

Organizing for TSMO

Case Study 10: State Department of Transportation Examples 2 of 2

August 2019



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List of Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADOT	Arizona Department of Transportation
CDOT	Colorado Department of Transportation
CMM.....	Capability Maturity Model
COBRA.....	Corridor Operations Bottleneck Reduction Assistance
DOT	Department of Transportation
FHWA.....	Federal Highway Administration
ITS.....	Intelligent Transportation Systems
MPO	Metropolitan Planning Organization
RTD.....	Regional Transportation Director
SHRP2.....	Strategic Highway Research Program 2
TRB.....	Transportation Research Board
TSMO	Transportation Systems Management and Operations

EXECUTIVE SUMMARY

Transportation systems management and operations (TSMO) provides tools for transportation managers to address safety, system performance, and reliability. TSMO is “an integrated set of strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system.¹” Through participation in the second Strategic Highway Research Program (SHRP2) workshops, transportation agencies are working to better support TSMO programs. Deploying intelligent transportation systems (ITS), hiring internal information technology staff, and using performance measures for data-driven decisions are just a few examples of the many activities a TSMO program can support.

Given the varying stages of TSMO adoption and advancement, the Federal Highway Administration identified the need for case studies to provide examples of common challenges and best practices for transportation agencies to learn from each other. This is one of 12 case studies developed to support organizing for TSMO. This case study focuses on how TSMO activities were implemented at two State agencies, including:

- Developing formal organization and structure for a TSMO program.
- Incorporating TSMO into planning documents and ITS architecture.
- Implementing safety and mobility strategies.
- Collaborating with stakeholders across the State.
- Identifying funding for TSMO activities and strategies.

Two State departments of transportation were identified as having a holistic approach to their TSMO programs: the Arizona Department of Transportation (ADOT) and the Colorado Department of Transportation (CDOT). Each agency provided information on how they engaged stakeholders and implemented TSMO activities, lessons learned, and next steps to continually improve these efforts. Some of the best practices identified include:

- ADOT’s integration of innovative mobility strategies into its statewide architecture.
- ADOT’s development and consistent review of performance measures.
- CDOT’s regional operations manager role to support localized operations and maintenance activities.
- CDOT’s Corridor Operations Bottleneck Reduction Assistance program to fund bottleneck reduction projects.

¹ Source: <https://ops.fhwa.dot.gov/tsmo/index.htm>

CHAPTER 1 – INTRODUCTION

Historically, transportation agencies have managed congestion primarily by funding major capital projects that focused on adding capacity to address physical constraints such as bottlenecks. Operational improvements were typically an afterthought and considered after the new infrastructure was already added to the system. Given the changing transportation landscape that includes increased customer expectations, a better understanding of the sources of congestion, and constraints in resources, alternative approaches were needed. Transportation systems management and operations (TSMO) provides such an approach to overcome these challenges and address a broader range of congestion issues to improve overall system performance. With agencies needing to stretch transportation funding further and demand for reliable travel increasing, TSMO activities can help agencies maximize the use of available capacity and implement solutions with a high benefit-cost ratio. This approach supports agencies' abilities to address changing system demands and be flexible for a wide range of conditions.

Effective TSMO efforts require full integration within a transportation agency and should be supported by partner agencies. This can be achieved by identifying opportunities for improving processes, instituting data-driven decision-making, establishing proactive collaboration, and developing actionable activities to develop processes that optimize performance.

Through the second Strategic Highway Research Program (SHRP2), a national partnership between the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the Transportation Research Board, (TRB), a self-assessment framework was developed based on a model from the software industry. SHRP2 developed a framework for agencies to assess their critical processes and institutional arrangements through a capability maturity model (CMM). CMM uses six dimensions of capability to allow agencies to self-assess their implementation of TSMO principles¹:

1. Business processes – planning, programming, and budgeting.
2. Systems and technology – systems engineering, systems architecture standards, interoperability, and standardization.
3. Performance measurement – measures definition, data acquisition, and utilization.
4. Culture – technical understanding, leadership, outreach, and program authority.
5. Organization and workforce – programmatic status, organizational structure, staff development, recruitment, and retention.
6. Collaboration – relationships with public safety agencies, local governments, metropolitan planning organizations (MPO), and the private sector.

Within each capability dimension, there are four levels of maturity (performed, managed, integrated, and optimized), as shown in Figure 1. An agency uses the CMM self-assessment to

¹ FHWA, Office of Operations, "Organizing for Reliability – Capability Maturity Model Assessment and Implementation Plans Executive Summary," May 2015. <https://ops.fhwa.dot.gov/docs/cmmexesum/sec1.htm>

identify their level of maturity in each dimension, to determine their strengths and weaknesses in each dimension, and to determine actions they can take to improve their capabilities.

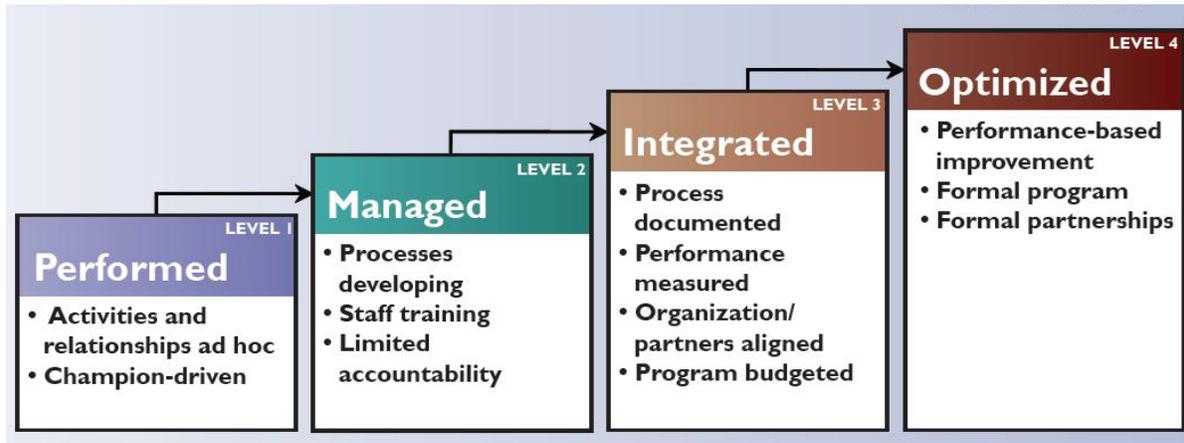


Figure 1. Chart. Four Levels of Maturity

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

Purpose of Case Studies

In the first 10 years of implementation of the TSMO CMM, more than 50 States and regions used the tool to assess and improve their TSMO capabilities. With the many benefits experienced by these agencies, FHWA developed a series of case studies to showcase leading practices to assist other transportation professionals in advancing and mainstreaming TSMO into their agencies. The purposes of the case studies are to:

- Communicate the value of changing the culture and standard practices towards TSMO to stakeholders and decision-makers.
- Provide examples of best practices and lessons learned by other State and local agencies during their adoption, implementation, and mainstreaming of TSMO.

These case studies support transportation agencies by showing a wide range of challenges, opportunities, and results to provide proof for the potential benefits of implementing TSMO. Each case study was identified to address challenges faced by TSMO professionals when implementing new or expanding existing practices in the agency and to provide lessons learned.

Identified Topics of Importance

This case study describes the holistic perspective of successful TSMO programs at State departments of transportation (DOT). This study features two agencies; another set of two agencies is featured in case study 9.

Highlighting all aspects of specific State DOTs is important because it demonstrates how the culmination of several different TSMO activities support the broader objective to improve safety and mobility. Agencies highlighted for this case study have different approaches, providing beneficial lessons learned for development of TSMO divisions, integration of TSMO with planning activities, and taking advantage of opportunities to integrate strategies into projects.

Interviews

Agencies were selected for each case study based on prior research indicating that the agency was excelling in particular TSMO capabilities. Care was taken to include diverse geographical locations and agency types (DOTs, cities, and MPOs) to develop case studies that other agencies could easily relate to and learn from.

Interviews were conducted with selected agencies to collect information on the topic for each case study. Permission was received from each agency to use information discussed during the interview and shared afterwards for the purpose of this case study.

Description of State Departments of Transportation

As the primary manager and operator of a State transportation system, State DOTs usually have a leading role in the execution of a TSMO program. How business is conducted in each State DOT affects the structure and delivery of TSMO programs in varying ways. Elements such as the DOT's organizational structure, involvement of executive staff, existing relationships with partner agencies, the DOT's culture, and other factors greatly impact development and integration of TSMO within an agency's existing work flow. It is the responsibility of all partner agencies to advocate for and help enhance TSMO planning in their regions. State DOTs can play a leading role in promoting TSMO in the following capacities:

- **Program Structure** – With their wide range of staff and responsibilities, State DOTs can be responsible for developing the structure and organization of a TSMO program. In this role, State DOTs are also responsible for developing TSMO goals and a unified vision for the program.
- **Processes and Institutional Arrangements** – Having a broad perspective, State DOTs can identify strategic partnerships, develop processes to improve collaboration or design, and establish maintenance or operations agreements.
- **Safety and Mobility Strategies** – State DOTs can identify specific strategies for deployment to improve safety and mobility. This requires close collaboration with MPOs and local agencies to produce seamless travel experiences between jurisdictions.
- **Funding** – State DOT's funding opportunities can guide their role in developing a TSMO program. TSMO can help inform a transportation investment plan to support specific programs, or they may have access to different federal options to fund projects or initiatives.
- **Communication with Stakeholders** – With statewide coverage, State DOTs have the opportunity to communicate with all MPOs, local agencies, multimodal agencies, and other stakeholders across various jurisdictions. State DOTs can leverage these relationships to share information about a TSMO program and unify the goals of regions with a wide range of participants.

CHAPTER 2 – BEST PRACTICE EXAMPLES

Agencies highlighted in this case study participated in the second Strategic Highway Research Program (SHRP2) workshops to complete capability maturity model (CMM) assessments. Workshop assessments supported the agencies in understanding their needs and raised awareness of transportation systems management and operations (TSMO). Both agencies created TSMO divisions soon after the workshops and developed strategic plans integrated with other long-term planning activities. This chapter highlights several successful initiatives each agency accomplished, specifically regarding advancing their TSMO programs across the State.

Arizona Department of Transportation (ADOT)

The Arizona Department of Transportation (ADOT) is a multimodal transportation agency serving one of the fastest growing areas in the country. ADOT is responsible for planning, building, and operating a complex highway system, and has seven geographic districts with unique needs and challenges that has led to mobility planning being adhoc at best. ADOT implemented the statewide TSMO division in 2015 to support statewide optimization of existing infrastructure through TSMO strategies.

TSMO Strategic Plan

ADOT developed a TSMO Strategic Plan after launching the new division in 2015. To develop the Strategic Plan, ADOT engaged internal and external stakeholders concerning design, construction, and maintenance. All stakeholder input was considered for incorporation into the plan. To gain buy-in, ADOT focused on educating stakeholders on what TSMO is and how the strategies supported through the program are cost-effective.

Completing the TSMO Strategic Plan was helpful to ADOT because it provided direction for near-, mid-, and long-term action items to implement TSMO strategies. It set the framework for the new TSMO division, supported decision-making, and helped staff understand the goals and organization of ADOT's TSMO initiative. Now that the plan has been in place for several years, ADOT is planning an update in 2020 to build on progress that has been made and continue process improvements.

Integration with ITS Plans and Statewide Architecture

ADOT updated the statewide architecture to include TSMO strategies such as smart work zones and incident management. Having these elements documented in plans will help with advocating for investing in statewide strategies to improve safety and mobility. Recent revisions to the plan were different from previous architecture updates because they were forward-thinking to include emerging technology and an increased need for effective communication to support connected and autonomous vehicles.

As part of the ITS statewide architecture plan, ADOT has committed to installing communication conduit on all new projects and has included the requirement in standard

specifications. Though the segments may not all currently connect, it will help connections in the future, especially outside of urban areas. ADOT understands the key role of communications in enabling emerging technology solutions and the framework that it builds for connected and autonomous vehicles. The agency predicts that emerging technology on key corridors has the highest potential for improving freight movement. They are working on strategies to take advantage of those opportunities.

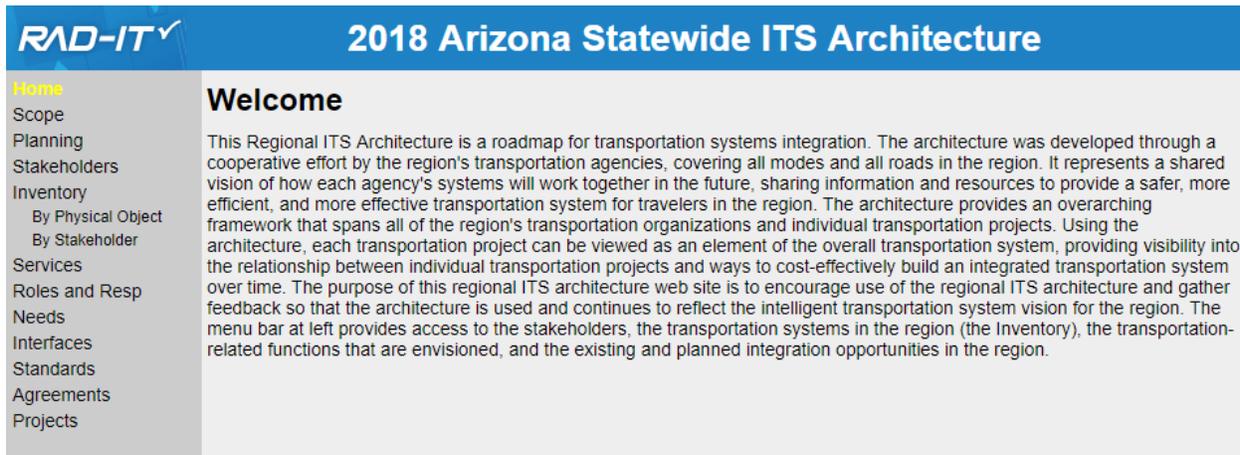


Figure 2. Chart. 2018 Arizona Statewide ITS Architecture Website

Source: <https://apps.azdot.gov/files/its-architecture/index.htm>

ADOT is planning to deploy other intelligent transportation systems (ITS) solutions including wrong-way driving countermeasures, connecting rural and urban signals, dust detection (notifications on dynamic message signs when dust storms occur), and deployment of solutions contributing to the national signal phase and timing challenge.

ADOT noted that strategies for wrong-way driving, connecting rural signals, dust detection, and more would not have been recommended prior to TSMO activities because their traditional business process was focused on design and construction. Now they are forward-thinking on how to operate and maintain their system.

Collaboration and communication have been key to deploying operational and safety strategies. ADOT has worked with AZTech and metropolitan planning organizations (MPO), and internationally with Mexico. Because of relationships that have been developed and an understanding of needs established through TSMO, emerging technology deployments are being advanced to be proactive in managing transportation with support from partners.

Performance Measures

In previous years, the University of Arizona had initiated development of performance measures. Through the TSMO program, the university and ADOT have worked together to expand and streamline these performance measures to assist with project planning and deployment. Each group manager in ADOT's TSMO division reports the "vital few" performance metrics on a monthly basis. The "vital few" are the performance measures that the division sees as most relevant to observing needs and challenges. ADOT collects data in the following categories:

- Administration (hiring, budget).
- System maintenance (connectivity, operability).
- Systems management (permits, coverage, maintenance).
- Traffic maintenance (pavement marking, signing).
- Traffic management (traffic incident management training, time to clear, after action reports).
- Operational traffic and safety (crashes, signal failures, safety funding).
- Systems technology (delay, reliability, system completion).

The performance metrics are flexible depending on agency needs and current challenges. The “vital few” are reported on a single sheet and color-coded to show if performance is reaching target, is within a range of reaching the target, or is not reaching the target. An excerpt from this output is shown in Figure 3. Having all relevant data on one page makes it easily accessible to executive leadership and staff. Countermeasure triggers have also been defined to highlight when targets are not met for consecutive months. This level of detail is key to ensuring ADOT is proactive in addressing issues.

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SYSTEMS MAINTENANCE																
[#3] Percent of Traffic Signals with Comm Equipment	Quality	6/30/2017	Target		31%	31%	31%	43%	43%	43%	43%	43%	43%	43%	43%	43%
		31%	Actual		31%	31%	31%	31%	31%	35%	35%	32%	32%	32%		
[#4] Maintain Phoenix Metro Roadway Lighting Operability at 95%	Quality	6/30/2017	Target		95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
		93	Actual		93%	93%	93%	94%	94%	94%	94%	94%	93.1%	93.1%		
[#5] Metro Phoenix CCTV Camera Operability at 100%	Quality	6/30/2017	Target		98%	98%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%
		97%	Actual		97%	98%	98%	98%	99%	99%	97%	98%	99.3%	95.6%		
[#19] TBD: WWD metric based on incursion data from pilot	Quality		Target													
			Actual													
[#6] Maintain Phoenix Metro Pump Stations at 90% Operability (Pump stations that dewater the freeway)	Quality	6/30/2017	Target		90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
		75	Actual		75%	68%	66%	61%	59%	59%	61%	63%	62.7%	65.0%		

Figure 3. Chart. Excerpt from ADOT TSMO Performance Measures
Source: ADOT

As a team, group managers discuss the metrics, set targets, and determine how to help meet targets. Focus on developing valuable, effective metrics that capture all work being done has been beneficial for ADOT to continue making progress. By consistently gathering and discussing the data, ADOT is able to support the TSMO story, indicating what the division has been doing and proving the value that it adds statewide.

The strategic plan, establishing performance measures and integrating TSMO strategies into existing plans, has helped improve the TSMO culture in the agency. As ADOT continues to advance and promote a TSMO approach to mitigating common transportation challenges, their maturity in each CMM dimension has improved. Forward thinking, revised processes, and development of new processes continues to advance TSMO in the agency.

Colorado Department of Transportation (CDOT)

The Colorado Department of Transportation (CDOT) is composed of five regions with a largely centralized organization. CDOT manages highway facilities, including over 35 mountain passes where inclement weather poses additional challenges for safety and mobility. A TSMO division was initiated in 2015 to provide statewide programs and strategies to improve travel time reliability and safety.

Regional Operations Manager

CDOT introduced corridor operations managers in 2014 along Interstates 70 and 25 to help facilitate and support incident management. This role was identified as a need because the facilities span multiple regions; therefore, several different jurisdictions are responsible for management and operations. Corridor operations managers provide consistency by reporting directly to headquarters, but they operate from a traffic management center located along the corridor they manage. Regional Transportation Directors (RTD) saw value in the corridor operations manager position and requested additional support in this capacity.

CDOT implemented regional operations centers that co-located State patrol with operations staff to foster collaboration when dealing with activities such as road weather management, highway maintenance, and incident management. CDOT determined that a regional operations manager would be a valuable role to manage regional operations centers and support the RTD's needs. This role reported to the TSMO division but was also in direct contact with the RTD. The regional operations manager provided valuable input into the direction, needs, and strategy for CDOT given their hands-on experience within the regions working in the operations centers.

CDOT chose to select Region 1 (Denver metro area) and Region 2 (Southern Colorado) regional operations managers. The regions supported these positions with funding for vacant positions and salary, showing their enthusiasm for the regional operations manager strategy. These changes improved collaboration for maintenance and operations statewide. Regional operations managers improved protocols, practices, and expectations for corridor operations, especially during the winter and inclement weather.



Figure 4. Photo. Hanging Lake Tunnel Traffic Control Center

Source: <http://www.kunc.org/post/traffic-watchers-and-first-responders-work-deep-inside-hanging-lake-tunnel#stream/0>

TSMO Evaluation

In 2014, CDOT initiated the TSMO Evaluation, an analysis of safety, operations, and technology performed prior to completing a project design phase. The TSMO Evaluation was originally planned to be an approval process similar to project planning processes at CDOT for environmental and right-of-way but it received pushback because it held up the progression of the project. By working closely with CDOT’s process improvement team, the TSMO division staff engaged a wide range of stakeholders and revised the process to be a streamlined evaluation, which was very well-received by region staff.

The TSMO Evaluation, shown in Figure 5, addressed and encouraged each element of CMM by acting as a checklist to ensure specific policies, procedures, and considerations are made during the project design. Regional staff used the evaluation to determine if innovative safety and mobility strategies can be incorporated into the project. CDOT planned to develop a process to complete the TSMO Evaluation earlier at the inception of the project to proactively identify if unique solutions can replace a traditional project, such as adding lanes of capacity. Additional details regarding the TSMO Evaluation can be found in Case Study 4: Culture – Changing the Culture Towards Transportation Systems Management and Operations in State Departments of Transportation.

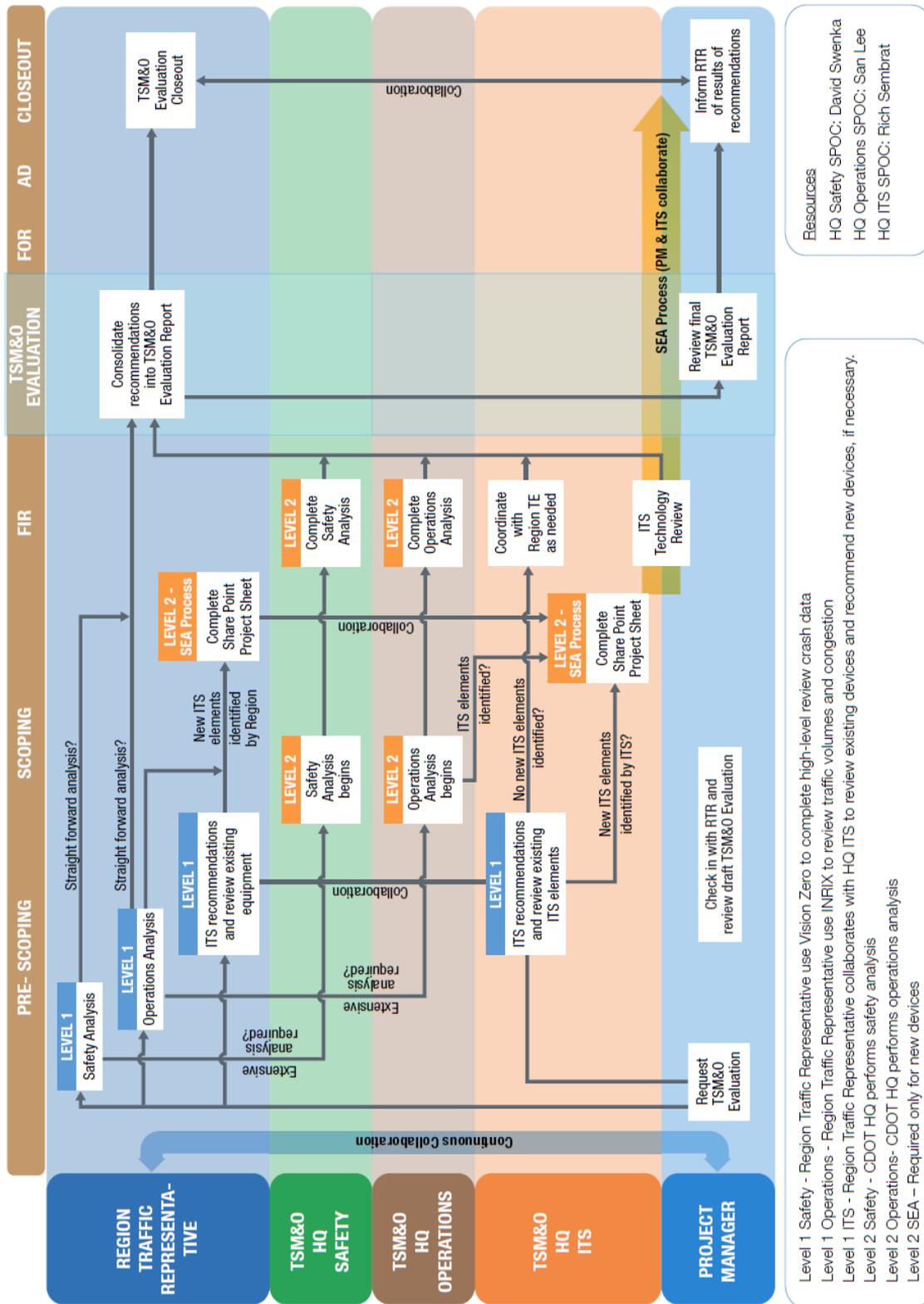


Figure 5. Chart. CDOT TSMO Evaluation Flow Chart

Source: CDOT, https://www.codot.gov/business/designsupport/bulletins_manuals/adg/tsmo

Corridor Operation Bottleneck Reduction Assistance

CDOT developed a funded program for Corridor Operations Bottleneck Reduction Assistance (COBRA). Through close collaboration with CDOT regions, a list was formulated of locations where operations could be improved. Previously, these localized issues did not have dedicated funding. The list of over 100 projects was prioritized and each year several projects were distributed to a pool of consultant teams to develop solutions.

Each region could receive COBRA program funding to analyze, design, and construct bottleneck reduction projects. An example of a recent success identified through the program was a lane reconfiguration project in which striping was modified along an urban section of Interstate 70 at a cost of approximately \$10,000. With this improvement, CDOT was able to significantly reduce travel times by reducing friction and weaving issues during peak periods.

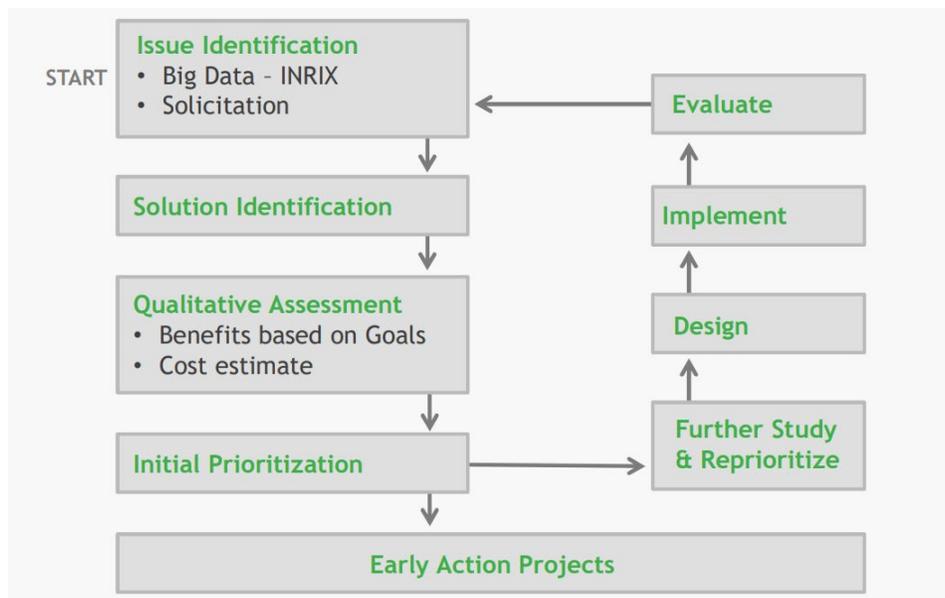


Figure 6. Chart. COBRA Program Workflow

Source: https://www.westernite.org/annualmeetings/16_Albuquerque/Presentations/4C_Borsheim.pdf

Statewide Planning Team Engagement

The CDOT TSMO division actively engaged CDOT and local agency planning stakeholders at several opportunities:

- Recurring planning meetings, including the monthly statewide planning meeting, State transportation advisory committee, and separate transportation planning region and MPO meetings.
- Statewide initiatives including traffic incident management, safety patrol, program management teams, and the TSMO Evaluation.
- Project-specific meetings including those for technical advisory committees, 2040 Long-Range Transportation Plan, and statewide Smart Mobility Plan.

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By attending these meetings and collaborating on statewide initiatives, CDOT's TSMO vision and goals were shared and gained endorsement. Performance measures collected by the TSMO division were incorporated into planning activities to help inform decisions. As partnerships grew, planning groups were a great advocate for TSMO.

TSMO business processes and recommendations were incorporated into planning and environmental linkage studies, a process to identify transportation and environmental concerns on large corridors or specific locations. CDOT identified this project type as a key opportunity to have discussions about operations and maintenance with planning subject matter experts to discuss solutions early in the project development process.

CHAPTER 3 – SUMMARY

State agencies have a vital role in developing and implementing transportation systems management and operations (TSMO) programs, including developing organizational structures and processes, identifying strategies to implement, and collaborating with a wide range of stakeholders. Both agencies interviewed for this case study have implemented dedicated TSMO divisions to raise the priority of safety and mobility considerations that optimize existing infrastructure. Each agency contributed to TSMO goals through initiatives that other agencies can gain lessons learned from:

- Developing a formal structure and processes can encourage advancement of TSMO activities. By documenting the institutional arrangement and organization framework, such as through TSMO program planning, a uniform understanding can be implemented statewide. It is important that TSMO program planning is a continuous process, evolving to fit the needs of the agency and addressing emerging opportunities.
- Collaborating with planning, design, construction, and maintenance groups can help integrate TSMO strategies into projects or replace projects more efficiently. By beginning conversations regarding safety, operations, and maintenance early in the project prioritization and development phases, innovative strategies and initiatives can be implemented cost-effectively.
- Using performance measures is beneficial to identifying and deploying mobility strategies. Targets should be established so that goals are understood by agencies and discussions about countermeasures can occur proactively. Performance measure reporting should be consistent and accessible to all staff to maintain and promote a culture of data-driven decision-making and continuous improvement.

State departments of transportation (DOT) can help ensure that objectives of transportation systems management and operations (TSMO) programs are consistent with existing statewide and regional objectives. In many cases, the DOT will lead the effort to develop a TSMO plan for their State. The DOTs highlighted in this case study have taken varying approaches to integrate TSMO with existing agency processes. Lessons learned in this case study can be used to develop TSMO plans in other agencies.

REFERENCES

Information used in this case study was gathered from sources noted throughout the report together with the following web sites:

- FHWA’s What is Transportation Systems Management and Operations (TSMO)?
 - <https://ops.fhwa.dot.gov/tsmo/>
- AASHTO’s TSMO Guidance
 - <http://www.aashtotsmoguidance.org/>
- FHWA’s Organizing and Planning for Operations
 - <https://ops.fhwa.dot.gov/plan4ops/>
- FHWA’s Organizing for Operations Resources
 - https://ops.fhwa.dot.gov/plan4ops/focus_areas/organizing_for_op.htm
- FHWA’s Organizing for Reliability – Capability Maturity Model Assessment and Implementation Plans
 - <https://ops.fhwa.dot.gov/docs/cmmexesum/sec1.htm>
- FHWA’s Creating an Effective Program to Advance Transportation Systems Management and Operations, Primer
 - <https://ops.fhwa.dot.gov/publications/fhwahop12003/index.htm>
- Arizona Department of Transportation
 - <https://azdot.gov/business/transportation-systems-management-and-operations-tsmo>
- Colorado Department of Transportation
 - <https://www.codot.gov/programs/operations>

Table 1. Interview Participants and Agencies

Agency	Arizona Department of Transportation (AZDOT)	Colorado Department of Transportation (CDOT)
Agency Representative Name:	Brent Cain	Ryan Rice
Agency Representative Title:	Division Director	Former Director of TSMO
Agency Representative Email:	bcaïn@azdot.gov	N/A
Interview Date:	May 24, 2018	July 9, 2018

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