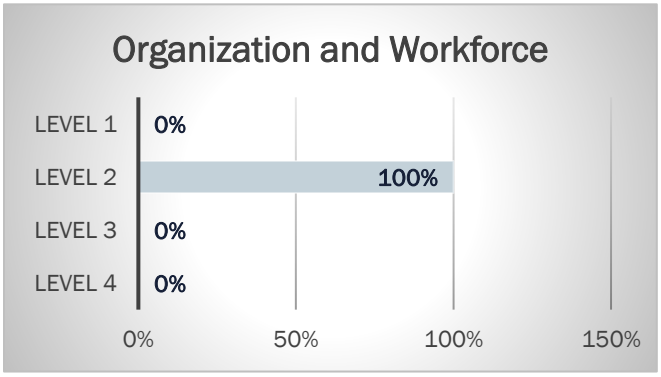


Figure 17: Organization and Workforce Assessment Results

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 how TSMO staff integration within the District may be organized. 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.

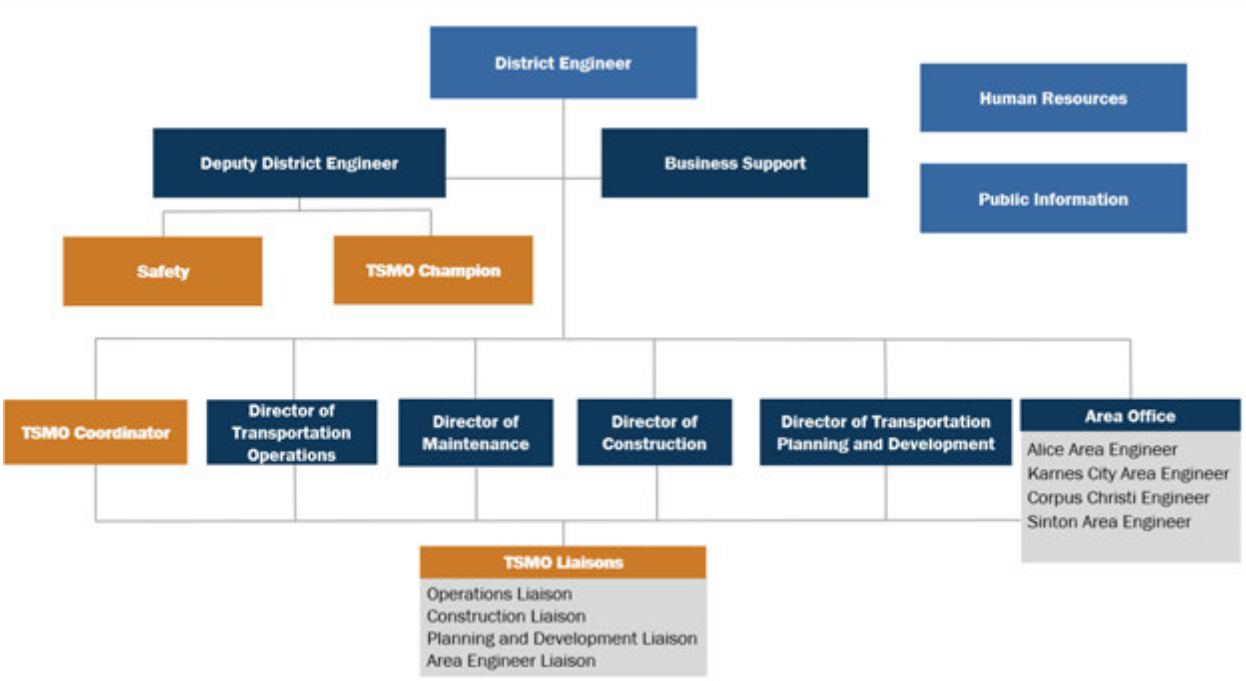


Figure 18: Organization Structure with TSMO Integration

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 is currently held by the Director of Transportation Operations. 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 is currently held by the District Traffic Engineer. 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:

- Embracing a TSMO mindset and identifying TSMO-related opportunities while performing functions critical to their department.
- Collaborating 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

The 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 4
Culture (Technical understanding, leadership, outreach, program authority)				**Explicit agency commitment to TSMO** as key strategy to achieve full range of mobility, safety, and livability

Figure 19 summarizes the results of the capability assessment for the Culture dimension. As seen on the figure, all participants ranked themselves between Level 1 and Level 2. 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.

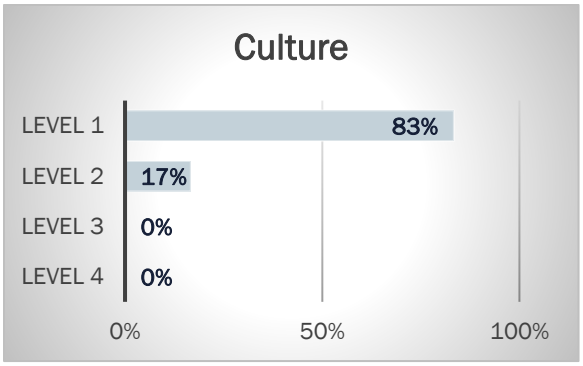


Figure 19: Culture Assessment Results

TSMO culture within the District can be enhanced in a similar way to how the District has enhanced the safety culture. The TSMO program within the District is endorsed by the DE and is currently being led by the Director of Transportation Operations (TSMO Champion) and the District Traffic Engineer (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 meetings, DCC, Design Review, 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

The 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 4
Collaboration (Partnerships among levels of government and with public safety agencies and private sector)				High level of operations **coordination institutionalized among key players**—public and private

Figure 20 summarizes the results of the capability assessment for the Collaboration dimension. As seen on the figure, all participants ranked between Level 1 and Level 2. The results reflect TxDOT's belief in having strong longstanding working relationships that streamline collaboration across agencies.

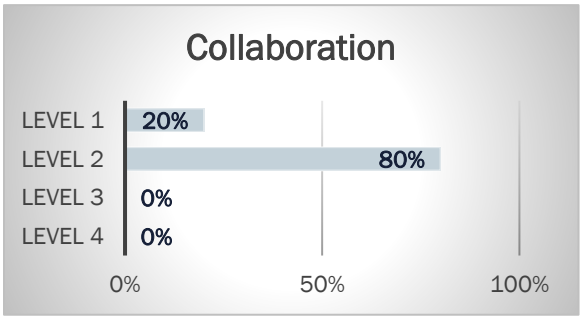


Figure 20: Collaboration Assessment Results

Internal Partnerships

Many of the senior leadership within TxDOT-CRP 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, Design Review, and DSRT meetings, form the basis for strong collaboration throughout traditional project development. However, the District is staff constrained with existing workload, and it can sometimes be a challenge for staff to attend every meeting. For this reason, the opportunity to provide input on TSMO opportunities can be missed. 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:

- Adding a discussion of TSMO opportunities to the existing Director's meeting, DCC, Design Reviews, and DSRT meetings.
- Obtaining input from Traffic Operations staff during planning, design, construction, and maintenance phases to ensure TSMO opportunities are considered.
- Collaborating with Operations and TP&D to develop performance measures for comprehensive TSMO projects to allow them to integrate TSMO with traditional project types during project selection.
- Collaborating with Operations and Maintenance, exploring the use of technology to make the maintenance process more effective and efficient.
- Collaborating with Operations and Construction, ensuring the consideration of appropriate smart work zone (SWZ) technology and detour signal timing within regionally significant projects.
- Collaborating with Operations, establishing funding needs for proactive management of traffic signals through a data-driven process.

External Partnerships

Partner agencies have been working in considerable capacity within the Corpus Christi 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, COCC, and Nueces County on Highway Safety Improvement Program projects to improve roadways and signals. Some opportunities to formalize the internal collaboration in the TSMO context include:

- Formalizing the process of interagency collaboration through the CCMPO Technical Advisory Committee meeting.
- Formalizing the process of collaboration during incident responses 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 TSM, TIM, RWM, and WZM. Tailored capability frameworks allow agencies and stakeholders to focus on specific capability improvement needs within each program area.

TxDOT-CRP 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-CRP 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 the streets safer and trips more reliable.

TxDOT-CRP currently operates approximately 196 traffic signals. Out of these 196 signals, 18 use fiber-optic cable for communications, 115 use cellular networks for communications, and 63 have no communications link available. All 196 traffic signals will soon be connected to the Centracs central system. TxDOT uses Econolite Cobalt controllers to control the signalized intersections and a mix of radar and video to detect vehicles. There are 9 signals currently operating with coordination. TxDOT does not currently operate traffic responsive or adaptive signal operation and does not collect performance measures such as ATSPM. The signal timing adjustments and equipment repairs are conducted once an 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.

TxDOT is in the process of modernizing the signal system by implementing cabinet upgrades and communication at signals. The Corpus Christi District will be using Econolite's central software, Centracs, to communicate with traffic signal controllers. Once completed, all 196 and any future traffic signals will have Econolite's Cobalt controllers and networked cabinet devices (detection system, video, controller, and battery back-up system) connected to Centracs. Centracs will allow signal technicians to remotely monitor (view traffic behavior) and access traffic signals to optimize timings. 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 TSM program-area recommendations presented in Table 15.

Table 10: TSMO Applications for Traffic Signal Management

Case Study 1: GDOT ATSPM Implementation and Dashboard Development (LINK) Extent: Statewide Program Components: GDOT in partnership with local and consultant partners: 1. Used open-sourced technologies to implement ATSPM. 2. Developed an automated, near-real-time public-facing web application for performance reporting—quarterly/monthly reports and detailed corridor-level and signal–level reports. Benefits: Approximately $250,000 in annual savings.
Case Study 2: GDOT RITIS Data-Driven Screening and Project Selection (LINK) Extent: Statewide Need: Intersection project identification and prioritization Project Components: GDOT in collocation with consultants: 1. Reviewed the RITIS platform to identify which tools will be the most effective for intersection prioritization. 2. Used the bottleneck prioritization tool and delay to prioritize intersection approaches. 3. Developed a spatial dashboard for easy review of intersection ranking. Benefits: Proactive identification of bottleneck intersections and better communication with the public concerning funding priorities.
Case Study 3: Traffic Signal Retiming Program, North Central Texas Council of Governments (LINK) Extent: 400+ 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-CRP generally conducts TIM activities on an ad-hoc basis as no formal TIM program exists. The District, partner agencies, and regional stakeholders had attempted to initiate a TIM program that was initially well received by all stakeholders, but the initial enthusiasm waned due to a lack of consistent participation from stakeholders and a lack of CCTV video-feed sharing capabilities by TxDOT.

TIM is currently considered in planning for construction and WZs on major projects but not for special events or weather-related events. Contractors are typically required to report incidents to TxDOT and adjust traffic control to facilitate clearing of the incident. District staff use the incident report from the contractor to publish traveler information on DMSs and ensure that the contractor implements appropriate actions at the scene of the incident.

The Claris system, which will provide a valuable online video sharing system, has been deployed by Skyline in the District. This system will help District staff, Traffic Operations staff, and incident responders to respond to events quicker.

TxDOT and stakeholders recognize the importance of a coordinated response to traffic incidents and therefore plan to develop a TIM program to identify ways to enhance the District's capability for incident management. As part of the program, the District will coordinate with key stakeholders, including representatives from partner agencies, to discuss TIM collaboration needs and ways to improve safety and mobility during TIM events. 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 with 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 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: Up to 50 percent reduction in incident clearance time; reduced travel delays and improved safety of the traveling public and responders.

4.2.3 Road Weather Management

RWM entails the advisory, control, and treatment capabilities of an institution to respond to adverse weather conditions. First, the institution needs advisory capability to provide information on prevailing and predicted conditions. Followed by advisory, the institution needs control capability to restrict and regulate traffic flow by operating roadway devices. In the end, the institution also needs treatment capability to supply resources to roadways to minimize/eliminate weather impacts.

Per TTI, Texas leads the nation in flood-related deaths, with the majority of deaths caused by motorists driving through moving water. In addition, flash flooding is the leading cause of weather-related deaths in Texas. It is important to note that 18 to 24 inches of moving water can sweep away a truck, while 6 inches can sweep a small car. Because it is impractical to raise/remove all low water crossings in the District, there is a need for low-cost and effective traveler information systems to warn drivers of these risks.

TxDOT-CRP has been funding RWM on a year-by-year basis. Budget amounts are typically based on previous budget allocations. Funds are used only for traditional road weather maintenance activities. Currently, there are several commercially available flood warning systems. Although they vary in terms of optional features, they are all designed to achieve two primary goals: to warn motorists they are approaching hazardous road flooding conditions by activating warning beacons and to notify TMC staff of the flooded roadway condition so action can be taken. The roadside equipment of a typical system is composed of a water level and velocity sensor connected to an ITS cabinet (also called a flood gauge) and warning equipment upstream of the crossing. The ITS cabinet houses electronic components such as communications equipment, a measurement processing unit, flashing beacon actuators, and a solar controller and batteries. The warning equipment is typically a solar-powered flashing beacon activated by the water sensor through wireless communications.

In addition to the roadside equipment, flood warning systems also include software to remotely monitor and control the roadside equipment. Currently, the Corpus Christi District has a data feed directly into Lonestar from which they can monitor and control roadside equipment.

Table 12 provides examples of how agencies across the country have utilized TSMO principles to enhance RWM. These examples, along with CMF assessment results and discussions with TxDOT leadership, were utilized to develop the RWM program-area recommendations presented in Table 15.

Table 12: TSMO Applications for Road Weather Management

Case Study 1: Comprehensive Hurricane Response Action Plan (HRAP) for South Florida (LINK) **Extent:** South Florida **Project Components:** 1. The HRAP covers RWM staffing, equipment, procedures, checklists, and guidelines. 2. Detailed actions and checklists for before, during, and after the event. 3. Plan for network redundancy as well as back-up locations and operations to safeguard connection during a hurricane. **Benefits:** During Hurricane Irma, the plan helped ensure proper operations and network connections despite the threatening conditions of the storm. More importantly, the HRAP ensured the Florida DOT was the primary source of coordination and information related to traffic management.
Case Study 2: Roadway Flood Warning System **Extent:** Houston Metro **Project Components:** 1. Capture rainfall rates from an existing network of 170+ flood gauges to identify areas highly likely to flood during heavy rain. 2. Integration of the flood gauge data onto the TranStar website and mobile app involved rigorous testing, data sharing, and cross-communication between TranStar, Harris County Flood Control District staff, and information technology personnel at various government agencies. **Benefits:** The project enhances traveler safety by giving motorists the information to avoid potential roadway flooding conditions. Emergency responders now have a reliable tool to use in determining the best routes to serve the community during heavy rain events.

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. The 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 include consideration of SWZ elements due to the limited knowledge on appropriate SWZ technologies. The District is, however, interested in implementing SWZ technology on projects. There are currently no performance measures pertaining to traffic operations being collected for WZs. On large projects for which mobility and safety concerns are raised, TRF plans to engage TTI to monitor performance measures and develop countermeasures.

The budget for traffic control during construction is generally included in the project budget during design. Many projects do have a safety contingency for traffic control that may be used for SWZ or to improve traffic control during construction without requiring a change order. If additional funding is necessary for traffic control improvements during construction, a change order funded by Category 1 funds may be utilized. The addition of SWZ elements during the design phase will ensure their inclusion during construction.

The District requires agencies and contractors to submit Lane Closure Forms to provide information on where the planned lane closures will be. The forms are not always received by the District, affecting TM through the construction areas.

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 Work Zone 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, and 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: Comprehensive Work Zone Management Program (LINK) **Extent:** All of Iowa DOT **Project Components:** 1. To determine which highway projects require additional WZM attention, developed Traffic Critical Projects process and added it within the Design Manual. 2. Added countermeasures such as traffic operations treatments, SWZ equipment, and WZ TIM plans to the Design Manual. 3. Partnered with Iowa State University on real-time performance monitoring, developed a database to store WZ 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 Corpus Christi 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 through which 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 and Technology (ST), Performance Measurement (PM), Culture (CU), Organization and 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-CRP Program-Level TSMO Action Items

ID	Action	Lead	Support	Cost	Impact	Time Frame	Measure of Success
Year 1 - 2 Actions							
BP-01	Consider incorporating TSMO/ITS strategies during planning.	TP&D	Traffic Operations	$	★★★★	1-2 years	Yes/No
BP-03	Develop a formal process that institutionalizes how project development and funding needs for TSMO projects are coordinated between TP&D, Construction, and Operations and Maintenance.	TP&D	All	$	★★★	1-2 years	Yes/No
BP-04	Incorporate TSMO discussions as part of existing meetings, such as District Directors' meetings.	Traffic Operations	All	$	★★★★	1-2 years	Yes/No
PM-01	Continuously analyze mobility (speeds and travel times) and safety data (crashes) to develop mobility- and safety-based performance measures.	TP&D/Traffic Operations	Area Engineers	$$	★★★	1-2 years	% Complete
CO-01	Formalize the process of collaboration with partner agencies including the CCMPO.	TP&D	Traffic Operations	$	★★★★	1-2 years	Yes/No
ST-01	Monitor ongoing system developments and update the ITS Regional Architecture to reflect changing needs.	Traffic Operations	TP&D	$$	★★★	1-2 years	% Complete
CU-01	Perform outreach efforts to inform staff on how TSMO will better help them do their jobs.	Deputy DE	All	$	★★★	1-2 years	Yes/No
0W-01	Evaluate training and development of existing staff to perform specialized functions related to data and technology to enhance TxDOT business processes.	Deputy DE	All	$	★★★	1-2 years	% Complete
Year 3 - 5 Actions							
BP-02	Enhance maintenance planning and tracking activities by utilizing systematic processes.	Maintenance	Maintenance	$$$	★★★★	3-5 years	% Complete
BP-05	Identify ways to incorporate TSMO priorities into existing and planned projects within the District's annual budget.	TP&D	Traffic Operations	$	★★★	3-5 years	Yes/No
PM-02	Share use cases of various TSMO strategies to help better understand their benefits and justify future deployments.	TP&D/Traffic Operations	Area Engineers	$	★★★	3-5 years	Yes/No

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

ID	Action	Lead	Support	Cost	Impact	Time Frame	Measure of Success
Traffic Signal Management							
Year 1 - 2 Actions							
BP-2	Include discussions about construction signal retiming and maintenance during project design meetings, pre-construction meetings, and DSRT meetings for significant projects. - Verify appropriate signal timing is implemented during construction.	Traffic Operations	Construction, Area Engineers	$	★★★	1-2 years	% Complete
ST-01	Provide communications for 100 percent of District signals, and acquire traffic signal central management system licenses to monitor and control all District signals.	Traffic Operations	TRF	$$	★★★★	1-2 years	% Complete
ST-02	Pilot-test technologies to improve traffic signal operations (ATSPM, traffic responsive signals, adaptive systems, connected vehicles).	Traffic Operations	TRF	$$	★★★	1-2 years	Yes/No
CU-01	Identify ways to communicate benefits, outcomes, and needs to various internal and external stakeholders, including policy makers, the media, and others. - Share benefits from signal timing at Directors' and supervisors' meetings. - Leverage social media to share information (e.g., Twitter, Facebook).	Traffic Operations	TRF	$	★★	1-2 years	Yes/No
CO-01	Establish regular meetings (e.g., quarterly meetings) with partner agencies to collaborate on TSM.	Traffic Operations	COCC, Nueces County, CCMPO, CCRTA	$	★★	1-2 years	Yes/No
PM-01	Utilize INRIX/probe data to obtain traffic signal performance measures. - Conduct before/after performance measure comparison	Traffic Operations	TP&D	$$	★★★	1-2 years	Yes/No
Year 3 - 5 Actions							
BP-1	Develop a TSM plan that identifies needs and strategies to operate, maintain, and upgrade the traffic signal system. - Establish goals that are aligned to TxDOT and the region. - Formalize/develop traffic signal timing and maintenance programs. - Determine funding streams, the level of collaboration, and training requirements.	Traffic Operations	Traffic COCC	$	★★★	3-5 years	% Complete
ST-03	Standardize detection layouts for ATSPM implementation. - Detector placement determines which kinds of performance measures could be collected.	Traffic Operations	TRF	$	★★★	3-5 years	Yes/No
ST-04	Deploy an asset management system for traffic signals (e.g., ATMS.now). - Have information on existing assets. - Ensure traffic signal assets are maintained in good condition.	Traffic Operations	TRF	$$$	★★★★	3-5 years	Yes/No
PM-02	Utilize an ATSPM pilot to develop ATSPM-based reporting for regionally significant corridors, and track performance measures for continuous improvement of signal operations.	Traffic Operations	Traffic Operations	$$	★★★	3-5 years	% Complete
OW-01	Develop a recurring staff training program. - Create staff redundancy by cross-training on skills and job functions. -Trainings should include existing and emerging technology relating to traffic signal system (detection, diamond intersections, troubleshooting signals, fiber-optics management, and ITS assets).	Traffic Operations	Traffic Operations	$$	★★★	3-5 years	Yes/No
CO-02	Develop a formal process of sharing traffic-signal-related data (e.g., timing data, traffic counts, video feeds) with partner agencies.	Traffic Operations	COCC	$	★★★	3-5 years	% Complete

ID	Action	Lead	Support	Cost	Impact	Time Frame	Measure of Success
Traffic Incident Management							
Year 1 - 2 Actions							
BP-1	Establish a working group to manage the District's wrong-way driving system. - Identify stakeholders. - Establish the role of each stakeholder. - Regularly discuss District needs.	Traffic Operations	Traffic Operations	$	★★★★	1-2 years	Yes/No
BP-3	Consider addressing TIM impacts prior to the final design of significant roadway projects. - The Project Development Process Manual (July 2019) requires consideration for TIM as a TSMO strategy.	Traffic Operations	Traffic Operations, Construction, COCC	$	★★	1-2 years	Yes/No
BP-4	Review any existing interagency agreements and determine the need for updates or additional agreements. - Address interagency TIM issues. - Additional agreements may include data-sharing agreements, roles/responsibilities of agencies, notification procedures, and joint operating procedures.	Traffic Operations	TP&D	$	★★★	1-2 years	Yes/No
PM-01	Utilize probe data sources (such as RITIS/INRIX) for incident detection, tracking, and reporting.	TRF	Traffic Operations	$$	★★★	1-2 years	Yes/No
PM-02	Establish continuous tracking performance measures for the wrong-way driving system.	Traffic Operations	TRF	$$	★★★★	1-2 years	Yes/No
ST-02	Evaluate emergency operation center enhancements to support: - incident management. - active traffic monitoring. - TSM.	Traffic Operations	Traffic Operations	$	★★	1-2 years	Yes/No
CU-01	Share lessons learned, benefits, and outcomes from traffic incident responses with stakeholders and TxDOT leadership.	Traffic Operations	Traffic Operations	$	★★	1-2 years	Yes/No
CO-01	Collaborate with all TIM partners to develop data-sharing policies, including access to CCTV cameras.	Traffic Operations	COCC, Nueces County, CCMPO, CCRTA	$	★★★	1-2 years	Yes/No
Year 3 - 5 Actions							
BP-2	Develop a District TIM handbook. - Document how the TIM program should function. - Identify agencies and stakeholders and the roles and responsibilities of each party.	Traffic Operations	TRF	$$	★★	3-5 years	Yes/No
OW-01	Establish reoccurring, consistent and evolving TIM training for all stakeholders: - to train new staff and develop redundancy in existing staff, - for multidisciplinary TIM program participants to understand the incident command structure, roles of involved agencies, and applicable standards (e.g., Texas Manual on Uniform Traffic Control Devices). - to improve TIM practices based on lessons learned.	Traffic Operations	Traffic Operations	$	★★★	3-5 years	Yes/No
OW-02	Establish the roles and responsibilities within TxDOT and TIM stakeholders to carry out TIM functions. - Helps define current TIM activities and where each partner fits into the lifecycle of a typical traffic incident.	Traffic Operations	COCC, Nueces County	$	★★★	3-5 years	Yes/No

ID	Action	Lead	Support	Cost	Impact	Time Frame	Measure of Success
Road Weather Management							
Year 1 - 2 Actions							
BP-3	Formalize the process of obtaining weather data from the National Weather Service and how it will be utilized in resource planning/ forecasting. - Evaluate the applicability of the FHWA Pathfinder initiative to the RWM activities within the District.	Maintenance	TRF	$	★★★	1-2 years	Yes/No
BP-4	Develop a process to be utilized by TxDOT (Operations, Maintenance), partner agencies, and first responders for coordinated response during a significant weather event.	Maintenance	COCC, Nueces County, CCMPO, CCRTA	$	★★★	1-2 years	Yes/No
BP-5	Identify alternate corridors that complement current designated evacuation routes to facilitate efficient and safer evacuation. - Helps identify corridor needs (capacity or operational improvements) for road weather master planning. - Improve communication to the public on all alternate corridors for evacuation.	Traffic Operations	COCC, Nueces County, CCMPO, CCRTA	$	★★★	1-2 years	Yes/No
CU-01	Discuss RWM lessons learned, process improvements, needs, and plans during leadership meetings to maintain support for RWM activities.	Traffic Operations	Traffic Operations, COCC, Nueces County	$	★★★	1-2 years	Yes/No
Year 3 - 5 Actions							
BP-1	Evaluate RWM needs, and establish multi-year RWM funding to address those needs. Collaborate with CCMPO to identify funding streams available to support RWM-related operational and maintenance activities.	Traffic Operations	CCMPO	$$	★★★★	3-5 years	Yes/No
BP-2	For significant weather events, utilize information from “after action” reviews to discuss and document challenges, lessons learned, and opportunities. Document/update RWM procedures as needed.	Traffic Operations	Traffic Operations	$$	★★★★	3-5 years	Yes/No
ST-01	Evaluate technology solutions to facilitate the advisory (e.g., traveler information) and control (e.g., road closure) functions during RWM.	Traffic Operations	TRF	$$$	★★★	3-5 years	Yes/No
PM-01	Develop a dashboard that provides historical and real-time performance measures related to weather events. - Historical performance measures to plan for future events. - Real-time performance measures for event response.	Traffic Operations	TRF	$$	★★★	3-5 years	Yes/No
OW-01	Provide reoccurring RWM training to TxDOT staff, and conduct biannual RWM exercises with partner agencies and first responders. - Enhance capabilities in areas of operations and maintenance. - Cross-train staff to ensure availability for critical functions.	Traffic Operations	Traffic Operations, COCC, Nueces County	$$	★★★	3-5 years	Yes/No
CO-01	Enhance collaboration with partner agencies, first responders, and the private sector to plan for and respond to significant weather events. - Meet periodically with partner agencies and first responders to discuss RWM policies, plans, strategies, and data needs. - Collaborate with the private sector (e.g., news organizations, Waze) on sharing RWM-related data.	Traffic Operations	COCC, Nueces County, CCMPO, CCRTA	$	★★★	3-5 years	Yes/No

ID	Action	Lead	Support	Cost	Impact	Time Frame	Measure of Success
Work Zone Management							
Year 1 - 2 Actions							
BP-1	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	$$	★★★	1-2 years	Yes/No
BP-2	Develop Transportation Management Plans for significant projects, and document mobility and safety performance measures. - Utilize WZM strategies listed under Table 4.1 of FHWA's "Developing and Implementing Transportation Management Plans for Work Zones." - Document how ITS/SWZ elements are evaluated to improve WZ mobility, safety, and monitoring capabilities. - Document how social media, crowdsourcing, and connected vehicle technology are evaluated to improve traveler information.	Traffic Operations	Construction	$$	★★★	1-2 years	Yes/No
BP-3	For significant projects, evaluate the need for and type of WZ ITS based on TxDOT's SWZ guidelines and the Go/No-Go Decision Tool.	Traffic Operations	Construction	$	★★★	1-2 years	Yes/No
BP-4	Develop a process to coordinate lane closures among multiple projects and agencies to achieve WZM objectives. - Avoid conflicting project road closures. - Compile all lane-closure data in one central database. - Share WZ data with the public, media, and transportation-focused businesses.	Traffic Operations	Construction	$$	★★★	1-2 years	Yes/No
ST-01	Assess whether the application of existing and/or new technologies to manage traffic and measure system performance would enhance WZ operations and safety. - Potential addition to DCC.	TP&D	Traffic Operations	$	★★★	1-2 years	Yes/No
PM-02	On significant projects, collect real-time and historical performance measures on travel speed, travel time, traffic volumes, queue lengths, and crashes. - Utilize performance measures to monitor WZ performance and to develop safety and mobility countermeasures. - Utilize performance measures from multiple projects to continually evaluate and improve WZ policies and procedures. - Utilize historical WZ performance measures and planning-level analyses to develop WZM funding needs for upcoming projects.	Traffic Operations	TP&D	$	★★★	1-2 years	Yes/No
CO-03	Identify ways to enhance collaboration with law enforcement during WZ activities (e.g., use of CAD data, WZ enforcement, incident response).	Traffic Operations	Construction	$$	★★★	1-2 years	Yes/No
Year 3 - 5 Actions							
ST-02	Pilot-test SWZ technologies to identify use cases and mainstream SWZ deployments.	Traffic Operations	Construction	$$	★★★	3-5 years	Yes/No
PM-01	Define safety- and mobility-based goals and performance measures to inform continuous improvements within WZs. - Utilize planning-level analysis. - Utilize historical WZ data.	TP&D	Traffic Operations	$$	★★★	3-5 years	Yes/No
CU-01	Discuss WZ safety and lessons learned in supervisors' and construction meetings. - Helps create awareness and garner support for WZM from within TxDOT.	Construction	Traffic Operations	$	★★★	3-5 years	Yes/No

ID	Action	Lead	Support	Cost	Impact	Time Frame	Measure of Success
OW-01	Establish periodic WZM training to: - train District staff on the Division's SWZ guidelines. - regularly update WZM knowledge and skills to incorporate the latest industry advances within the TxDOT practice. - cross-train staff to improve their understanding of all aspects of WZM. - capture, share, and refine institutional WZ knowledge within TxDOT.	Construction	Traffic Operations	$$	★★★	3-5 years	% Complete
CO-01	Identify ways to enhance collaboration with the private sector and stakeholders during WZ activities. - Document input and resulting countermeasures because of concerns from the affected public, businesses, schools, and emergency medical services. - Provide regular construction updates via social media platforms/project websites. - Utilize enhanced ways to obtain input from stakeholders (encourage input from social media platforms such as MetroQuest).	Traffic Operations	Construction	$$	★★★	3-5 years	% Complete
CO-02	Collaborate with partner agencies on coordination of construction projects and sharing data that may help address construction impacts.	Traffic Operations	Construction, COCC, Nueces County, CCMPO, CCRTA	$$	★★★	3-5 years	Yes/No

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. The purpose of this chapter is to provide a framework for future development of tactical planning activities as part of TSMO implementation.

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, BCR, funding sources, detailed schedules). Criteria for tactical plans applied at the strategic plan level are as follows:

- Alignment with TxDOT-CRP 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

Based on current projected needs, TSMO tactical plans recommended for TxDOT-CRP are summarized in Table 16. Additional tactical plans as identified during the TSMO implementation process will be included in future TSMO Program Plan updates.

Table 16: TxDOT-CRP 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	COCC, Nueces County, CCRTA, CCMPO	$$	★★★
TSM Plan	X	X	X	X	X	X	Operations	COCC, Nueces County, CCRTA, CCMPO	$$	★★★
TIM Handbook	X	X	X	X	X	X	Operations	COCC, Nueces County, CCMPO	$$	★★

7 REFERENCES

- Texas Transportation Plan 2050
- TxDOT Transportation Systems Management & Operations
- TxDOT (2018) Transportation Systems Management and Operations (TSMO) Statewide Strategic Plan
- TTI Urban Mobility Report Corpus Christi 2019
- TxDOT Performance Dashboard
- TxDOT (2022) Unified Transportation Program
- Corpus Christi (2003) Regional ITS Architecture
- 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 Corpus Christi District TSMO Leadership Engagement and Outreach Plan - Contact List

TxDOT Corpus Christi District

Executive Leadership			
Valente Olivarez Jr. P.E.	District Engineer	(361) 808-2275	Valente.Olivarez@txdot.gov
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TSMO Steering Committee			
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Juan Marfil , P.E.	TSMO Champion	(361) 808-2501	Juan.Marfil@txdot.gov
Paula Sales-Evans, P.E.	Director TP&D	(361) 808-2222	Paula.SalesEvans@txdot.gov
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James Harris, P.E.	Director of Maintenance	(361)-808-2224	James.Harris1@txdot.gov

Partner Agencies

Corpus Christi Metropolitan Planning Organization			
Robert MacDonald, MPA, PE	Transportation Planning Director	(361) 884-0687 Extension: 105	rmacdonald@cctxmpo.us
Craig Casper, AICP;	Senior Transportation Planner	(361) 884-0687 Extension: 103	ccasper@cctxmpo.us
Nueces County			
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City of Corpus Christi - Transportation			
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Renee Couture, P.E.	City Traffic Engineer	(361) 826-3539	ReneeC@cctexas.com
Billy Delgado	Emergency Management Coordinator	(361) 826-1130	BillyD@cctexas.com
Corpus Christi Regional Transportation Authority			
Jorge Cruz-Aedo	Chief Executive Officer	(361) 425-4144	jcruz-aedo@ccrta.org
Gordon Robinson	Director of Planning	(361) 289-2712	grobinson@ccrta.org
Derrick Majchszak	Managing Director of Operations	(361) 903-3784	dmajchszak@ccrta.org

Other Possible Agencies for Outreach

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