



Developing and Sustaining a Transportation Systems Management & Operations Mission for Your Organization

A PRIMER FOR PROGRAM PLANNING



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7. Authors Michael Grant, Pat Noyes, Lindsay Oluyede, Jocelyn Bauer, Matthew Edelman		8. Performing Organization Report No.	
9. Performing Organization Name and Address Leidos 11251 Roger Bacon Drive Reston, VA 20190 ICF 1725 Eye Street NW Washington, DC 20006 Pat Noyes & Associates 1566 County Road 83 Boulder, CO 80302		10. Work Unit No. (TRAIS)	
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16. Abstract This primer discusses the rationale for and key elements of successful transportation systems management and operations (TSMO) program planning. It is designed as a practical resource to help State departments of transportation, metropolitan planning organizations, and local or regional operations organizations to integrate and mainstream TSMO within their organizations. The primer describes why TSMO program planning is important and how it can benefit a transportation agency. It identifies the strategic, programmatic, and tactical elements needed to advance TSMO as a critical part of the agency's mission which describes ten guiding principles to advance TSMO program planning, and building on successful practices to date.			
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Preface

Transportation agencies have historically organized themselves around a core mission to expand and deliver infrastructure capacity. As our society begins to place more and more value on system performance and reliability, the use of technology, and the ability to share information rapidly, transportation agencies must evolve their mission to effectively manage and operate the transportation system that has been built in order to meet public expectations.

More and more, agencies are recognizing the importance of focusing on transportation systems management and operations (TSMO) as a core mission. This shift in focus comes from a growing understanding of the extensive impacts on traffic that result from incidents, reconstruction, weather conditions, emerging technologies (such as connected and autonomous vehicles), and greater access to and use of real-time information. Managing and operating the transportation system now needs to move beyond implementing specific ad hoc projects to become a structured core function of a transportation agency as well as a sustained part of its mission.

Research conducted through the Second Strategic Highway Research Program (SHRP2) demonstrated that agencies that most effectively manage and operate their transportation systems were not differentiated by budgets, types of projects, or technical skills alone. Very often, the SHRP2 research found that these agencies developed critical processes and institutional arrangements that enable systems management and operations to be seen as on par with infrastructure and capacity improvements.

Subsequent assessments by the Federal Highway Administration (FHWA) found that several of these transportation agencies developed a Program Plan to structure and sustain TSMO as one of their core missions. FHWA found that many agencies planned to develop a TSMO program plan.

FHWA prepared this primer because program planning is viewed as such an effective management tool for building and sustaining an effective TSMO mission within a transportation agency. Recognizing that there are no Federal requirements to develop a TSMO program plan, this primer is intended to provide general guidance on TSMO program planning in order to help improve the consistency and quality of TSMO program plans. The document is not intended as a “cookbook” to be strictly followed. Instead, it lays out key questions and considerations for agencies to explore based on their unique needs, organizational structures, and the issues confronting their particular organization or region.

FHWA intends for State transportation agencies, metropolitan planning organizations, and other transportation organizations to use this resource to help them develop and sustain a TSMO mission and advance effective program delivery. For more information on TSMO and TSMO program planning, please visit the website for the FHWA Office of Operations at: <https://ops.fhwa.dot.gov/>.



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List of Abbreviations

AASHTO	American Association of State Highway and Transportation Officials	RIMIS	Regional Integrated Multi-Modal Information Sharing
API	arterial progression index	RTOP	Regional Transportation Operations Plan
ATDM	active transportation and demand management	SEWRPC	Southeastern Wisconsin Regional Planning Commission
CAD	Computer Aided Dispatch	SHA	(Maryland) State Highway Administration
CDOT	Colorado Department of Transportation	SHRP2	Second Strategic Highway Research Program
CMAQ	Congestion Mitigation and Air Quality Improvement Program	SHSP	Strategic Highway Safety Plan
CMM	capability maturity model	SMART	Specific, Measurable, Agreed-upon, Realistic, and Time-bound
CMP	congestion management plan	SOV	single-occupancy vehicle
DOT	departments of transportation	TIM	traffic incident management
DSS	decision support systems	TIP	transportation improvement program
DVRPC	Delaware Valley Regional Planning Commission	TOC	traffic operations center
F2C	field-to-center	TSMO	transportation systems management and operations
FAST	Fixing America's Surface Transportation Act	TTI	travel time index
FHWA	Federal Highway Administration	VMT	vehicle miles traveled
ICM	integrated corridor management		
IMRT	incident management response teams		
ITS	intelligent transportation systems		
LRSTP	long-range statewide transportation plan		
MAG	Maricopa Association of Governments		
MAP-21	Moving Ahead for Progress in the 21st Century Act		
MPO	metropolitan planning organization		
MTP	metropolitan transportation plan		
MTP	metropolitan transportation plan		
NCHRP	National Cooperative Highway Research Program		
NCTCOG	North Central Texas Council of Governments		
NOCoe	National Operations Center of Excellence		
PTI	planning time index		

Chapter 1. Introduction to Transportation Systems Management and Operations Program Planning

Historically, transportation agencies were organized to deliver infrastructure capacity as the core mission. State and local departments of transportation (DOT) traditionally focused on capital project planning, design, construction, and maintenance, with limited emphasis and resources applied to managing and operating the transportation systems. Similarly, metropolitan planning organizations (MPO) grew out of a need to plan for and program funding for infrastructure projects. This focus is now changing rapidly, and transportation agencies at all levels increasingly recognize the importance of transportation systems management and operations (TSMO) activities to their core mission.

With road capacity largely built out in urban areas and transportation funding in limited supply, State and local DOTs and MPOs are turning to cost-effective, near-term TSMO solutions to address customer needs. The public and elected officials now expect existing transportation networks to be seamlessly optimized without regard to jurisdictional boundaries. Increasingly, the public has access to real-time traffic and transit information and expects agencies to use technology to help reduce traffic congestion and improve coordination of multimodal transportation services.

Moreover, nonrecurring events such as incidents, construction, special events, and weather conditions are responsible for a significant portion of travel delays. Consequently, improved condition monitoring and detection of disruptions, coordination across transportation agencies, and communication with the public and agency partners such as emergency responders can yield

significant improvements in system performance and benefits to customers, including the traveling public, freight shippers, and communities.

To be effectively implemented, transportation systems management and operations should be recognized and structured as a core function of a transportation agency—more than simply a strategy or ad hoc set of activities, it is a cohesive *program* that is vital to the mission of the agency.

An integrated program focused on TSMO offers opportunities to improve system performance through multimodal, intermodal, and cross-jurisdictional systems, services, and projects that preserve capacity, enhance public safety and security, enhance seamless connections between modes, and improve reliability. Effective TSMO relies upon institutional arrangements and processes within agencies to shift the focus to managing transportation systems in order to optimize performance. Collaboration among

functional areas within a transportation agency, including planning, project development, traffic engineering, maintenance, and safety, is a fundamental element of TSMO. Collaboration among partner agencies—including State DOTs, MPOs, transit agencies, local jurisdictions, toll authorities, and law enforcement—to implement integrated corridor management, transit signal priority, and other strategies and to coordinate for special events and emergency management functions is also key to a successful TSMO program. More than simply a strategy or set of activities, TSMO is recognized as a core part of the mission of a transportation organization and should be supported by clear organizational roles, responsibilities, and business processes.

TSMO program planning is an effective practice for making TSMO a part of the mission of a transportation organization. TSMO program planning involves strategic, programmatic, and tactical elements. It involves the organizational business process and discipline of regularly assessing, enhancing, and documenting:

- The relationship of TSMO to the agency mission and the fundamental reasons or business case for organizational commitment to TSMO.
- The organizational structure and business processes to administer TSMO as a core program area.
- The services, programs, technologies, and infrastructure to which an organization or geographic area commits to implement in order to support achievement of performance outcomes.

Transportation systems management and operations (TSMO) program planning facilitates *integration and mainstreaming* of TSMO within a transportation organization to support the new and evolving roles and responsibilities of these organizations. The process of TSMO program planning identifies the ***strategic, programmatic, and tactical elements*** needed to advance TSMO as a critical part of the agency's mission.

A TSMO program plan is the documented outcome of this process.

Purpose of this Primer

The purpose of this primer is to help State DOTs, MPOs, and regional operations organizations understand the rationale for and the key elements of successful TSMO program planning. The primer is intended to help agencies understand:

- Why is TSMO program planning important? How can it benefit a transportation agency or region?
- What are key elements of effective TSMO program planning, and what steps or activities should be taken?
- What would an effective TSMO program plan look like?

This primer is designed to help transportation agencies increase the quality, effectiveness, and consistency in TSMO program plans, while being flexible to reflect the different needs of diverse States and regions based on their unique contexts and existing capabilities.

Who Should Use the Primer?

This primer is written for a broad audience, and can assist several types of agencies:

- **State DOTs** – While State DOTs have traditionally been project-oriented, a TSMO program can expand that orientation to focus on a range of operational and management strategies to optimize system performance. TSMO programs incorporate skills and capabilities of project delivery with effective systems management, traffic operations, technological innovations, and other activities that improve travel safety and reliability, enhance traveler information and user experience, and maximize the agency’s return on capital investments. As a result, TSMO program planning helps the agency develop a common vision, organize and prioritize TSMO activities, and create a structure for advancing TSMO effectiveness.
- **MPOs** – As planning agencies, MPOs typically do not manage or operate the transportation system. However, they play a critical role in planning for investments, facilitating regional coordination and collaboration, and providing direction and focus on common goals. Consequently, an MPO-led TSMO program at a regional level can address the organizational issues and structure for ensuring a focus on TSMO within the region, and establish priorities that can feed into the metropolitan transportation plan (MTP) and transportation improvement program (TIP).
- **Local/regional operations organizations, including transit agencies** – Some areas have regional operations organizations, which are structured specifically to support communication and collaboration among transportation agencies for effective TSMO, such as by coordinating construction management, incident management, emergency management, and traveler information services. Transit agencies also operate services and may benefit by conducting TSMO program planning to define the strategic vision and goals for the organization, institutional structures, and priorities. In addition, local jurisdictions often work together to implement traffic signal coordination programs and other TSMO initiatives, and often are key stakeholders within a State or regional TSMO program planning effort.

This document acknowledges that the roles different types of organizations play in TSMO vary, and no single approach to TSMO program planning or a TSMO program plan is appropriate for every organization. Moreover, organizations operate in a wide array of contexts in terms of agency size and staffing, transportation challenges being faced (e.g., levels of traffic congestion, road weather conditions, multimodal options, rural/urban conditions), level of sophistication with TSMO, and existing organizational structure around TSMO.

How to Use the Primer?

This primer introduces the concept of TSMO program planning. However, the primer is not a “cookbook,” or a step-by-step set of directions to be implemented sequentially. It identifies a high-level approach for TSMO program planning within transportation agencies and is organized around key elements of this TSMO program planning model.

Users are encouraged to view the primer as a general approach, which can be adapted to specific circumstances and issues within the organization or region. The primer also provides examples of effective practices. It is organized into the following sections:

- **Introduction to TSMO Program Planning (Section 1):** Provides an introduction to the primer topic, purpose, and organization.
- **The Rationale for TSMO Program Planning (Section 2):** Highlights why TSMO program planning is important for advancing TSMO within an organization and how a TSMO program plan benefits transportation agencies.
- **The Evolution and Current Practice of TSMO Program Planning (Section 3):** Provides background on the origins of TSMO program planning, early efforts to define a framework for TSMO program planning, and how the approach described in this document builds on best practices.
- **Key Elements of TSMO Program Planning (Section 4):** Identifies and describes three key elements of TSMO program planning – strategic, programmatic, and tactical – and how activities associated with these elements can be documented within a TSMO program plan.
- **Strategic Elements: Setting Clear Direction and Common Understanding (Section 5):** Describes the early, foundational component of TSMO program planning, including the identification of TSMO as a key part of the agency mission or regional vision, and development of strategic goals and objectives. *This section may be particularly helpful for agencies without a formal TSMO program or those with a need to elevate the understanding of TSMO within the organization.*
- **Programmatic Elements: Organizing, Staffing, and Developing Processes to Advance TSMO (Section 6):** Describes the core programmatic component of TSMO program planning associated with creating the organizational and process structure for institutionalizing TSMO with an agency. *This section may be particularly useful for agencies that have already defined strategic goals and objectives for TSMO but need to focus on program structure, workforce development, and staff and financial planning.*
- **Tactical Elements: Identifying Priority Services, Activities, and Projects (Section 7):** Describes the final component of TSMO program planning, where priority services and programs are defined more specifically, and a near-term action plan for implementation is developed. This section helps agencies that already have defined the programmatic structure for their TSMO program and are ready to define more specific services, activities, and projects for implementation.
- **Guiding Principles to Advance TSMO Program Planning for Your Organization (Section 8):** Identifies guiding principles for any agency to keep in focus in developing a TSMO program plan.
- **Resources (Section 9):** Lists resources available for supporting TSMO program planning, and sample statewide and regional TSMO program plans.



Throughout, the document asks prompting questions to help agencies and organizations evaluate their current status and guide development of a program plan that meets users' needs. These questions are called out from the text with the graphic (at left).

Chapter 2. The Rationale for Transportation Systems Management and Operations Program Planning

While State, local, and regional agencies address transportation systems management and operations (TSMO) in a variety of ways, in many cases, TSMO has not been identified as a primary focus within an organization. Even in cases where TSMO has been elevated as a priority for an agency, it has often been acknowledged strategically (e.g., incorporated into goals) or in terms of specific needs, investments, or activities, but has not been mainstreamed into the agency's organizational responsibilities and business processes.

As noted in a series of white papers on “Improving Transportation System Management and Operations,” research conducted through the Second Strategic Highway Research (SHRP2) Program determined that agencies with the most effective TSMO activities were differentiated not by budgets or technical skills alone, but by the existence of critical processes and institutional arrangements focused on TSMO applications. The significance of this finding was validated in over 40 State and regional self-assessment workshops.¹

These assessments found that few States or regions had developed plans that describe TSMO activities comprehensively. While many States have plans for specific TSMO services, projects, and activities, such as ITS plans, traffic incident management plans, emergency response plans, or special event plans, these plans do not describe the role of TSMO in support of the agency's mission and do not address all TSMO functions. TSMO planning and budgeting have been largely limited to specific projects or initiatives, and initiatives have been limited based on available funding and program status.

Agencies with the most effective TSMO activities were differentiated not by budgets or technical skills alone, but through the existence of critical processes and institutional arrangements focused on TSMO applications.

Although some agencies have begun to elevate operations objectives, the business case for TSMO is not widely understood at the State or regional level. At the same time, emerging technology applications and approaches, such as integrated corridor management (ICM), active transportation and demand management (ATDM), and connected vehicles, highlight the need and value of a systematic approach to TSMO planning. Consequently, many of the action plans coming out of the SHRP2 self-assessment efforts identified the development of a TSMO program plan as a key action to guide organizations in advancing the institutional focus on TSMO.

¹ For information on the white papers, see Federal Highway Administration, “Organizing for Operations” web page at: https://ops.fhwa.dot.gov/plan4ops/focus_areas/organizing_for_op.htm.

TSMO operations program plan lays out the important role of TSMO in the agency. It describes what the TSMO program seeks to accomplish, including strategic goals, objectives, and focus areas. As importantly, it describes how the organization is structured and how work is accomplished toward those objectives, who is involved and their roles; and what resources are needed and will be deployed. It may also include identification of investment priorities to support desired performance outcomes.

A TSMO program planning process guides development of the structure, resources, business processes, and decision support systems needed to deliver the strategic vision for TSMO. Although a TSMO program plan is not required by Federal law, State and regional transportation agencies benefit from developing TSMO program plans to better mainstream TSMO within their agencies and to set priorities for activities and investments. Moreover, the TSMO program plan defines the programmatic structure for organizing activities, functions, and the workforce to accomplish the goals and objectives of the TSMO program.

A TSMO program plan, and the process of TSMO program planning, helps agencies in many ways, as described below.

Creating a Transportation Systems Management and Operations Mission

TSMO program planning can play a vital role in creating a TSMO mission within an agency by clearly articulating how TSMO supports the state or regional vision and the agency's core purpose. Specifically, a TSMO program plan:

- Articulates the benefits of TSMO across the organization (or “business case”), including to departments not directly involved in operations, to help facilitate culture change and increase support.
- Describes the importance of TSMO to the organization's mission, and clarifies the linkages between TSMO activities and goals and objectives found in the long-range statewide transportation plan (LRSTP) or metropolitan transportation plan (MTP).
- Describes the connections between TSMO activities and other agency plans (e.g., asset management plan, strategic highway safety plan, etc.), as well as agency processes, such as the congestion management process, ITS architecture, and regional concept for transportation operations.
- Defines strategic goals and objectives.

Similar to developing a Strategic Highway Safety Plan (SHSP), which brings together the wide range of stakeholders involved in traffic safety across functional areas of the State department of transportation (DOT) and external partners (e.g., law enforcement, emergency management, and local governments), a State or regional TSMO program plan helps to focus agencies, their partners, and other stakeholders on strategies to improve transportation system performance, including mobility, reliability, and travel choices. As a result, the culture of the agency becomes more focused on TSMO, and TSMO considerations are integrated into all aspects of the agency, including long-range planning, specialized planning (e.g., freight planning, corridor planning), programming, project development and design, asset management, as well other program areas (e.g., safety, environment).

Sustaining and Institutionalizing the Transportation Systems Management and Operations Mission

By formalizing a TSMO program plan, the organization helps ensure that initiatives are not simply reactive or subject to leadership changes but are institutionalized. A TSMO program plan:

- Identifies how TSMO responsibilities are integrated into the responsibilities of key organizational units, outlines interactions with stakeholders, and establishes mechanisms for setting priorities.
- Provides an explanation of roles, responsibilities, and business capabilities for advancing TSMO within the organization or geographic area, and can support consideration of organizational changes that are needed to most effectively undertake TSMO functions.
- Supports organizational decision-making and prioritization of investments and actions.
- Identifies staffing expertise and workforce development needs for advancing TSMO practices.
- Creates a consistent and common understanding and approach for coordinating TSMO program planning across partner agencies (including with local jurisdictions, transit agencies, and other partners involved in operations).

TSMO program planning is an active business administration and program management activity that is likely to be particularly vital during periods of rapid change caused by changes in leadership, expansion or contraction of available fiscal or human resources, staff turnover, changes in technology, or changes in programmatic emphasis (e.g., Towards Zero Deaths, transportation system resiliency, sustainability). A TSMO program plan provides an agency with a well-defined organizational structure and series of processes and procedures to sustain the TSMO mission.

Supporting Effective Program Delivery

TSMO program planning not only creates and sustains a TSMO mission within the agency but also helps to ensure effective delivery of TSMO program services by identifying the financial and staff resources needed and developing procedures for prioritizing TSMO investment needs. Specifically, TSMO program planning:

- Includes discussion of tactical considerations associated with implementation of the plan, including identification of funding needs and sources, deployment activities, and responsible parties.
- Identifies program and project priorities, often including investment needs in relation to technology deployment, program implementation, and maintenance.
- Identifies performance measures for tracking ongoing progress toward strategic goals and objectives, as well as mechanisms for reporting on performance outcomes.

Moreover, with the rapid advances in technology that are taking place in the transportation industry, including connected and autonomous vehicles, new shared mobility options, and opportunities to more actively manage travel demand, TSMO program planning helps an agency to look beyond “today” to position for what is coming in the near future. It helps the organization to consider how system management and operations functions, roles, and needs are changing and better prepare to integrate new data sources, technologies, and approaches into the agency’s investments and programs.

Responding to Unique Needs and Issues

There is no one-size-fits-all structure of a TSMO program plan, and a TSMO program plan may look different for a State DOT or MPO or other organization.

- For a State DOT, a TSMO program plan can help the agency to assess challenges it experiences in managing and operating the State’s transportation system and define the organizational structure, workforce needs, partnerships, and strategies needed to deliver an effective TSMO program.
- Given the role of an MPO as a planning agency, the mission for a TSMO program at an MPO may focus on regional coordination and collaboration and prioritization of TSMO investments and services in plans and programs, rather than on service delivery. An MPO can develop a TSMO program plan as part of (or in coordination with) the congestion management plan (CMP) to create a common vision and organizational structure for advancing TSMO within the region.
- A TSMO program plan could also be developed by a local DOT or other organization, such as a transit agency or regional operations organization, to help guide activities, investments, and responsibilities.

The process of and outcomes associated with developing a TSMO program plan help support the organization to better meet its customers’ needs. A TSMO program plan provides the structure by which the organization coordinates to deliver enhanced system performance as a part of its mission. It serves as a business plan for TSMO activities, supporting organizational decisions and processes needed to proactively manage a safe, efficient, and reliable transportation system. As a result, TSMO program planning is a vital component of integrating TSMO into the culture of a transportation agency.

Chapter 3. The Evolution and Current Practice of Transportation Systems Management and Operations Program Planning

Over the past decade, the transportation community has advanced different approaches to organizing for and creating a program structure for transportation systems management and operations (TSMO). The Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials, and the Transportation Research Board have developed several TSMO resources designed for metropolitan planning organizations (MPOs) and State departments of transportation (DOT), including guidebooks and reference manuals to share best practices. Through these various efforts, the state of the practice has evolved significantly and provides a context for the key elements of the approach to TSMO program planning identified in this primer.

Strategic Highway Research Program 2: Reliability Research and Self-Assessment Workshops

Research conducted under the second Strategic Highway Research Program (SHRP2) in the Reliability focus area played a pivotal role in the concept of TSMO program planning by examining both technical and organizational support needed to enhance highway operations and travel time reliability at State DOTs and MPOs. The research developed a capability maturity model (CMM) consisting of six key dimensions to help transportation agencies improve the effectiveness of their TSMO activities (Figure 1).

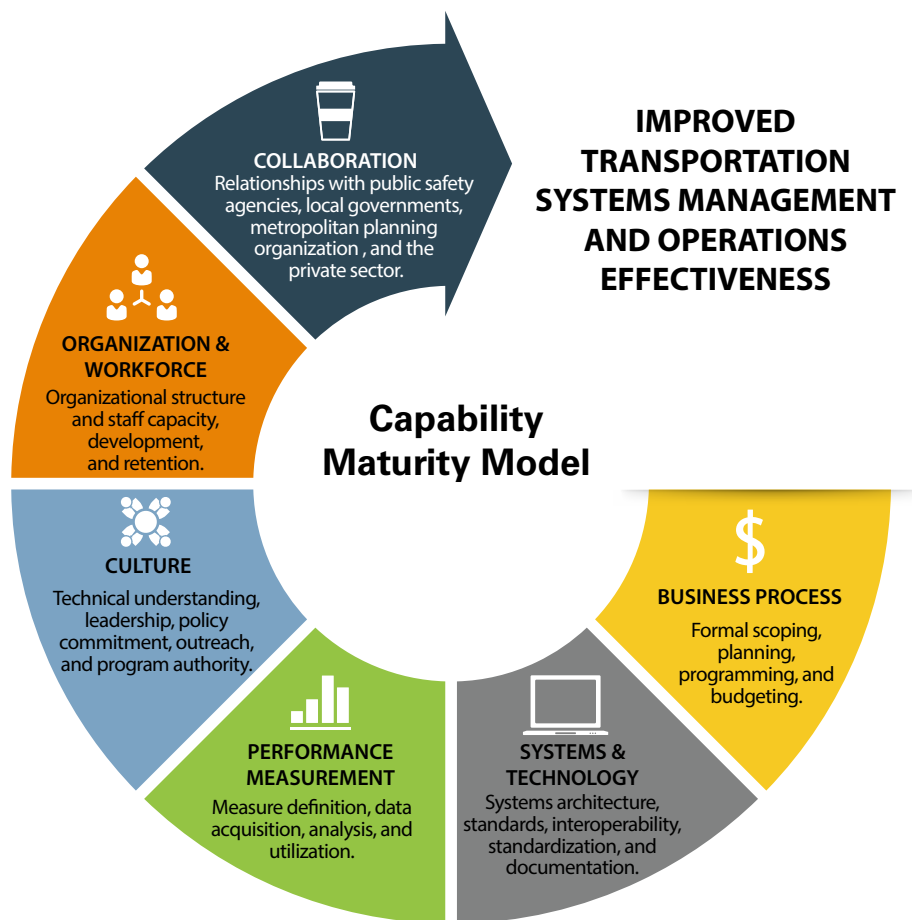


Figure 1. Diagram. Capability maturity model for improved transportation systems management and operations effectiveness.

The CMM is used as part of an assessment process by a transportation agency. This capability improvement process begins with a self-evaluation of the agency's current level of capability in the key dimensions, and provides strategies and actions to reach a higher level of capability.

Building on this effort, the FHWA document *Creating an Effective Program to Advance Transportation System Management and Operations Primer* (January 2012) provided high-level guidance focused on key program, process, and organizational capabilities that are essential to the development of more effective TSMO strategy applications. As shown in Figure 2 below, reaching full TSMO program potential requires that business and technical processes as well as supporting institutional arrangements be put in place and managed.

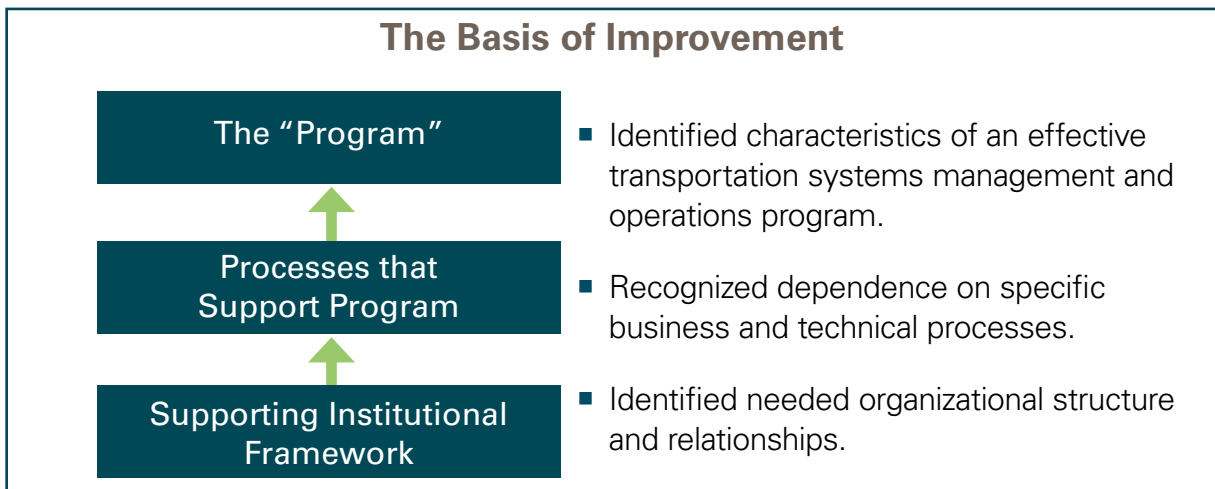


Figure 2. Diagram. Relationship among program, processes, and the institutional framework.²

Through the SHRP2 program and with support from FHWA, over 40 States and regions have conducted CMM self-assessment workshops focused on TSMO using the six dimensions of organizational capabilities. As a part of their resulting Action Plans, many have identified the value of developing a structured TSMO program plan to further advance their TSMO programs.

National Cooperative Highway Research Program Project 20-07/345 Program Planning and Development for Transportation Systems Management and Operations in State Departments of Transportation

The National Cooperative Highway Research Program (NCHRP) *Project 20-07/345: Program Planning for Transportation System Management and Operations in State Departments of Transportation* (June 2014) set out to explore the state of the practice in TSMO program planning and to begin defining alternative approaches to develop and administer a TSMO program plan. Based on an extensive scan of documents, including TSMO-related plans developed by several State DOTs and MPOs, interviews with key personnel, and a workshop with State and regional practitioners, it recommended five interrelated elements for consideration in TSMO program planning (See Table 1).

² Federal Highway Administration, *Creating an Effective Program to Advance Transportation System Management and Operations Primer*, FHWA-HOP-12-003 (Washington, DC: January 2012). Available at: <https://ops.fhwa.dot.gov/publications/fhwahop12003/>.

Table 1. Elements of transportation systems management and operations program planning and development for State departments of transportation.

Component	Description
1. Mission, Vision, Goals, Objectives, and Performance Measures	The program plan is based on a clear understanding of what the department or agency seeks to accomplish. Transportation systems management and operations (TSMO) goals and objectives and performance measures are visibly aligned with the department's mission and vision. The lead TSMO unit has a clear mission, vision, etc. The department of transportation (DOT) promotes a shared, statewide vision among all TSMO stakeholders.
2. Leadership and Organization	Leadership and organizational responsibilities and corresponding authority are well defined, and the program plan addresses topics such as department-wide integration of TSMO, responsibilities of key organizational units, interaction with external stakeholders, and mechanisms for setting priorities and making other leadership decisions.
3. Business Processes	The program plan identifies the most important business processes for TSMO success, evaluates each of those processes, and proposes improvements to help ensure TSMO success. Some of the processes are departmental and need to be adapted or have new variations added. In addition some entirely new processes may be needed to support TSMO.
4. Resources (Financial, Human, Infrastructure, and Technology)	The available and needed resources are systematically evaluated for all aspects of the TSMO program. Constraints on those resources and the implications for the TSMO program are examined, and the program plan includes strategies to improve both the availability and effective use of key resources.
5. Packages of Services, Projects, and Activities with Related Policies and Guidelines	The program plan broadly identifies the packages of TSMO services, projects, and activities that are most effective in accomplishing the DOT's mission, vision, goals, and objectives. The program plan enumerates policies and decision-making guidelines for implementation of services, projects, and activities (e.g., warrants, priorities, service levels).

Source: M.E. Baird, Ph.D., P.E. and P. Noyes, *National Cooperative Highway Research Program Project Number 20-07/345: Program Planning and Development for Transportation System Management and Operations (TSM&O) in State Departments of Transportation*, National Cooperative Highway Research Program (Washington, DC: NCHRP 2014). Available at: [http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07\(345\)_FR.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(345)_FR.pdf).

National Cooperative Highway Research Program Project 20-07/365: Transportation Systems Management and Operations Program Planning – Experiences from the Second Strategic Highway Research Program Implementation Assistance Program

Most recently, building on the earlier NCHRP study, the NCHRP Project 20-07/365, *Transportation System Management and Operations Program Planning – Experiences from the SHRP2 Implementation Assistance Program* (July 2016), documented the experiences, lessons learned, challenges, and best practices in TSMO program planning. This study involved a national survey of transportation agencies and held a workshop of leaders from State DOTs and MPOs in February 2016 to evaluate and validate program planning frameworks from the NCHRP 20-07/345 and CMM efforts. The result was a unified TSMO program planning framework, as shown in Table 2.

Table 2. Unified transportation systems management and operations program planning framework from NCHRP 20-07/365.

Unified, Agreed-Upon Framework at the End of the Workshop	
A.	Mission, Vision, Goals, and Objectives.
B.	Performance Measurement.
C.	Leadership, Organization, and Staffing.
D.	Business Processes and Planning.
E.	Resource Positioning and Development.
F.	Services and Projects.
G.	Roles and Responsibilities.
H.	Evaluation and Reassessment.

Source: NCHRP, *Transportation Systems Management and Operations Program Planning – Experiences from the SHRP 2 Implementation Assistance Program*, NCHRP 20-07 TASK 365 Final Report. Available at: [http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07\(365\)_FR.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(365)_FR.pdf).

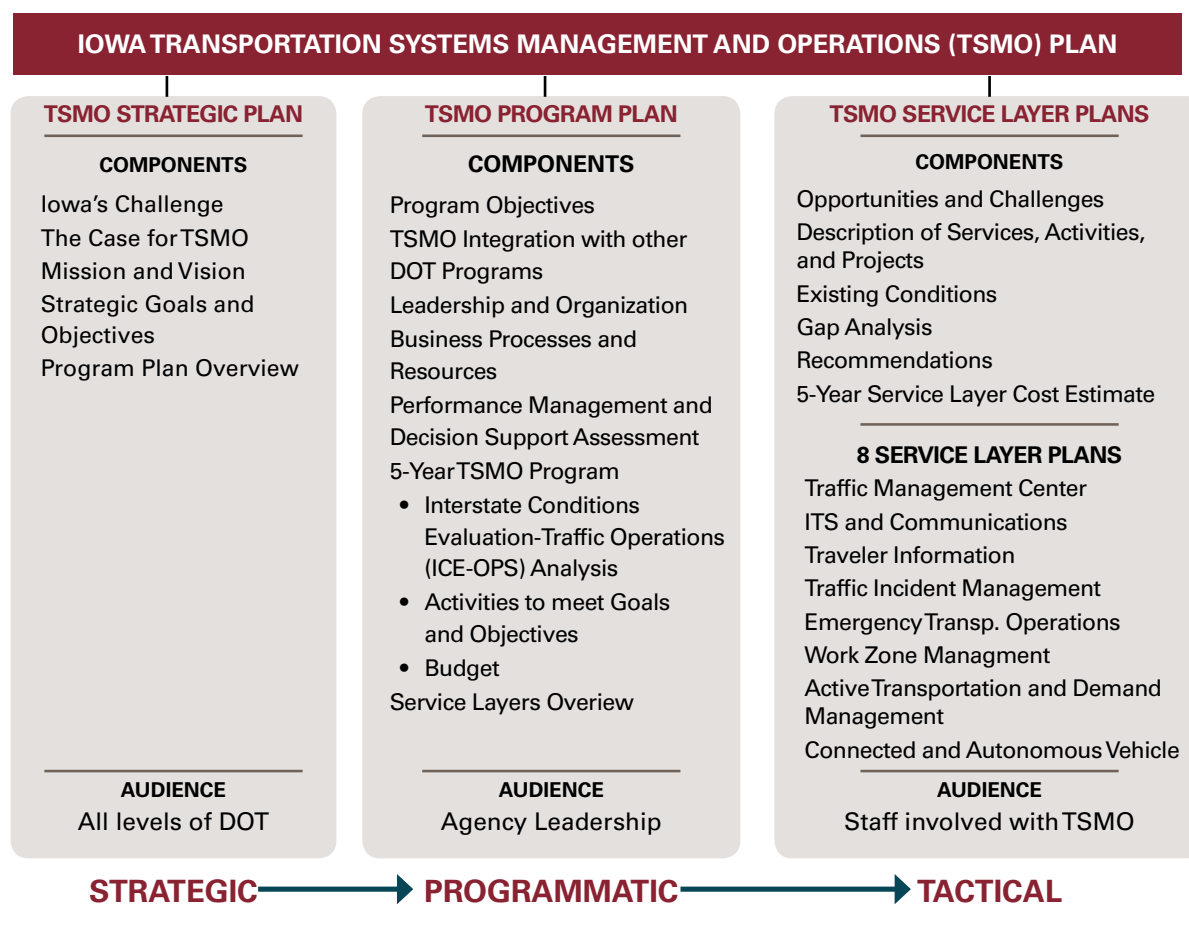
Leading State and Metropolitan Planning Organization Efforts

Meanwhile, over the past several years, a number of States and MPOs have undertaken efforts to develop TSMO program plans, which provide good examples of effective and emerging practices. For instance, Virginia DOT developed a statewide operations program plan using the TSMO capability improvement approach based on the six dimensions and levels of capability. Similarly, Tennessee DOT developed a TSMO program plan building off of the SHRP2 CMM self-assessment. Some agencies have developed TSMO strategic plans, such as Florida DOT, which developed the Florida TSMO Strategic Plan, completed in 2013, laying out key goals and objectives for its TSMO Program.

At the regional level, MPOs such as Metro in Portland, Oregon, the Delaware Valley Regional Planning Commission (DVRPC) in Philadelphia, and the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in Milwaukee, Wisconsin, developed regional TSMO plans. These plans generally identify key TSMO goals and objectives as well as program and project investment priorities for funding.

One notable example of a TSMO program plan, which provides a critical basis for recommendations in this primer, is the plan developed by Iowa DOT in 2015-16. Iowa DOT developed a three-layer TSMO plan (as shown in Figure 3) to improve the capability of the agency to manage the State's transportation system. The three major components of the Iowa TSMO planning effort reflect a tiered approach and include three sets of planning documents:

1. The Iowa TSMO Strategic Plan, which identifies why TSMO matters, the challenges of congestion, the business case for TSMO, and a TSMO vision, mission, and strategic goals and objectives.
2. The Iowa TSMO Program Plan, which incorporates the Strategic Plan but expands it to focus on program development within Iowa DOT, including leadership, organization, business processes, performance management, and resources.
3. TSMO service layer plans that describe in more detail eight specific TSMO areas and the associated services, activities, and projects to be undertaken by the agency.



Note: DOT = department of transportation. ITS = intelligent transportation systems.

Figure 3. Diagram. Structure for the Iowa transportation systems management and operations plan.³

³ Iowa Department of Transportation, *Iowa Transportation Systems Management and Operations Program Plan*, February 2016. Available at: <http://www.iowadot.gov/TSMO/TSMO-Program-Plan.pdf>.

Development of this Primer

This primer builds upon the NCHRP 20-07/345 and NCHRP 20-07/365 resource documents, as well as lessons from effective State and MPO practices. It also draws from input gathered through a workshop of representatives from several leading State DOTs, MPOs, and a regional operations organization, convened by FHWA in April 2016 to identify key elements of an effective TSMO program planning process.

Specifically, the primer is designed as a practical, user-friendly resource to help State DOTs, MPOs, and other organizations understand the benefits of and effective practices associated with TSMO program planning. It takes the research-based information from the national survey and unified TSMO program planning framework discussed in the NCHRP 20-07/365 report and organizes the components into three key elements of TSMO program planning: strategic, programmatic, and tactical. The Iowa TSMO Plan, with its three levels of TSMO documents—a strategic plan, program plan, and service layer plans—provided a strong basis for the program planning approach discussed in this document. The validity and applicability of this approach was verified through discussions with leading State DOTs and MPOs, who helped to shape the content into this primer. In addition, the primer provides examples to help agencies advance their practices, and includes questions for consideration to prompt thinking concerning issues to assist agencies in advancing their program planning efforts.

Chapter 4. The Key Elements of Transportation Systems Management and Operations Program Planning

Transportation systems management and operations (TSMO) program planning should reflect the roles and responsibilities of the organization undertaking the development of the program. Typically, TSMO program planning should be an iterative process within the context of other agency plans and initiatives and should reflect relationships with TSMO partners and stakeholders. No single set of instructions for each step in a program planning process addresses the variations in responsibilities among State departments of transportation (DOT), metropolitan planning organizations (MPO), regional coalitions, or other organizations. However, several key considerations and principles should be addressed by all agencies undertaking TSMO program planning to ensure that the program and resulting plan are comprehensive.

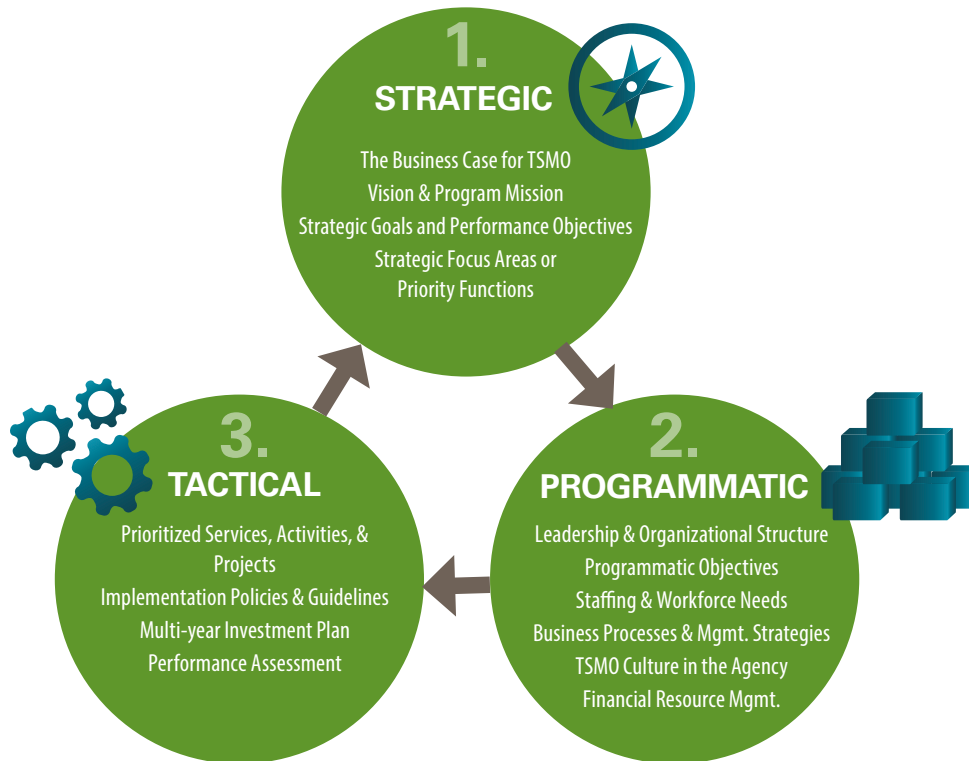
A robust TSMO program plan supports a sustainable and responsive program that reflects the vision and mission of the organization and responds to changing demographics, technology, and external pressures. The resulting TSMO program plan itself provides an opportunity to document and formalize programmatic policies, procedures, and structures to guide an effective and sustainable program.

Three Key Elements: Strategic, Programmatic, and Tactical

A model approach for TSMO program planning includes three key elements, as shown in Figure 4:

1. **Strategic elements:** Strategic thinking is a foundation for developing a TSMO program and involves clearly defining the relationship of TSMO to the agency mission or regional vision. The strategic aspect of TSMO program planning provides answers to questions of “why” TSMO is important, and a high-level vision of “what” the agency seeks to achieve, along with strategic goals and objectives.
2. **Programmatic elements:** The programmatic elements of TSMO program planning addresses issues surrounding organizational structure and business processes for implementing TSMO activities. This level of planning addresses “how” the program operates, resource and workforce needs, and internal and external coordination and collaboration. It identifies responsibilities of organizational units for specific TSMO services, projects, and activities, as well as use of analysis tools to guide investment decision-making.
3. **Tactical elements:** The tactical elements step down from the broad institutional and organizational issues to address specific services, programs, and priorities.

TSMO program planning is an *ongoing, iterative process*, connected to other plans and initiatives of the organization and stakeholders. As a result, monitoring and evaluation is an important part of the process to provide feedback on whether goals and objectives are being achieved and whether strategies are being implemented. Monitoring and evaluation informs subsequent TSMO planning by identifying opportunities for improving the process and affirming successful approaches. Consequently, while the product of TSMO program planning is a TSMO program plan, the process should continue on a regular cycle to sustain and evolve the program and its role within the organization over time.



Note: TSMO = transportation systems management and operations.

Figure 4. Diagram. Building and sustaining a transportation systems management and operations mission: three elements of program planning.




Many agencies currently engaged in TSMO planning focus on the first and third components, with less consideration of the programmatic structure needed to translate the strategic vision into delivery of projects and services. Establishing an effective TSMO program requires that the programmatic component involving organizational structure, resources, processes, and business functions needed to deliver the vision be addressed. The programmatic component plays a critical role in integrating TSMO into the culture of the agency and its structure. In this component, the agency and partners identify the organizational structure for the program, including roles, responsibilities, and relationships with other core business functions of the agency.

Note that some issues, such as performance management and financial planning, occur across all components, but with a different focus, as shown in Table 3. For instance, in strategic planning, the organization defines performance objectives to address strategic goals focused on outcomes for the

transportation system and system users (e.g., congestion, reliability, access to traveler information). In the programmatic component, the organization defines programmatic objectives and performance measures focused on internal processes and activities. In the tactical component, program monitoring and performance evaluation efforts help inform specific actions and deployments. Monitoring and evaluating outcomes serves as the feedback loop for all elements by informing participating organizations and agencies about how well strategic goals and objectives, as well as programmatic objectives, are achieved.

Similarly, there are financial considerations for each aspect of TSMO planning. The strategic element sets agency priorities relative to the financial resources and constraints of the organization and its partners. The programmatic element addresses staffing and resource needs to support the TSMO program and procedures for ensuring sustainable funding. The tactical element may connect specific services, activities, or projects with identified funding sources.

Table 3. Aspects of performance management and financial management across all elements.

Element of TSMO Program Planning	Performance Management	Financial Management
<p>STRATEGIC</p> 	<ul style="list-style-type: none"> ▪ Strategic goals and performance objectives. ▪ Uses measures focused on outcomes for system users (e.g., congestion, reliability, access to information). 	<ul style="list-style-type: none"> ▪ Considers financial resources in developing the strategy and performance objectives.
<p>PROGRAMMATIC</p> 	<ul style="list-style-type: none"> ▪ Programmatic objectives. ▪ Uses measures focused on internal processes and activities (e.g., development of plans, analytical tools, data collection). 	<ul style="list-style-type: none"> ▪ Identifies staffing and resources needed for the TSMO program. ▪ Identifies sustainable funding sources or approaches for the TSMO program, including public and private sector sources, innovative finance mechanisms, and partnerships.
<p>TACTICAL</p> 	<ul style="list-style-type: none"> ▪ On-going program monitoring and evaluation to assess performance in relation to strategic and programmatic objectives. ▪ Uses data to inform specific actions and deployments. 	<ul style="list-style-type: none"> ▪ Develops near-term (e.g., 5-year) investment plan, including specific actions or projects, along with funding sources.

Note: TSMO = transportation systems management and operations.

Most agencies do not start from scratch in TSMO program planning. An organization may already have defined strategic goals and objectives, and may need to focus attention on the programmatic or tactical aspects. Another organization may be executing TSMO projects and activities but not have clearly defined overall goals and performance targets for its agency and the transportation system to guide its efforts. Not every agency or organization will include every item associated with each of the three components. However, agencies should explore the issues identified in this primer and consider how they should be addressed in their TSMO program planning efforts. The process of examining the elements and how they may support and advance the TSMO program is important in developing a mature, comprehensive program.

Making the Key Elements Work Together: The Resulting Transportation Systems Management and Operations Program Plan

Ultimately, a TSMO program plan is an important document (or set of documents) that results from the program planning effort and serves as a guidepost for TSMO in the organization. The TSMO program plan identifies and incorporates the three key elements of program planning: strategic goals and objectives, programmatic structure, and key tactics, programs, or priorities.

This three-tiered document approach has been applied in States like Iowa, with its three TSMO planning documents. In some States and regions, the strategic elements of program planning may already be documented in a TSMO strategic plan, agency business plan, or even long-range transportation plan. The approach to TSMO program planning presented in this primer, however, emphasizes that to mature their implementation of TSMO, agencies should also focus on the programmatic aspects of organizational structure, staffing, and business processes for TSMO in their agencies and among partners, and the tactical aspects of defining priority services, activities, and projects. They also should document this information in a TSMO program plan to sustain and institutionalize the TSMO mission.

Below is a sample table of contents for a TSMO program plan. It is intended to illustrate how a TSMO program plan may be structured, demonstrating the integration of the three key elements of TSMO program planning into the program plan document itself. For instance, the document ideally should start with a discussion of the purpose of the TSMO program plan, the business case for TSMO, the relationship of TSMO to the agency's vision and mission, and strategic goals and objectives (strategic elements). The document then should contain a section or sections addressing program objectives, the organizational structure for implementation, business processes, resources, and communications (programmatic elements). Finally, the TSMO program plan should contain a

The transportation systems management and operations (TSMO) program plan could be a single document, or may be in the form of a series of products that work together, such as:

- A TSMO strategy document or strategic plan.
 - A document laying out the programmatic structure of TSMO within the agency.
 - One or more TSMO service deployment plans.
-

section or refer to supporting documents that discuss TSMO services, projects, and activities, implementation policies, and priorities. The sample table of contents references relevant sections of this primer that contain helpful information.

The following sections of the primer describe each of the three key elements of TSMO program planning—strategic, programmatic, and tactical—and key considerations for each component.



1. Strategic Foundations – See Chapter 5 on Strategic Elements

- a. Why Transportation Systems Management and Operations (TSMO) Matters
- b. TSMO Plan Purpose
- c. TSMO Vision and Mission
- d. Strategic Goals and Objectives



2. The TSMO Program – See Chapter 6 on Programmatic Elements

- a. TSMO Program Objectives
- b. Organizational Structure
 - i. Program Structure
 - ii. Inter- and Intra-agency Integration
- c. Business Processes
 - i. Budgeting and Accounting
 - ii. Procurement and Contract Management
 - iii. Administrative Processes
 - iv. Quality Management and Continuous Improvement
 - v. Systems Engineering
 - vi. Performance Management, including Data Management and Decision Support
- d. Resources
 - i. Staffing and Workforce Development
 - ii. Resource Inventories and Asset Management
 - iii. Financial
 - iv. Research and Development
- e. Communication and Collaboration
 - i. Internal Collaboration
 - ii. Collaboration with External Partners
 - iii. Communications, Marketing, and Outreach with Users



3. Implementation and Deployment – See Chapter 7 on Tactical Elements

- a. TSMO Services, Projects, and Activities
- b. Annualized Actions and Deployment
- c. Implementation Policies and Guidelines
- d. Performance Assessment

Figure 5. Illustration. Sample table of contents for a transportation systems management and operations program plan and references to primer.



Chapter 5. Strategic Elements: Setting Clear Direction and Common Understanding

The strategic component of transportation systems management and operations (TSMO) program planning provides a clear, common understanding of what the agency is trying to accomplish and how TSMO fits within its mission. It answers questions of “why” TSMO is important, provides a high-level vision of “what” the agency seeks to achieve, and makes the case for TSMO. It includes some assessment of current conditions and future challenges and identifies high-level strategic goals and objectives, or focus areas for the TSMO program.

A State department of transportation (DOT) or operations organization should identify and explain how TSMO aligns with the department’s mission, goals, and objectives and the specific challenges that TSMO can address. A metropolitan planning organization (MPO) may not have direct responsibility for operational programs (e.g., incident management, road weather management), but may define the mission for TSMO in relation to the region’s vision and goals for enhancing system performance in areas such as mobility, reliability, and safety.

Transportation systems management and operations (TSMO) program planning starts with defining a high-level strategic business case for TSMO and clearly defining TSMO as a core part of the agency’s mission and vision. It involves development of strategic goals and objectives for TSMO within the organization.

Developing the Business Case for Transportation Systems Management and Operations

While operations staff and practitioners who work within the field understand the role of TSMO strategies in contributing to mobility and safety of the transportation system, they and others need to understand the business case for integrating TSMO into the core mission of a DOT and the role TSMO can play in the region. Agencies can draw upon the *Business Case Primer: Communicating the Value of Transportation Systems Management and Operations*,⁴ which was developed under the second Strategic Highway Research Program (SHRP2) Program. The business case should address:

- Internal motivation – *Why is TSMO important for the agency?* There are many possible answers to this question, including the inability to build our way out of congestion, using more cost-effective and faster solutions, and improving agency stewardship of resources.
- The value to customers – *Why is TSMO important to the traveling public and communities?* Again, there are many answers to this question, but these are generally the most important and compelling issues for a transportation agency as a customer-oriented organization. TSMO strategies address the most significant causes of congestion and reliability issues, support efficient goods movement that is vital to the economy, and support safety as well.

⁴ J. D’Ignazio and B. Bowen, *Business Case Primer: Communicating the Value of Transportation Systems Management and Operations*, (TRB: December 2014). Available at: <http://www.transportationops.org/business-cases/business-case-primer-communicating-value-transportation-systems-management-and-operations>.

Given budget constraints that limit funding for major capital improvements, a case for TSMO can be made as TSMO strategies are more cost-effective than capital solutions. However, the argument for TSMO goes much beyond “it’s all we can afford,” to stress the critical role of system operations in achieving goals related to system reliability, mobility, and safety. TSMO is not simply an “option” or “alternative” to transportation system capacity; it is an inherent function of delivering mobility, safety, and reliability for the traveling public. Transportation agencies cannot simply provide transportation infrastructure and maintain it. They need to play a role in actively managing transportation services and system assets to get maximum performance from the investment.

In defining the business case, issues that can be brought into the discussion include:

- Challenges facing the region, which may include traffic congestion, incident-based delay, weather-based delay, and fatalities and injuries on the road.
- Information on the cost-effectiveness of TSMO strategies in relation to capacity expansion.
- Anticipated future issues, such as increased population, traffic growth, and increased freight movement.
- Opportunities for the future, such as leveraging of new sources of data and technologies, as well as multimodal connections.
- Comparisons showing the performance of similar facilities with and without TSMO treatments, or comparing before-and-after implementation of TSMO strategies.
- Experience in other States and regions, or industries.

Florida Department of Transportation (DOT) Transportation Systems Management and Operations (TSMO) Program: Business Case

Florida DOT developed a TSMO Strategic Plan, completed in 2013, which provides groundwork for the DOT’s TSMO program. The Strategic Plan describes Florida’s challenges, including population growth, traffic fatalities, and safety for older drivers in particular. It also describes the value of TSMO in terms of benefit-cost ratios of intelligent technologies, and the economic benefits associated with intelligent transportation systems and operations investments due to creation of technology sector jobs for engineers, electronics technicians, software developers, and system integrators.

Source: Florida DOT, *Florida Transportation Systems Management and Operations Strategic Plan*, December 13, 2013.

The business case for TSMO is the cornerstone for integrating and advancing a comprehensive TSMO program.

In developing the case for TSMO, it is important to consider national, State, and regional trends in economics, demographics, land use, and technology, as well as forecasts of transportation system outcomes related to mobility and safety. These influence current and future opportunities and needs for the transportation system.



Questions for Consideration

- What issues and trends are affecting the performance of our transportation system?
- What are our unique transportation needs and challenges?
- What opportunities does TSMO offer in addressing the challenges?
- Who are the users of our transportation system?
- What is most important to the system users?
- What is most important to our decision makers?
- What constraints must we work with to manage and operate the system effectively?

Developing a Transportation Systems Management and Operations Vision and Program Mission

In the strategic components of a TSMO program plan, the agency should include a high-level vision and mission for the TSMO program.

Depending on how the organization wishes to develop its TSMO program plan, this component may include:

- Identifying of a vision for TSMO within the State or region, describing the intended outcomes.
- Developing a description of the agency's mission and the role of TSMO in supporting that mission.
- Updating the mission or vision of the organization to align with TSMO.
- Developing a TSMO program-specific mission or vision.

Maryland Department of Transportation (DOT) State Highway Administration's (SHA) Transportation Systems Management and Operations (TSMO) Program Vision and Mission

In developing a TSMO program, Maryland DOT SHA clearly defined its TSMO program vision and mission, along with associated goals and objectives to support attainment of that vision.

TSMO Program Vision

Maximize mobility and reliable travel for people and goods within Maryland by efficient use of management and operations of transportation systems.

TSMO Program Mission

To establish and maintain a TSMO program and implement supporting projects within Maryland SHA improving mobility and reliability for all people and goods through operations of transportation facilities.

Source: Maryland DOT, *Maryland Transportation Systems Management and Operations Strategic Implementation Plan*, August 2016.

The vision provides a shared intention and direction for the organization's TSMO program and a focal point for agency or regional alignment. To be effective, the vision for TSMO should speak to high-level outcomes while reflecting the needs of the organization and its constituents and should be consistent with and support the organization's overall vision and mission. This component of planning may also identify core principles for how the transportation system should be operated.

The mission for a TSMO program defines the program's purpose. The mission may emphasize partners, stakeholders, and participants working together to leverage mutual interests, and advance TSMO through an environment of cooperation, coordination, and collaboration. The TSMO mission encourages all agencies and subunits involved to move toward a comprehensive and integrated approach to TSMO.

Given the cultural challenges in many transportation agencies that historically have focused on and been organized around project development and design, an effective approach is to conduct a deliberate crosswalk between the agency's overall mission and goals and TSMO. At the strategic level, an organized effort to change the culture of the organization to focus on TSMO as part of its core mission and to integrate operations considerations within all activities often is an important component of this level of TSMO program planning. Leadership at a senior management level can play a key role in advancing this outcome. Leadership and organizational culture are discussed further as part of the programmatic element of TSMO program planning.



Questions for Consideration

- How does TSMO support our agency mission?
- What makes TSMO activities important to our agency and our constituents?
- What opportunities and TSMO applications do we want to take into the future?
- What current practices or challenges do we want to overcome or leave behind?
- Who will gain the greatest benefits from TSMO and what are those benefits?

Developing Strategic Goals and Performance Objectives for Transportation Systems Management and Operations

Strategic goals and objectives for TSMO focus on the desired outcomes to be achieved through TSMO. While goals are high-level, objectives should be more specific and measurable to guide performance-based tracking and reporting of the TSMO program's ability to deliver the strategic goals. These goals and objectives generally focus on outcomes to the customer and may relate to specific aspects of TSMO. For instance:

- Effective management of congestion to reduce traveler delays.
- Seamless multimodal travel.
- Reliability and on-time performance.
- Comprehensive and accurate, available information about travel conditions.
- Effective winter weather management.

In developing performance objectives, it is useful to consider the concept of SMART objectives, or objectives which are:

- **S**pecific – Provide adequate details to guide the development of viable approaches to achieving the objective.
- **M**easurable – Allow for quantitative evaluation to track progress.
- **A**greed-Upon – Have consensus among planners, operators, and other key stakeholders.
- **R**ealistic – Address what can be reasonably accomplished, given resource constraints and other critical factors.
- **T**ime-bound – Establish a timeframe for achieving the objective.⁵

Performance measures that are used to track and assess progress toward desired outcomes should be associated with each objective.

Several steps are typically part of developing strategic goals and performance objectives:

1. **Build off of Agreed-upon State and Regional Planning Goals.** An important first step is to identify existing State and regional goals that relate to system management and performance. TSMO goals and objectives should align with and tie together with those that are used in a long-range statewide transportation plan (LRSTP) or metropolitan transportation plan (MTP). Ultimately, it is important to tie the TSMO program together with the overall strategic goals of the agency, State, or region.
2. **Gather Data and Understand Baseline Conditions.** An important step in the process of developing SMART objectives is to gather data to establish the baseline conditions for system performance as well as the performance of the TSMO program activities. First, the organization needs to understand how the transportation system is performing in order to develop performance objectives or targets. Next, it is useful to explore the reasons for performance deficiencies or gaps in order to develop objectives to address those issues. For instance, if reliability issues are caused due to weather conditions, incidents, and special events, strategic objectives may relate to improving performance across each of these areas.
3. **Collaborate Internally and Externally with Partner Agencies.** Gathering information internally and externally also is an important step in this process. For instance, an agency can conduct outreach to partners for input on goals and objectives; establish a working group internally or together with partner organizations to collaboratively define goals, objectives, and performance outcomes; and identify data available for the creation of performance measures.
4. **Define Performance Targets.** Finally, an agency can use the information on existing and forecast conditions, together with input from partners and stakeholders, to define specific desired performance outcomes or targets for the transportation system. Developing targets will require agencies to consider what kinds of data are available for tracking and to ensure that systems are in place to conduct ongoing monitoring.

⁵ Federal Highway Administration, *Advancing Metropolitan Planning for Operations: The Building Blocks of a Model Transportation Plan Incorporating Operations – A Desk Reference*, FHWA-HOP-10-027 (Washington, DC: April 2010). Available at: <https://ops.fhwa.dot.gov/publications/fhwahop10027/index.htm>.

Denver Regional Council of Governments Transportation System Management and Operations (TSMO) Goals, Objectives, and Performance Measures

While not part of a formal TSMO program plan, the Denver Regional Council of Governments identified strategic goals and associated performance objectives for TSMO when developing a regional concept of transportation operations. Three TSMO strategic goals were identified, along with objectives, which link to program initiatives and performance measures.

Objectives	Initiatives	Performance Measures
Goal 1: Provide reliable transportation operations for regional travelers		
<p><i>Daily Operations</i></p> <ul style="list-style-type: none"> • Increase trip travel time reliability on freeways and arterials for all modes • Reduce traveler stops and delay due to signal operations <p><i>Incident Management</i></p> <ul style="list-style-type: none"> • Reduce average incident duration time • Reduce the occurrence of secondary incidents 	<p><i>Daily Operations</i></p> <ul style="list-style-type: none"> • Continue to coordinate signal timing system management across jurisdictional boundaries • Continue to coordinate freeway management • Expand freeway management <p><i>Incident Management</i></p> <ul style="list-style-type: none"> • Establish regional incident management process <p><i>Work Zones and Special Conditions</i></p> <ul style="list-style-type: none"> • Improve work zone/special event management <p><i>Cross-cutting</i></p> <ul style="list-style-type: none"> • Coordinate/integrate multi-modal traveler information • Expand traffic monitoring capabilities and infrastructure • Establish shared monitoring between jurisdictions • Expand a shared communications network • Establish a shared data warehouse or data management process 	<ul style="list-style-type: none"> • Travel Time Index (TTI) • Planning Time Index (PTI) • Transit on-time reliability • Arterial Progression Index (API) • Average roadway clearance time • Average incident clearance time • Number of secondary incidents
Goal 2: Provide safe transportation operations for regional travelers and for public safety and construction/maintenance personnel		
<ul style="list-style-type: none"> • Reduce traffic injury rates • Reduce traffic fatality rates • Reduce public safety and construction/maintenance personnel injury/fatalities 	<ul style="list-style-type: none"> • Establish regional incident management process 	<ul style="list-style-type: none"> • Traffic fatality rates • Traffic injury rates • Number of personnel injuries/fatalities
Goal 3: Provide transportation operations support for non-auto modes of travel		
<ul style="list-style-type: none"> • Reduce single-occupant vehicle (SOV) mode share • Reduce per capita vehicle miles traveled (VMT) • Reduce per capita greenhouse gas emissions 	<ul style="list-style-type: none"> • Further coordinate/integrate multi-modal traveler information • Define criteria for operations improvements and monitoring for bicycle and pedestrians 	<ul style="list-style-type: none"> • SOV mode share • Annual per capita VMT • Annual per capita greenhouse gas emissions

Source: Denver Regional Council of Governments, *Regional Concept of Transportation Operations*, Adopted August 15, 2012. Available at: https://drcog.org/sites/drcog/files/resources/Regional%20Concept%20of%20Transportation%20Operations_2.pdf.

For examples of operations objectives that could be applied at a regional scale or on the State level, see the FHWA publication, *Advancing Metropolitan Planning for Operations: The Building Blocks of a Model Transportation Plan Incorporating Operations - A Desk Reference*.

? Questions for Consideration

- What goals will support our TSMO vision and program mission? What strategic objectives will help us move toward attainment of our goals?
- How do TSMO strategic goals and objectives align with and support the agency's goals?
- What data are available to track progress?

Identifying Strategic Focus Areas and Priority Functions

In addition to strategic goals, objectives, and performance measures, the TSMO program may identify strategic focus areas or priorities that are important for achieving the goals and objectives. These focus areas or priorities may be defined in different ways, based on the needs of the agency. For instance, they may identify:

- Geographic focus areas.
- Functional areas.
- Internal capabilities.

Geographic Focus Areas

An organization may identify geographic areas of focus for its TSMO program. For instance, some agencies have begun to identify the corridor level as a key focus within the organization for planning and system management. This corridor level focus can have important implications for how the TSMO program is structured and possibly even how the organization is structured to address corridor performance, which will form the basis for programmatic decisions. Another geographic area of focus could be to differentiate between urban areas and rural areas in terms of describing the needs, expectations, and issues surrounding system performance and how this relates to strategic goals and objectives. A third approach would be to conduct planning and implementation at the district or regional level within a State.

The California Department of Transportation (Caltrans) Focuses on Corridors

Caltrans recognizes that working with partners is vital to ensuring that the State's transportation system is contributing to an efficient and interconnected network. In its system planning, Caltrans has put significant emphasis on the corridor-level through development of Corridor System Management Plans because it recognizes that these plans are unique in their ability to analyze existing corridor conditions, to forecast corridor performance through scenario testing utilizing complex traffic simulation models on a corridor-wide scope, and to recommend consensus-driven long-range implementation strategies.

Source: Caltrans, Corridor System Management Plans: Findings and Recommendations, January 2013, available at: http://www.dot.ca.gov/hq/tp/offices/omsp/system_planning/documents/CSMP_Findings.pdf.

Functional Areas

Another way of looking at strategic focus areas is to identify key functions associated with TSMO that form the basis for the TSMO program. For instance, functions such as traveler information, incident management, work zone management, and demand management could be identified as strategic focus areas, and these functions relate to programmatic and organizational aspects as well as tactical deployment decisions.

Internal Capabilities

Finally, an agency could focus its strategic priorities on internal capabilities, such as data management and decision support. This type of priority ties directly to the programmatic elements of TSMO program planning (discussed in the next section). Identifying these capabilities as a priority may come out of an agency self-assessment in which gaps or weaknesses are identified in the capabilities of the organization to advance TSMO.

In laying out strategic priorities, it is important to be forward-looking, to be focused not just on the functions of the organization today, but on the technologies and issues of the future that will affect TSMO over the next 10 to 20 years. For instance, issues such as the impact that connected and autonomous vehicles will have on system management needs, the role of mobile apps, and the shifting role of the private sector in providing traveler information and transportation services should be considered.



Questions for Consideration

- What are the most important functions that our agency has, or could have, in optimizing system performance?
- How will these functions change in the future?
- Is there a geographic focus needed to advance TSMO?
- What are the technologies and issues that will affect TSMO over the coming decade or more? And do we need to put a new focus on those issues?

Portland Metro Regional Transportation System Management and Operations (TSMO) Plan Identified Priority Functions

The Portland Metro *Regional TSMO Plan, 2010-2020* identifies four key functional area priorities:

- Multimodal traffic management.
- Traveler information.
- Traffic incident management.
- Transportation demand management.

For each functional area, the plan identifies strategies and projects that improve the operation of the existing infrastructure and manage demand on the transportation system using a 10-year planning horizon.

Source: Portland Metro, *Regional TSMO Plan, 2010-2020*. Available at: http://www.oregonmetro.gov/sites/default/files/062010_regional_transportation_system_management_operations_plan_executive_summary.pdf.



Chapter 6. Programmatic Elements: Organizing, Staffing, and Developing Processes to Advance Transportation Systems Management and Operations

To understand the programmatic elements of transportation systems management and operations (TSMO) program planning, it is important to start with a general understanding of what a program is. For the purposes of TSMO program planning, one can think of the program as the organizational structure and mechanisms needed to deliver the vision, mission, and strategic goals and objectives for advancing TSMO in an organization. One working definition developed by the Federal Highway Administration is that a program “is a coordinated, inter-related set of strategies, procedures, and activities (such as projects), all intended to meet the goals and objectives articulated in vision statements and policies.”⁶

The programmatic elements of transportation systems management and operations (TSMO) program planning address institutional and organizational changes needed to deliver the TSMO mission for the agency in coordination with its partners.

The programmatic component of TSMO program planning addresses the “how” of delivering a TSMO program, with a focus on identifying institutional and organizational changes needed to deliver the TSMO mission for the agency. It addresses issues such as leadership support, organizational structure, career development plans for TSMO staff, and strategies to promote TSMO culture within the agency and among partners.

It may not be appropriate for all types of agencies and organizations to include all elements; however, the process of considering each is important to the program planning and development process. Some of the elements may uncover organizational opportunities or constraints and lead to a more sustainable and robust program. A good starting point for programmatic discussions is to conduct an organizational assessment using the capability maturity model (CMM) framework.

Defining an Organizational Structure

Having a clearly defined leadership and organizational structure for TSMO is important for effectively advancing a TSMO culture and executing TSMO strategies within an agency. Organizational structure considers the interactions and linkages between divisions/offices (e.g., planning, operations, maintenance) and between headquarters and subunits (e.g., districts, member agencies). It also addresses the roles and responsibilities of each of these and opportunities for intra- and interagency integration.

⁶ Federal Highway Administration, *Freeway Management and Operations Handbook*, FHWA-OP-04-003 (Washington, DC: 2003 [revised 2006]). Available at: https://ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/toc.htm.

The organizational structure addresses the roles and responsibilities for the TSMO program, defining the lead for each aspect of program delivery. It is important to address where TSMO is within the organizational hierarchy, particularly for a State department of transportation (DOT): is it a division, department, branch, or other component of the organization? In some organizations, TSMO is a subpart of a maintenance division, or TSMO functions may occur across many different departments (e.g., intelligent transportation system (ITS) technology in design and construction, incident management in traffic operations), which makes it challenging for TSMO to be elevated within a policy and resource allocation discussion. In conducting TSMO program planning, an agency may find that it will be helpful to implement changes in the structure of the agency to consolidate or elevate the TSMO functions; for instance, through a reorganization within a State DOT. In other cases, it may be important to develop a new position, such as a TSMO program manager within a metropolitan planning organization (MPO). In other cases, it may simply suffice to define the existing program structure that is used to deliver the TSMO program.

The Arizona Department of Transportation (DOT) Transportation System Management and Operations (TSMO) Division

When Arizona DOT initially conducted a capability maturity model assessment of TSMO for its organization, it recognized a number of weaknesses in how it was organized to advance TSMO. As a result, the agency developed a new transportation systems management and operations division in 2015 to provide focus within the agency. The division added very little staff, and in fact the agency has reduced its number of full-time employees from more than 4,500 in 2008 to fewer than 3,800 in 2016. The agency shifted several core functions into the TSMO Division, including traffic safety and operational programs, such as roadway-safety improvements, traffic signal systems, intelligent transportation system operations, pavement conditions, traffic operations center, incident management, emergency management, and innovative technologies.

For more information, see: Arizona DOT, Organization Chart as of May 2016. Available at: <https://www.azdot.gov/about/inside-adot/OrganizationalChart> and press release at: <https://www.azdot.gov/media/News/news-release/2016/01/12/adot-division-focuses-on-efficiencies-in-operating-sustaining-a-reliable-transportation-system-for-arizona>.



Questions for Consideration

- How does TSMO fit into the organizational structure?
- What organizational unit(s) have primary responsibility for TSMO? Who is responsible for TSMO?
- In a State agency, what responsibilities are led by headquarters? By regional or district offices? In an MPO or regional operations organization, who has lead responsibility for TSMO planning?
- What responsibilities are led by partner agencies and organizations?
- What other stakeholders need to be engaged in TSMO strategic and deployment planning?
- What are the structure and processes for setting priorities, resolving issues, and making other management decisions?
- How can the organizational structure take advantage of current champions or sponsors in developing a formal and sustainable structure?

Developing Transportation Systems Management and Operations Programmatic Objectives

Objectives identified in the strategic component of TSMO program planning define high-level outcomes for the transportation system and/or customers to be accomplished through TSMO. In contrast, programmatic objectives are focused on the effectiveness of delivering the program and business processes and procedures; in essence, determining how well the program is managed.

Programmatic objectives address what the agency wants to achieve from a business perspective. Typically these objectives address program implementation and business process issues such as:

- Development of plans, programs, or services.
- Gaining new staffing capabilities.
- Customer service and responsiveness.
- Resources.

These objectives are meaningful and measurable to assess how well the TSMO program is working – how well are we doing our job? In this context, they serve as a bridge between the overall strategic goals and objectives of TSMO and the specific strategies and tactics that are implemented.

Maryland State Highway Agency (SHA) Transportation Systems Management and Operations (TSMO) Program Objectives

Maryland SHA defined a series of objectives to support its TSMO program goals. The objectives address issues such as developing freeway and arterial monitoring plans and developing integrated corridor management (ICM) plans.

GOAL 1.

Develop and implement a sustainable TSMO program at SHA

Objective 1.1.

Incorporate TSMO oriented practices in routine planning and programming business processes by 2018.

Objective 1.2.

Promote culture supporting TSMO both inside and outside SHA and raise overall TSMO awareness.

GOAL 2.

Improve travel time reliability for both people and freight.

Objective 2.1.

Develop freeway and arterial master plans by April 2018.

Objective 2.2.

Develop ICM plans by December 2018.

Source: Maryland State Highway Administration.

Figure 6. Maryland State Highway Administration transportation systems management program goals and objectives.

Other programmatic objectives include:

- Implement a comprehensive, system level performance measurement program to monitor mobility and reliability targets by June 2017.
- Coordinate and ensure TSMO is considered in SHA's asset management program.
- Include reliability in existing traffic analyses and travel forecasting modeling tools.

Source: Maryland SHA, *Maryland Transportation Systems Management & Operations Strategic Implementation Plan*, August 2016.

Questions for Consideration

- What are the critical priorities and activities for the program to undertake? What do we need to accomplish over the next 5 years?
- What are the best indicators of an effective TSMO program?
- What data do we have or do we need to assess program effectiveness?
- What aspects of program effectiveness do we control and what are we reliant on others to achieve?

Identifying Staffing and Workforce Development Needs

While TSMO relies upon technology investments, delivering a robust TSMO program is heavily dependent on having a workforce with the right background and capabilities. As noted in NCHRP *Report 693: Attracting, Recruiting, and Retaining Skilled Staff for Transportation System Operations and Management*, State DOTs, MPOs, corridor coalitions, and other transportation agencies are being called on to expand their activities beyond the more traditional design and construction functions most closely associated with civil engineering to the broader and more diverse tasks of TSMO. While a large portion of transportation agency staff have traditionally had backgrounds in civil engineering, and MPOs have traditionally employed transportation planners, TSMO has a primary focus on *providing services*—e.g., performing incident management, work zone management, and freeway management, all of which are very dependent on staff skills—as well as multi-agency communication and collaboration.

While many transportation agencies view TSMO as a priority, they are encountering a shortage of management, professional, and technical staff with appropriate skills and knowledge in their agencies. Specific skills and capabilities within TSMO are evolving to include emerging technologies, data management, data and statistical analysis, and emergency management. Consequently, staff position descriptions may need to be updated and new roles defined within the organization. Staffing and workforce development may require close coordination with human resources to identify and develop these new capabilities. As many transportation agencies have limited ability to hire new employees, TSMO program development should identify the core TSMO program staff roles, responsibilities, and requirements. This may include a staffing plan for the TSMO program that identifies current and needed skills and a strategy for recruiting, training, developing, and retaining qualified TSMO personnel.

In addition, the staffing plan may include using contractors or outsourcing staff responsibilities to other organizations in gap areas. In particular, as technology advances, there are opportunities to outsource some functions (e.g., monitoring traffic congestion and providing traveler information) to private sector data providers.

Questions for Consideration

- What skill sets will be needed to meet TSMO program objectives and functions?
- How well are our current positions and staffing structure meeting our current and future needs? Is there a need to update position descriptions, or create new positions?

- What is the career path for TSMO staff?
- What training is needed to develop or enhance skills?
- Can we meet our staffing needs in-house?
- What are the advantages and disadvantages of utilizing contract employees?
- What is the role of outsourcing services entirely?

Transportation Systems Management and Operations Program Resource Management: Financial Resources, Planning, and Budgeting Processes

Financial resource management, maintenance of systems, and budgeting is a critical part of an effective TSMO program. TSMO program planning should include an evaluation of needed and available resources and identify resource gaps and areas for investment. In most transportation agencies, there is not a single, dedicated funding stream for TSMO activities and projects. Traditional budgeting and accounting practices in departments of transportation and regional organizations also are generally project focused. TSMO changes the focus to include ongoing services, deployment of systems of devices, and maintenance of software and hardware.

Consequently, financial resource considerations within a TSMO program involve several considerations:

- **Staffing** – As discussed earlier, staffing relates not only to internal agency positions but also financial resource requirements for use of consultants or contractors to operate programs or undertake specific functions.
- **TSMO-related Assets** – TSMO includes not only traditional transportation infrastructure and equipment, but also traffic control devices, communications infrastructure, data, public outreach platforms and other ITS devices. These equipment require maintenance, updates, or replacement over time. As a result, it is important to understand the level of funding needs and explore funding sources and mechanisms available in relation to these needs. As with pavements and bridges, the TSMO functions of the agency should explore opportunities to adopt asset management techniques for identifying needs for refurbishment, replacement, or upgrades to equipment and technologies and developing a financial plan. It is also important to consider how new technologies will affect the need for and ways of implementing TSMO services, such as traveler information.
- **Processes and Procedures for Sustainable Funding** – The financial component also may address the broader issue of how TSMO programs are funded, or compete for funding within the programming process. Some MPOs have developed specific processes and procedures to ensure sustainable funding for TSMO activities in their metropolitan transportation improvement program (TIP). For instance, some MPOs set aside funding for TSMO projects to be funded each

Maricopa Association of Governments (MAG) Procedures for Intelligent Transportation System (ITS) Project Prioritization

Since 1998, MAG has had a dedicated funding stream for ITS projects. Although most of the ITS projects are funded with Congestion Mitigation and Air Quality Improvement (CMAQ) Program funds received by the region, several other regional transportation funding sources are applied as well. MAG's ITS project selection process includes extensive involvement from various policy and technical committees as well as the public. First, MAG solicits project applications, which are reviewed by the ITS committee and the transportation review committee. The ITS committee, comprised entirely of ITS professionals representing member agencies, is responsible for regional ITS planning and is supported by metropolitan planning organization (MPO) technical staff. All proposed ITS projects are reviewed by the ITS committee against established criteria, ranked, and recommended for funding and inclusion in the transportation improvement program. This recommendation is reviewed by the transportation review committee, which is comprised of high-level transportation staff from member agencies and is the primary committee responsible for assembling and recommending the transportation improvement program.

MAG is currently in the process of developing a transportation systems management and operations plan that will establish updated procedures for prioritizing investments in future ITS infrastructure and funding support for operations.

Source: FHWA, *Programming for Operations: MPO Examples of Prioritizing and Funding Transportation Systems Management & Operations Strategies*, FHWA-HOP-13-050 (Washington, DC: September 2013). Available at: <https://ops.fhwa.dot.gov/publications/fhwahop13050/index.htm>.

year and use specific project selection criteria to prioritize funding. Other MPOs do not set aside funding, but use evaluation criteria that address mobility, reliability, safety, and cost effectiveness to help TSMO initiatives compete effectively for funding.

- **Processes and Procedures for Prioritizing Funding** – The financial component also may address procedures or criteria for prioritizing funding among the many possible needs for TSMO projects and investments.

Questions for Consideration

- How are TSMO program funding needs determined?
- What are the current funding levels and funding needs? What are the current sources of funds?
- How will the ongoing services and programs be funded sustainably for the long term?
- How do TSMO assets (signals and ITS) interface and interact with the agency's asset management planning? What additional resources are needed for a state of good repair for TSMO assets?

- Are new accounting procedures needed to track operational expenses and evaluate TSMO investments?
- How do TSMO services and actions compete with infrastructure projects in programming and budgeting?
- What opportunities exist to integrate TSMO strategies into infrastructure projects?

Developing Business Processes and Management Strategies

Business processes include specific, structured activities or tasks and related decision points that are needed to deliver a TSMO program successfully. The Second Strategic Highway Research Program CMM framework recognized the important role of business processes for advancing TSMO. Business processes include formal planning, programming, scoping, budgeting, and project development.

Existing and new processes should be reviewed, revised or developed to meet the unique challenges and opportunities associated with TSMO. These include standard business practices as well as emerging and evolving practices needed to deliver new services. Some of the unique and emerging opportunities are highlighted in the discussion of each business area below.

Organizational and Administrative Processes

Organizational and administrative processes include day-to-day workflow activities that support the TSMO program. These functions may require review and revision to meet the changing timeframes and nature of TSMO activities. A number of TSMO functions occur in real time and require timely action. Interaction with internal and external partners may require new or enhanced decision processes. It is important to consider how the changing nature of doing business in TSMO may impact daily workflow and functions to provide an effective program.

Questions for Consideration

- What day-to-day activities are needed to support the TSMO program?
- Are our current administrative processes nimble enough to satisfy TSMO program objectives in a timely manner?
- What current processes or procedures should be revised or enhanced?

Procurement and Contract Management

ITS and emerging technologies are integral parts of a comprehensive TSMO program. Many data-sharing services involve new models of procurement and contracting. Emerging technologies require contracting with non-traditional businesses that may involve public-private partnerships, information sharing, and new legal relationships. Agency personnel involved in contracting and procurement related to TSMO program planning and development can identify challenges and opportunities to enhance current business practices resulting in timely and effective procurement and contract management.



Questions for Consideration

- What are current challenges associated with ITS or technology procurement?
- Do current contracting or procurement processes limit the opportunities for public-private partnerships with emerging technology firms?
- What opportunities exist to streamline the efficiency of procurement and contracting?
- Who needs to be involved in evaluating and revising current procurement and contract procedures?

Performance Management, Quality Management, and Continuous Improvement

Across transportation agencies, there is increasing emphasis on monitoring and measuring performance in relation to goals. Driven in part by the Federal surface transportation authorization law, Moving Ahead for Progress in the 21st Century (MAP-21) Act, and its successor, the Fixing America's Surface Transportation (FAST) Act, transportation agencies must utilize performance-based planning and programming to enhance decision-making and increase accountability (see 23 USC Section 134(h)(2) and 23 USC Section 135(d)(2)). Since TSMO focuses on optimizing system performance, it is critical that a TSMO program utilize a performance-based approach to support continuous improvement.

As noted earlier, performance management spans all three elements of TSMO program planning. In the programmatic phase, the transportation organization should develop monitoring and measurement approaches in relation to strategic (outcome-based) and programmatic (internal) objectives.

- An agency may establish on-going data collection programs or develop dashboards to communicate system-level performance. For instance, an agency can develop procedures for monthly performance reporting on traffic congestion, incident response time, and reliability. Measurement can also include statistics such as number of incidents recorded and number of visits to a traveler information website.
- An agency may also establish monitoring and measurement of activities designed to assess the effectiveness of specific strategies and tactics. An example would be the regular implementation of post-project assessment procedures to calculate the travel time savings associated with traffic signal coordination projects.

Performance management helps the organization to make informed decisions that correct the course or more effectively move the program toward its goals and objectives. At a programmatic level, performance measurement and response procedures provide a bridge between the strategic and tactical elements by supporting the agency's ability to evaluate and respond to performance outcomes effectively.

In addition to supporting tactical decisions, performance measurement helps to support quality management and continuous improvement. Regular review and evaluation of program objectives provide a measure of program effectiveness and improvement. A large number of State and regional agencies have participated in the CMM workshops. A periodic review of the CMM dimensions will provide an ongoing assessment of the TSMO program, including areas for improvement and dimensions where advancements are being made. An important component of program management is to continually track and respond to these measures in a formal, structured approach designed to deliver continuous improvement.

Questions for Consideration

- How will we measure each of the TSMO program objectives?
- What actions are needed to address shortcomings in achieving program objectives?
- What actions are needed to advance the TSMO program along the CMM dimensions?
- What decision support systems are in place to translate measures into actions?

Data Management

Data management ties into and is an important element of both asset management and performance measurement. In light of recently established national performance reporting and target setting requirements, data management is an increasingly important issue within State DOTs. Moreover, in the operations realm, the availability of data is expanding exponentially as crowd sourcing, vehicle-to-infrastructure communications, and the “Internet of Things” expands. Weather and roadway conditions, vehicle speeds, incident occurrence, and other real-time data are being extensively collected and made available throughout the system. How the data are gathered, analyzed, reported and stored can provide a tremendous resource to support TSMO activities. Big data analytics allows system managers to identify trends and relationships previously unconsidered to manage traffic and operations more efficiently. The management, duration, evaluation and analysis of data are critical to an effective TSMO program.

In response, some transportation agencies have developed a data business plan, and TSMO can be an important component. A data business plan guides an agency in data management, and links business objectives, programs, and processes to data systems, services, and products.

Questions for Consideration

- What are our current sources of historic and real-time data?
- What new and emerging sources are available?
- Do we have the tools and skills we need to leverage new data sources?
- Who are our potential partners for data sharing and analytics?
- Are procedures for analyzing performance data in place? Are responsible parties assigned to perform this analysis?

Decision Support Systems

Current and emerging data sources provide inputs into automated, computer-based applications that support business and operational decision-making. Decision support systems (DSS) provide decision-making structures for everything from real-time traffic operations to capital investment strategies. Applications of DSS include freeway speed algorithms for traffic control operations, incident detection, winter maintenance routing and tracking, and adaptive signal control. DSS can also support project planning and design, service investments, and other programmatic decisions.

Big data offers new sources of information, and big data analytics allows TSMO programs to identify previously undetected trends and relationships. DSS provides a decision framework to make informed decisions to support TSMO program goals and objectives. This allows program managers and decision-makers to consider the trade-offs of various actions or investments.



Questions for Consideration

- What current DSS are in place and are they effective?
- What additional DSS would enhance TSMO program decision-making?
- What new data could be leveraged for DSS?
- Do staff use the DSS capabilities?
- What in-house capabilities are needed for big data analytics?

Research and Development

TSMO is a rapidly evolving field that includes traditional and emerging technologies and applications. Ongoing research and development is essential for taking advantage of new technologies and maximizing an agency's return on investment. Identifying new and emerging technologies with TSMO applications provides opportunities to consider technology alternatives that address system issues more cost effectively than traditional construction solutions. Increasing data sources and types provide new insights into system challenges and trends that can refocus investments more effectively. Multimodal integration and information sharing offer new options for system users and system managers. To integrate new technologies into TSMO, focus on research, evaluation, and testing.



Questions for Consideration

- Who are our partners for TSMO research (agency staff, universities or research organizations, vendors)?
- What opportunities exist or are emerging that may be applicable to our program?
- How will we evaluate or test new technologies?

Promoting and Embedding a Transportation Systems Management and Operations Culture throughout Agency and Partner Business Practices

Whether a TSMO program is developed by a single agency, multiple agencies, or across a region, communication and collaboration between and among partners and stakeholders is essential to the program's success. Within a State DOT there are numerous subunits with responsibility for various aspects of TSMO planning and deployment. Similarly, in a region where multiple jurisdictions need to coordinate activities to deliver a systems approach to transportation management and operations, communication and collaboration become a critical programmatic component of effective TSMO.

Internal Collaboration: Incorporating Transportation Systems Management and Operations into Other Processes and Procedures Used Throughout the Agency

Beyond the organizational units with lead responsibility for TSMO activities, embedding TSMO as a key priority within an agency will typically require integration of TSMO into other agency functions, plans, and programs to support optimized system performance.

These functions may include:

- **Planning** – The TSMO program should support the goals and objectives in the agency's long range transportation plan and also serve as a basis for identifying these objectives and priorities. TSMO thinking and TSMO strategies should permeate all relevant planning documents, including freight plans, bicycle/pedestrian plans, and safety plans. The strategic objectives of the TSMO program plan also should be integrated into corridor plans, and sub-area planning.
- **Programming/Funding** – The TSMO program's priorities should be integrated into investment and funding decisions, including integration into the TIP and STIP.
- **Project Development/Design** – TSMO needs to be considered at the project level when considering both project design and strategies to incorporate into a project (e.g., transit signal priority, dynamic lane control, demand management).

Caltrans Organizational Integration for Transportation Systems Management and Operations (TSMO)

Caltrans has focused its efforts to develop a TSMO program on organizational integration. Caltrans has had many of the pieces needed to effectively advance TSMO; for instance, corridors that are managed in an integrated manner, policy, and an intelligent transportation systems architecture, but it has needed better institutional integration. Caltrans has focused on getting planners, operations staff and their partners to work better together; one way to do that has been conducting regional operations forums. In California, the regions have most of the funding and programming authority, and Caltrans Districts work with metropolitan planning organizations and other regional partners to advance priorities.

Colorado Department of Transportation (CDOT) Integration of Transportation Systems Management and Operations (TSMO) Evaluations into its Project Development Process

As part of making a culture change to focus on improved traffic operations and on continual process improvements, CDOT developed an operations evaluation process to be conducted as an essential element of the project development process for new infrastructure projects. The purpose of this effort is to avoid past instances when CDOT completed improvements to the roadway (e.g., paving, striping, widening) and then, after a brief period of time, returned to the same location to make additional improvements. By considering safety, operations, and intelligent transportation systems elements throughout the design process and in an institutionalized manner, CDOT attempts to optimize its limited resources to make the right decisions for transportation improvements and build public trust.

The agency's TSMO evaluation consists of three parts: 1) a safety analysis, 2) an operations analysis, and 3) an ITS analysis in the project development process. The project manager will coordinate with the regional traffic representatives for the completion of these safety and operational reviews along with a systems engineering analysis for any proposed ITS elements during the project.

See: <https://www.codot.gov/business/process-improvement/lean-case-studies/first-in-the-country-implementing-tsm-o-evaluations-to-be-the-best>.

- **Maintenance and Asset Management** – TSMO needs to consider how its assets (including ITS equipment, transportation management centers, etc.) are maintained and replaced over their life-cycle.

For TSMO to permeate an agency, TSMO considerations need to be brought into processes and procedures used throughout the agency, such as other types of transportation planning studies. Specifically, TSMO should be incorporated into statewide and metropolitan transportation planning, safety planning, and asset management, as well as project development and design. This integration will often involve the inclusion of TSMO considerations into guides and process manuals used throughout these processes.



Questions for Consideration

- Who are our partners within the organization? (Consider current and potential partners across disciplines and areas of responsibility)
- How can the TSMO program support other agency units and functions and how should that information be communicated?
- What other agency initiatives or responsibilities are closely aligned with TSMO?
- In what other processes and procedures should TSMO be integrated? How does TSMO interface with agency strategic planning?

- How can integration of TSMO lead to process improvements that save money and benefit our customers?
- What are the specific processes, manuals, and documents within which TSMO considerations should be added?

Collaboration with External Partners

Recognizing the critical role of different partners in operating a multimodal transportation system, TSMO program planning should address collaboration among statewide/regional partners and coordination across multiple disciplines (e.g., maintenance, law enforcement, emergency response). In particular, given the dominant impact of incidents on delay and reliability—and in light of the key legal and traditional role of law enforcement, a DOT’s effectiveness in TSMO is dependent in significant part on the level and type of cooperation that can be developed with law enforcement for traffic incident management. Similarly, coordination with local governments responsible for traffic signal operations, transit agencies, and new transportation service providers (such as transportation network companies) are critical to the effective implementation of strategies supporting integrated corridor management and active transportation demand management, among others.

Interaction with external stakeholders, expanding coordination and collaboration to enhance existing relationships, and building new partnerships will enhance program effectiveness and sustainability. Structured interaction between stakeholders expands coordination and collaboration to enhance existing informal relationships, builds new partnerships, and formalizes a program within and across agencies.



Questions for Consideration

- Who are our external partners and what does TSMO offer to their organizations’ mission?
- What mechanisms and forums are needed to build multiagency collaboration?
- What informal relationships should be expanded or formalized to support TSMO and leverage limited resources?

Oregon Department of Transportation (DOT) Transportation System Planning Guide

Jurisdictions throughout Oregon are required to prepare and adopt regional or local transportation plans that serve as the transportation element for their comprehensive plans. To support integration of transportation systems management and operations (TSMO) and other concepts, Oregon DOT developed Transportation System Planning Guidelines, which include best planning practices that provide examples of strategies that communities can use to strengthen their plans.

See: <https://www.oregon.gov/ODOT/TD/TP/Plans/Guidelines.pdf>.

- What are the mechanisms needed to set priorities, resolve disagreements, and make other system management decisions?

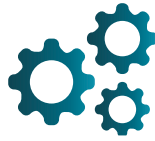
Communications, Marketing, and Outreach with System Users

Communicating with system users is an important part of developing a TSMO program and builds support for a program that is not as visible to daily transportation users as a major construction project might be. The TSMO program, in collaboration with agency public information personnel, should reach out to customers to identify their needs and expectations and to communicate TSMO goals, objectives, activities, and outcomes.



Questions for Consideration

- What mechanisms are in place to solicit and address user needs and expectations?
- How will the TSMO program work with public information/relations staff to build public support for the program?



Chapter 7. Tactical Elements: Identifying Priority Services, Activities, and Projects

The tactical component of transportation systems management and operations (TSMO) program planning focuses on identifying the packages of TSMO services, activities, and projects to accomplish the organization's adopted mission, vision, goals, and objectives. In this phase, transportation agencies also describe implementation policies and decision-making guidelines that will direct deployment for services, activities, and projects. In effect, this component should establish the foundation for subsequent TSMO deployment. Often, this phase of TSMO program planning involves a near-term focus of 3 to 5 years, and is used by metropolitan planning organizations (MPO) to identify priorities to move forward as investments and programs within a transportation improvement program (TIP) or by States to identify key priorities for the statewide TIP.

Transportation systems management and operations (TSMO) program planning addresses tactical issues that lay the groundwork for TSMO deployment, including the identification of prioritized services, activities, and projects.

While tactical program planning focuses on identifying a set of investment or service priorities, it should involve more than simply identifying a list of projects. This component of planning ideally should involve establishing clear organizational responsibilities for each set or package of services, projects, or activities. It also must recognize that TSMO implementation goes beyond just deploying ITS infrastructure and implementing programs, but has to include field procedures and protocols, adjustments to the systems architecture, staff training, and performance measurement.

It is important to note that several organizational units may need to share responsibilities for a particular service, activity, or project, and collaboration with specific external partners may be critical to success. Any unique organizational or system-related needs for business processes should be identified and addressed. In addition, tactical planning should involve developing a financial plan to identify funding sources for services and/or investments, as well as other categories of resources (e.g., staffing, capabilities) needed.

Identifying Prioritized Services, Activities, and Projects

Planning for the implementation or deployment of TSMO identifies the services, activities, and projects needed to meet the TSMO strategic and programmatic goals and objectives. Each of these areas should be developed more fully to prioritize, program, and deploy specific services and activities.

“No service, project and activity should be a candidate for subsequent deployment planning without systematic screening through the TSMO Program Plan.”

NCHRP Project Number 20-07/345: Program Planning and Development for Transportation System Management and Operations in State Departments of Transportation

Unlike more traditional transportation agency programming, TSMO deployment goes beyond projects to include a broad range of activities and services that support operations and management of the transportation system. For example, traffic incident management (TIM) involves not only deployment of cameras or other infrastructure to detect incidents, but also procedures, communications, interagency coordination, and scene management practices. TIM programs may identify specific technology investments or intelligent transportation system (ITS) applications that support these activities, but the focus is generally not on project construction or technology procurement alone. Program plans should discuss in more depth, or link to more specific plans that address, the structure, relationships, and procedures needed to advance each service or function, as well as funding.

? Questions for Consideration

- What services, activities and projects provide the greatest return on investment in meeting our TSMO goals and objectives?
- What services and activities are we performing today that can be leveraged or enhanced to support TSMO?
- What gaps do we currently have that need to be addressed to meet our TSMO mission and vision?
- What is the structure of the service delivery program?
- Who should we engage to develop strong multiagency, multidisciplinary deployment?

Delaware Valley Regional Planning Commission (DVRPC) Identification of Specific Strategies to Support Transportation Systems Management and Operations (TSMO) Goals and Objectives

DVRPC, the metropolitan planning organization (MPO) for the Philadelphia region, developed a *Transportation Operations Master Plan*, which outlines a long-range vision of transportation operations for the region. It presents transportation operations goals, objectives, and operational strategies, including plans and programs to accomplish the regional goals and vision. A financial analysis was conducted to estimate the costs to construct, operate, and maintain these initiatives. The table below highlights strategies, which include projects, policies, programs, and activities designed to support one goal associated with reducing traffic congestion through improved incident management and associated objectives.

Goal	Reduce Traffic Congestion Through Improved Incident Management			
Objectives	Improve Incident Detection and Verification	Improve Response Times	Improve Interagency Coordination and Cooperation	Improve Incident Clearance
Strategies	Implement and/or upgrade traffic operations centers Construct traffic surveillance systems, fill in missing gaps Share 9-1-1 and State police Computer Aided Dispatch (CAD) information with traffic operations centers	Install reference location signs Construct Regional Integrated Multi-Modal Information Sharing (RIMIS) data interfaces with traffic operations center (TOC) field-to-center (F2C) software to collect traffic speeds Share traffic surveillance information with emergency responders Incorporate real-time traffic information into CAD systems and emergency vehicle mobile data terminals	Operate and maintain RIMIS Establish and maintain incident management task forces Create incident management response teams (IMRT) Conduct training programs, post-incident reviews Develop regional evacuation plan, and disaster response and recovery plan TOC/County 9-1-1 centers act as a communication hub for emergency traffic text alerts	Deploy emergency service patrols Pass quick clearance legislation Develop and promote "Move It" policies, erect "Move It" signs Identify and sign prearranged detour routes Develop policy and procedures to modify signal timings on detour routes, upgrade traffic controllers/ F2C communication systems Pre-deploy traffic control equipment Install ramp gates and barrier gates Develop tow truck incentive program

Source: DVRPC, *Transportation Operations Master Plan*, 2009.

Defining Implementation Policies and Guidelines to Support Service Functions

In the tactical stage of TSMO program development, policies and guidelines are needed for services and strategies. These may include State level policies such as quick clearance for TIM, standards specifications for communications technologies, guidelines for selection or deployment of ITS devices, policies guidance on public/private initiatives in data sharing, decision-making guidelines for implementation of services, projects, and activities, and service levels standards for devices.



Questions for Consideration

- What statewide or regional implementation policies are needed to support and enhance TSMO?
- What guidelines would be helpful to coordinate and cooperate across multiple agencies and disciplines?

Regional Transportation Operations Plan for Southeast Wisconsin – Short-Range Priorities

The Southeastern Wisconsin Regional Planning Commission, the metropolitan planning organization for the Milwaukee area, developed a Regional Transportation Operations Plan (RTOP) as a short-range plan identifying system operations measures and actions recommended for implementation over a five year period. The RTOP builds on the recommendations from the region's long-range regional transportation plan, and identifies the operations measures in the regional transportation plan recommended for priority implementation in the five-year period, along with potential funding sources, and the relationship of each measure to the regional intelligent transportation system architecture.

Source: Southeastern Wisconsin Regional Planning Commission, *Regional Transportation Operations Plan for Southeastern Wisconsin: 2012-2016*. Available at: <http://www.sewrpc.org/SEWRPCFiles/Publications/mr/mr-202-reg-transportation-operations-plan-for-se-wisc.pdf>.

Developing an Investment Plan or Financial Plan

Effective planning for TSMO involves identifying the costs associated with deployment of services, which may include new infrastructure investments, technology purchases, staff time and resources, or other resources. The TSMO program plan may identify general funding levels, resource needs, and funding sources to support a sustainable program by major function over a 5- or 10-year period. It also could identify specific types of project priorities and estimated costs, which could be incorporated into the MPO's TIP or State DOT's STIP.

Prioritizing specific TSMO services and projects typically depends on data and analysis tools. Benefit/cost analysis or multi-criteria analysis methods can be developed to support this project-level or service-level prioritization. For example, Federal Highway Administration's Tool for Operations Benefit Cost Analysis (TOPS-BC) can be used to help support identification of specific TSMO strategies or investments that may be most cost-effective. Alternatively, multiple factors or criteria may be used to prioritize investments.



Questions for Consideration

- What are the current funding resources for TSMO deployment for each service area?
- What are the priority or highest value investments needed for each service area?
- What funding sources can be matched to individual project priorities?

Developing Annual Action Plans and Deployment

Identification and prioritization of TSMO services, activities and projects provide the basis for annualized actions and deployment. Based on funding resources, and opportunities to integrate TSMO in other activities and projects, annual deployment plans provide the basis for actualizing TSMO. Annual plans should be developed in coordination with larger agency planning efforts and integrated in standard programs, which often have a 5-year timeframe.



Questions for Consideration

- What operational projects or initiatives are needed in the near-term to address specific needs?
- What are the highest ranked priorities for implementation in the next year? Two years? Five years?

Tracking Progress: Performance Assessment

For each of the service areas, performance analysis should be conducted to measure the effectiveness of tactics in meeting program objectives. Using metrics identified in strategic planning, on-going monitoring of system performance, together with evaluation of specific projects and investments, will provide the basis for informed, performance-oriented decision-making and program improvements. It will also provide data useful for justifying future TSMO investments.

Dallas Region Annual Evaluation of Intelligent Transportation System (ITS) Priorities

The ITS strategic deployment plan developed by the North Central Texas Council of Governments (NCTCOG) is a living document, which the organization seeks to improve continuously. On an annual basis, NCTCOG leads a stakeholder task force in a review of the ITS plan. As part of this process, the task force uses performance measurement data to make decisions about whether to add or remove regional ITS projects and proposed deployments from the plan.

Source: North Central Texas Council of Governments, North Central Texas Intelligent Transportation System (ITS) Strategic Deployment Plan, May 2016. Available at: <http://www.nctcog.org/trans/its/RegITSArch/documents/ITSSDPFINALReportwithAppendix.pdf>.



Questions for Consideration

- How will we measure how well we are meeting the program's stated objectives?
- What data are available and what additional data needs do we have?
- How can we capture effectiveness data and success stories to help justify future TSMO investments and build a case and culture for TSMO?

Chapter 8. Ten Guiding Principles to Advance Transportation Systems Management and Operations Program Planning for Your Organization

Transportation systems management and operations (TSMO) program planning involves several steps. Each organization will have its own set of considerations based on the organization type and responsibilities. Recognizing that agencies are at various stages in their development of TSMO Programs and have different needs, this section highlights ten “guiding principles” associated with an effective TSMO program planning effort.

The process of getting started in TSMO program planning may also vary based on which office or group is leading the effort. For example, some agencies may develop a program plan through an operations group while others may initiate it in a strategic planning or research office. Regardless of who spearheads the development of a program plan, representation from these and other potentially affected or interested staff should be included to provide a broad and comprehensive approach to program development. It is important to determine the capability of your organization for undertaking TSMO program planning and to solicit support and expertise as needed.

Understand Motivation

It is important to understand and articulate the motivating factors for developing a TSMO program and a TSMO program plan. Consider what the potential advantages are to the organization and to the transportation system users to build a vision for what TSMO can do to support transportation through the implementation of a TSMO program. It is also important to understand the risks of not formalizing a TSMO program and allowing initiatives to become reactive or subject to leadership changes or political shifts. Clearly articulating the motivation for TSMO is a key ingredient for ensuring buy-in and on-going support.



Questions for Consideration

- Are we committed to support TSMO and to make changes recommended by a TSMO program plan?
- How will this plan be linked and coordinated with existing plans (e.g., strategic highway safety plan (SHSP), long-range transportation plan (LRTP), intelligent transportation systems (ITS) plans, traffic incident management (TIM) plans)?
- Do we have leadership support? If not, how can we gain buy-in from leadership for the planning effort and resulting TSMO program plan?
- Who are the audiences for the plan? How can we manage expectations among stakeholders?

Identify a Leader and Key Internal Partners

TSMO is a multi-disciplinary approach to enhancing the management and operations of the transportation system. As such, it is important to engage partners within the agency who will play a key role in advancing the TSMO throughout program and who will play a role in implementing business processes or tactical deployments. Other disciplines to consider in developing and implementing a TSMO program include planning, design, maintenance, construction, IT, and procurement. Engaging district or regional offices also will need to be part of the effort. Each of the units will need to understand how the TSMO program interfaces with their areas of responsibility and should be engaged to develop a sense of ownership in the program and its implementation. Different approaches may be effective in different circumstances. For instance, in Maryland, the TSMO Program efforts have been spearheaded by the Office of Planning and Preliminary Engineering, in coordination with operational units. In Tennessee, the Traffic Operations Division was the lead in TSMO program planning efforts. In Texas, the Texas Department of Transportation (DOT) central office is conducting outreach to its districts and regional partner agencies, then based on input from those entities and the state of the practice, setting a TSMO framework for planning at the district and regional level.

Questions for Consideration

- Who will lead the process, and who will be consulted?
- How will we involve all of the key units in the department (e.g., planning, maintenance, construction, regions)? How will we ensure that each unit feels “ownership” when it is time for implementation?
- How will we involve the region/district offices? Will the TSMO program plan provide the same level of guidance and direction to the region/district offices as to headquarters?
- How will decisions be made, and what role will the metropolitan planning organization (MPO), DOT, and external partners have? What role will the Federal Highway Administration (FHWA) have?

Develop a Clear Definition and Understanding of Transportation Systems Management and Operations

In order to develop an effective TSMO program plan, it is important to clearly define TSMO so everyone working on the plan has a common understanding. Many people with the organization may not have experience with the term “TSMO” or be familiar with all aspects of the concept. Therefore, it will be important to discuss and document key terms to be used in the plan in order to communicate effectively.

Questions for Consideration

- Do all stakeholders have a common understanding of TSMO?
- How can we most clearly convey the value and importance of TSMO?

Establish Baseline Conditions/Conduct Self-Assessment

This is a critical step in the process. Data can help illustrate the current TSMO activities and provide baseline metrics for performance measurement for the TSMO program. Another aspect of establishing current conditions is identifying current agency plans and examining how a TSMO program can expand and support current strategic goals and tactical initiatives. In addition to strategic plans, State transportation improvement plans (STIP) and transportation improvement plans (TIP), consideration for how the TSMO program will support and interface with organizational asset management, performance management, and sustainability plans is important.

Self-assessment may include conducting a survey to assess program needs, conducting outreach to partners for input on needs and goals, and establishing a panel of experts to identify best practices and provide guidance as the plan is developed. A self-assessment can identify key areas for improvement building on current strengths and developing areas identified as current weaknesses. Many States and regions have participated in TSMO capability maturity model (CMM) workshops and can build on what they learned from these workshops and other self-assessments to guide the TSMO program planning effort.



Questions for Consideration

- What TSMO functions do we have and where are they housed in the agency?
- What parts of the TSMO program plan do we have already? What is our “point of departure”?
- What do we know about current and future challenges and needs?
- What components of the model approach are already in place, and what needs to be developed?
- What have we learned from CMM workshops and other self-assessments that should guide or be further addressed in the TSMO program plan?

Identify What Expertise Is Needed

Organizations approaching TSMO program planning for the first time may find it helpful to engage experts through FHWA, academia, or the private sector to provide guidance and support to program planning. Specific expertise, either in-house or external, should include an understanding of TSMO and the role of program planning and development in supporting the development of a clearly articulated, well documented and integrated plan that can guide a comprehensive TSMO program into the future. An understanding of organizational and change management is also important to the integration of the TSMO program across the agency.

Expertise is also needed to carry out the plan and build an effective TSMO program. TSMO programs include planning, design, deployment, business processes, data analytics, decision support systems, traffic operations, multi-agency coordination, and program management. As new applications and technologies emerge, these areas will evolve and expand, changing the nature of the work and skill sets needed to perform that work. Transportation agencies have traditionally been

the arena of design, construction, and maintenance. As agencies take on an increased focus on system management and operations, and as technology and social expectations evolve, the skills and capabilities needed in the workforce must expand and change as well.

? Questions for Consideration

- What skill sets are needed for TSMO program planning?
- What capabilities for execution of the plan are needed in-house and what can be provided by consultants or vendors?
- What is the process for identifying new capability needs?
- Where do we need to enhance or add capabilities to support program delivery and to address changing demands or needs?
- What resources are available to train current employees in new areas?

Organize for Transportation Systems Management and Operations

Across all phases or elements of TSMO program planning, a key theme is that program planning goes beyond development of strategic goals and objectives, or identification of projects or tactics. It involves focusing on broader programmatic issues that define how the “business of TSMO” is conducted within an agency, State, or region. This may involve looking at how the agency is organized to most effectively carry out the business of TSMO, and may involve developing new organizational structures or positions within the organization.

Organizational integration should address issues associated with bringing a culture of TSMO to an agency. There are a number of ways TSMO programs can develop and evolve within the overall agency structure. The more TSMO is integrated across all aspects of an agency, the more effective it will be in leveraging strategies to support system management.

? Questions for Consideration

- Is the agency organized optimally to advance TSMO?
- Does the organizational structure hinder effective planning or deployment for TSMO?
- How does the current organizational structure affect recognition or awareness of TSMO across the agency?
- Does the structure support or adversely affect budgeting for TSMO?

Engage Key External Stakeholders

While many of the initial TSMO program planning efforts of State DOTs have focused internally on the organization, it is important to recognize the important role that many agencies and organizations play in TSMO. Local agencies that operate traffic signals, transit agencies, toll authorities, port authorities, and other organizations all play a role in managing components of the transportation system and should be considered. In addition, non-traditional stakeholders, such as school districts (e.g., responsible for school bus schedules), major employers, emergency responders, and others play a role in transportation system demand and performance, and could be part of outreach efforts to develop collaborative partnerships.

As TSMO embraces new and emerging technologies, agencies will develop increasingly complex partnering arrangements with service providers and original equipment manufacturers. It is likely that each of these partnerships will be a unique business arrangement reflecting the business strategies and objectives of each industry partner.

Questions for Consideration

- Who are important stakeholders for the TSMO program plan?
- What role do these organizations play?

Look Ahead to Emerging Technologies and Innovations

In addition to the challenges of today, new technologies are quickly shaping and molding the landscape of future mobility and system operations. These issues can have significant implications for system performance, travel patterns, and the roles and responsibilities of transportation agencies in providing and operating transportation services as well as for relationships with partners in the private sector. These issues should be considered in planning for a TSMO program.

Emerging technologies provide a number of new challenges and opportunities, and should be planned for in a way that supports the TSMO strategic vision and program development. Technology is evolving quickly and business systems need to be able to respond and adapt quickly to leverage new technologies and ensure they are beneficial and not a distraction to the program's goals and objectives. For example, with the evolution of autonomous and connected vehicles, traffic operations and system management may change tremendously. Other emerging technologies and social changes may also impact TSMO policies and programs.

New technologies, such as autonomous and connected vehicles and mobility on demand services, will likely change how transportation agencies approach traveler information and traffic management. For instance, the private sector may play a larger role in providing detection, data, and analytics services for performance measurement, and new detection technologies such as drones may be used. New technologies also may reduce the needs for certain types of transportation programs and partner efforts, such as law enforcement efforts to reduce speeding or drunk driving. At the same time, new technologies are likely to increase the roles and responsibilities of the public sector in terms of cybersecurity and maintaining the data security.

? Questions for Consideration

- What new and potentially disruptive technologies are anticipated in the near term?
- What new technologies are just beginning to emerge?
- How could these technologies impact current practices and policies?
- How can we position ourselves to maximize our opportunities?
- What role can we or should we play in private sector innovations?
- What business processes are needed to procure and contract with new technology partners?
- How flexible should our business processes be to adapt to and deploy these technologies?
- What new roles will transportation agencies need to play in protecting data?
- What new roles will agencies need to play in regard to cybersecurity?
- What security issues should be addressed in planning and deploying new technologies?

Consider External Forces and Other Emerging Issues

It is important for transportation agencies to consider a range of issues that go beyond technology advancements when planning for the future. Specifically, issues such as changes in demographics, land use/development patterns, the economy, and freight movement, as well as increasing opportunities for shared use mobility should be considered in defining the TSMO program and its priorities. In addition, changing areas of focus—such as the emerging role of resiliency, risk management, and environmental sustainability within transportation agencies—should be considered.

? Questions for Consideration

- How will changes in demographics, land use, and the economy potentially affect system operations?
- How will potential impacts of climate change and increased severe weather affect TSMO needs?
- How can TSMO support environmental sustainability?
- What are emerging roles of TSMO in relation to system resiliency?
- What is the role of TSMO in relation to other issues of concern (e.g., equity, risk management)?

Analyze and Evaluate Performance

Performance management is a critical component of effective TSMO program planning. Building off of the self-assessment at the beginning of the process, it is important to continually explore how well the agency is doing in achieving both its strategic goals and objectives, as well as its programmatic objectives. Performance measurement provides greater definition to the high-level goal outcomes, and provides a tangible way to assess the current state, goal state, and gaps. Evaluation and reassessment ensures that the TSMO services and projects are effective at realizing progress towards goals and objectives, and establishes processes for continuous improvement.

Questions for Consideration

- Are we measuring the right things?
- What data are available or could be used to track performance?
- Who will be responsible for implementing elements of the plan?
- How will we track progress toward implementing the plan? How will we keep leadership apprised of progress and supportive of the efforts?
- At what point will we update the program plan?

Chapter 9. Resources

Federal Highway Administration Resources

Organizational Issues

Creating a Foundation for 21st Century Operations

https://ops.fhwa.dot.gov/program_areas/creating_foundation.htm

Creating an Effective Program to Advance Transportation System Management and Operations Primer

<https://ops.fhwa.dot.gov/Publications/fhwahop12003/background.htm>

Organizing for Reliability Tools

https://www.fhwa.dot.gov/goshrp2/Solutions/Reliability/L06_L01_L31_L34/Organizing_for_Reliability_Tools

Planning for Operations

Advancing Metropolitan Planning for Operations: An Objectives-Driven, Performance-Based Approach – A Guidebook

<https://ops.fhwa.dot.gov/publications/fhwahop10026/>

Advancing Metropolitan Planning for Operations: The Building Blocks of a Model Transportation Plan

<https://ops.fhwa.dot.gov/publications/fhwahop10027/fhwahop10027.pdf>

Planning for Operations

<https://ops.fhwa.dot.gov/plan4ops/>

Regional Concept for Transportation Operations: The Blueprint for Action - A Primer

https://ops.fhwa.dot.gov/plan4ops/focus_areas/trans_ops.htm

Statewide Opportunities for Integrating Operations, Safety and Multimodal Planning: A Reference Manual

<https://www.fhwa.dot.gov/planning/processes/statewide/practices/manual/>

Statewide Opportunities for Linking Planning and Operations: A Primer

<https://ops.fhwa.dot.gov/publications/fhwahop08028/index.htm>

Transportation Planning for Operations: Quick Guide to Practitioner Resources

<https://ops.fhwa.dot.gov/publications/fhwahop13049/index.htm>

American Association of State Highway Transportation Officials and Transportation Research Board Resources

General Transportation Systems Management and Operations and Reliability Resources

American Association of State Highway and Transportation Offices (AASHTO):

Transportation Systems Management & Operations

<http://www.aashtotsmoguidance.org/>

National Operations Center of Excellence (NOCoE)

<http://www.transportationops.org/>

Advancing Regional Transportation Operations, A National Workshop Transportation Research Circular

<http://onlinepubs.trb.org/onlinepubs/circulars/ec150.pdf>

A Framework for Improving Travel Time Reliability

<http://www.trb.org/Main/Blurbs/169243.aspx>

Business Case Primer: Communicating the Value of Transportation Systems Management and Operations.

<http://www.transportationops.org/business-cases/business-case-primer-communicating-value-transportation-systems-management-and>

Glossary of Regional Transportation Systems Management and Operations Terms, Second Edition

<http://onlinepubs.trb.org/onlinepubs/circulars/ec166.pdf>

Presentation Guide: Operations in the 21st Century DOT: Meeting Customer Expectations

<http://www.trb.org/Main/Blurbs/169179.aspx>

Strategic Approaches at the Corridor and Network Level to Minimize Disruption from the Renewal Process

<http://www.trb.org/Main/Blurbs/168143.aspx>

Organizational Issues, Institutional Capabilities, and Business Processes

Alternative DOT Organizational Models for Delivering Service (NCHRP Project 20-24 (83))

[http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-24\(83\)_FR.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-24(83)_FR.pdf)

Attracting, Recruiting, and Retaining Skilled Staff for Transportation System Operations and Management (NCHRP Report 693)

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_693.pdf

E-Tool for Business Processes to Improve Travel Time Reliability

https://www.fhwa.dot.gov/goshrp2/Content/Documents/Factsheets/SHRP2_L34_Final_Report1401.pdf

Guide to Improving Capability for Systems Operations and Management

http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-L06-RR-2.pdf

Guide to Integrating Business Processes to Improve Travel Time Reliability

http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-L01-RR-2.pdf

Incorporating ITS into the Transportation Planning Process: An Integrated Planning Framework – Parts I and II

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w118part1.pdf (Part I)

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w118part2.pdf (Part II)

Institutional Architectures to Improve Systems Operations and Management

http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-L06-RR-1.pdf

Managing Change in State Departments of Transportation, Scan 3 of 8: Innovations in Institutionalization of Operations

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w39-3.pdf

Planning for Transportation System Management & Operations (NCHRP Project 20-07(345))

[http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07\(345\)_FR.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(345)_FR.pdf)

Strategic Transportation Systems Management & Operations program planning Lead States Initiative Development & Evaluation (NCHRP 20-07(365))

[http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07\(365\)_FR.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(365)_FR.pdf)

Transportation Operations Training Framework (NCHRP 20-77)

<http://www.catt.umd.edu/research/transportation-operations-framework>

Sample Transportation Systems Management and Operations Program Plans and Related Documents

Statewide Plans and Programs

Colorado Department of Transportation (DOT) Transportation Systems Management and Operations (TSMO) Program (2016)

<https://www.codot.gov/programs/operations>

Florida Transportation Systems Management and Operations Strategic Plan (2013)

<http://floridait.com/01ITSGC/doc-TSMO/TSMO-Strategic-Plan-2013-v2.pdf>

Iowa TSMO Strategic Plan and TSMO Program Plan (2016)

<http://www.iowadot.gov/TSMO/>

Minnesota DOT Highways Systems Operations Plan 2012-2015 (2012)

<http://www.dot.state.mn.us/maintenance/hsop/pdf/report.pdf>

Washington State DOT Statewide Intelligent Transportation Systems Plan (2009)

<http://www.wsdot.wa.gov/partners/prtpo/docs/materials/ITSPlan32409.pdf>



Regional Plans

Delaware Valley Regional Planning Commission, TSMO Program and Transportation Operations Master Plan

<http://www.dvrpc.org/Transportation/TSMO/>

Denver Regional Council of Governments, Regional Concept of Transportation Operations (2012)

https://drcog.org/sites/drcog/files/resources/Regional%20Concept%20of%20Tranp%20Operations%2008-15-12_0.pdf

North Central Texas Intelligent Transportation System (ITS) Strategic Deployment Plan (2016)

<http://www.nctcog.org/trans/its/RegITSArch/documents/ITSSDPFINALReportwithAppendix.pdf>

Portland Metro Regional Transportation System Management and Operations 2010-2020 (2010)

http://www.oregonmetro.gov/sites/default/files/062010_regional_transportation_system_management_operations_plan_executive_summary.pdf

Southeastern Wisconsin Regional Planning Commission 2012-2016 (2012)

<http://www.sewrpc.org/SEWRPCFiles/Publications/mr/mr-202-reg-transportation-operations-plan-for-se-wisc.pdf>



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U.S. Department of Transportation
Federal Highway Administration

U.S. Department of Transportation
Federal Highway Administration
1200 New Jersey Avenue, SE
Washington, DC 20590
Toll-Free “Help Line” 866-367-7487
<https://ops.fhwa.dot.gov>
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