TxDOT Statewide TSMO Training

February 2021

Version 1.1

Prepared By

AECOM Imagine it. Delivered.

Table of Contents

List of Tables

DOCUMENT CONTROL		
Date	Version	Description
7-22-20	1.0	Traffic Operations Safety Division Review (Prepared by AECOM)
2-16-21	1.1	Addresses internal AECOM comments and formatting.

List of Acronyms

Acronym	Definition
AASHTO	American Association of State Highway Transportation Officials
ATM	Active Traffic Management
ATMS	Advanced Traffic Management System
CCTV	Close Circuit Television
CMAQ	Congestion Management Air Quality
DMS	Dynamic Message Sign
DOT	Department of Transportation
FHWA	Federal Highway Administration
HERO	Highway Emergency Response Operations
ICM	Integrated Corridor Management
IMAP	Incident Management Assistance Patrol
IT	Information Technology
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
ITSA	Intelligent Transportation Systems of America
IVR	Interactive Voice Recognition
LMS	Learning Management System
NCCIW	North Carolina Correctional Institute for Women
O&M	Operations and Maintenance
PANYNJ	Port Authority of New York and New Jersey
PDH	Professional Development Hours
PS&E	Plans, Specifications and Estimates
STOC	Statewide Traffic Operations Center
TIM	Traffic Incident Management
TOPS-BC	Tool for Operations Benefit-Cost Analysis
TSMO	Transportation Systems Management and Operations
TxDOT	Texas Department of Transportation

1. Introduction

As Transportation Systems Management and Operations (TSMO) continues to change the way Departments of Transportation (DOT) do business, it is important that staff be provided the training needed to adapt and continuously improve their skill sets. This is essential in optimizing the application of TSMO strategies to improve efficiency in addressing current and future transportation safety and mobility needs.

The training program presented herein provides a structured curriculum for TxDOT division and district staff to have access to TSMO training at the level that is appropriate for their specific needs, interest and career path. This technical memorandum describes the recommended TxDOT TSMO Training Program inclusive of the following components:

- **National TSMO Training Programs:** Research was conducted on available TSMO training programs. The most relevant sources include the materials posted on the websites for ITS Heartland, Federal Highway Administration (FHWA), and National Operations Center of Excellence (NOCoE). These sources provide an excellent start in preparing a more detailed TSMO Training program for TxDOT.
- **TxDOT TSMO Training Curriculum:** A recommended TSMO training curriculum for TxDOT is presented to provide a strong foundation to support the vision, mission and goals of the Statewide TSMO Strategic Plan and District TSMO Program Plans. This curriculum builds off existing national initiatives and takes the training to a more detailed level so that TxDOT staff can mainstream TSMO strategies as part of their day-to-day operations.
- **TxDOT TSMO Training Content:** The TxDOT TSMO training curriculum is described in further detail as to the content for each module. In total, there are 30 training modules grouped into five general areas: TSMO Overview, TSMO Planning, TSMO Strategies, TSMO Implementation and TSMO Operations & Maintenance. Each training module is described in terms of training level (i.e., basic, intermediate, advanced), course description, expected outcomes, target audience, content and time required to provide the training.
- **Training Delivery:** Alternative training delivery methods are presented to provide flexibility for trainees to take courses at their own pace. These methods include Instructor-Led Training as a stand-alone activity, through multi-district meetings (e.g., Statewide ITS meetings) and at conferences as well as through a web access learning system. In addition, a "train-the-trainer" approach is presented to cascade TSMO training to TxDOT staff at the division and district levels and other stakeholder staff, as applicable.
- **Learning Management System:** A Learning Management System (LMS) is recommended to enable TxDOT to offer training to its staff and stakeholders anytime, anywhere. The LMS may include a variety of learning media in each course, including video, presentations, quizzes, and more. This would enable training for new employees, recurrent skills training as well as training to support career development.
- **Certifications:** A certification program is recommended to provide recognition to staff completing TSMO training modules. This may be in the form of Professional Development Hours (PDH), as an autonomous TxDOT credential program or both. Training certifications would be tracked in an employee database indicating TSMO courses assigned and completed, then addressed during staff performance / career development annual reviews.

In summary, the recommended training curriculum has the potential to be the most advanced TSMO Training Program in the nation, leveraging the industry's impressive efforts conducted by others and tailoring it to support TxDOT's vision of the future.

2. National TSMO Training Programs

In recent years, there has been significant development of training materials to support TSMO planning, implementation and operations. Three excellent sources of TSMO training includes ITS Heartland, FHWA, NOCoE. The following sections provide an overview of these sources with the intent of applying relevant content to the development of a TxDOT TSMO Training Program that advances training to the next level of detail.

2.1 ITS Heartland TSMO University (Reference 1)

ITS Heartland created the TSMO University Educational Program to deliver monthly webinars and in-person trainings to broaden the implementation and integration of TSMO among ITS Heartland members. ITS Heartland's TSMO University provides a high-level "train the trainer" program focusing on how state representatives can deliver information about TSMO to various groups from executive level leaders in their DOTs to operations staff, designers, contractors and maintenance personnel. The program content is archived for self-paced training on the ITS Heartland website with PDH certificates offered for each webinar to encourage participation and completion. The TSMO training modules are presented in Table 1 below.

Table 1: ITS Heartland TSMO University

Training Module	Summary of Content
ITS Heartland TSMO Overview	Provides an overview of TSMO in terms of its definition; why it's gaining support; what it's all about; objectives, geographical context, TSMO program areas and strategies.
ITS Heartland TSMO Strategies	Introduces a wide range of TSMO strategies including: work zone management; traffic incident management and responder training; safety service patrols and incident response trucks; planned special event management; road weather management; traveler information; ramp management; active transportation and demand management; managed lanes; active traffic management; and integrated corridor management.
ITS Heartland TSMO Benefits of TSMO	Introduces the benefits of TSMO including reliability, safety, environmental, performance management, traveler information, cost savings, alternatives to building, improved internal communications, coordination of multiple transportation modes, improved incident management and improved road weather maintenance management.
Deep Dive Communicating TSMO	Focuses on communicating the value of TSMO, why it's important, leadership engagement, defining and addressing the audience, building a TSMO business case and identifying opportunities to engage with decision-makers and the media.

Training Module	Summary of Content
TSMO to Improve Reliability	Defines what reliability is, why travel time reliability is important, methods to improve reliability and applicable TSMO strategies.
Deep Dive Work Zone TSMO	Defines work zone management; reviews the various types of work zones; addresses trends in the industry; identifies benefits, leadership actions, business process enhancements, new approaches to transportation management plans, public information, staffing requirements, stakeholder collaboration and performance measures. Technologies are also addressed including dynamic merge, queue warning, variable speed limit and intrusion alarm systems.
Freight Operations	Defines freight management, bottleneck mitigation, freight information systems, truck parking and routing systems, emerging technologies, private sector collaboration, benefits, leadership actions, role in transportation planning and funding.
TSMO and Incident Management	Focuses on the importance and basic principles of good TIM practices; responder training; safety service patrols and incident response trucks; equipment; memoranda of understanding; and costs and benefits.
Emerging Technology	Introduces connected automated vehicles, smart cities, mobility as a service and big data. These areas are discussed in terms of definitions, why it's important, examples, policies, benefits and leadership actions.
Creating a TSMO Organization and Culture	Addresses definitions, why it is important, benefits, leadership actions, organizational and staffing changes to accommodate TSMO.
Creating a TSMO Program Plan	Explains why TSMO program planning is important; its benefits; strategic, programmatic and tactical elements; and ten guiding principles to advance TSMO program planning.
TSMO Discussion Points	Includes interactive discussions about TSMO issues from the perspective of executives, operations personnel, field staff, and contractors.

2.2 Federal Highway Administration TSMO Briefs (References 2 – 10)

The FHWA has published several briefs that provide insight into TSMO. These briefs serve as an excellent source of references to supplement the training program. These TSMO briefs are each 2-4 pages and listed in Table 2 below.

Table 2: FHWA TSMO Briefs

FHWA TSMO Brief	Summary of Content
TSMO and Planning (Reference 2)	TSMO provides an approach to planning for operations that integrates operations in each major step of the planning process focusing on reliability and operations. Functionally, this includes identifying such issues along with other planning related concerns early on and developing operations objectives and related performance measures during objective setting.
TSMO and Safety (Reference 3)	TSMO strategies incorporate routine safety planning and practices into TSMO strategy development. It raises the awareness of the benefits of employing TSMO strategies as approaches to safety solutions.
TSMO and Performance Management (Reference 4)	Performance measures are applied as part of a strategic approach that uses system information to make investment and policy decisions to achieve national performance goals. TSMO strategies enable agencies to monitor performance in real time and actively manage the system by adjusting signal timing, updating traveler information, opening shoulders for travel, and application of other operational tactics to improve system performance.
TSMO and Maintenance (Reference 5)	TSMO strategies help make road and bridge maintenance activities safer for workers and traffic and less disruptive to travelers by managing traffic during maintenance activities and alerting drivers to the presence of work crews and lane closures. It emphasizes the importance for maintenance staff to provide input to roadway design decisions that may impact their ability to access ITS devices and other TSMO-related equipment for maintenance. It also emphasizes the need for maintenance staff to provide input to the asset management of ITS devices to ensure that ITS devices are scheduled for maintenance and updated at appropriate frequencies.
TSMO and Human Resources (Reference 6)	TSMO depends on Human Resource (HR) practitioners to integrate new job classifications, recruitment approaches, skill sets and career paths that are needed to lead transportation agencies into the future. The TSMO practitioner workforce of the future should have a broad range of skillsets that allow individuals to work in areas such as systems engineering, data management, cybersecurity, software development and emergency response.

FHWA TSMO Brief	Summary of Content
TSMO and Environment (Reference 7)	Environmental and project development personnel should consider TSMO strategies as a key tool in the toolbox of eco-friendly strategies. TSMO can support environmental goals by reducing congestion, supporting multimodal solutions and advancing strategies that increase mobility without the need to expand roads or undertake major construction. The Congestion Mitigation and Air Quality Improvement (CMAQ) Program provides funding to eligible surface transportation projects and related efforts that contribute air quality improvements and provide congestion relief. TSMO projects can reduce emissions rates and are frequently eligible for CMAQ funding.
TSMO and Design (Reference 8)	Design personnel, transportation planners, and operations staff can work together to enhance the linkage between design and operations. Some States are now working to more fully incorporate operations into their project development processes and design manuals. Considering facility operation during the design process and incorporating TSMO strategies into facility design can improve system performance for little cost. For example, designing shoulders to support part time shoulder use during peak congestion periods provides additional capacity.
TSMO and Construction (Reference 9)	TSMO is integral to effective work zone management. TSMO strategies can: provide road users with more “up front” information about planned work that will reduce capacity awhile offering mobility alternatives (e.g., alternate routes, modes, or travel times); improve traffic flow through work zones by using dynamic traffic management technologies and providing real-time data and traveler information; and assist construction crews, heavy equipment operators, and delivery vehicles to enter and exit construction sites safely.
TSMO Asset Management (Reference 10)	Asset Management is a strategic and systematic process of operating, maintaining, and improving physical assets. Lifecycle planning and risk-based management are two concepts from asset management that hold promise for advancing TSMO programs. TSMO strategies often suffer from a lack of funding to maintain the technology and equipment required to operate the system after the initial deployment. Asset management uses a network-level lifecycle approach for managing assets over their useful service life with a focus on minimizing costs while preserving or improving the asset condition.

2.3 National Operations Center of Excellence (References 11 - 26)

NOCoE is designed to offer a suite of industry accessible resources to serve the TSMO community. It provides a single-point-of-contact for the TSMO community to access a wide range of resources related to best practices, training and skills development, technical assistance, communities of practice, and other opportunities to assist professionals in learning about and enhancing their knowledge of TSMO-related activities. These resources are available through a variety of means, including webinars, peer exchanges, workshops, conferences, and a national summit. The services include the following:

- NOCoE Website (continuously accessible)
- Research Needs Database (continuously accessible)
- On-demand Resource Identification Service (continuously accessible)
- In-Person Peer Exchanges (offered four times per year)
- Webinars (offered two times per month)
- National TSMO Summit (offered every two years)
- Digital Outreach (continuously accessible)

The Center is a partnership of the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the Intelligent Transportation Society of America (ITSA) with support from FHWA. The NOCoE's web portal, www.transportationops.org, contains case studies, resources, links to an array of information, discussion forums and a calendar of TSMO-related events. Table 3 provides a summary of case studies posted on the web portal that would be useful reference materials to support a TxDOT TSMO Training Program. Additional detail for each case study is available by accessing the associated reference.

Table 3: National Operations Center of Excellence TSMO Case Studies

Case Study	Summary of Content
Arizona DOT, US-60 and I-10 Interchange Transformation using TSMO Signage and Restripe Capabilities (Reference 11)	The ADOT TSMO Division took a unique approach to identifying, documenting, engineering and implementing a sign redesign and lane restriping project to greatly improve system operations and safety of this major interchange. Crashes were reduced by 70% resulting in a BCR of 850 to 1.
Arizona DOT, Thermal Imaging Wrong Way Detection System (Reference 12)	The pilot system was initially designed to prevent wrong way drivers from entering the freeway system. The wrong way detection system has proven to reduce risk, improve response and provide critical data that can prevent wrong way driving from happening in the first place.
Florida DOT, Hurricane Irma Evacuees Use of Florida 511 (Reference 13)	FL511 became a critical communications link before, during and after this damaging storm. FL511's live camera views allowed travelers to see road conditions along their planned route, anywhere in the state.

Case Study	Summary of Content
Florida DOT, Truck Parking Availability System (Reference 14)	The Truck Parking Availability System deployed in-ground space detection at the rest areas and welcome centers, and microwave detection for ingress/egress monitoring at the weigh stations to gather real-time parking availability information. That information is shared using DMS, the Florida 511 website and third-party data feeds.
ITS Heartland's TSMO University Educational Program (Reference 15)	The ITS Heartland TSMO University Education Program was modeled to keep transportation professionals abreast of the latest technologies and trends.
Michigan DOT, Development and Maintenance of TSMO Implementation and Strategic Plan (Reference 16)	These initial efforts helped solidify a strong foundation for TSMO in Michigan and identify a core group of TSMO champions, including several in senior leadership roles at MDOT. With this momentum, MDOT began to develop five TSMO business cases which drove the MDOT TSMO Implementation and Strategic Plan.
North Carolina DOT, Live 511 Call Center created between NCDOT and Correctional Institute for Women (NCCIW) (Reference 17)	The 511 Call Center provides NCCIW inmates the opportunity to develop skills such as navigating websites, using Call Center technology and interacting with the public. In addition to gaining skills to support transitioning back into public life, women working in the 511 Call Center were excited to receive calls and communicate with individuals seeking traveler information. NCDOT was able to find an alternative to pursuing a large procurement to replace the aging 511 system and partnering with NCCIW provided significant cost savings.
North Carolina DOT, Hurricane Florence Preparation and Response (Reference 18)	The NCDOT Statewide Traffic Operations Center (STOC) and regional TMCs coordinated resources around the clock to provide preparation and response based on the storm's path. NCDOT was pleased with the effort and identified areas needing improvement: reconfiguration of IMAP driver routes and coverage areas; additional emergency management radios needed and radio channels could be used more efficiently; streaming video from IMAP trucks to the STOC would reduce manual transmission; make traffic count data available in real-time; develop an automated overlay of flood warning areas and install flood gauges at critical points to identify flash floods and river floods.
Nevada DOT, Nevada TIM Coalition Hosts Las Vegas Valley Hands-On Team Exercises (Reference 19)	The momentum from this event spurred the positive effects that TIM has had on the roadway system, including: 51% reduction in secondary crashes in the Las Vegas Valley and a major reduction in fatalities; 298% increase in stakeholder participation in TIM coalition meetings; and 317% increase in effective TIM training of first responders.

Case Study	Summary of Content
Amtrak, Corridor Wide Planning Ahead of the Amtrak Cascades Derailment (Reference 20, 21)	On December 18, 2017, Amtrak train 501 derailed near DuPont, Washington, causing railcars and one locomotive to fall onto I-5, hitting several passenger cars and shutting down I-5 which was blocked for 57 hours. While the use of drones to speed up the investigation played a large role in the quick clearance, much of the success of the clearance, the efficient detours, and the overall management of the incident was due to corridor wide planning efforts.
Georgia DOT, I-85 Bridge Collapse and Rebuild (Reference 22)	On March 30, 2017, a massive fire caused a section of I-85 in Atlanta to collapse. After the fire was extinguished, it was determined that 700 feet of both the northbound and southbound lanes required demolition and reconstruction, resulting in the closure of a critical stretch of highway which normally carries 243,000 vehicles per day. Several TSMO strategies were deployed in response to the bridge collapse and demolition including emergency response, traffic incident management, inter-agency collaboration, active traffic management, knowledge transfer, traveler information, telecommunications and contractor incentives to accelerate construction.
Michigan DOT, Washtenaw Community College: How Collaboration Between Education and Industry Can Advance the Transportation Workforce (Reference 23)	Washtenaw Community College (WCC), located in southeastern Michigan, leveraged the experience of the Michigan DOT, local Michigan Road Commissions and the burgeoning automotive and transportation technology sector, to tackle the short-and long-term workforce needs for diverse technical skills that employers in the region are seeking regarding ITS and emerging technologies.
Oregon DOT, Oregon TIM: Use of Social Media to Engage Responders & Promote Safety Laws & Practices (Reference 24)	To address the limitations of traditional channels, the Oregon DOT developed a strategic communications plan to increase interaction, outreach and awareness of TIM program elements and activities. Central to the plan was diversifying their communications portfolio to include social media. Developing a Facebook site allowed them to engage a larger audience given its social ubiquity, integration of a range of features (e.g. photo, video, links, messaging) and connection to the broader social media universe (e.g., Twitter).
Pennsylvania DOT, 511 PAConnect: Two-Way Direct Emergency Communication for Stranded Travelers (Reference 25)	In January 2016, Winter Storm Jonas caused hundreds of travelers to be trapped in vehicles on the Pennsylvania Turnpike. Many agencies, like PennDOT and the Pennsylvania Turnpike, offer websites, email alerts, mobile apps and phone systems to help travelers avoid dangerous travel conditions. When email, apps and Interactive Voice Response (IVR) phone systems are used in a trapped queue situation, the agency can only provide one-way information to travelers who may or may not be aware that these

Case Study	Summary of Content
	services exist. As a result of Winter Storm Jonas, it was apparent that there was a need to establish a framework and tool for two-way communications with travelers who are trapped on the roadway. In response, the Pennsylvania agencies implemented 511 PAConnect which establishes two-way communications with people who are stuck on the road, directly from the agency operations center to the travelers' smartphones.
Port Authority of New York and New Jersey (PANYNJ), Partnerships Transforming Communication and TSMO (Reference 26)	PANYNJ has broadened the traditional understanding of "communications" at a TMC to extend well beyond speaking with peer agencies and issuing traveler information. Highlights of current tools and services include: Awareness: Travel Time, Analysis, Reporting and Sensors Everywhere; Routing: Construction, Roadways Up to Date, Safety, Points of Interest and Beacons; and Messaging: Targeted Push Notifications and Hazard Alerts.

2.4 Summary

In summary, there are several other sources of information to support development of TSMO training. The three sources referenced herein appear to be the most applicable and will be considered in developing a TxDOT TSMO Training Program that is more focused on the end-users. These end-users include division and district staff responsible for all phases of transportation program development, implementation, operations and maintenance.

3. TxDOT TSMO Training Curriculum

A TSMO Training Program is being developed for TxDOT to build off past and current initiatives referenced in Section 2 and take the training to a more detailed level so that TxDOT staff can mainstream TSMO strategies as part of their day-to-day functions. Table 4 provides an outline of the recommended curriculum categorized in five areas: Overview, Planning, Strategies, Implementation and Operations & Maintenance.

Table 4: TxDOT TSMO Training Curriculum

Module	Training Module Subject
TSMO Overview (O)	
O-1	TxDOT TSMO Program Overview
O-2	Systems Engineering Process
O-3	Performance Measures
TSMO Planning (P)	
P-1	TxDOT Statewide TSMO Strategic Plan
P-2	TxDOT TSMO District Program Plans
P-3	Capability Maturity Model
P-4	Benefit-Cost Analysis
P-5	TSMO Evaluation Tool
P-6	Funding
TSMO Strategies (S)	
S-1	Active Traffic Management
S-2	Integrated Corridor Management
S-3	Traffic Incident Management
S-4	Smart Work Zones
S-5	Traffic Signal System Coordination
S-6	Road Weather Management
S-7	Managed Lanes
S-8	Rural Traffic Management
S-9	Freight Management
S-10	Emerging Technologies

Module	Training Module Subject
TSMO Implementation (I)	
I-1	Policies and Procedures
I-2	Standards and Specifications
I-3	Design
I-4	Construction
I-5	Technology Solutions
I-6	Data Management
TSMO Operations & Maintenance (OM)	
OM-1	TMC Operations
OM-2	HERO/Safety Service Patrol/Courtesy Patrol Operations
OM-3	ITS Maintenance
OM-4	Asset Management
OM-5	Configuration Management

4. TxDOT TSMO Training Content

The TxDOT TSMO training curriculum, referenced in Section 3, is described in further detail. In total, there are 30 training modules grouped into five general areas. Each training module is described in terms of training level (i.e., basic, intermediate, advanced); course description; expected outcomes; target audience, content, and time required to complete the training.

4.1 TSMO Overview

Training Level: Basic

Course Description

The "TSMO Overview" training modules provide a high-level overview of the TxDOT TSMO Program. It introduces the various components of TSMO as to what it is, why we need it and how the Capability Maturity Model (CMM) is used to identify TSMO strategies to improve transportation safety, mobility and efficiency. CMM analyses help agencies identify their strengths and areas needing improvement across six dimensions: business processes, systems and technology, performance measures, organization and workforce, culture and collaboration. This overview is followed by targeted training pertaining to application of the systems engineering process and performance measures during each phase of TSMO program development, implementation, operations and maintenance.

Expected Outcomes:

- Explains the purpose of TSMO and how it fits within the TxDOT organization.
- Explains the CMM process and how it is used to identify TSMO strategies.
- Provides a practical understanding of the systems engineering process as applied to TSMO.
- Introduces the role of performance measures to drive continuous improvement.

Target Audience:

These training modules are designed for transportation professionals being introduced to TSMO. Primarily intended for TxDOT staff and consultants, this training is also relevant to regional and local government staff, as well as others whose roles include development, implementation and operations of TSMO programs. There are no course pre-requisites or assumed pre-training competencies.

Table 5: TSMO Training Content – TSMO Overview

Module	Training Content	Hours
0-1	TxDOT TSMO Program Overview	1.0
	What is TSMO	
	Why is TSMO Needed	
	Capability Maturity Model	
	TSMO Strategies	
	Keys to TSMO Success	
	TSMO Program Plans and Tactical Plans	
	TxDOT TSMO Progress	
	Summary (TSMO Video)	
	Frequently Asked Questions	
	Quiz – 10 Questions	

Table 5: TSMO Training Content – TSMO Overview (cont.)

0-2	Systems Engineering Process	2.0
	Overview	
	Regional ITS Architecture	
	Concept of Operations	
	System Requirements	
	Requirements Verification Traceability Matrix	
	Workshop Exercise: Prepare High Level Concept of Operations	
	Frequently Asked Questions	
	Quiz – 10 Questions	
0-3	Performance Measures	2.0
	Overview	
	TxDOT Performance Measures	
	Best Practices (Other States)	
	Performance Measure Applications	
	Workshop Exercise: Performance Management Plan for TMC Operations	
	Frequently Asked Questions	
	Quiz – 10 Questions	

4.2 TSMO Planning

Training Level: Intermediate

Course Description

The "TSMO Planning" training modules walk participants through the planning process beginning with development of the Statewide TSMO Strategic Plan and District TSMO Program Plans. This is followed with more detailed training illustrating how the Capability Maturity Model (CMM) is applied to real-world examples in identifying appropriate TSMO strategies; applying a benefit-cost analysis methodology for TSMO strategies; use of the TxDOT TSMO Evaluation tool; and a discussion of eligible sources of funding to support TSMO.

Outcomes:

- Provides an understanding of how to develop and maintain TSMO Strategic and Program Plans.
- Hands on experience applying the CMM to identify TSMO strategies.
- Understanding of how the Benefit-Cost Analysis and TSMO Evaluation tools may be applied.
- Provides an understanding of eligible sources of funding to support TSMO programs.

Target Audience:

These training modules are designed for transportation planning professionals being introduced to TSMO. Primarily intended for TxDOT staff and their consultants, this training is also relevant to regional and local government staff as well as others involved in the planning phase of TSMO programs. Completion of the "TSMO Overview" training modules is a pre-requisite.

Table 6: TSMO Training Content – Planning

Module	Training Content	Hours
P-1	TxDOT Statewide TSMO Strategic Plan	1.5
	Overview	
	Business Case	
	Vision, Mission, Goals and Objectives	
	Capability Maturity Model	
	Strategic Plan Initiatives	
	Tactical Plan Assessment	
	Workshop Exercise: Develop New Statewide TSMO Initiative(s)	
	Frequently Asked Questions	
	Quiz – 10 Questions	

Table 6: TSMO Training Content – Planning (cont.)

P-2	TxDOT TSMO District Program Plans	1.5
	Overview	
	Case Study – Metro District	
	Case Study – Urban District	
	Case Study – Rural District	
	Workshop Exercise: Develop New District TSMO Initiative(s)	
	Frequently Asked Questions	
	Quiz – 10 Questions	
P-3	Capability Maturity Model	2.0
	Overview	
	Business Processes	
	Systems and Technology	
	Performance Measures	
	Organization and Workforce	
	Culture	
	Collaboration	
	Case Study – El Paso District	
	Workshop Exercise: FHWA "TSMO One Minute Guidance Evaluation"	
	Frequently Asked Questions	
	Quiz – 10 Questions	
P-4	Benefit-Cost Analysis	1.0
	Overview	
	Qualitative Analysis	
	Quantitative Analysis	
	Case Study – Fort Worth District	
	FHWA Tool for Operations Benefit Cost Analysis (TOPS-BC)	
	Workshop Exercise: Apply TOPS-BC for Active Traffic Management	
	Frequently Asked Questions	
	Quiz – 10 Questions	

Table 6: TSMO Training Content – Planning (cont.)

P-5	TSMO Evaluation Tool	1.0
	Overview	
	Coordination and Collaboration	
	Safety	
	Operations	
	Technology	
	Workshop Exercise: Apply TSMO Evaluation Tool for Signal Coordination	
	Frequently Asked Questions	
	Quiz – 10 Questions	
P-6	Funding	1.0
	Overview	
	Moving Forward Act	
	TxDOT Funding	
	Mainstreaming	
	Federal Grants	
	Workshop Exercise: Prepare Grant Application for Smart Multimodal Center	
	Frequently Asked Questions	
	Quiz – 10 Questions	

4.3 TSMO Strategies

Training Level: Intermediate

Course Description

The "TSMO Strategies" training modules provide participants a deeper understanding of a wide variety of TSMO strategies that may be applied within metro, urban and rural areas. The training addresses active traffic management, integrated corridor management, traffic incident management, smart work zones, traffic signal system coordination, road weather management, managed lanes, rural traffic management, freight management and emerging technologies. Training modules reference case studies throughout the United States and includes interactive workshops.

Outcomes:

- Provides a deeper understanding of various TSMO strategies.
- Addresses planning, institutional, design, construction, operations and maintenance issues.
- Shares TSMO case studies of best practices in Texas and other states.
- Provides an end-user's perspective through interactive role playing within selected workshops.

Target Audience:

These training modules are designed for TSMO professionals to obtain a more detailed understanding of TSMO strategies. Primarily intended for TxDOT staff and their consultants, this training is also relevant to regional and local government staff as well as other TSMO stakeholders. Completion of the "TSMO Overview" training modules is a pre-requisite.

Table 7: TSMO Training Content – Strategies

Module	Training Content	Hours
S-1	Active Traffic Management	1.5
	Overview	
	Components	
	Benefits	
	Costs	
	Planning and Institutional Issues	
	Design and Implementation Issues	
	Operations and Maintenance Issues	
	Workshop Exercise: Develop “Active Traffic Management” Master Plan	
	Frequently Asked Questions	
	Quiz – 10 Questions	
S-2	Integrated Corridor Management	1.5
	Overview	
	Freeway-Arterial Integration	
	Multimodal Applications	
	System Infrastructure	
	Joint Operations and Maintenance Agreements	
	Decision Support Systems	
	Case Study: I-75 Dallas ICM Lessons Learned	
	Frequently Asked Questions	
	Quiz – 10 Questions	

Table 7: TSMO Training Content – Strategies (cont.)

S-3	Traffic Incident Management	1.5
	Overview	
	TIM Team Meetings	
	HERO/Safety Service Patrols/Courtesy Patrols	
	TIM Training	
	FHWA TIM Self-Assessment	
	Special Event	
	Emergency Event	
	TMC-TIM Operational Integration	
	Workshop Exercise: Role Play “After Action Review” of Interstate Closure	
	Frequently Asked Questions	
	Quiz – 10 Questions	
S-4	Smart Work Zones	1.5
	Overview	
	Guidelines	
	Specifications	
	Information Systems	
	Selection Criteria	
	Standard Drawings	
	Workshop Exercise: Develop “Smart Work Zone” Schematic	
	Frequently Asked Questions	
	Quiz – 10 Questions	

Table 7: TSMO Training Content – Strategies (cont.)

S-5	Traffic Signal System Coordination	1.5
	Overview	
	Traffic Signal Timing 101	
	Signal System Components	
	Traffic Adaptive Systems	
	Automated Traffic Signal Performance Measures	
	Active Arterial Management	
	Signal System Maintenance	
	Video: Day in the Life of a Traffic Signal Engineer at Austin TOC Workstation	
	Frequently Asked Questions	
	Quiz – 10 Questions	
S-6	Road Weather Management	1.5
	Overview	
	Road Weather Information Systems	
	Equipment and Operations	
	Weather Responsive Traffic Management	
	Case Study: Houston TranStar “Flood Detection System”	
	Frequently Asked Questions	
	Quiz – 10 Questions	
S-7	Managed Lanes	1.5
	Overview	
	Design Considerations	
	System Components	
	Dynamic Pricing	
	Enforcement	
	Case Study: Dallas-Fort Worth Managed Lanes Regional Network	
	Frequently Asked Questions	
	Quiz – 10 Questions	

Table 7: TSMO Training Content – Strategies (cont.)

S-8	Rural Traffic Management	1.5
	Overview	
	Low Cost Enhancements	
	ITS Needs Checklist	
	Incident Management	
	Freight Management	
	Partnering Agreements with Border Districts	
	Case Study: Amarillo District	
	Frequently Asked Questions)	
	Quiz – 10 Questions	
S-9	Freight Management	1.5
	Overview	
	ITS Technologies	
	Freight Signal Priority	
	Truck Parking Advisory Systems	
	Truck Platooning Applications	
	Border Crossing Technologies	
	Case Study: Texas Connected Freight Corridors Project	
	Frequently Asked Questions	
	Quiz – 10 Questions	
S-10	Emerging Technologies	1.5
	Overview	
	Cooperative Automated Transportation	
	Electric Vehicle Charging System	
	AI/Machine Learning	
	Mobility on Demand	
	Smart Cities	
	Workshop Exercise: Apply “Connected Roadway Classification System” Tool	
	Frequently Asked Questions & Quiz – 10 Questions	

4.4 TSMO Implementation

Training Level: Advanced

Course Description

The "TSMO Implementation" training modules provide participants a deeper understanding of the steps necessary to progress TSMO strategies through the project delivery stages in alignment with the systems engineering process. The training addresses policies and procedures, standards and specifications, design, construction, technology solutions and data management. Training modules reference case studies and includes interactive workshops.

Outcomes:

- Provides a deeper understanding of advancing TSMO strategies through implementation phases.
- Addresses TxDOT policies and procedures as well as standards and specifications.
- Applies systems engineering process through each phase of project development and delivery.
- Introduces the development and application of data management.

Target Audience:

These training modules are designed for TSMO professionals to obtain a more detailed understanding of implementing TSMO strategies. This training is primarily intended for TxDOT staff and their consultants. Completion of the "TSMO Overview" and "TSMO Strategies" training modules are a pre-requisite.

Table 8: TSMO Training Content – Implementation

Module	Training Content	Hours
I-1	Policies and Procedures	1.0
	Overview	
	TSMO Planning Policies and Procedures	
	ITS Design Manual	
	PS&E Plans Preparation Manual	
	Modernize Portfolio and Project Management	
	Standard Operating Procedures	
	Workshop Exercise: Develop Job Description for a TSMO Engineer	
	Frequently Asked Questions	
	Quiz – 10 Questions	
I-2	Standards and Specifications	1.0
	Overview	
	ITS Equipment Standards	
	State's Material Producers List	
	Procurement Procedures	
	Workshop Exercise: Walk through Entire Process for ITS Deployment	
	Frequently Asked Questions	
	Quiz – 10 Questions	
I-3	Design	1.5
	Overview	
	Mainstreaming as part of Roadway Improvement Project	
	Design as Separate Project	
	Development of Plans, Specifications and Estimates	
	Workshop: Value Engineering Roadway Project to include TSMO Elements	
	Frequently Asked Questions	
	Quiz – 10 Questions	

Table 8: TSMO Training Content – Implementation (cont.)

I-4	Construction	1.5
	Overview	
	Alternative Procurement Methods	
	Procurement Process	
	Construction Engineering and Inspection	
	Systems Acceptance Testing	
	Operational Burn In	
	Video: Installation of DMS, CCTV Camera, Detector, Communications	
	Frequently Asked Questions	
	Quiz – 10 Questions	
I-5	Technology Solutions	1.0
	Overview	
	Lonestar™ ATMS Software	
	Network Management	
	Cyber Security	
	Change Management	
	Case Study: Lonestar™ ATMS Software Enhancements	
	Frequently Asked Questions	
	Quiz – 10 Questions	
I-6	Data Management	1.0
	Overview	
	Public Data	
	Private Data	
	Data Platform	
	Dashboards	
	Workshop Exercise: Develop High Level Data Platform Architecture	
	Frequently Asked Questions	
	Quiz – 10 Questions	

4.5 TSMO Operations and Maintenance

Training Level: Advanced

Course Description

The "TSMO Operations and Maintenance" training modules provide participants a deeper understanding of utilizing TSMO strategies to achieve the desired benefits while managing the assets to optimize system availability and life-cycle costs. The training addresses TMC operations, HERO/Safety Service Patrol/Courtesy Patrol Operations, ITS maintenance, asset management and configuration management. Training modules include video clips illustrating operations and maintenance activities in real world environments.

Outcomes:

- Provides a deeper understanding of TSMO operations and maintenance activities.
- Illustrates a "day in the life" for different operations and maintenance functions.
- Emphasizes the role of performance measures to drive continuous improvement.
- Introduces the role of "asset" and "configuration" management to address upgrades.

Target Audience:

These training modules are designed for TSMO professionals to obtain a more detailed understanding of operating and maintaining TSMO strategies. This training is primarily intended for TxDOT staff as well as their consultants and contractors. Completion of the "TSMO Overview" and "TSMO Strategies" training modules are a pre-requisite.

Table 9: TSMO Training Content – Operations and Maintenance

Module	Training Content	Hours
OM-1	TMC Operations	2.0
	Overview	
	Functions	
	Staffing	
	Standard Operating Procedures	
	Training	
	IT Networks	
	Performance Measures	
	Interoperability	
	Video: Houston TranStar Operations illustrating Different Functions	
	Frequently Asked Questions	
	Quiz – 10 Questions	
OM-2	HERO/Safety Service Patrol/Courtesy Patrol Operations	1.5
	Overview	
	Functions	
	Staffing	
	Vehicles and Equipment	
	Training	
	Video: A Day in the Life of HERO Operations (Austin)	
	Frequently Asked Questions	
	Quiz – 10 Questions	

Table 9: TSMO Training Content – Operations and Maintenance (cont.)

OM-3	ITS Maintenance	1.5
	Overview	
	ITS Field Devices	
	Communications	
	IT Networks	
	Preventive, Corrective and Emergency Maintenance	
	Video: A Day in the Life of an ITS Maintenance Technician (San Antonio)	
	Frequently Asked Questions	
	Quiz – 10 Questions	
OM-4	Asset Management	1.0
	Overview	
	TxDOT Maintenance Management System	
	Applying Data on Workload and Costs to Support Budgeting	
	Providing Tools for Analyzing Maintenance Activities to Improve Efficiency	
	Prioritizing TSMO Systems for Maintenance or Replacements	
	Maintenance Costs performed under Contract versus State Forces	
	Providing Tools to Plan Maintenance Work (Labor, Equipment, Material)	
	Case Study: Walk Through Applying the TxDOT Asset Management System	
	Frequently Asked Questions	
	Quiz – 10 Questions	
OM-5	Configuration Management	1.0
	Overview	
	Lonestar™ ATMS Software	
	ITS Expansion	
	Systems and Technology	
	Business Processes	
	Organization and Workforce	
	Workshop Exercise: Walk Through a new Lonestar™ ATMS Software Function	
	Frequently Asked Questions & Quiz – 10 Questions	

4.6 Summary

In summary, the TSMO Training Program presented herein provides the participant with flexibility to learn at a basic, intermediate or advanced level based on their job description (i.e., knowledge, skills and abilities) as well as their interest in career advancement within the TSMO domain. While it is recommended that all trainees complete the "TSMO Overview" modules, the balance of training is available as an ala carte menu of courses based on the individual's needs and desires as agreed upon with their supervisor.

5. Training Delivery

Alternative training delivery methods are presented to provide flexibility for trainees to take courses at their own pace. These methods include Instructor-Led Training, through a web access learning system or as a "train-the-trainer" approach.

5.1 Instructor-Led Training

Instructor-Led Training is any kind of training that occurs in a training room, typically in an office, classroom or conference room. This form of training can have one or more instructors; and they teach skills or material to another person or group through lectures, presentations, demonstrations and discussions. (Wikipedia)

Instructor-Led Training may be delivered as a stand-alone activity, through multi-district meetings (e.g., Statewide ITS meetings) and at conferences. Furthermore, they may be delivered through webinars scheduled on a regular basis.

Instructor-Led Training is an effective means of delivering information, as it allows for real-time feedback, questions and answers, manipulation and changeable delivery to suit the needs of learners in a real-time environment, and a learning environment can be created by the instructor's style. Although instructor-led training dominates the market in terms of use because of its effectiveness, it tends to be a costlier learning delivery method.

While training management systems focus on managing instructor-led training, they can complete an LMS. In this situation, an LMS will manage e-learning delivery and assessment, while a training management system will manage ILT and back-office budget planning, logistic and reporting. Recently, there have been many trends in modernizing and optimizing instructor-led training through educational technology.

Instructor-led training can be delivered within a classroom or remotely through a virtual classroom, in which case it is called virtual instructor-led training. Instructor and learners are in different locations, and a classroom environment is replicated through online tools. This type of training can be delivered synchronously or asynchronously.

Instructor-led training can also be combined with e-learning in a blended learning scenario to achieve a maximum effectiveness. In this case, some of the training is delivered live while online courses serve as refreshers between sessions. A growing type of blended learning is called the flipped classroom model, where students acquire information by watching lectures online and then engage in problem-solving, discussion and group activities in class.

Training within the classroom can be also enhanced through a range of technology and collaborative tools such as video software and system to access content during the class.

Lastly, instructor-led training back office management can be optimized through dedicated software which streamline all processes (scheduling, logistics, costs and budget management, administration, reporting, etc.)

such as a training management system. This allows training organizations to improve the efficiency of their ILT and optimize their training budget.

5.2 Web-Based Training

Web-based training is any form of training that is delivered online. Other terms include internet-based training, eLearning and distance education. It allows flexibility – anyone, anywhere, at any time, can access course content or training programs. As a result, web-based training is one of the most convenient, cost-effective, and flexible methods of training available, especially for large organizations. There are three main types of web-based training (Reference 27):

1. Synchronous web-based training is most closely related to in-person training – they're both instructor-led and involve real-time interactions with learners. However, with synchronous web-based training, while the instructor and learners need to be online at the same time, teaching and learning occur in different places. Synchronous learning includes online tutoring, lectures, peer meetings, webinars and teleconferencing. Training can be delivered to one or more learners at a time who may or may not be in different places.

2. Asynchronous web-based training is standard in the eLearning realm, as it affords the most flexibility. As the content is purely digital, learners can progress through training programs at their own pace and convenience. There is no "real-time" element to asynchronous training, which comes in many formats, such as eLearning courses, video tutorials, screencasts, readings, pre-recorded webinars or some combination thereof.

3. Blended web-based training combines elements of both synchronous and asynchronous learning. For example, the first half of a course for TSMO might contain theoretical knowledge, such as the CMM process, while the second half might contain hands-on elements that require learners to demonstrate their learned skills.

There are several benefits to Web-based training including flexibility, cost-effectiveness and higher learning potential.

- Flexibility: One of the greatest benefits of web-based training is that it is flexible. Employees, no matter where they are based, have access to learning at their own pace. Whether they commit to a series of several sessions each week, or one-hour sessions over a month or year, they can customize the training needed to adapt to their schedules. Moreover, staff can maximize their learning potential by training within their environment (e.g., office, home).
- Cost Effectiveness: Web-based training provides cost efficiencies in mainstreaming the training within available timeframes as well as eliminating travel time and expenses. Furthermore, it is adaptable to being updated to address future needs as they change over time.

- Higher Learning Potential: Web-based training includes a variety of media to address different learning styles of the trainees. The learner-centered approach heightens interactivity and thus draws learners in. For example, specific references may be hyperlinked to provide the trainee an opportunity to learn more about the subject. Most notably with asynchronous web-based training, staff will have the time to reflect on the questions and activities posed in training in greater depth.

5.3 Train-the-Trainer

Train-the-Trainer is a framework for instructors to train other people within their organizations. The expected outcome is that attendees learn the new knowledge or skill, and they will instruct other staff within the organization.

The attributes of a good trainer include comfort in speaking in front of people, knowledge of the subject matter, experience, a passion for learning and interest in people. The role of a trainer is to develop a competency in TSMO and skill sets an individual will need to perform effectively and efficiently. The trainer should communicate to the trainees about what is expected from the training in a simple and professional manner.

It is recommended that trainers be certified. The certification process would require the candidate to shadow a certified trainer for the same modules that they would be teaching others. The certified trainer would evaluate the readiness for the candidate to become certified based on their knowledge of the subject, ability to effectively communicate and respond to questions.

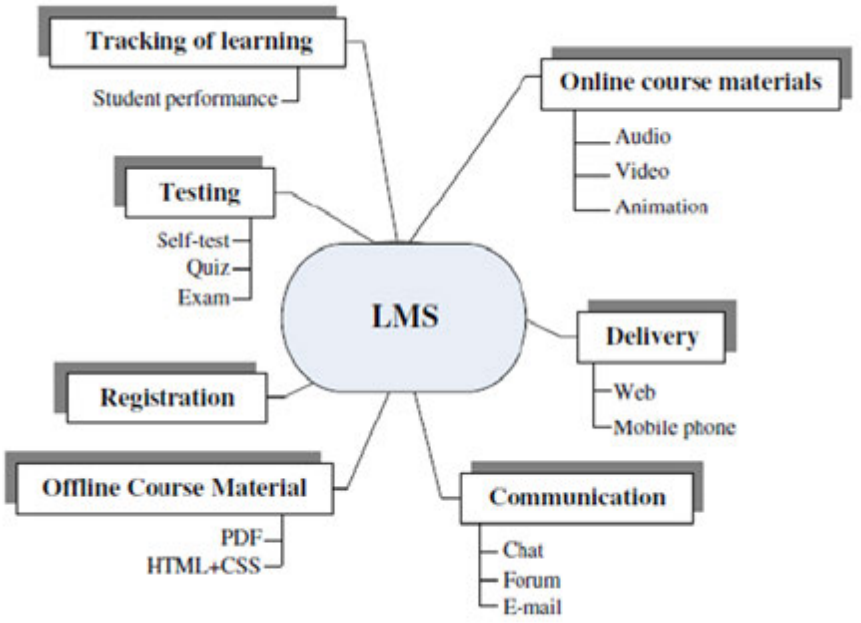
5.4 Summary

In summary, a variety of methods may be applied for the TSMO Training Program. It is recommended that alternative methods be available and utilized for delivering the TxDOT TSMO Training Program. Alternative methods will use a combination of PowerPoint presentations, case studies, video clips, vendor demonstrations and interactive workshops. Usage of a Learning Management System (LMS) is recommended to provide consistent course materials that would be available for trainees to complete modules at their own pace and be upgraded as the need arises in the future.

6. Learning Management System

Usage of a Learning Management System (LMS) would enable TxDOT to offer training to its staff and stakeholders anytime, anywhere. The LMS may include a variety of learning media in each course, including video, presentations, quizzes, and more. This would enable training for new employees, recurrent skills training as well as training to support career development. A high-level overview of a typical LMS is presented in Figure 1 below.

Figure 1: Learning Management System: Typical High-Level Overview (Reference 28)



The LMS should provide the following capabilities:

- Develop training materials (e.g., PowerPoint presentations, video, text, audio) within the LMS;
- Import training materials created outside the LMS;
- Publish and archive training materials;
- Deliver on-line training to specific users and groups;
- Conduct staff testing;
- View and update user information (name, division, district, contact information);
- Track completion and view performance data for specific lessons, users, or groups;
- Report data about specific lessons, users, or groups to identify knowledge gaps and opportunities for improvement;
- Generate training reports based on user defined parameters; and

- Output the results of reports and queries in different formats.

Usage of the TxDOT LMS should be coordinated to make it seamlessly available to users; establish and manage LMS user accounts; develop and provide documentation for the use of the LMS; and keep the training sessions available.

7. Certifications

A certification program is recommended to provide recognition of staff completing TSMO training modules. This may be in the form of PDHs, as an autonomous TxDOT program or both. Training certifications would be tracked in an employee database indicating TSMO courses assigned, completed and addressed during annual performance evaluation/career advancement reviews. Recommended training for TxDOT employees is presented in Table 10.

Table 10: TSMO Training Certification Levels

Training Module	# Hours	Minimum Hours
Basic Level		
0-1: TxDOT TSMO Program Overview	1.0	Basic Level: 5.0
0-2: Systems Engineering	2.0	
0-3: Performance Measures	2.0	
Intermediate Level (Planning)		
P-1: TxDOT Statewide TSMO Strategic Plan	1.5	Intermediate Level: 8.0
P-2: TxDOT TSMO District Program Plans	1.5	
P-3: Capability Maturity Model	2.0	
P-4: Benefit-Cost Analysis	1.0	
P-5: TSMO Evaluation Tool	1.0	
P-6: Funding	1.0	
Intermediate Level (Strategies)		
S-1: Active Traffic Management	1.5	Select Minimum of 6 Modules Intermediate Level: 9.0
S-2: Integrated Corridor Management	1.5	
S-3: Traffic Incident Management	1.5	
S-4: Smart Work Zones	1.5	
S-5: Traffic Signal System Coordination	1.5	
S-6: Road Weather Management	1.5	

Training Module	# Hours	Minimum Hours
S-7: Managed Lanes	1.5	
S-8: Rural Traffic Management	1.5	
S-9: Freight Management	1.5	
S-10: Emerging Technologies	1.5	
Advanced Level (Implementation)		
I-1: Policies and Procedures	1.0	Advanced Level: 7.0
I-2: Standards and Specifications	1.0	
I-3: Design	1.5	
I-4: Construction	1.5	
I-5: Technology Solutions	1.0	
I-6: Data Management	1.0	
Advanced Level (Operations and Maintenance)		
OM-1: TMC Operations	2.0	Advanced Level: 7.0
OM-2: HERO/Service Patrol/Courtesy Patrol Operations	1.5	
OM-3: ITS Maintenance	1.5	
OM-4: Asset Management	1.0	
OM-5: Configuration Management	1.0	

TSMO courses for each employee would be assigned by the employee's supervisor based on their job description and career path. TSMO training certifications includes three levels:

- **Basic:** Completion of the "TSMO Overview" training modules (5 hours).
- **Intermediate:** Completion of the "TSMO Planning" training modules (8 hours) and a minimum of six "TSMO Strategies" training modules (9 hours). In addition to Basic Training (5 hours), the total minimum number of hours is 22.
- **Advanced:** Completion of the "TSMO Implementation" training modules (7 hours) or the "TSMO Operations and Maintenance" training modules (7 hours). In addition to Basic and Intermediate Training (22 hours), the total number of hours is 29.

Upon completion of initial training, refresher training is recommended on an annual basis where staff completes an additional three hours of training to maintain their certification. Staff should consider completing modules not taken during their initial training before repeating modules already completed. As discussed in Section 5.3, "train-the-trainer" certification is recommended with candidates shadowing a certified trainer for the same modules that they would be teaching others.

8. Summary

The TSMO Training Program presented in this technical memorandum provides basic, intermediate and advanced training to enable TxDOT division and district staff, as well as stakeholder partners, to develop, implement, operate and maintain and effective TSMO Program. Specifically, the benefits of this training program include the following:

- Targeted Training – modules are organized to provide training on specific areas of interest and needs as determined by the employee's job description and career path.
- Flexibility – modules can be completed by the employees at their own pace, and their desired location, within a timeframe assigned by their supervisor.
- Certification – staff will receive certification in the form of PDHs or as part of a TxDOT certification process. Certifications may be considered during annual reviews for career advancement opportunities.

In summary, the TxDOT TSMO Training Program provides a scalable curriculum to provide and enhance the skill sets needed by staff to support the vision, mission and goals of the TxDOT Statewide TSMO Strategic and District TSMO Program Plans. The Appendix presents an initial version of the "TSMO Overview" training modules (i.e., TxDOT TSMO Program Overview (O-1), Systems Engineering Process (O-2), and Performance Measures (O-3)).

References

1. ITS Heartland TSMO University, https://itsheartland.org/tsmo-university/
2. https://itsheartland.org/wp-content/uploads/2019/08/TSMO-and-Planning-4-pager-fhwahop18096.pdf
3. https://itsheartland.org/wp-content/uploads/2019/08/TSMO-and-Safety-2-pager-fhwahop18091.pdf
4. https://itsheartland.org/wp-content/uploads/2019/08/TSMO-and-Performance-Management-2-pager-fhwahop18095.pdf
5. https://itsheartland.org/wp-content/uploads/2019/08/TSMO-and-Maintenance-2-pager-fhwahop18090.pdf
6. https://itsheartland.org/wp-content/uploads/2019/08/TSMO-and-Human-Resources-fhwahop18093.pdf
7. https://itsheartland.org/wp-content/uploads/2019/08/TSMO-and-Environment-2-pager-fhwahop18089.pdf
8. https://itsheartland.org/wp-content/uploads/2019/08/TSMO-and-Design-4-pager-fhwahop18088.pdf
9. https://itsheartland.org/wp-content/uploads/2019/08/TSMO-and-Construction-2-pager-fhwahop18092.pdf
10. https://itsheartland.org/wp-content/uploads/2019/08/TSMO-Asset-Mngmt-2-pager-fhwahop18094.pdf
11. https://itsheartland.org/wp-content/uploads/2019/08/AZ-DOT-Case-Study-Wrong-Way-Driving.pdf
12. https://itsheartland.org/wp-content/uploads/2019/08/AZ-DOT-Case-Study-I-60-Lane-Restriping.pdf
13. https://itsheartland.org/wp-content/uploads/2019/08/Florida-DOT-Case-Study-FL511-During-Hurricane-Irma.pdf
14. https://itsheartland.org/wp-content/uploads/2019/08/Florida-DOT-Case-Study-Truck-Parking-System.pdf
15. https://itsheartland.org/wp-content/uploads/2019/08/ITS-Heartland-Case-Study-TSMO-University.pdf
16. https://itsheartland.org/wp-content/uploads/2019/08/Michigan-DOT-Case-Study-TSMO-Program_0.pdf
17. https://itsheartland.org/wp-content/uploads/2019/08/NCDOT-Case-Study-511-Call-Center.pdf
18. https://itsheartland.org/wp-content/uploads/2019/08/NCDOT-Case-Study-Hurricane-Florence.pdf
19. https://itsheartland.org/wp-content/uploads/2019/08/Nevada-DOT-Case-Study-TIM-Excercises.pdf
20. https://itsheartland.org/wp-content/uploads/2019/08/NoCoe-Case-Corridor-Planning-Ahead-of-Amtrak-Cascades-Derailment.pdf
21. https://itsheartland.org/wp-content/uploads/2019/08/NoCoe-Case-Drone-Use-During-Amtrak-Cascades-Derailment.pdf
22. https://itsheartland.org/wp-content/uploads/2019/08/NoCoe-Case-I-85-Bridge-Collapse-1b.pdf
23. https://itsheartland.org/wp-content/uploads/2019/08/NoCoe-Case-Study-Washtenaw-CC.pdf
24. https://itsheartland.org/wp-content/uploads/2019/08/Oregon-DOT-Case-Study-TIM-Responder.pdf
25. https://itsheartland.org/wp-content/uploads/2019/08/PA-DOT-Case-Study-PA-511-Connect.pdf
26. https://itsheartland.org/wp-content/uploads/2019/08/PANYNJ-Case-Study-Partnerships.pdf
27. https://www.ispringsolutions.com/blog/web-based-training
28. Balogh, Zoltan, “Possibilities of Modelling Web-Based Education”, researchgate.net, November 2011

Training Module 0-1: TxDOT TSMO Program Overview

Training Module 0-2: Systems Engineering Process

Training Module 0-3: Performance Measures