Regional TSMO Business Case and TSMO Plan Guide

Final Report

Regional Transportation Commission of Southern Nevada

September 2023

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List of Acronyms and Abbreviations

Caltrans	California Department of Transportation
CDOT	Colorado Department of Transportation
CHART	Coordinated Highways Action Response Team
CMM	Capability Maturity Model
FAST	Freeway and Arterial System of Transportation
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
IOP	Institutional, Organizational, and Procedural
IPT	Investment Prioritization Tool
IT	Information Technology
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
JBLM	Joint Base Lewis-McChord
JOG	Joint Operations Group
KSA	knowledge, skills, and abilities
LADOT	Los Angeles Department of Transportation
LCC Tool	Lifecycle planning tool
LVMPD	Las Vegas Metropolitan Police Department
MDOT	Maryland Department of Transportation
MOU	Memoranda of Understanding
NCHRP	National Cooperative Highway Research Program
NDOT	Nevada Department of Transportation
ODOT	Oregon Department of Transportation
OR	Oregon Route
PATG	Parking and Transportation Group
PTC	Pennsylvania Turnpike Commission
RTC	Regional Transportation Commission
SHRP2	Second Strategic Highway Research Program
SME	Subject Matter Experts
TAMP	Transportation Asset Management Plan
TIM	Traffic Incident Management
TMC	Traffic Management Center
TSMO	Transportation Systems Management and Operations
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation
UDOT	Utah Department of Transportation
WSDOT	Washington Department of Transportation

Executive Summary

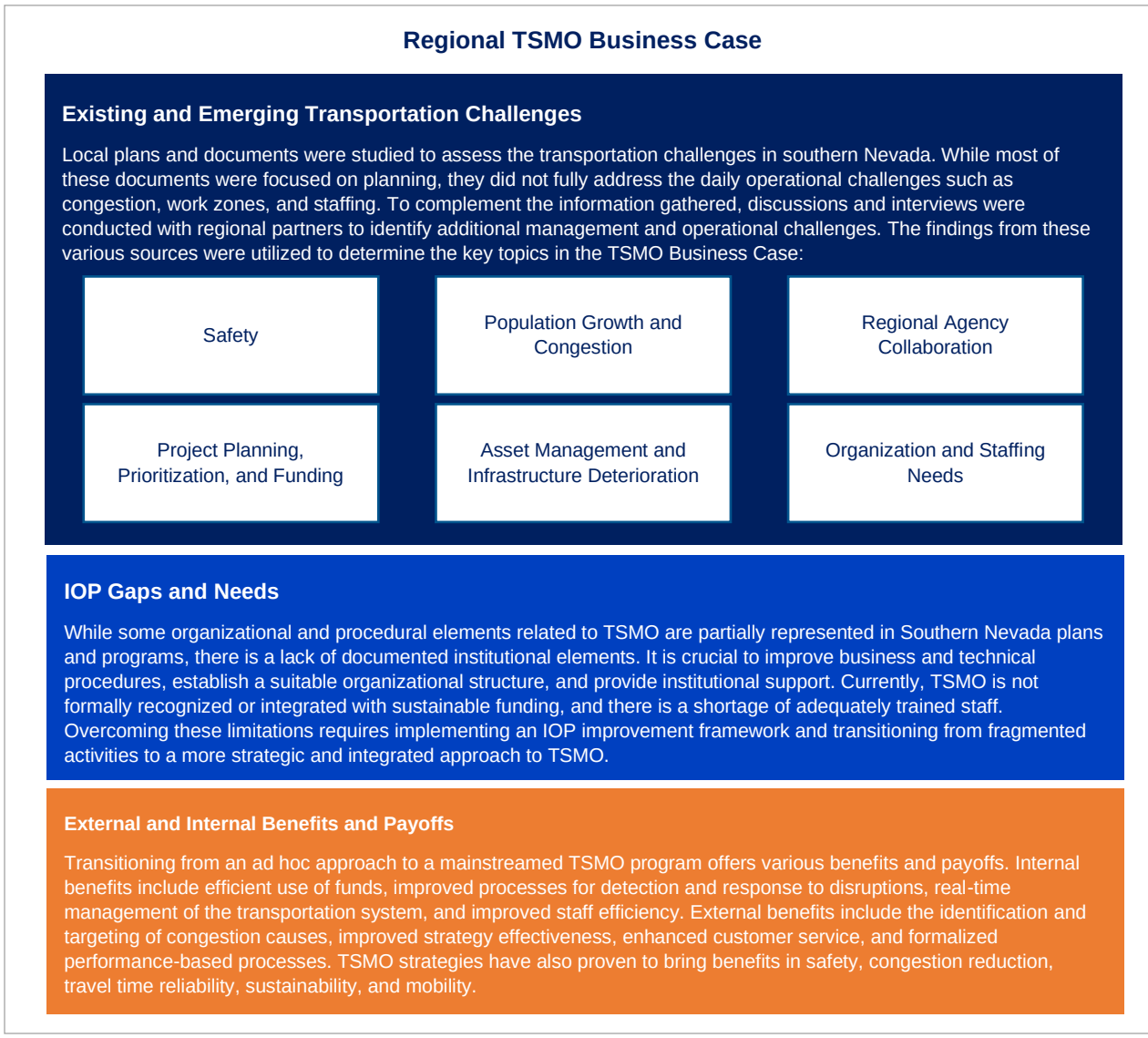
Transportation Systems Management and Operations (TSMO) is gaining recognition as a core mission as agencies shift their focus from infrastructure expansion to effectively managing and operating the existing transportation systems. TSMO provides an integrated approach that optimizes systemwide performance through projects, strategies, technologies, and processes, improving safety, reliability, and connectivity while preserving infrastructure and addressing congestion. Collaborative efforts and well-defined institutional arrangements are crucial for successful TSMO planning and implementation, ensuring its integration into the agencies' core mission and operational practices.

The Regional Transportation Commission (RTC) of Southern Nevada initiated the Regional TSMO Business Case and TSMO Plan Guide development to understand the appetite of Southern Nevada agencies in 1) creating a regionally distinct TSMO Plan, and 2) addressing Southern Nevada's unique challenges in lieu of adopting the Statewide Nevada Department of Transportation's (NDOT) TSMO Program. The outcome is to create TSMO Plans and/or Tactical TSMO Strategies, that address regional needs, while still complementing the state's Program.

In collaboration with local partner agencies, RTC has developed the TSMO Business Case and TSMO Plan Guide to foster greater commitment to advancing transportation systems among senior leadership and regional partners. The development of this document involved identifying the state of TSMO practices in Southern Nevada, engaging stakeholders for feedback on the importance of enhancing TSMO in the region, and conducting an internal Capability Maturity Model (CMM) self-assessment.

This comprehensive document describes the need for TSMO, emphasizes on Institutional, Organizational, and Procedural (IOP) arrangements that go beyond traditional practices, and outlines the next steps for TSMO planning implementation in Southern Nevada.

The Regional TSMO Business Case addresses existing and emerging transportation challenges, IOP needs and gaps, and external and internal benefits and pay offs. The TSMO Business Case also informs the development of the TSMO Plan Guide which frameworks the implementation guidelines for an effective regional TSMO program.



The TSMO Plan Guide provides direction and guidance for implementing a coordinated TSMO approach in southern Nevada, specifically tailored to the region's transportation challenges. Local agencies are responsible for hands-on activities related to identifying, deploying, operating, and maintaining TSMO strategies. Accordingly, the TSMO Plan Guide focuses on three components: 1) regional goals and objectives, 2) strategies and tactical plans for the initial implementation phase, and 3) IOP enhancements to optimize the TSMO culture in the region.

Strategic Goals and Objectives

Strategic goals and objectives highlight the "what". What will the southern Nevada region achieve with TSMO? The Southern Nevada Strategic Goals and Objectives were developed using findings from State of the Practice and stakeholders' feedback.

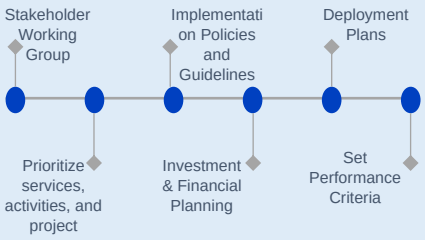
- **Enhance Safety**
- **Optimize Customer Service**
- **Strengthen Technology Integration**
- **Optimize Resource Allocation**
- **Address ITS and Infrastructure Gaps**
- **Manage Congestion**
- **Strengthen TSMO Integration**
- **Promote Data Sharing**
- **Enhance TSMO Workforce and Training**

Initial TSMO Strategies for Southern Nevada

Tactical plans could be developed to formalize and cohesively document existing activities and additional processes for TSMO strategies in the following order:

- ✓ **Work Zone Management**
- ✓ **Traffic Signal Coordination**
- ✓ **Integrated Corridor Management**
- ✓ **Incident and Emergency Management**
- ✓ **Bike and Pedestrian Crossings**

Step by Step process to develop and implement TSMO Tactical Plans:



IOP Enhancements for Southern

IOP arrangements play a crucial role in enabling a cultural shift to support TSMO beyond budgets and technologies. While implementing changes to IOP arrangements may not be costly or time-consuming, they can be challenging due to reorganization, new reporting requirements, resource competition, and adjustments to existing policies and processes. It is important to approach these changes incrementally to facilitate ongoing improvements in emerging TSMO activities. IOP enhancements will be further identified during the development of the TSMO Tactical Plans.

The next steps for implementation of the recommended tactical plans identified in the TSMO Plan Guide involve two categories: mobilization and preparedness, and execution. The RTC will lead the development of the tactical plans, with an internal TSMO champion overseeing the process and subject matter experts. Local agencies are encouraged to participate as stakeholders, provide input, and commit to supporting the regional TSMO goals and objectives.

Strong leadership support is essential for fully embracing TSMO as a core component of agency processes. Southern Nevada stakeholders are encouraged to consider recommended action items to enhance the TSMO culture within their organizations and drive successful implementation.

1 Introduction

Historically, transportation agencies have organized activities and processes to address congestion through expanding and delivering infrastructure capacity. As societies begin to place a greater value on safety, system performance, and reliability, agencies are evolving their mission to efficiently manage and operate the existing infrastructure to meet public expectations. To this end, agencies are recognizing the importance of Transportation Systems Management and Operations (TSMO) as a core mission, shifting the focus to growing an understanding of how managing and operating the transportation system goes beyond implementing ad hoc projects.

Research conducted by the Second Strategic Highway Research Program (SHRP2) demonstrated that effective management and operations of the transportation system does not solely rely on budget, types of projects, or technical skills. It also relies on the development of Institutional, Organizational, and Procedural (IOP) arrangements that enable system management and operations to be in line with capacity improvements.

The Regional Transportation Commission (RTC) of Southern Nevada, supported by the member agencies, is committed to enhance safety, mobility, and reliability of transportation systems to move people, goods, and services safely and efficiently. This TSMO Business Case and TSMO Plan Guide will describe how the agencies can rearrange their “way of doing business” to reduce barriers and increase capabilities for TSMO implementation in Southern Nevada.

1.1 The Need for TSMO

Transportation agencies have traditionally focused on capital project planning, design, construction, and maintenance, with minimal emphasis applied to an integrated approach on managing and operating the transportation systems. This focus is now changing rapidly, as agencies are recognizing safety and financial impacts of both recurring and non-recurring congestion, change in public demand, resource limitations, and advancements in technology.

TSMO is an emerging concept used to describe an integrated program of projects, strategies, services, technologies, and processes to plan, manage, and operate transportation networks to optimize systemwide performance. TSMO offers opportunities that can improve system performance through multimodal, intermodal, and cross-jurisdictional efforts that preserve existing infrastructure and capacity while enhancing public safety and security, seamless connection between modes, and improved reliability. Additionally, TSMO can be applied in combination with capacity improvement projects to enhance effectiveness, especially when managing non-recurring congestion.

Most local agencies in Southern Nevada have been conducting TSMO activities for years, although not necessarily labelled as TSMO. Educational efforts have increased awareness and understanding that TSMO is what agencies do on a daily basis. The majority of TSMO strategies are relatively inexpensive, compared to capacity improvements, and can be implemented in the short term. Improving the system’s operational management also has the potential to offer a variety of co-benefits, such as lower vehicle operating costs or faster project implementation timelines. However, effective TSMO planning and implementation relies on IOP arrangements and processes within agencies. Internal and external collaboration is a fundamental element and will help advance TSMO as a core part of the mission supported by organizational roles, responsibilities, and processes.

1.2 The Need for Business Case and IOP Arrangements

Improving TSMO effectiveness requires development of IOP arrangements or changes that may differ from legacy or existing arrangements. This can introduce a unique set of challenges such as reorganization, new reporting requirements, competition for resources, or changes that impact legacy policies and processes. Overcoming these challenges and leveraging opportunities can be accomplished through the lens of a TSMO Business Case, which explores IOP elements that can reduce barriers and enhance TSMO capabilities. These elements generally fall into three categories:

- **Institutional:** includes elements that are primarily focused on advancing the agency's culture that values TSMO, along with the mission, objectives, technical understanding, leadership, outreach, and program authorities that support TSMO.
- **Organizational:** includes elements that help adjust or rearrange the structure of roles and responsibilities such as reorganization, new or revised position descriptions, staff development and training, recruitment and retention, and collaboration that support TSMO functions.
- **Procedural:** includes elements that improve both technical and business processes to formally integrate TSMO, such as adjustments to planning, programming, budgeting, systems engineering, developing Standard Operating Procedures, and performance measurement processes.

Changes and adjustments to IOP arrangements are cost effective and can be implemented in the short term. However, these should be incremental to support continuous enhancement of emerging TSMO activities. Therefore, they should not be used as a substitute for making systematic changes.

IOP changes and adjustments should be identified and implemented to advance TSMO, with consideration to the agency's unique context and culture. Therefore, RTC has acknowledged the importance of developing a regional TSMO Business Case that aligns with the priorities in Southern Nevada and partnering agencies. Despite multiple TSMO Business Cases that have been developed at a statewide level by Nevada Department of Transportation (NDOT), RTC has recognized the need for developing a Regional TSMO Business Case that reflects specific Southern Nevada challenges. IOP arrangements are highlighting the need for TSMO senior leadership and regional partners for a greater commitment to further prioritize the continuous advancement of transportation systems.

2 Process Summary

To develop the Southern Nevada TSMO Business Case and TSMO Plan Guide, the project team performed various research and outreach activities including:

- Identifying the current state of TSMO practices in Southern Nevada on IOP elements
- Engaging stakeholders and soliciting feedback on the importance and relevance of enhancing TSMO in the region
- Performing an internal Capability Maturity Model (CMM) self-assessment with the RTC of Southern Nevada

The following subsections provide a summary of each activity.

2.1 TSMO State of the Practice

The State of the Practice Framework includes a targeted review of more than 120 Southern Nevada, national, and Federal documents with key focus areas, as outlined in **Table 1**.

Table 1: RTC TSMO State of the Practice Framework

Key Focus Areas	Purpose
TSMO Implementation Guidance Parameters	Identify TSMO program planning components and IOP arrangements.
TSMO Strategies	Review and identify the best practices and lessons learned when TSMO Tactical Elements are in effect.
Dimensions of TSMO Capability	Identify the application of CMM dimensions for TSMO program planning and integration.

Findings from the Southern Nevada state of practice reviews illustrate that Organizational and Procedural elements and actions are the most represented topics within Southern Nevada plans and programs. On the other hand, there is a lack of documented Institutional elements and actions to support the strong strategic direction defined by Southern Nevada efforts.

Analysis of the state of practice also indicates that the majority of planned and deployed TSMO strategies in Southern Nevada are focused on Bicycle and Pedestrian Crossings and Transit Management. Although RTC and partnering agencies have implemented several other TSMO strategies, the process of planning, budgeting, and implementation these strategies are not formally integrated into the majority of Southern Nevada plans and programs.

The completed State of the Practice Report and associated findings are provided in **Appendix A**.

2.2 Stakeholder Engagement

Regional partners collaborated quarterly during the Business Case development process through the TSMO Planning Steering Committee and one-on-one interviews. Participants provided feedback on transportation challenges, interest in pursuing TSMO strategies in the region, and TSMO strategic

elements to guide the future of TSMO in Southern Nevada. The following regional stakeholders participated in engagement activities:

- Clark County – Office of Traffic Safety
- Clark County – Public Works
- City of Las Vegas
- City of North Las Vegas
- City of Henderson
- City of Boulder City
- City of Mesquite
- Regional Transportation Commission of Southern Nevada

Qualitative feedback obtained as part of stakeholder engagement activities provided the regional direction for existing and emerging transportation challenges, strategic goals and objectives, and top five tactical plans to be pursued in a collaborative manner. Detailed discussion of findings from the stakeholder engagement can be found in **Appendix B.**

2.3 Capability Maturity Model Self-Assessment

A CMM self-assessment workshop was held at the RTC Freeway and Arterial System of Transportation (FAST) offices in Las Vegas, Nevada, on August 18, 2022. The purpose of the CMM Workshop was to assess the RTC's internal capability maturity and readiness, ranging from Unknown to Mainstream, for regional TSMO adoption by evaluating the RTC's business processes, institutional capabilities, and technology systems.

Key findings from this assessment include:

- Stakeholders, in general, are not broadly familiar with the TSMO-specific activities.
- Internal stakeholders rated themselves at a low maturity level for each dimension compared to activity-specific responses which indicate there are more TSMO activities being performed than what the agency as a whole realizes.
- Responses generally indicated that participants are critically rating themselves because they have major willingness to strengthen and improve their maturity under the different dimensions of the assessment.
- The FAST department is the champion of TSMO since they have a greater awareness of TSMO-specific activities and strategies compared to the rest of the stakeholders.
- The RTC scored a maturity level below 2 in most categories based on the CMM findings. Hence, the RTC's development of a TSMO plan that optimizes operations, improves community service, and fosters collaboration with regional partners is crucial.

The CMM technical memo detailing findings from the assessment can be found in **Appendix C**.

3 RTC TSMO Business Case

As documented in National Cooperative Highway Research Program (NCHRP) 20-07 Task 365, developing the business case for TSMO has become an important tool as agencies plan and organize for TSMO. In addition, a variety of motivations can be aligned with different approaches in developing a business case. In some cases, agencies have developed extensive technical reports to document the business case for TSMO. In other cases, a brief technical memo or section within the TSMO planning documents was found to be more effective.

As stated earlier and based on the findings in the State of the Practice, Southern Nevada transportation partners are currently performing TSMO activities. However, TSMO needs to be formally integrated into a wide range of agencies' processes at a regional level in order to maximize the efficiency of existing and future TSMO efforts. RTC recognizes that TSMO should become a more visible program in Southern Nevada. To this end, RTC has taken the lead in developing this Regional TSMO Business Case tailored to the region's transportation stakeholders as an effective method to engage, educate, and gain support from various regional partners.

There is no "one size fits all" approach to developing a TSMO Business Case. Making the business case for TSMO is not a one-time activity, nor is it limited to a technical document or section within a plan. The need for immediate response to IOP changes may sometimes require a variety of business case formats and styles, such as formal or informal conversations, presentations, and visual aids. Integrating a wide range of TSMO strategies is a continual process, and experience suggests that several marketing and communication strategies with multiple audiences are essential in generating support for IOP changes that are required for an optimized TSMO program. Therefore, RTC has identified the following components to be included in this Regional Business Case to communicate the value of TSMO and highlight the need for formalizing the regional strategic direction for TSMO-related activities. Additionally, informational handouts are being prepared to aid in effectively communicating the importance of TSMO and its unified vision when speaking with the public, leadership and/or elected officials.

Existing and Emerging Transportation Challenges

Many triggers may result in developing a TSMO Business Case. Generally, these triggers are discussed within the context of existing and future transportation challenges and/or transportation disruptive events. Through an extensive study of existing plans and documents together with the stakeholders' feedback, this document establishes the foundations of the business case on both technical and non-technical existing and emerging transportation challenges.

IOP Needs and Gaps

The identification of IOP needs and gaps will establish specific actions to achieve desired outcomes relating the changes to the appropriate decision-making level or agency. In addition, IOP changes and adjustments should be tailored to the local transportation context and priorities, with consideration to both improving existing TSMO activities and advancing new activities in Southern Nevada. Some of these are also discussed in the non-technical existing and emerging challenges section of the business case.

External and Internal Benefits and Payoffs

One of the most effective strategies in making the business case for TSMO is through highlighting both internal and external benefits and payoffs. In addition, it is also important to leverage improvements in the entire range of TSMO strategies. These benefits and payoffs can be demonstrated at both program and tactical levels.

Based on the findings from the TSMO State of the Practice and one-on-one interviews with partnering agencies, this section will describe the required level of effort associated with IOP improvements, strategic direction for TSMO, and implementation guidelines for an effective TSMO Program in Southern Nevada.

3.1 Existing and Emerging Transportation Challenges

More than 45 local plans and documents were reviewed to identify and study existing and emerging transportation challenges in Southern Nevada. However, most of these plans were planning level documents that did not fully address the daily operational programs and challenges such as work zones, congestion, or staffing. A complete list of these documents and the description of challenges are in **Appendix D**. In addition, through TSMO Planning Steering Committee meetings and one-on-one interviews with regional partners, RTC had the opportunity to conduct a TSMO-focused discussion and identify management and operations challenges that are not formally documented in the reviewed materials. A combination of these findings was used to identify the top six topics for discussion in this section of the TSMO Business Case.

3.1.1 Safety

Challenges: A significant challenge in Southern Nevada is the high number of fatal and serious injury crashes. According to Nevada Zero Fatalities (www.zerofatalitiesnv.com):

- In 2021, there were 385 crash fatalities in Nevada, of which 236 occurred in Clark County (61 percent).
- In 2022, there were a total of 396 crash fatalities in Nevada, of which 257 occurred in Clark County (65 percent).
- From 2021 to 2022, the number of Nevada fatalities increased by 2.9 percent, and the number of Clark County fatalities increased by 8.9 percent.

Of particular concern are crash fatalities involving pedestrians and bicyclists. According to the RTC 2017 Regional Bicycle & Pedestrian Plan for Southern Nevada (assets.rtcsnv.com/wp-content/uploads/sites/4/2020/10/20135858/Appendix-O-Regional-Bicycle-Pedestrian-Plan.pdf_), Southern Nevada has one of the highest rates of vehicle-pedestrian crashes for metropolitan areas in the United States. Additionally, the RTC 2019 Access 2050 Regional Transportation Plan (www.rtcsnv.com/projects-initiatives/transportation-planning/access-2050-regional-transportation-plan/) states that the region has experienced a significant increase in serious injuries, particularly for pedestrians and bicyclists. The State of the Practice review indicated that most of the safety related challenges can be grouped in the following categories:

- Pedestrian and bicycle demand management
- Pedestrian- and bicycle-friendly infrastructure
- school drop-off/pick-up area access points for all transportation modes
- Safe and connected network for multimodal mobility options
- Wide rights-of-way which result in long crosswalk lengths, long signal cycle lengths, red light running, and speeding
- Transit turnouts and long through queues in the outer lane

Opportunities: TSMO and safety are inherently linked as TSMO provides an opportunity for significant overlaps between strategies that improve both operations and safety. For example, TSMO strategies that

manage or reduce congestion could also reduce unsafe driver behaviors, such as red light running. If incorporated into routine safety planning and practices, these strategies will ensure the safety impacts of TSMO are considered. Using a data-driven, performance-based approach for both TSMO and safety planning will help agencies better understand the potential impacts of safety and identify the appropriate threshold for risk. Making these trade-offs involves balancing the needs of different users of the system based on community goals and priorities (ops.fhwa.dot.gov/publications/fhwahop18091/index.htm).

TSMO Examples:

- An FHWA study on the effectiveness of traffic signal coordination concluded that crash rates on intersection approaches decreased 6.7 percent after signal coordination (safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/sa4_Signal_Coordination.pdf).
- In Virginia, researchers found nearly a 25 percent reduction in total crashes of all severity levels on segments of I-66 where hard-shoulder running was deployed (www.virginiadot.org/vtrc/main/online_reports/pdf/19-R7.pdf).
- Road weather information systems can reduce traveler delay and lower crash rates by 7 to 83 percent (www.its.dot.gov/about/its_jpo.htm).
- The Coordinated Highways Action Response Team (CHART) of Maryland Department of Transportation (MDOT), which provides incident detection, response, and traffic management operations on Interstate highways and major arterials, prevents an estimated 225 to 250 secondary crashes each year (ops.fhwa.dot.gov/publications/fhwahop18091/index.htm).
- In 2014, the Oregon Department of Transportation (ODOT) deployed an active traffic management system on Oregon Route (OR) 217 that included variable speed limits, traveler information, queue warning, and updated ramp metering. Preliminary crash data showed a 21 percent reduction in the total number of crashes after the first full year (www.oregon.gov/ODOT/Regions/Documents/Region1/2016_TPR_FinalReport.pdf).

3.1.2 Population Growth and Congestion

Challenges: According to RTC's Access 2050, rapid growth in population and tourism are expected to continue in Southern Nevada, historically one of the fastest growing regions in the country (assets.rtcsnv.com/wp-content/uploads/sites/4/2021/01/20171418/Access-2050-Final-Plan.pdf). Southern Nevada currently attracts more than 42 million visitors each year and is home to more than 2.3 million residents. By 2050, the region is anticipated to surpass 3 million residents. Forecasts estimate that Southern Nevada will continue experiencing population increases of almost 1 percent annually, averaging more than 20,000 new residents each year. This growth, coupled with constrained funds, can strain the region's transportation system and make travel for residents and visitors more difficult. Congestion and delay levels are expected to increase due to the growth in population and demand. This not only impacts customer service and operational objectives, but also increases safety risks. Based on the Texas Transportation Institute (TTI) 2015 Urban Mobility Scorecard (static.tti.tamu.edu/tti.tamu.edu/documents/umr/archive/mobility-scorecard-2015-wappx.pdf), lost time and wasted fuel due to congestion can cost the average Las Vegas driver $984 (46 hours) annually. But the impact is more than financial. For every minute a lane is blocked during peak hour, it leads to potential traffic delays of four to five minutes (ntimc.transportation.org/Pages/default.aspx) and a 2.8 percent increased chance of a secondary crash (www.dot.nv.gov/home/showpublisheddocument/6446/636222553025900000) — which represent more than 20 percent of total crashes and usually are deadlier than initial incidents. These secondary crashes are to blame for 18 percent of overall fatalities on the interstate highway system (ops.fhwa.dot.gov/eto_tim_pse/publications/timhandbook/tim_handbook.pdf). A study by the transportation research board of secondary crashes along urban arterial roadways suggests that 15% of

reported crashes have occurred partly or entirely due to primary crashes (journals.sagepub.com/doi/abs/10.3141/1581-07).

Opportunities: TSMO offers a variety of congestion and demand management solutions and strategies that cross over modal and jurisdictional boundaries. It expands beyond roads and emphasizes the origin to destination experience for travelers, regardless of the mode of transportation. Integration of these strategies will not only help address increased demand, but also will increase the transportation system's efficiency, reduce both recurring and non-recurring congestion, increase reliability, and optimize mobility. TSMO can also be integrated with projects that expand transportation facilities to balance supply and demand, enabling day-to-day coordination of operational strategies to achieve regional operations objectives. TSMO strategies provide the opportunity of developing flexible solutions to match the changing conditions and trends with increased urbanization in Southern Nevada. The performance-based approach of TSMO will assist agencies in identifying the root causes of congestion and delay that cannot be addressed by capacity improvements only. Integrating TSMO into planning and project development processes will ensure consideration for the most cost-effective application in operational solutions. This has proven as low cost and quick to implement, compared to capacity improvement projects.

TSMO Examples:

- In response to concerns about slow and unreliable bus service, the Los Angeles Department of Transportation (LADOT) introduced a new service designed to improve transit operating speeds through a system of operating changes and priority bus treatment strategies. These include bus signal priority, level boarding/alighting with low-floor buses, headway rather than timetable-based schedules, fewer stops, far-side intersection location of stations, and joint active management of the service in the field and the Metropolitan Transportation Authority Bus Operations Control Center. Since the initial date of service, the Metro Rapid operation has achieved an overall operating speed improvement of between 20 to 31 percent (ops.fhwa.dot.gov/publications/fhwahop18072/fhwahop18072.pdf).
- RTC implemented a live, real-time detour notification system on RTC's transit system that allows users to communicate directly and quickly with thousands of customers via text, email, and social media. They also recently launched the RTC cash to mobile solution, a contactless payment option that enables transit customers to purchase passes with cash using mobile phones through the RTC's smartphone app, ride RTC. RTC customers can now access the new on-demand, ride-share transportation service expanding connectivity for residents in West Henderson and the Southwest Valley. The RTC-OnDemand App applies technology to connect riders to medical facilities, grocery stores, and other amenities and destinations (assets.rtcsnv.com/wp-content/uploads/sites/3/2022/04/04130321/RTC_Strategic-Plan_2022_NoFootnotes.pdf).
- Many venues are establishing bike parking and bike valet services. One example is Nationals Park in Washington, DC, which offers free, secure bike parking for more than 250 bicycles. The lot opens two hours prior to game time and remains open until one hour after the game ends. Capital Bikeshare also has docks and bikes available at the stadium. Bike valet parking is also available at AT&T Park (San Francisco, California), Amalie Arena (Tampa, Florida), Golden 1 Center (Sacramento, California), and Kauffman Stadium (Kansas City, Missouri) (ops.fhwa.dot.gov/publications/fhwahop18072/fhwahop18072.pdf).

3.1.3 Regional Agency Collaboration

Challenges: Although collaboration is a key strength between RTC and the local public agencies, collaboration specifically for TSMO can present unique challenges. This is primarily why collaboration is one of the six key dimensions of the TSMO CMM framework. Optimizing this dimension involves the highest levels of cross-agency and cross-jurisdictional coordination. In addition, enhancing collaboration

and prioritizing the right actions often requires leadership's support of the relevant initiatives to ensure alignment with TSMO-related goals and objectives. This requires development of additional business processes, such as memoranda of understanding (MOU) or agreements with clear TSMO responsibilities for all. In some cases, Southern Nevada transportation partners need to access key technical resources, which involves development of clear policy for outsourcing and level of external dependencies. Collaboration also plays a critical role in public-private partnerships, particularly in cases involving technology.

Opportunities: TSMO collaboration can help member agencies achieve their goals and have a positive impact on measuring and communicating successes with RTC leadership, partnering agencies, and the public. As a result, this enables long-term sustainability between RTC and partnering agencies that places a much higher emphasis on integrated operations and management of the transportation network. To develop and maintain an optimized TSMO program, Southern Nevada transportation partners need to identify and prioritize TSMO collaboration actions at both program and leadership levels. Formal TSMO collaboration processes will clearly demonstrate a unified, regional commitment to improving safety, mobility, and reliability. This alignment will optimize TSMO and the effectiveness of other programs through delivering an integrated transportation system for the region, customers, and State/regional economy.

TSMO Examples:

- Washington Department of Transportation (WSDOT) attributes the success of their response to incidents and emergency management directly to their efforts to advance IOP arrangements for TSMO. WSDOT stated that, "through our TSMO activities, we had established communications and relationships with the leaders at Joint Base Lewis-McChord (JBLM) and were able to quickly work with them to determine the best way to address traffic flow in the region due to the Interstate 5 (I-5) closure." Key activities prior to the incident have included formal chartering by the State Secretary of Transportation, the Chief of the Washington State Patrol; and the Commanding Officer of JBLM of a regional multi-agency Joint Operations Group (JOG), which facilitated sharing of multi-agency experience and training, integrating innovative technology, and joint planning and policy development (ops.fhwa.dot.gov/publications/fhwahop19017/fhwahop19017.pdf).
- In early 2012, the Colorado Department of Transportation (CDOT) began to discuss the importance of providing improved operations in an integrated and systematic manner and committed to place a much higher emphasis on improving the operations of the transportation network. By January 2013, CDOT created the Division of TSMO and hired a Director for the Division. The CDOT Executive Director tasked the Director to collaborate with staff directly involved in operations and recommend an organization structure that would facilitate improved systematic and integrated delivery of statewide operations in Colorado. The changes resulted in a long-term sustainable organization structure that enabled improved cooperation and collaboration within CDOT, and the ability to deliver integrated and systematic statewide operations with regards to TSMO. (ops.fhwa.dot.gov/publications/fhwahop19017/fhwahop19017.pdf).
- In 2021, the Southern Nevada Regional Events Traffic Management Working Group (Working Group) was formed to work collaboratively across multiple agencies and jurisdictions within public and private sectors. This group proactively coordinates with local venues, event promoters, sports teams, private traffic control companies and law enforcement to better understand and prepare for the regional impact of major events. Members of the Working Group include several departments from RTC of Southern Nevada, including transit, government affairs and its FAST department, which manages traffic in Southern Nevada utilizing innovative approaches and technologies. Other members include Nevada State Police, Nevada Department of Transportation (NDOT), Clark County Public Works, Las Vegas Metropolitan Police Department

(LVMPD) and major event venues, including Allegiant Stadium, T-Mobile Arena, Fremont Street Experience, Downtown Las Vegas Events Center, and Orleans Arena. Other participants include Las Vegas Parking, PATG (Parking and Transportation Group), and MOB Traffic, private companies that facilitate barricades and other traffic control measures for major events. As the agency responsible for transportation planning for the Las Vegas Valley, RTC is no stranger to working in a collaborative environment. RTC knows that success requires a collective, comprehensive approach to minimize traffic impacts, especially during these large, concurrent events.

3.1.4 Project Planning, Prioritization, and Funding

Challenges: With constrained funds, Southern Nevada transportation partners recognize that they cannot build their way out of congestion. In addition, capacity improvement project do not directly address the safety and mobility challenges. Therefore, Southern Nevada transportation partners are seeking more efficient ways to achieve their goals, objectives, and performance targets. The region also recognizes the lack of performance-based approaches to transportation planning for operations that has a greater focus on mobility-oriented outcomes. Although there is strong collaboration among internal and external stakeholders, a discussion with regional agencies indicated that they are still experiencing silos between planners and operators. There are limited formalized processes and procedures in planning for reliability and operational challenges. As a result, the operators' long-term vision for system performance is not considered, and therefore, operational challenges and considerations have become an afterthought. This leads to the need for planners and operators to collaborate and focus their attention on planning for TSMO investments while addressing both short-term and long-term goals more effectively.

Opportunities: TSMO strategies help planners address operational issues and improve performance measures without increasing capacity. Planning for operations follows the same approach as the traditional planning process. Functionally, integrating TSMO into planning includes identifying reliability and operations issues along with other planning-related concerns early on and developing operational objectives and related performance measures when establishing the project's objectives. TSMO strategies can be evaluated alongside other strategies and included in transportation plans and programs. Operators can collect data routinely to identify needs such as bottlenecks and recommend TSMO strategies that can address those needs. Planners and operators can develop aligned goals, objectives, and related performance measures for mobility within the Southern Nevada region. With a greater emphasis on travel time reliability, Southern Nevada transportation partners can identify and prioritize unreliable roadway segments and identify which TSMO strategies to include in long-range plans, short-term corridor plans, and Transportation Improvement Programs/State Transportation Improvement Programs to address reliability challenges on those segments (ops.fhwa.dot.gov/publications/fhwahop18096/index.htm).

TSMO Examples:

- CDOT's reorganization for TSMO helped facilitate changes such as the establishment of a TSMO Evaluation, which launched in 2016 and required all projects with a design scoping review to complete a TSMO Evaluation that consisted of a safety, operations, and Intelligent Transportation Systems (ITS) analysis. (ops.fhwa.dot.gov/publications/fhwahop19017/fhwahop19017.pdf).
- One of the Southern Nevada Traffic Management Center's priorities in the last couple of years is to mitigate traffic from major events. In close collaboration with many local partners, the RTC created the Regional Events Traffic Management meeting to coordinate with venues, agencies, and law enforcement to better understand the regional impacts of multiple events at various venues. This committee meets bi-weekly to discuss impacts of various large-scale events. This helps RTC's FAST department better prepare ingress and egress plans for higher volumes

vehicles in the area. In 2022, FAST actively assisted in traffic management of 325 events including the NFL Draft, Raiders games, Vegas Golden Knights games, Electronic Daisy Carnival (EDC) and other large-scale sporting and entertainment events.

- Florida Department of Transportation (FDOT) has established a guidance for planning, prioritization, and selection of TSMO projects to recommend the development of programmatic funding sources. This guidance ensures TSMO is part of the FDOT capital infrastructure planning process. It also establishes a framework for performance measurement and reporting to validate whether TSMO programs and projects achieve anticipated impacts on safety and mobility (transportationops.org/case-studies/tsmo-project-selection-and-prioritization-process).
- NDOT developed the TSMO Investment Prioritization Tool (IPT) to help identify and prioritize projects based on the State's transportation priorities, and in a manner that helps achieve established TSMO goals and objectives. NDOT collaborated internally to ensure priorities are aligned with the One Nevada Transportation Plan and held workshops with the stakeholders to provide education and training on the tool's functionalities. The tool has been successfully integrated into project planning processes, assisting the agency with allocating resources in a data-driven and performance-based manner (transportationops.org/case-studies/tsmo-investment-prioritization-tool-ipt).
- The Texas Department of Transportation (TxDOT) TSMO Statewide Strategic Plan includes a TSMO evaluation section which consists of questions related to project planning and development. The evaluation covers areas such as coordination and collaboration with stakeholders, safety, operations, and technology (ftp.dot.state.tx.us/pub/txdot-info/trf/tsmo/tsmo-statewide-strategic%20plan.pdf).

3.1.5 Asset Management and Infrastructure Deterioration

Challenges: The transportation industry in Southern Nevada is rapidly evolving with advanced technology and new emphasis on enhanced management and operations. Arterials are becoming increasingly complex due to the application of communications and technologies systems, as well as the supporting infrastructure. Travelers rely on the software, hardware, and resources necessary to dynamically manage and operate the system in real-time. With the rapid urbanization in Southern Nevada, the reliance on transportation assets for TSMO, both physical and digital, is expected to rise as transportation becomes increasingly automated. Therefore, Southern Nevada transportation partners recognize the need for a comprehensive approach to asset and infrastructure management that addresses existing gaps, deteriorating infrastructure, and supports emerging needs, leading the agencies into the future.

Opportunities: TSMO and asset management work toward enhancing system performance with similar processes, but they have different focuses. While asset management is concerned with preserving or improving the condition of assets, TSMO focuses on preserving and/or maximizing mobility. However, TSMO and asset management programs share a strategic, performance-based approach to monitoring performance and applying actions to reach their targets. Lifecycle planning and risk-based management are two concepts from asset management that hold promise for advancing TSMO programs. TSMO strategies often suffer from a lack of funding to maintain the technology and equipment required to operate the system after the initial deployment. Asset management uses a network-level lifecycle approach for managing assets over their whole life with a focus on minimizing cost while preserving or improving the asset condition. By applying this approach for the assets supporting TSMO strategies, agencies would estimate the useful life of the technology and the need for upgrades and maintenance during the planning stages of the TSMO strategy. This would ensure that there is an ongoing funding source for maintenance activities. This approach will also help agencies identify critical assets and infrastructure required for continuous service. Risk-based management as applied to TSMO would lead

agencies to plan for, assess, mitigate, avoid, or accept risks to mobility, especially in critical corridors (ops.fhwa.dot.gov/publications/fhwahop18094/index.htm).

TSMO Examples:

- In a recent effort, RTC's FAST department assisted NDOT with the expansion and adoption of NDOT's Lifecycle planning tool (LCC Tool) that is part of the Statewide Transportation Asset Management Plan (TAMP). The Excel-based tool assists NDOT (as the owning agency) and FAST (as the operating agency) to develop an inventory of ITS devices, monitor maintenance activities, measure the reliability and performance of the devices annually, monitor the health of the assets, and utilize lifecycle planning analysis models to plan and make informed decisions for funding TSMO/ITS assets management and maintenance activities. This tool received the 2023 Institute of Transportation Engineers (ITE) Transportation Achievement Awards in the TSMO category.
- California Department of Transportation (Caltrans) incorporates the ITS assets into an annual Asset Management Performance Report. The report tracks the performance or health of the agency's ITS assets and shows the projected performance or health of the ITS elements over the next five years. Caltrans establishes a performance threshold to evaluate the effectiveness of ITS assets and provides explanations and solutions to resolve potential ITS health issues (ops.fhwa.dot.gov/publications/fhwahop18094/index.htm).
- The Utah Department of Transportation (UDOT) TAMP outlines a data-driven, performance-based approach, allocating transportation funds to manage its pavements, bridges, advanced traffic management systems (or as referred to in this guide, ITS), and signal devices. The UDOT Asset Advisory Committee/Performance Management Group developed a tiered system to prioritize the most valuable assets and those with the highest risk to system operation. To achieve its safety and mobility strategic goals, UDOT included traffic signals and ITS devices in the highest tier for management (alongside pavements and bridges). Its highest tier is "performance-based management," which requires accurate data collection, performance target setting and tracking, predictive modeling and risk analysis, and dedicated funding (ops.fhwa.dot.gov/publications/fhwahop20048/fhwahop20048.pdf).

3.1.6 Organization and Staffing Needs

Challenges: Review of existing conditions and discussions with partnering agencies in Southern Nevada are listed below:

1. Position of activity manager: TSMO activity managers are typically two to three levels down in the organization structure and often restricted in engineering versus operational units. They typically report to senior managers and executive leadership who may have divided programmatic responsibilities.
2. Reliance on middle managers: TSMO initiatives rely heavily on middle management champions rather than a formal organization, and TSMO activities are siloed between engineering/project development and system operations/management units of the agencies.
3. Non-traditional career path: TSMO is not seen as part of the traditional career track to senior management and executive leadership and senior roles are usually embedded in engineering and planning.
4. Limited training of TSMO staff: TSMO is an emerging concept, and as a result, staff with TSMO responsibilities are limited and typically trained on the job. TSMO is not yet a formal discipline (such as planning, maintenance, or traffic engineering) with a distinct education and training.

5. Recruiting challenges: Core technical capabilities for TSMO are difficult to recruit and retain because agencies may not be able to offer competitive salaries, and there is lack of resources to recruit for TSMO in rural areas of Southern Nevada.

The real time nature of TSMO brings a culture at odds with the traditional Civil Engineering office settings. One that requires reacting to events, improvising solutions, and working closely with external collaborators — all without formal recognition. These challenges lead to a lack of knowledge, skills, and abilities (KSA) for TSMO and has resulted in increased outsourcing and relying on technical functions provided by private entities.

Opportunities: Organization and staffing are critical institutional dimensions of the TSMO capability. As one of the six key dimensions of the TSMO CMM framework, it will incorporate the development of an appropriate TSMO-focused organizational structure within and between partnering agencies in Southern Nevada. It also assists in the identification, development, and retention of essential staff with TSMO capabilities. Moreover, determining the role of TSMO in transportation agencies of Southern Nevada depends on whether TSMO is seen as a set of unrelated activities, coordinated group of activities, a subpart of another program, or as its own program. The RTC TSMO CMM self-assessment results revealed that internal individuals have a direct responsibility for visible TSMO functions, such as TMC operations, incident management, ITS device management, etc. They are aware of the existing organizational challenges and lack of KSAs. However, the RTC is limited in their span of control over organizational changes and constrained by partnering agencies' resource limitations. Therefore, there is an opportunity for RTC's partnering agencies to conduct internal TSMO CMM self-assessments to review and define organization structure for TSMO and develop TSMO staffing and succession plans.

TSMO Examples:

- The NCHRP TSMO Workforce Guidebook (published in 2018 and updated in 2019) provides practitioners with a tool to develop a strong TSMO workforce. This guidebook goes into detail on the hiring and workforce development practices recommended through literature and currently in place within existing and successful TSMO programs. It identifies 19 specific positions and job descriptions required for a robust TSMO program; the KSAs required for those job positions; and recommendations tailored to hiring each position. Information on training and professional development are also presented, including specifics on training providers and courses (transportationops.org/sites/transops/files/TSMO%20Workforce%20Guidebook%20NCHRP.pdf).
- In 2022, RTC began review and update of the FAST department's job descriptions to ensure alignment with TSMO roles and responsibilities, referencing the NCHRP TSMO Workforce Guidebook (published in 2018 and updated in 2019) Model TSMO Position Descriptions. An example of this is the update of Traffic Management Center (TMC) Supervisor position. The updated TMC Supervisor job description outlines specific TSMO roles and responsibilities such as gathering and compiling operational data, performance analysis and reporting, effective communication and collaboration internally and externally, and evaluation of existing work processes and procedures.
- As part of the Statewide TSMO Implementation Plan, NDOT has identified five TSMO positions to add into Traffic Operations Division's organizational structure. These positions are TSMO Engineer, TSMO Program Manager/Coordinator, TSMO Performance Manager, TSMO Data Analyst, and TSMO Modeling Specialist. For each position, NDOT has described the positions' contribution in TSMO maturity through CMM dimensions analysis; defined level, and frequency of interaction between TSMO positions and internal and external partners; and established job descriptions with specific TSMO roles and responsibilities. These positions will assist NDOT in achieving their target of Level 3 in TSMO maturity and mainstream TSMO at a statewide level.

- Within Maricopa County, Arizona, a partnership of public agencies across the entire Phoenix metropolitan area (called AZTech) developed a regional fiber network and data archival system. This was part of a Metropolitan Model Deployment Initiative to integrate ITS systems. To support the initiative, Maricopa County provided an Information Technology (IT) specialist to directly support the development of center-to-center communication and the fiber network. After the initial fiber network was complete, the dedicated IT specialist remained embedded in the TSMO/ITS group, since that person understood the operations and functions better than anyone available in the enterprise IT groups. As efforts gained momentum, the Arizona partnership determined that a Regional Archived Data System with dedicated staff, specializing in TSMO data became a critical function (ops.fhwa.dot.gov/publications/fhwahop21004/fhwahop21004.pdf).
- Many agencies have found that creating opportunities for IT staff to work within the TSMO structure on current activities can improve their understanding of the TSMO mission and TSMO end-user (e.g., managers and operations staff) data and software platforms needs. The Pennsylvania Turnpike Commission (PTC) relies on its TSMO and IT staff to maintain system functionality and provide continuous customer service. To overcome their internal organizational silos, the PTC integrates IT staff into its operations business to enhance an understanding and collaboration. Additionally, the IT group was a part of the efforts, such as the TSMO CMM workshop and TSMO strategic planning. IT staff also accompany TSMO staff on field visits. These "ride-alongs" help IT staff understand how to work with and configure field devices. The PTC believes that this interaction provides IT staff a better perspective on daily operational needs, and how IT may positively impact TSMO operations (ops.fhwa.dot.gov/publications/fhwahop21004/fhwahop21004.pdf).

3.2 IOP Needs and Gaps

The purpose of IOP discussions in the business case is to identify and document specific IOP elements' needs and gaps to support the evolutions from TSMO as a set of ad hoc activities to a mainstream approach. Based on the definitions established in **Section 1.2**, key IOP elements for TSMO implementation were mapped against IOP categories, as shown in **Table 2**.

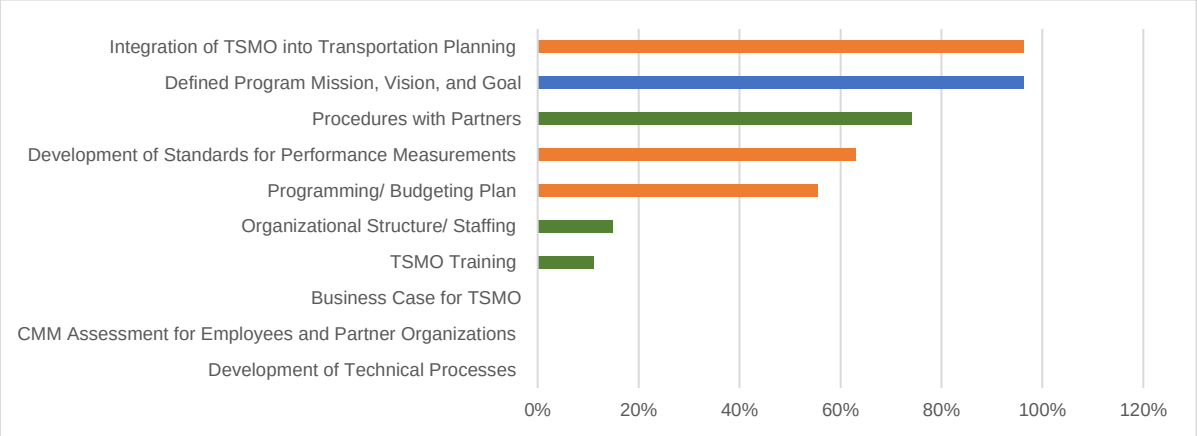
Table 2: IOP Categories and Elements

IOP Category	IOP Elements and Actions
Institutional	• Development of technical and business processes • Defined program mission, vision, and goals • CMM assessment for employees and partner organizations • Business Case for TSMO
Organizational	• TSMO training • Procedures with partners • Organizational structure/staffing
Procedural	• Development of standards for performance measurements • Integration of TSMO into transportation planning • Programming/budgeting plans

As shown in **Figure 1**, the State of the Practice reviews indicate that TSMO Organizational and Procedural elements and actions are somewhat represented within Southern Nevada plans and programs — although not formalized or necessarily under the name of TSMO. However, there is a lack of

documented Institutional elements and actions. Improvements in TSMO effectiveness will require improvements in current business and technical procedures, organization and staffing, and institutional structures tailored to TSMO — all essential to support TSMO effectiveness and especially essential to advanced strategy applications.

Figure 1: Analysis and Rankings of IOP Elements in Southern Nevada Plans and Programs



As embodied in local plans and documents, there is clear commitment to improving safety, reliability, and sustainability of the transportation system in Southern Nevada. However, TSMO should be formally recognized and adopted beyond individual plans and jurisdictions to increase effectiveness. The legacy IOP structure introduces constraints for TSMO implementation, as most project planning, programming, and budgeting are for capacity-oriented improvements. There is a limited understanding of TSMO at the executive management level and among key decision makers, and currently, it is treated as an activity or a project rather than a formal program. Therefore, Southern Nevada transportation agencies have not formally integrated TSMO with planned and sustainable funding to support TSMO advancement. In addition, due to the absence of TSMO-oriented staffing and training, most TSMO activities are fragmented, uncoordinated, and in some cases redundant. An IOP improvement framework must be available as a mechanism for continuous improvement, capitalizing on the growth of current practices to identify logical, incremental changes on a regular basis.

TSMO implementation and its effectiveness in Southern Nevada depends on overcoming these constraints. TSMO advancement requires changes in the business and technical processes to effectively conduct a full range of TSMO strategies and applications, and these processes depend on capable staff and efficient organizational structure to execute them. IOP changes must be structured in a manner to transfer from a set of ad hoc activities and projects to a more strategic, systematic, cooperative, and integrated approach. Recommendations on improving these core IOP elements are in **Section 4** of this document.

3.3 External and Internal Benefits and Payoffs

There are specific benefits and payoffs that can be expected as TSMO activities move from an ad hoc approach to a mainstreamed program in Southern Nevada. As there is a wide range of internal and external benefits anticipated on areas such as customer service, funding and investment options, and agency efficiency. This section will also describe a full range of operational benefits based on the findings from the State of the Practice. **Table 3** includes some of the internal and external benefits and payoffs to gain from IOP changes to advance and mainstream TSMO.

Table 3: Example Internal and External Payoffs of Advancing IOP Capabilities

Internal Payoffs	External Payoffs
• Efficient use of limited funds • Ability to identify and use best available technology for efficiency • Improved processes for detection and response to disruptions • Real time management of the transportation system • Improved staff efficiency • Ability to identify and capitalize on new concepts • Improved processes for project planning and prioritization • Improved reliability and support TSMO activities • Efficient integration of management and operations	• Identification and targeting of root causes of congestion (recurring and non-recurring) • Ability to focus on more complex settings or events • Improved strategy effectiveness • More accurate and timely responses to non-recurring congestion and events • Clarification of customer expectations and demands • Improved customer service and accountability • Effective detection management and solution arrangements • Formalized performance-based processes for operational gaps and needs

TSMO strategies have demonstrated numerous benefits and payoffs. Reviews were performed to identify best practices and benefits of each strategy. These reviews indicate that most experienced benefits include improvements in safety, congestion, travel time reliability, sustainability, and mobility.

Appendix E provides a detailed description of benefits obtained from TSMO strategies' deployments across the nation.

4 Southern Nevada TSMO Plan Guide

Southern Nevada is addressing current transportation issues and preparing for the future. NDOT released the Statewide TSMO Program Plan in 2020 which outlines the strategic direction for TSMO in Nevada. The NDOT TSMO Program Plan recognizes challenges and TSMO solutions statewide, unspecific to a particular region. The RTC of Southern Nevada alongside regional partners have built upon NDOT guidance and taken TSMO in the State to a deeper, tactical level by developing a Business Case that reflects regional challenges, values, and goals.

The purpose of this TSMO Plan Guide is to provide direction for enhancing and implementing a regionally coordinated TSMO approach to manage transportation challenges specific to Southern Nevada. This Southern Nevada TSMO Plan Guide centers on extensive research and discovery summarized in **Section 3.**

4.1 TSMO Plan Guide Framework

At the statewide level, TSMO sets the strategic direction and provides support for implementation through provisional resources, standards, leadership, and guidance. At the regional level, local agencies focus on the implementation of TSMO at the tactical level. Local agencies are responsible for a hands-on approach to the identification, deployment, operation, and maintenance of TSMO strategies that are most relevant to their regional needs and priorities.

This plan focuses on three primary components to enhance TSMO in the Southern Nevada region and mitigate local challenges identified in the Business Case:

- **Regional Goals and Objectives:** Representative of values in the Southern Nevada region that can be enhanced through implementation of TSMO strategies and processes.
- **Recommended Tactical Plans:** These TSMO strategies have been identified for the first phase of TSMO Implementation for the region through outreach and analytics.
- **IOP Enhancements:** The IOP enhancements recommended for Southern Nevada aim to optimize the TSMO culture in the region.

4.2 TSMO in Southern Nevada: Strategic Goals and Objectives

Strategic goals and objectives in the Southern Nevada region outline the desired outcomes and achievements that will be realized through the implementation of TSMO. The Southern Nevada Strategic Goals and Objectives were developed using findings from State of the Practice and stakeholders' feedback. Additionally, goals and objectives already identified in regional plans and programs were considered and mapped against the NDOT (State-wide) TSMO Program Plan to ensure alignment with documented regional and state-wide priorities. Moving forward, all services, activities, and projects should address one or more of the TSMO strategic goals and objectives provided in **Appendix B.**

Table 4: Regional TSMO Strategic Goals and Objectives for Southern Nevada

Strategic Goals	Strategic Objectives
Enhance Safety	Enhance safety for all road users through implementation of TSMO strategies and optimizing IOP practices
Optimize Customer Service	Provide reliable, safe, and efficient mobility for all transportation modes
Strengthen Technology Integration	Leverage technology to more efficiently manage and operate the regional transportation network
Optimize Resource Allocation	Efficiently manage resources to support TSMO implementation
Address ITS and Infrastructure Gaps	Prioritize projects that will address gaps in ITS infrastructure
Manage Congestion	Utilize TSMO strategies to improve the efficiency and effectiveness of the transportation system and air quality by managing congestion
Strengthen TSMO Integration	Streamline TSMO into regional agency project planning and execution processes.
Promote Data Sharing	Share transportation data among all partner agencies to enable performance-based decision making
Enhance TSMO Workforce and Training	Provide TSMO education and training

4.3 Initial TSMO Strategies for Southern Nevada

It is recommended that the Southern Nevada region focus their efforts on developing tactical plans for specific TSMO Strategies in lieu of developing a regional TSMO Plan because the relationship between local agencies and TSMO is focused on specific strategies and implementation. Tactical plans define detailed actions for specific strategies to achieve regional TSMO goals and objectives. The recommended tactical plans are based on stakeholders' feedback provided in **Appendix B**. Activities which support some TSMO strategies have already been implemented in the region, and as such, the recommendations for tactical plans are split into two groups, which require varying levels of effort from regional stakeholders.

Group 1: Many existing processes, plans, and procedures are already documented. Tactical plans could be developed to formalize and cohesively document existing activities and additional processes for the following TSMO strategies:

- Bike and Pedestrian Crossings
- Traffic Signal Coordination

Group 2: While some processes and plans are in place, the region is lacking a multi-jurisdictional coordinated and formalized program. Tactical plans could be developed for the following TSMO strategies:

- Work Zone Management
- Incident and Emergency Management
- Integrated Corridor Management

4.3.1 Tactical Plan Development and Implementation Guidance

Guidance for development and implementation of recommended Tactical Plans has been divided into two categories:

- Mobilization and Preparedness
- Execution

Prior to executing development of a Tactical plan, the following roles and responsibilities will enable stakeholders to more easily mobilize or be prepared for development of the regional plan(s).

The RTC of Southern Nevada will:

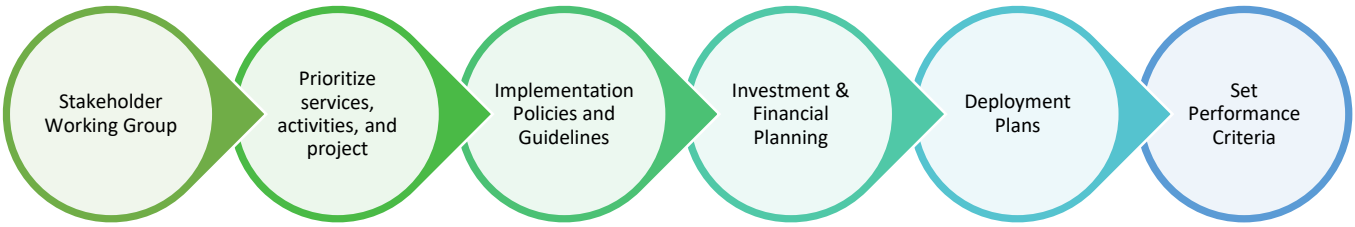
- Lead the Tactical Plan Development for the Region
- Identify an internal RTC TSMO Champion to oversee Tactical Plan Development
- Identify internal Subject Matter Experts (SME) to lead development of Tactical Plans

It is recommended that local agencies:

- Participate in the Tactical Plan development as a Stakeholder
- Participate in tactical CMM Workshops
- Identify internal SMEs to provide input during development of the recommended Tactical Plans
- Be prepared to share internal processes and activities related to the tactical strategy
- Commit to facilitating a cultural shift within their own agencies which supports the regional TSMO goals and objectives

Execution will be led by RTC and will include six steps as shown in **Figure 2**.

Figure 2: Step by Step Process to Develop and Implement TSMO Tactical Plans



4.4 IOP Enhancements for Southern Nevada

IOP arrangements facilitate a cultural shift to support TSMO rather than budgets and technologies alone. Changes and adjustments to IOP arrangements are cost effective and can be implemented in the short term. However, they may be challenging as they generally involve reorganization, include new reporting requirements, may involve competition for resources, or may require changes that impact legacy policies and processes. In addition, these changes and arrangements should be incremental to support continuous enhancement of emerging TSMO activities.

4.4.1 Local Agency Leadership

Fully embracing TSMO as a core component of agency processes is most successful when backed by agency leadership. **Appendix F** provides a quick reference to the action items recommended by the Federal Highway Administration (FHWA) in the “Advancing TSMO: Making the Business Case for Institutional, Organizational, and Procedural Changes” for local agency leadership. Leadership of Southern Nevada stakeholders should consider these action items to enhance TSMO culture within their organization.

5 Conclusion

TSMO is gaining recognition as a core mission as agencies shift their focus from infrastructure expansion to effectively managing and operating the existing transportation systems. Collaborative efforts and well-defined institutional arrangements are crucial for successful TSMO planning and implementation, ensuring its integration into the agencies' core mission and operational practices.

Most local agencies in Southern Nevada have been conducting TSMO activities for years. However, formal adoption, integration, and effectiveness of TSMO requires development of IOP arrangements that may differ from legacy or existing arrangements.

There is no “one size fits all” approach to TSMO, and TSMO should become a more visible program in Southern Nevada. Recognizing this, the Regional TSMO Business Case and TSMO Plan Guide demonstrates the approach of Southern Nevada agencies in creating a regionally distinct TSMO Plan that addresses their unique challenges and priorities.

The Regional TSMO Business Case addresses:

- Existing and emerging transportation challenges to baseline regional focus areas
- IOP needs and gaps for advancing TSMO internally and externally
- External and internal benefits and pay offs of TSMO strategies

The TSMO Plan Guide provides guidance for implementing a coordinated TSMO approach in Southern Nevada, focusing on:

- Regional TSMO goals and objectives
- TSMO strategies and tactical plans for the initial implementation phase
- IOP enhancements to optimize TSMO culture in the region

In conclusion, it is recommended that the Southern Nevada region focuses their efforts on developing Tactical Plans for specific TSMO Strategies. The following presents a list of recommended TSMO strategies in the order of priority:

- Work Zone Management
- Traffic Signal Coordination
- Integrated Corridor Management
- Incident and Emergency Management
- Bike and Pedestrian Crossings

These Tactical Plans define detailed actions for specific strategies to achieve regional TSMO goals and objectives, and address IOP arrangements to facilitate a cultural shift to support TSMO. The RTC will lead the development of the Tactical Plans, with an internal TSMO Champion overseeing the process and subject matter experts. Local agencies have committed to participate as stakeholders, provide input, and commit to supporting the regional TSMO goals and objectives.

Appendix A. TSMO State of the Practice Tech Memo

Transportation Systems Management & Operations (TSMO) State of the Practice

January 2023

Regional Transportation Commission (RTC) of Southern Nevada

Contents

Tables

Figures

Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ATM	Active Traffic Management
CAT	Connected and Autonomous Technology
CMM	Capability Maturity Model
ConOps	Concept of Operations
FAST	Freeway and Arterial System of Transportation
FHWA	Federal Highway Administration
ICM	Integrated Corridor Management
ICT	Information and Communications Technology
IOP	Institutional, Organizational, and Procedural
ITS	Intelligent Transportation Systems
MaaS	Mobility as a Service
MOD	Mobility on Demand
NDOT	Nevada Department of Transportation
RTC	Regional Transportation Commission
RWM	Road Weather Management
SHRP 2	Second Strategic Highway Research Program
TDM	Transportation Demand Management
TIM	Traffic Incident Management
TSMO	Transportation Systems Management and Operations
TRB	Transportation Research Board

1 Summary

Transportation Systems Management and Operations (TSMO) is a set of integrated strategies and applications to improve current and future transportation systems by implementing multimodal, intermodal, and cross-jurisdictional systems, services, and projects (Federal Highway Administration (FHWA), Organizing and Planning for Operations).TSMO strategies are designed to preserve capacity while improving the safety, efficiency, and reliability of transportation networks with relatively low-cost and high-impact actions that can be implemented within a relatively short timeframe.

Over the past few years, various state and regional agencies have incorporated TSMO strategies into their business. This document provides a detailed overview of the available Federal, national, and Southern Nevada TSMO practices. The findind willprovide the Regional Transportation Committee (RTC) of Southern Nevada with valuable insight into other agencies' best practices, successful policies, challenges, and lessons learned, which could serve as a solid foundation for future projects and implementation efforts.The state of the practice framework was developed with a targeted approach on four key focus areas, including 1) TSMO implementation guidance parameters, 2) TSMO strategies, 3) dimensions of TSMO Capability, and 4) points of connection to the Statewide NDOT TSMO Program Plan and Implementation Plan.

1) TSMO implementation guidance parameters: TSMO implementation guidance parameters are divided into three main categories: Institutional, Organizational, and Procedural elements. Findings from the Southern Nevada state of practice reviews illustrate that Organizational and Procedural elements and actions are the most represented topics within Southern Nevada plans and programs. On the other hand, there is a lack of documented Institutional elements and actions to support the strong strategic direction defined by Southern Nevada efforts.

2) TSMO strategies: Analysis of the state of practice indicates that the majority of planned and deployed TSMO strategies in Southern Nevada are focused on Bicycle and Pedestrian Crossings and Transit Management. Although RTC and partnering agencies have implemented several other TSMO strategies, the planning, budgeting, and implementation process of these strategies are not formally integrated into the majority of Southern Nevada plans and programs.

3) Dimensions of TSMO Capability: Reviews of the state of the practice for the dimensions of TSMO Capability in Southern Nevada indicate no records of Capability Maturity Model (CMM) dimensions. However, several TSMO elements were identified within Southern Nevada plans and programs and were mapped against CMM dimensions to demonstrate associated activities.

4) Points of connection to the Statewide NDOT TSMO Program Plan and Implementation Plan: Reviews of the NDOT Statewide TSMO Program Plan indicate that RTC is supporting the TSMO Implementation Program through formal collaboration with NDOT, mainly focused on NDOT TSMO Programmatic and Tactical Elements. However, there are potential opportunities for further collaboration between NDOT and RTC, which can be established following the analysis of the RTC CMM workshop and the development of the RTC regional TSMO business case.

2 Research Process and Sources

This section includes findings on the review of Federal, national, and Southern Nevada TSMO documents and plans. The findings will provide RTC with valuable insight into other agencies' best practices, successful policies, challenges, and lessons learned, which could serve as a solid foundation for future TSMO projects and implementation efforts. The findings will be taken into consideration in the RTC's decision-making process when evaluating TSMO benefits on the Southern Nevada transportation network and as the TSMO plan approach is being scoped.

A comprehensive literature review was conducted to identify the TSMO state of the practice with a focus on Southern Nevada agencies. The literature review included a comprehensive study of available Southern Nevada, national, and Federal TSMO practices. Over 120 documents were reviewed. The following key resources were used for this literature review, and a complete list of the reviewed documents has been provided in **Section 6:**

- **Federal TSMO Guidance Documents,** including:
  - American Association of State Highway and Transportation Officials (AASHTO) TSMO Guidance
  - Federal Highway Administration (FHWA), Organizing and Planning for Operations
  - FHWA, Office of Operations
  - U.S. Department of Transportation
  - Strategic Highway Research Program
  - National Cooperative Highway Research Program
  - National Operations Center of Excellence
- **National TSMO Plans and Documents,** including national TSMO materials developed by regional and local agencies across the nation.
- **Southern Nevada Plans and Programs (TSMO and non-TSMO),** including documents, plans, and programs that are developed by RTC and local/regional partners in Southern Nevada.

The State of the Practice Framework was then developed for a targeted review of the literature, including key focus areas as outlined in **Table 1**. This framework has been provided as a supplemental document.

Table 1: RTC TSMO State of the Practice Framework

Key Focus Areas	Purpose
TSMO Implementation Guidance Parameters	Identify TSMO program planning components and Institutional, Organizational, and Procedural (IOP) arrangements.
TSMO Strategies	Review and identify best practices and lessons learned when TSMO Tactical Elements are implemented.
Dimensions of TSMO Capability	Identify the application of CMM dimensions for TSMO program planning and integration.

In addition, the Statewide NDOT TSMO Program and Implementation Plan were reviewed to identify potential points of connection, develop a list of areas within the Statewide TSMO Program Plan which RTC's efforts have and could align, and identify potential management and operational practices for integration.

Section 3 includes detailed discussions and analysis of the literature review findings.

3 Discussion of Findings

As demonstrated in **Table 1** in the previous section, the literature review was conducted using a targeted approach on three key focus areas. Under each key focus area, the reviews were performed to identify and analyze specific components as follows:

1- TSMO Implementation Guidance Parameters:

- Institutional
  - Development of technical processes
  - Defined program mission, vision, and goals
  - CMM assessment for employees and partner organizations Business Case for TSMO
- Organizational
  - TSMO Training
  - Procedures with partners Organizational structure / staffing
- Procedural
  - Development of standards for performance measurements Integration of TSMO into transportation planning
  - Programming / budgeting plans

2- TSMO Strategies:

- Incident and Emergency Management
- Road Weather Information Systems
- Integrated Corridor Management
- Active Traffic Management
- Transportation Demand Management
- Improved Bicycle and Pedestrian Crossings
- Advanced Traveler Information
- Connected and Automated Vehicles
- Work Zone Management
- Freight and Commercial Vehicle Transportation Management
- Access Management
- Managed Lanes
- Mobility as a Service/Mobility on Demand
- Transit Management

3- Dimensions of TSMO Capability:

- Business Processes
- Systems and Technology
- Performance Measurement
- Culture
- Organization and Staffing

- Collaboration
- TSMO Strategy-Specific CMM Dimensions

The following sub-sections include detailed discussions and analysis of the findings under each focus area and associated components.

3.1 TSMO Implementation Guidance Parameters

The key focus areas were developed in alignment with the IOP elements for TSMO program planning and integration. Per FHWA guidelines (FHWA, Advancing TSMO: Making the Business Case for Institutional, Organizational, and Procedural Changes, 2018), these elements include:

- **Institutional:** Actions or changes that are focused on growing an agency culture that values TSMO, including mission and objectives, technical understanding, leadership, outreach, and program legal authorities.
- **Organizational:** Actions or changes that adjust the structure of responsibilities including reorganizations, staff training and development, recruitment and retention, and collaboration to better support TSMO functions.
- **Procedural:** Actions or changes that improve business and technical processes to better incorporate TSMO, including adjustments in planning, programming and budgeting, systems engineering, and performance measurement.

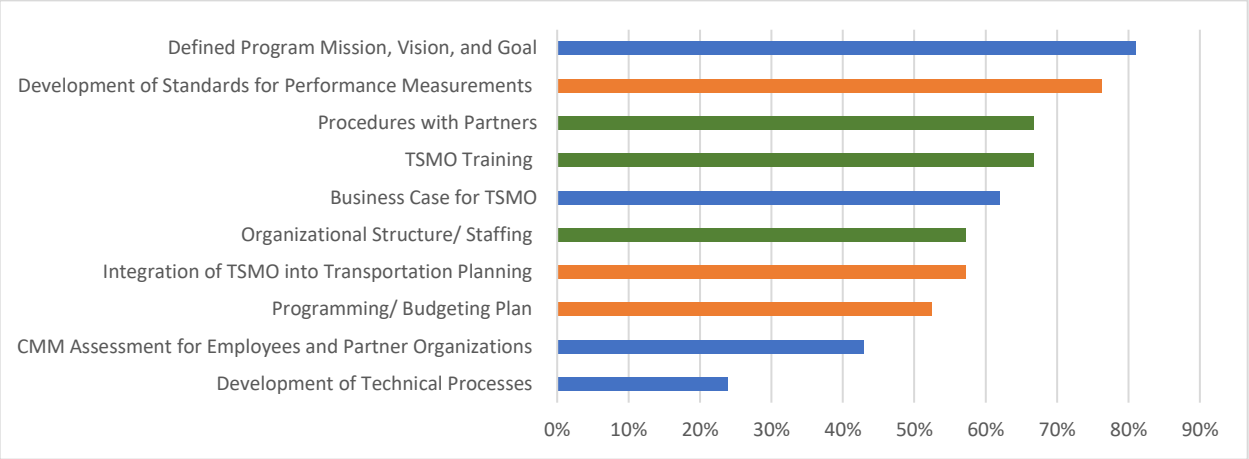
Based on these definitions, the key components identified for TSMO implementation guidance parameters review were mapped against the IOP categories as shown in **Table 2**.

Table 2: TSMO Implementation Guidance Parameters

IOP Category	TSMO Implementation Guidance Parameters – Key Components
Institutional	• Development of technical processes • Defined program mission, vision, and goals • CMM assessment for employees and partner organizations • Business Case for TSMO
Organizational	• TSMO training • Procedures with partners • Organizational structure / staffing
Procedural	• Development of standards for performance measurements • Integration of TSMO into transportation planning • Programming / budgeting plans

This State of the Practice summary included a review of other agency TSMO Plans from across the County in order to identify which TSMO elements that are essential and critical during the development of a TSMO Plan. **Figure 1**demonstrates the findings from the review of Federal TSMO guidance documents, focused on TSMO implementation guidance parameters.

Figure 1: Findings on IOP Elements and Rankings from the Review of Federal TSMO Guidance Documents



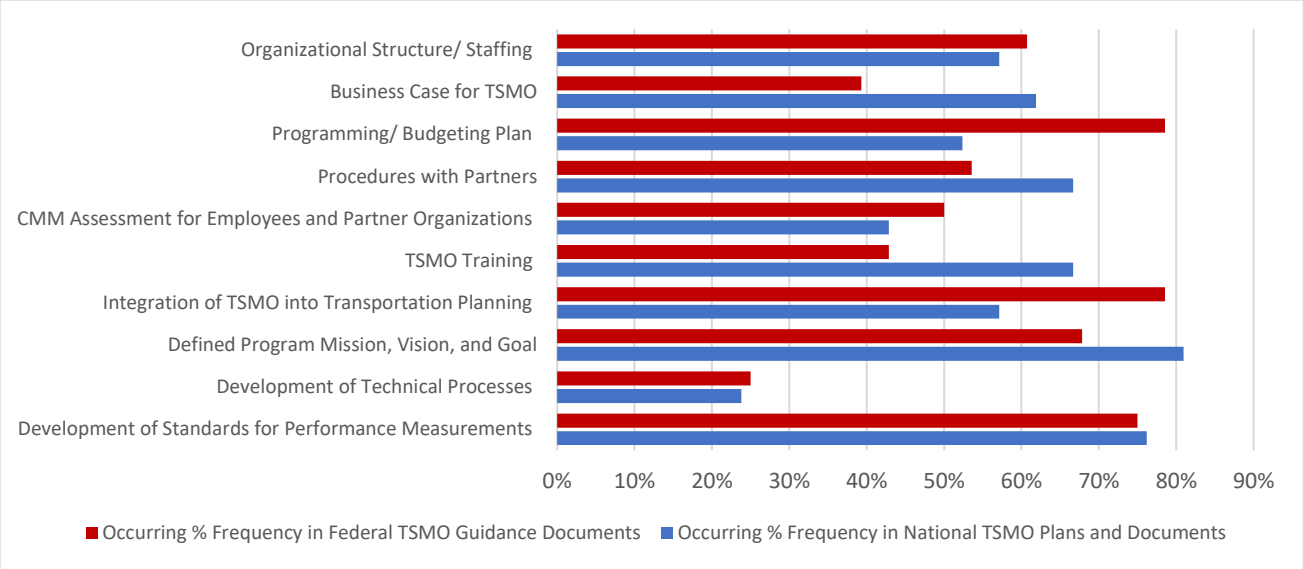
As demonstrated in **Figure 1**, over 80% of Federal TSMO guidance documents have defined mission, vision, and goals, also known as Strategic Elements, that are critical components in the preparation of a TSMO Plan. The majority of these Strategic Elements are in alignment with statewide long-range transportation plans and/or their statewide TSMO program. Considering the differences in local versus statewide transportation management and operations roles and responsibilities, local agencies in general have developed more specific Strategic Elements in alignment with local challenges and priorities.

The second most represented topic in the Federal TSMO guidance documentsis the development of standards for performance measurements. Federal TSMO guidance documents also highlight the importance of developing standards for performance measurements and findings in national TSMO plans and documents indicate that they follow the Federal guidelines. This reflects the importance of the development and formal adoption of performance metrics and targets in alignment with the Strategic Elements as the basis of a performance-based program. Defining the performance metrics and targets has also assisted the Southern Nevada agencies with the identification of gaps and needs in the performance measurement and evaluation process.

Development of Concept of Operations (ConOps) for technical processes is not represented in the majority of national TSMO plans and documents; however, the need to develop these technical processes has been highlighted in several documents. ConOps is systems-driven and is a secondary document which is typically developed at a later stage in the TSMO implementation process for specific TSMO strategies (also known as Tactical Elements). As-such, it is appropriate that the need for ConOps is only highlighted and not discussed in great detail in the Federal TSMO guidance documents.

Figure 2 demonstrates a comparison of findings between national TSMO plans and documents versus Federal TSMO guidance documents. This comparison was performed to establish a better understanding of how TSMO plans and documents adopted by state and local agencies align with Federal guidelines with respect to IOP changes and actions.

Figure 2: Comparison of IOP Elements (National TSMO Plans and Documents versus Federal TSMO Guidance Documents)

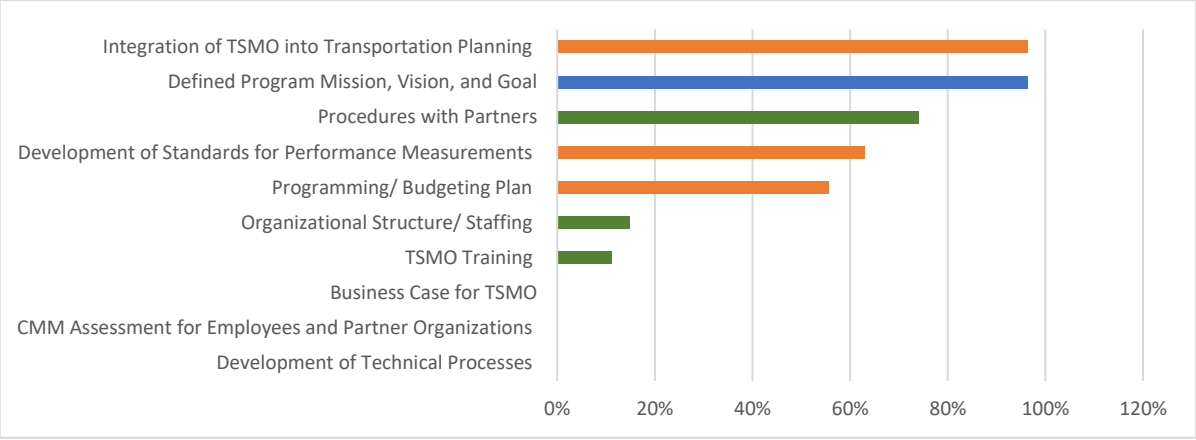


Findings from this comparison reveal that Federal TSMO guidance documents provide holistic guidelines for TSMO program management and implementation and place a greater focus on **Procedural** elements and actions. These include development of standards for performance measurement, TSMO integration into transportation planning, and development of procedures and agreements with partners.

On the other hand, national TSMO plans and documents place a greater focus on development of mission, vision, and goals; TSMO training; and development of a business case for TSMO. As seen in **Figure 2**, areas where the two major categories are somewhat similar include organization structure and staffing, CMM assessments, and development of technical processes. Based on these findings, it is evident that agencies around the nation primarily focus on **Institutional** and **Organizational** elements and actions to support their TSMO planning and implementation.

Figure 3 demonstrates analysis of IOP elements and actions within Southern Nevada plans and programs.

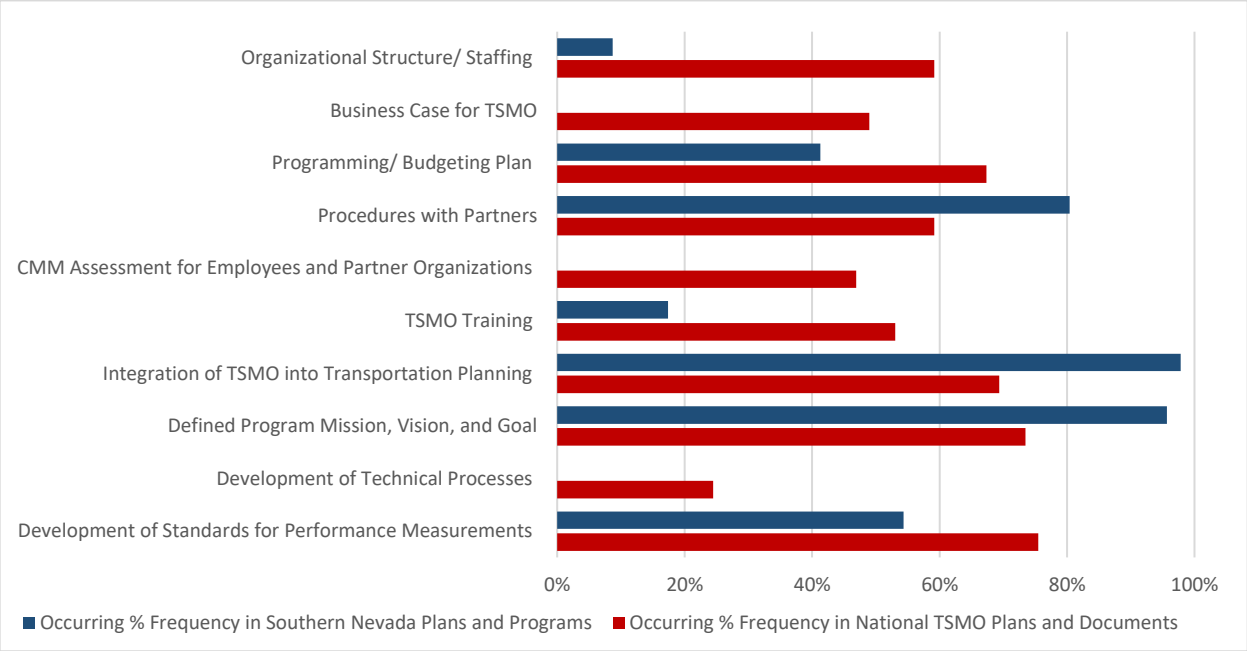
Figure 3: Analysis and Rankings of IOP Elements in Southern Nevada Plans and Programs



As shown in **Figure 3**, **Organizational** and **Procedural** elements and actions are the most represented topics within Southern Nevada plans and programs. Although defined program mission, vision, and goals is the second highest ranking component, there is a lack of documented **Institutional** elements and actions to support the strong strategic direction defined by local efforts. These findings highlight the need for **Institutional** elements and actions to advance TSMO culture and obtain regional support for TSMO planning that will build upon the existing **Organizational** and **Procedural** elements.

Further analysis and reviews were performed to compare TSMO State of the Practice in Southern Nevada versus national efforts with respect to IOP elements and actions. As shown in **Figure 4**, it is evident that Southern Nevada is well ahead of national efforts in formally defining programs' strategic direction, foundation for integration of TSMO into transportation planning, and collaboration with regional partners. These strengths can be capitalized within the RTC TSMO Business Case in addressing the identified gaps and formal adoption of elements and actions for TSMO implementation in Southern Nevada.

Figure 4: Comparison of IOP Elements between Southern Nevada Plans and Programs vs National TSMO Plans and Documents



3.2 TSMO Strategies

Planning for operations involves identifying operational objectives and performance measures, which guide the selection of investments, programs, and strategies. The result is implementation of programs and projects to better manage and operate transportation systems and services to preserve capacity and improve security, safety, and reliability. Today, local agencies have policies to improve transportation operations by first managing travel demand and applying management techniques prior to considering additional capacity for a roadway. Reviews indicate that while many statewide and regional policies and programs are advancing implementation of effective TSMO strategies, more benefits will occur when TSMO is considered and applied strategically at a smaller scale where many critical implementation decisions are made. TSMO within corridors presents opportunities for agencies to plan for operations at a more-refined geographic scale and

at a level where actionable plans can be developed (FHWA, Planning for Transportation Systems Management and Operations within Corridors).

National TSMO plans and documents were reviewed to find the most represented TSMO strategies. Case studies were also reviewed to identify if these strategies are best practices. The following list includes the most represented TSMO strategies in the reviewed sources.

- **Incident and Emergency Management (also known as, Traffic Incident Management [TIM]):** Planned and coordinated multi-disciplinary process to detect, respond to, and clear traffic incidents so that traffic flow may be restored as safely and quickly as possible.
- **Road Weather Management (RWM):** Strategies and tools that assist to sustainably strengthen the resiliency of the highway system by mitigating the weather impacts. These may include Road Weather Information Systems, Maintenance Decision Support Systems, etc.
- **Integrated Corridor Management (ICM):** Proactive use of managed lane strategies, alternate routing of traffic, and proactively managing and controlling traffic within corridors that have the potential to achieve significantly greater levels of service and utilization of the existing roadway capacity, improve travel times, and enhance safety and reliability of travel.
- **Active Traffic Management (ATM):** Ability to dynamically manage recurrent and non-recurrent congestion based on prevailing and predicted traffic conditions, focusing on trip reliability, maximizing the effectiveness and efficiency of the facilities, and increasing throughput and safety, resulting in synergistic performance gains.
- **Transportation Demand Management (TDM):** Set of strategies aimed at maximizing traveler choices that can be effectively integrated into the planning processes at all levels using an objectives-driven, performance-based approach that includes a process for setting specific, measurable objectives.
- **Improved Bicycle and Pedestrian Crossings:** Strategies that promote multimodal modes of transportation and advance safety, comfort, and convenient choices for people of all ages and abilities. These strategies support pedestrian and bicycle transportation through funding, policy guidance, program management, and resource development.
- **Advanced Traveler Information:** Static and real-time information on traffic conditions, schedules, road and weather conditions, special events, and tourist information classified by how and when travelers receive their desired information (pre-trip or in-route) and divided by user service categories.
- **Connected and Autonomous Vehicles:** Application of smart, connected, and automated tools to take advantage of data, technology, and cross-sector collaboration opportunities in managing and operating the transportations system. Information and Communications Technology (ICT) strategies enable these applications and the innovation in the way communities carry out Connected and Autonomous Technology (CAT) functions that improve safety, enhance mobility, increase reliability, address climate change, and improve quality of life.
- **Work Zone Management:** Assessing work zone impacts and documenting strategies for mitigating the impacts that are identified based on the project constraints, construction phasing/staging plan, types of work zone, and anticipated work zone impact. Once implemented, these strategies need to be monitored to ensure they effectively manage work zone impacts. Examples of possible performance

measures for work zone traffic management strategies include volume, travel time, queue length, delay, number of incidents, incident response and clearance times, contractor incidents, community complaints, user costs, and cumulative impacts from adjacent construction activities.

- **Freight and Commercial Vehicle Transportation Management:** Development of strategies, tools, data, and analysis to support agencies in freight system management. Developing a better understanding of how freight moves and impacts the transportation network will enable State and local agencies to implement improved operational processes and increase reliability of the movement of goods and services.
- **Access Management:** Strategies that proactively manage vehicular access points to land parcels adjacent to all manner of roadways. Good access management promotes safe and efficient use of the transportation network. It encompasses a set of techniques that State and local agencies can use to control access to highways, major arterials, and other roadways including access spacing, driveway spacing, safe turning lanes, median treatments, and right-of-way management.
- **Managed Lanes**: Highway facilities or a set of lanes where operational strategies are proactively implemented and managed in response to changing conditions. Common elements include a "freeway-within-a-freeway" where a set of lanes within the freeway cross section is separated from the general-purpose lanes, incorporating a high degree of operational flexibility so that over time operations can be actively managed in response to growth and changing needs, and using a combination of tools and techniques in order to continuously achieve an optimal condition, such as free-flow speeds. Principal strategies can be categorized into three groups: pricing, vehicle eligibility, and access control.
- **Mobility as a Service (MaaS)/Mobility on Demand (MOD):** MOD is an innovative, user-focused approach which leverages emerging mobility services, integrated transit networks and operations, real-time data, connected travelers, and cooperative Intelligent Transportation Systems (ITS) to allow for a more traveler-centric, providing improved mobility options to all travelers and users of the system in an efficient and safe manner. MaaS approaches provide joint digital channels that enable users to plan, book, and pay for multiple types of mobility services based on demand. MaaS and MOD are sometimes used interchangeably, however, they are different. Although both strategies involve the integration of different transportation modes, MaaS creates a “single mobility service”, while MOD establishes “an integrated and connected multi-modal network of options”.
- **Transit Management:** improvements in transit travel time, reliability (e.g., on-time performance), customer access to information about transit services, or other approaches that improve the performance of transit or of other modes through transit. Transit-related maintenance and operations strategies often utilize technologies, such as ITS, advanced vehicle location, communications technologies, traffic signalization, smart fare systems, etc. They typically also involve coordination with various partners.

Further analysis and reviews were performed to identify best practices and benefits of each strategy. Reviewed documents include case studies of deployments by agencies. In some cases, the case studies also include detailed benefit-cost analysis and quantitative benefits of deployed strategies. **Table 3** provides a summary of benefits obtained from TSMO strategies’ deployments across the nation.

Table 3: Deployment Benefits of TSMO Strategies

#	TSMO Strategies	Experienced Deployment Benefits	Reference
1	**Incident and Emergency Management**	• Reduced congestion • Boosted efficiency and productivity for local agencies • Increased safety • Reduced number required law enforcement staff • Promoted understanding of benefit to the community • Heightened driver confidence	**User-Friendly TIM Program Benefit-Cost Estimation Tool** *https://www.fhwa.dot.gov/publications/research/operations/16055/003.cfm*
2	**Road Weather Management**	• Improved safety due to reduced crash risk • Increased mobility due to restored capacity, delay reductions, and more uniform traffic flow • Increased productivity due to reduced labor, treatment material, and equipment costs	**Best Practices for Road Weather Management** *https://ops.fhwa.dot.gov/weather/q2_benefits.htm*
3	**Integrated Corridor Management**	• Better management of congestion on the multimodal network • Enhanced TIM • Enhanced transit service the corridor • A more reliable revenue source for multimodal improvements in the corridor • Pre-trip travel decisions or travel motivations • Enhanced choice of mode • Enhanced travel route decisions • Vehicle flow along the entire network	**ICM, Managed Lanes, and Congestion Pricing: A Primer** *https://ops.fhwa.dot.gov/publications/fhwahop16042/fhwahop16042.pdf*
4	**Active Traffic Management**	• Reduced congestion • Increased travel time reliability • Improved traffic flow • Reduction in primary and secondary incidents • Reduced emissions • Improved transit and freight operations	**Active Traffic Management Feasibility and Screening Guide** *https://ops.fhwa.dot.gov/publications/fhwahop14019/ch2.htm*
5	**Transportation Demand Management**	• Mode shift • Reduced vehicle trips • Reduced vehicle miles traveled • Reduced congestion • Improved travel time reliability • Reduced emissions • Land use improvements and economic development	**Known Effectiveness of TDM Strategies** *https://ops.fhwa.dot.gov/publications/fhwahop12035/chap10.htm*

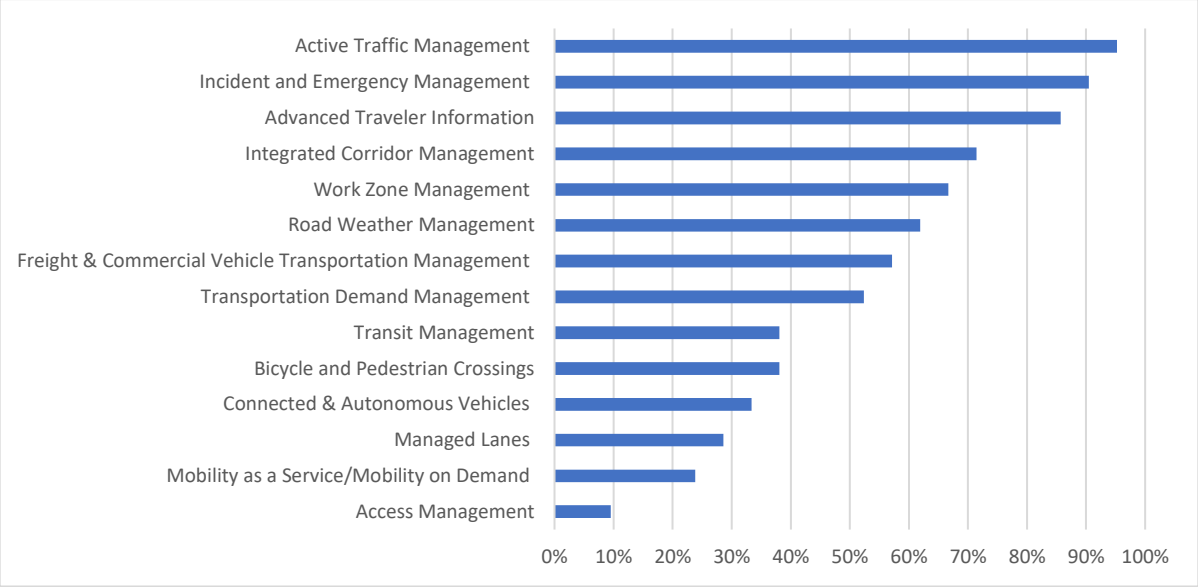
#	TSMO Strategies	Experienced Deployment Benefits	Reference
6	**Bicycle and Pedestrian Crossings Improvements**	• Improved community health and physical wellness/quality of life • Improved non-motorized modes of transportation and mobility • Reduced emissions and environmental benefits • Reduced congestion and associated costs • Reduced incidents involving certain types of vehicles	**The Need for Bicycle and Pedestrian Mobility** *https://safety.fhwa.dot.gov/PED_BIKE/univcourse/pdf/swless01.pdf*
7	**Advanced Traveler Information**	• Improved travel time reliability • Pre-trip travel decisions or travel motivations • Enhanced choice of mode • Enhanced travel route decisions • Reduced congestion and demand • Improved commuter behavior • Improved customer service and satisfaction ratings	**Best-of-the-month Practices for Traveler Information** *https://ops.fhwa.dot.gov/travelinfo/practices/benefits.htm*
8	**Connected & Autonomous Vehicles**	• Improved collaboration among stakeholders • Improved perception of risks and rewards • Improved connectivity • Enhanced investment in data sharing • Enhanced safety and reliability • Reduction in emissions • Energy efficiency • Enhanced access to opportunities • Improved quality of life • Improved congestion and demand management • Land use improvements and economic vitality	**TSMO in Smart Communities** *https://ops.fhwa.dot.gov/publications/fhwahop19004/fhwahop19004.pdf*
9	**Work Zone Management**	• Enhance safety and reduced fatalities • Reduced congestion • Improve efficiency during construction • Improved travel time reliability and traffic flow within work zones • Improved traveler information and driver awareness • Enhanced incident response during construction and within work zones	**Enhancing Transportation: Connecting TSMO and Construction** *https://ops.fhwa.dot.gov/publications/fhwahop18092/index.htm#:~:text=TSMO%20is%20integral%20to%20effective,through%20an%20active%20work%20zone.*

#	TSMO Strategies	Experienced Deployment Benefits	Reference
10	**Freight & Commercial Vehicle Transportation Management**	• More efficient use of resources • Improved reliability in movement of goods and services • Improved performance on highways • Economic vitality • Improved freight travel time reliability • Reduced emissions and environmental impacts • Improved freight asset management and performance • Improved freight policy and coordination with neighboring states • Reduced impacts to aging infrastructure	**Freight Management Cost Benefit Analysis** *https://ops.fhwa.dot.gov/freight/freight_analysis/cba/index.htm*
11	**Access Management**	• Improved traffic flow and speed • Improved land use and urban planning • Reduced incidents and fewer vehicle conflicts • Economic vitality • Increased roadway capacity • Maximized performance and efficiency on existing roadway • Improved air quality	**Benefits of Access Management Brochure** *https://ops.fhwa.dot.gov/access_mgmt/docs/benefits_am_trifold.htm#:~:text=The%20benefits%20usually%20identified%20with,depend%20on%20pass%2Dby%20traffic.*
12	**Managed Lanes**	• Improved traffic operations and system performance • Reduced congestion and demand on roadways • Improved incident management and response times • Improved travel time reliability • Improved multimodal mobility • Increased high-occupancy and ride share travel	**Managed Lanes: A Primer** *https://ops.fhwa.dot.gov/publications/managelanes_primer/*
13	**Mobility as a Service/ Mobility on Demand**	• Promote multimodal, integrated, and connected transportation system • Increased mode choice alternatives to manage demand • Improved mobility along congested corridors • Improved traveler information access and trip planning • Increased efficiency in movement of people and services • Increased efficiency in corridor management as a multimodal system	**Integrated Corridor Management, Transit, and Mobility on Demand** *https://ops.fhwa.dot.gov/publications/fhwahop16036/ch1.htm#s11*

#	TSMO Strategies	Experienced Deployment Benefits	Reference
14	**Transit Management**	• Promote alternative modes of travel • Improved travel time reliability and traveler information • Reduced emissions and vehicle miles traveled • Reduced travel and associated costs • Improved customer service and satisfaction • Increased efficiency in transit services • Improved transit infrastructure • Enhanced regional coordination • Improved management of special events	**TSMO & Transit Management** *https://ops.fhwa.dot.gov/plan4ops/resources/transit_agencies.htm*

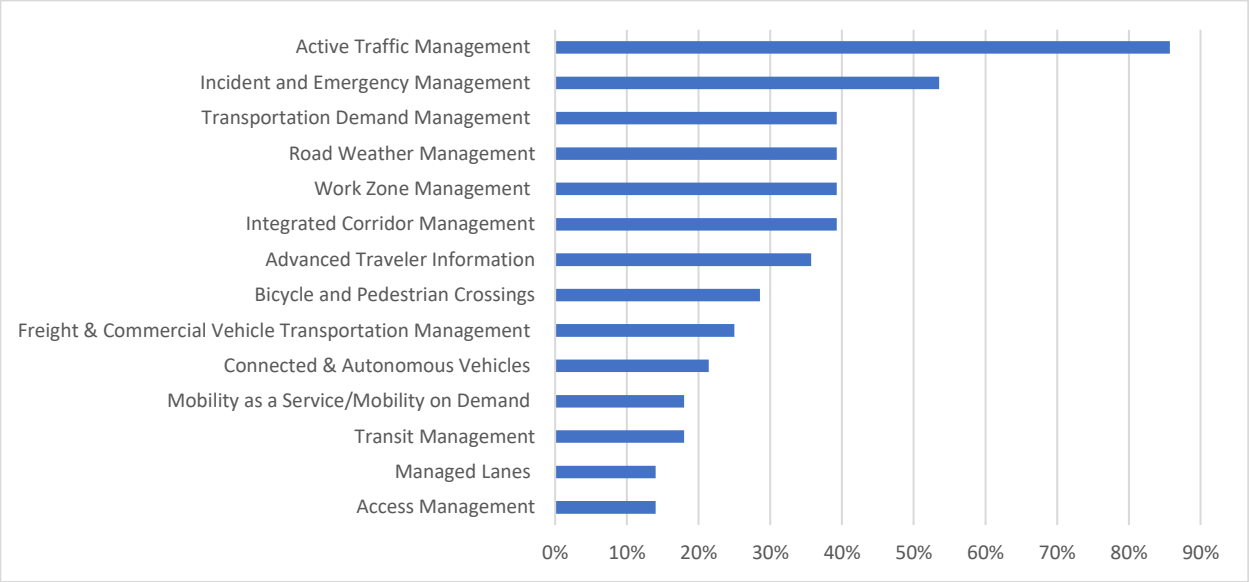
As shown in **Figure 5**, review of the TSMO strategies within the review of national TSMO plans and documents indicate a primary focus on **Active Traffic Management**, **Incident and Emergency Management**, and **Advanced Traveler Information** strategies.

Figure 5: TSMO Strategies' Rankings within National TSMO Plans and Documents



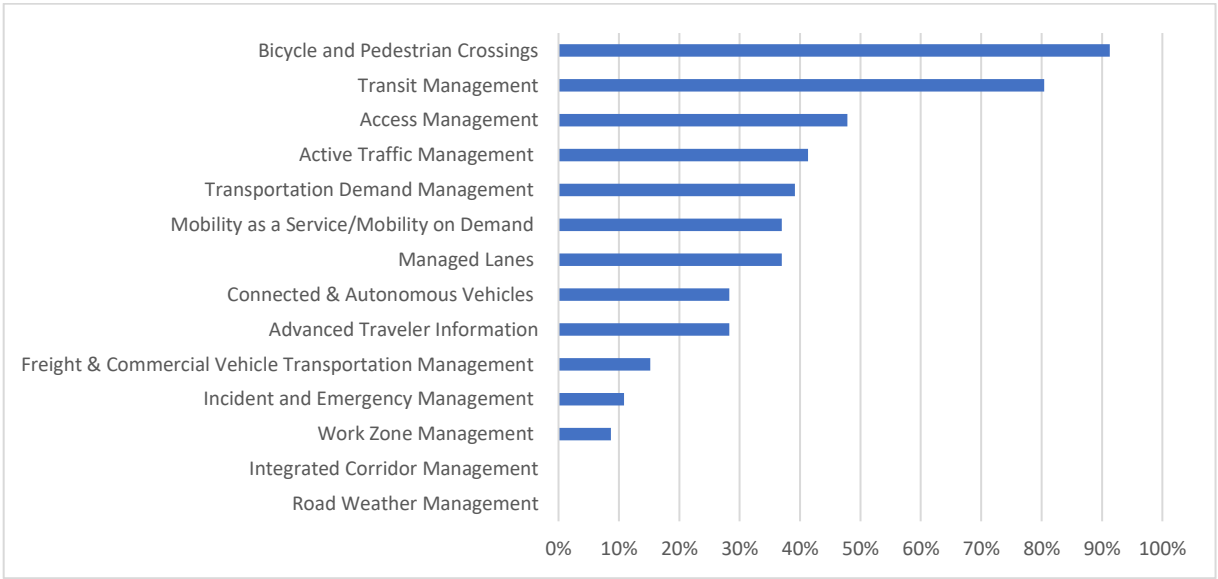
As shown in **Figure 6**, these findings are in alignment with the primary focus of strategies addressed in Federal TSMO guidance documents with **Active Traffic Management** and **Incident and Emergency Management** ranking as the most represented strategies on the list. Further reviews indicate that specific strategies were not largely discussed in detail in Federal TSMO guidance documents due to the very broad nature of each item; however, findings suggest that there is a focus on developing secondary plans if the plans do not include full recommendations and action items on specific strategies.

Figure 6: TSMO Strategies' Rankings within Federal TSMO Guidance Documents



On the other hand, reviews of Southern Nevada plans and programs indicate that the majority of planned and deployed TSMO strategies in Southern Nevada are focused on **Bicycle and Pedestrian Crossings** and **Transit Management**. **Figure 7** summarizes findings related to existing and planned TSMO strategies in Southern Nevada and within local plans and programs. Although RTC and partnering agencies have implemented several other TSMO strategies, the planning process for these strategies is not formally integrated into the majority of Southern Nevada plans and programs.

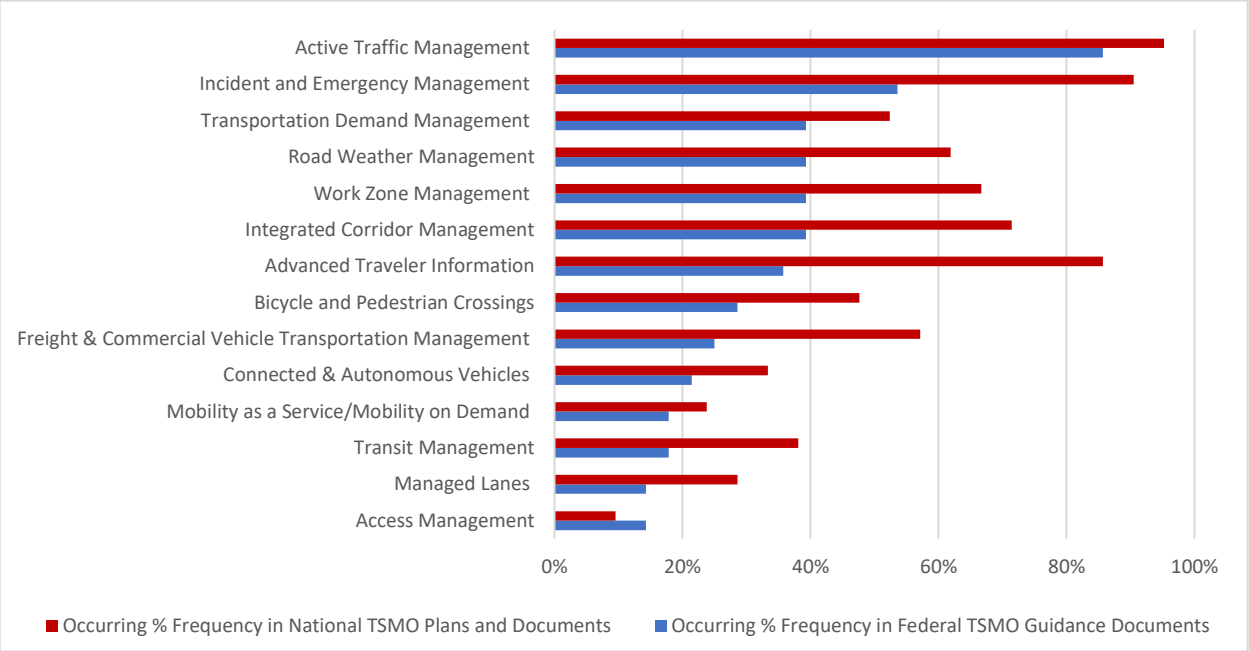
Figure 7: TSMO Strategies' Rankings in Southern Nevada Plans and Programs



To demonstrate a better understanding of the state of the practice, **Figure 8** provides a comparison between national TSMO plans and documents versus Federal TSMO guidance documents. As stated previously, even

though the reviews indicate similar trends in the literature, it is important for each agency to select and prioritize the TSMO Strategic Elements that would have the greatest benefit for their community.

Figure 8: Comparison Between National TSMO Plans and Documents versus Federal TSMO Guidance Documents



In conclusion, the reviews indicate that local agencies across the country tailor and apply a variety of approaches for their TSMO implementation; however, the selection and prioritization of the types of strategies are based upon the following three themes:

1. Use of an objectives-driven, performance-based approach.
2. Collaboration across agencies, jurisdictions, and modes.
3. Linking to overarching planning processes at the regional level.

As described previously, many strategies are applicable and effective at the regional level. However, the reviews identified the following list of top six strategies explored, planned for, and implemented by regional and local agencies around the nation (**Table 4**):

Table 4: Top Six Strategies

TSMO Strategies	Supporting Activities
Traveler Information	• Local/regional multimodal traveler information • Roadside traveler information dissemination • Predictive traveler information • Real-time transit arrival information • Trip planning and routing systems
Road Weather Operations	• Road weather information systems • Winter roadway operations

TSMO Strategies	Supporting Activities
Maintenance and Construction Management	• Maintenance and construction activity coordination • Work zone management
Incident and Emergency Management	• Traffic incident management • Emergency management • Commuter-aided dispatch integration • Emergency vehicle routing
Public Transportation Management	• Advanced transit operations management • Electronic fare collection and integration • Transit surveillance and security • Multimodal travel connections
Transportation Demand Management	• Traveler information marketing campaigns • Route planning tools • Employed programs and commuter incentives • Rideshare support • Telecommuting • Congestion pricing • Corridor investments to support mode transfer or trip ends.

Across the country, local agencies play a critical role in TSMO through collaborative relationships among diverse agencies and organizations that play a role in transportation system operations, as well as through implementation of TSMO programs. Over the past decade, TSMO has benefited from rapidly advancing technology and an increased emphasis on cost-effective transportation solutions. In Nevada, Nevada Deapartment of Transportation (NDOT) is elevating TSMO as a top priority and systematically increasing operational capabilities. With the responsibility for operating traffic signals, transit services, road maintenance, collaboration with law enforcement, and other service, RTC and local agencies in Southern Nevada play an increasingly important role as TSMO strategies become part of regional jurisdictions. As a result, building consensus around needs, priorities, performance measures, resources, and responsibilities is critical in successful planning and implementation of TSMO strategies. Error! Reference source not found. demonstrates how TSMO planning occurs in a range of planning contexts (FHWA, Advancing Metropolitan Planning for Operations: An Objectives-Driven, Performance-Based Approach – A Guidebook).

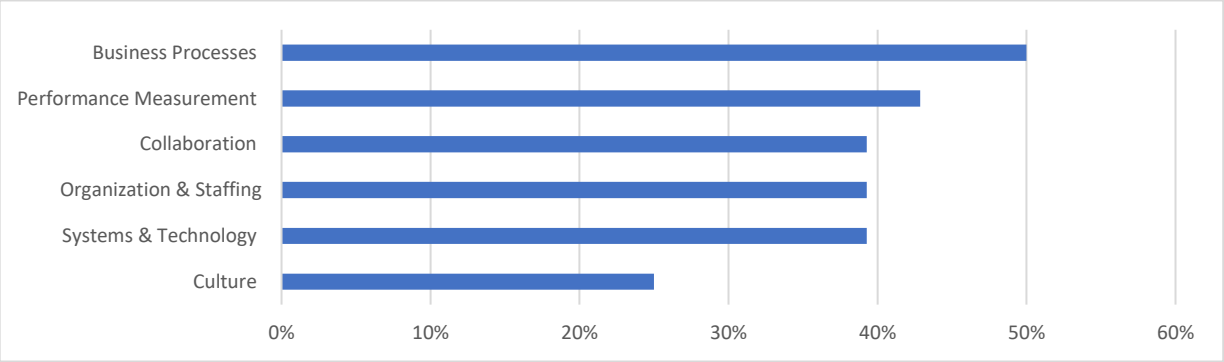
Figure 9: TSMO in a Range of Planning Contexts

3.3 TSMO Capability Dimensions

Reviews and analysis were conducted to demonstrate a better understanding of how the CMM framework was utilized by other agencies, which dimension or dimensions were the primary focus of the discussions for TSMO integration, and what were the associated challenges and lessons learned.

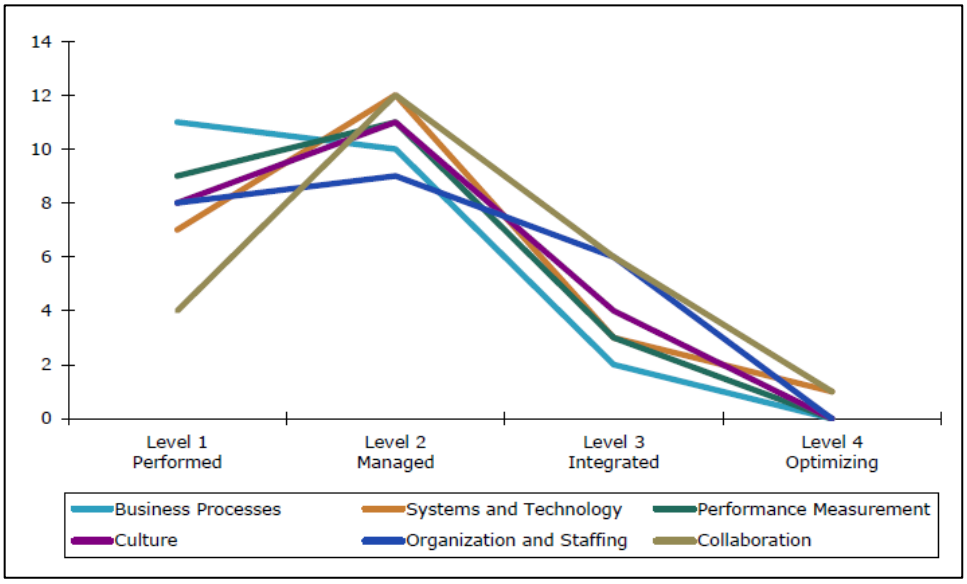
As shown in **Figure 10**, reviews indicate that within the capability dimensions, Business Processes were the most discussed dimension. On the other hand, Culture was identified to be the major component affecting the success of a statewide TSMO program and yet, remains to be the biggest challenge.

Figure 10: TSMO Capability Dimensions and Rankings



Second Strategic Highway Research Program (SHRP) 2 conducted numerous workshops and self-assessment practices on CMM across the nation. A total of 23 workshop documents indicated the maturity level of each capability dimension. As demonstrated in **Figure 11**, most of the studied regions and states are operating between “performed” and “managed” levels for most of the dimensions. It can be concluded that these regions or states have developed a TSMO program, are in the process of considering TSMO solutions, or are working toward integration and improvement of a TSMO plan.

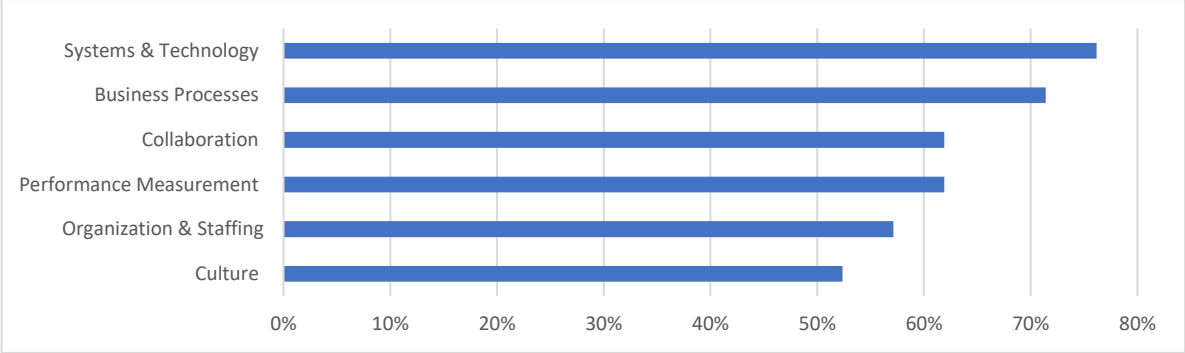
Figure 11: Distribution of TSMO Maturity Levels by SHRP 2



Reviews also focused on determining the state of the practice for CMM dimensions within national TSMO plans and documents. As shown in **.**

Figure 12, other state agencies' primary focus has been on Systems and Technology dimension due to their roles and responsibilities in managing, operating, and maintaining TSMO systems, technologies, and projects. However, similar to the trends witnessed within the Federal TSMO guidance documents, improving the maturity of TSMO Culture was identified as the most challenging item represented within regional agencies' TSMO plans and documents.

Figure 12: CMM Dimensions' Rankings in National TSMO Plans and Documents



Reviews also indicate that some agencies take a different approach with TSMO implementation by using specific CMM dimensions for TSMO planning and strategies' implementation rather than focusing on developing TSMO programs. For example, Maricopa Association of Governments released the agency's Systems Management and Operations Plan in 2018. Their approach to developing strategic and tactical business processes for this plan is uniquely driven by financial considerations. For strategic business processes, TSMO objectives are presented as four key investment priorities in Systems and Technology

including integrated corridor management, regional priority arterials, local priority corridors, and regional operations priorities (FHWA, Organizing for TSMO - Case Study 11: MPO Examples).

Findings from the reviews also indicate that agencies apply the CMM framework not only for overall TSMO program planning, but also in development of specific programs. The concept of a CMM framework emerged from SHRP2 L01 and L06 projects that promoted a process-driven approach to identify current level of maturity and improve TSMO. Later on, the FHWA Office of Operations led efforts to develop six additional TSMO CMM frameworks which elaborate on, and are consistent with, the CMM developed under SHRP2 by the Transportation Research Board (TRB), AASHTO, and FHWA, but provide more focused assessment and suggested actions in each of the following operations program areas:

1. Traffic Management
2. Traffic Incident Management
3. Road Weather Management
4. Planned Special Events
5. Work Zone Management
6. Traffic Signal Management

Additional reviews were also performed to determine the state of the practice for the CMM dimensions in Southern Nevada. The reviews indicated no records of CMM dimensions; however, as stated in the findings in **Section 3.1**, several TSMO elements were identified within Southern Nevada plans and programs and are mapped against CMM dimensions as shown in **Table 5**.

Table 5: IOP Elements and Relevance to CMM Dimensions

IOP Elements within Southern Nevada Plans and Programs	Relevant CMM Dimension
TSMO integration into transportation planning	Business Processes
Defined mission, vision, and goals	Culture
Procedures with partners	Collaboration
Development of standards for performance measurement	Performance Measurement
Programming and budgeting plan	Business Processes
Organizational structure and staffing	Organization and Staffing
TSMO training	Organization and Staffing

4 Connections to NDOT TSMO Program

NDOT formally adopted the Statewide TSMO Program Plan in 2020. Within the Program Plan, NDOT identified specific Strategic, Programmatic, and Tactical elements in alignment with the FHWA's recommended TSMO planning framework. A summary of these elements is provided in **Table 6**.

Table 6: NDOT TSMO Program Plan Summary

Strategic Elements	Programmatic Elements	Tactical Elements
TSMO Missions: Deliver a safe and connected multi-modal transportation system that links Nevadans and supports the state's economic vitality through TSMO solutions. **TSMO Vision: Proactively manage, operate, and improve the transportation system through the integration of TSMO throughout NDOT.** **Goals:** • **Enhance Safety** • **Preserve Infrastructure** • **Enhance Reliability** • **Optimize Mobility** • **Optimize Customer Service** • **Enhance Collaboration** • **Foster Sustainability** • **Strengthen TSMO Integration** **The Business Case for TSMO: Identified and documented statewide transportation challenges, highlighted the needs for TSMO, and demonstrated the contribution and success stories of TSMO activities that can be applied to address these challenges.**	**Program Objectives:** Defined program objectives, performance measures, data sources, and baseline targets for each Strategic goal. **Organizational Structure:** Developed a phased approach for updating the organizational structure to establish a more TSMO-centric team and accommodate TSMO in a formalized manner. **Business Processes and Program Management:** Identified action items to develop TSMO processes and structured tasks related to performance-based and informed decision-making. **Staffing and Workforce Development:** Identified action items to develop staffing and workforce with appropriate TSMO knowledge and skills. **Financial Resources Management:** Identified actions items to ensure evaluation of both available and required resources to efficiently identify areas of investment for TSMO. **Communication and Collaboration:** Identified action items to appropriately coordinate TSMO activities in delivering TSMO goals and objectives.	• Real-time Traveler Information • Connected and Automated Vehicles • Active Traffic Management • Traffic Incident Management • Transportation Asset Management • Transportation Performance Management • ITS Database and Communications

Following the formal adoption of the TSMO Program Plan, NDOT continued their efforts in TSMO integration through implementation of the identified action items with a primary focus on Programmatic and Tactical Elements. **Table 7** provides a summary of the implementation efforts.

Table 7: NDOT TSMO Implementation Plan

Item	Category	Description	Next Steps
2020 CMM Workshop	Strategic Elements	Conducted their second CMM workshop and expanded participants to include statewide partners and stakeholders.	Identified action items for progress to Level 3 of TSMO maturity by 2024.
TSMO Business Case for NDOT Divisions	Strategic Elements	Developed their second TSMO business case to demonstrate NDOT Divisions' contribution with TSMO implementation, projects, and activities.	Utilized the business case as a tool to advance TSMO culture dimension and engage internal stakeholders in TSMO implementation.
TSMO Website	Strategic Elements	Developed a TSMO website that could be accessed by all internal partners and external partners including TSMO documents, case studies, publications, and news.	Utilize this platform for TSMO program outreach, education, and engagement and promote TSMO culture.
TSMO Steering Committee	Programmatic and Tactical Elements	Transitioned from an internal TSMO Champion Team to a TSMO Steering Committee including both internal and external partners, providing an opportunity for all to participate in TSMO activities.	Define roles and responsibilities for members in TSMO project planning, development, implementation, management, and operation.
TSMO Performance Management Program	Programmatic and Tactical Elements	Developed the Statewide TSMO Performance Management Program to assist in measurement and monitoring of TSMO performance measures, assets, and associated statewide goals and objectives. The program also includes defined roles and responsibilities of stakeholders in performance measurement and management process through a RACI matrix.	Implement the Program's action items including performance measurement and management activities, integrate asset management and reporting, conduct trainings for stakeholders, monitor progress, and develop a TSMO performance measurement dashboard.
TSMO Staffing and Workforce Development Plan	Programmatic Elements	Developed detailed plan to recruit, train, and maintain a TSMO workforce; work with local educational institutions to promote TSMO and offer TSMO-centric education.	Hire five (5) TSMO-specific team members, roll out the TSMO Training Modules, engage HR in recruitment process, engage TSMO positions in other NDOT Divisions' business processes to enhance collaboration.

Item	Category	Description	Next Steps
TSMO Coordination Plan with Stakeholders	Programmatic Elements	Developed a step-by-step process on when and how to engage stakeholders in TSMO activities, identified TSMO topics for discussions, and identified TSMO strategies to be implemented collaboratively with partners.	Roll out the plan, expand stakeholders' engagement in TSMO activities through formalized meetings, update existing engagement processes to include TSMO topics.
TSMO Interagency Agreements	Programmatic and Tactical Elements	Review and update existing interagency agreement to incorporate TSMO elements, identify opportunities for development of TSMO-specific interagency agreements	Roll out the new and updated agreements, engage the stakeholders in TSMO project planning, development, and management through formal TSMO roles and responsibilities.
TSMO Planning and Financial Resources Processes and Procedures	Programmatic and Tactical Elements	Review, update, and development of new business processes for TSMO project planning and TSMO Financial Planning	Implement the plan to formalize inclusion of TSMO elements in project planning processes and procedures, implement the financial plan to secure funding and resources for TSMO projects and strategies.

Historically, NDOT and RTC have a close working relationship and support each other in management, operations, and maintenance of the transportation system in Southern Nevada. The NDOT-RTC Freeway and Arterial System of Transportation (FAST) Agreement is one example of how the two agencies formally collaborate in delivering a safe and reliable transportation system in Southern Nevada. In addition, the two agencies also partner on TSMO grants, strategies, project development, and other management, operation, and maintenance activities. Considering this, RTC has currently adopted, budgeted for, and is actively engaged in implementing TSMO in alignment with the State TSMO Program Plan. A summary of most recent examples of this collaboration is included in **Table 8**.

Table 8: Example of Recent TSMO Collaboration Between NDOT and RTC

Items	NDOT TSMO Program Plan Category	Description
NDOT 2020 CMM Workshop	Strategic Elements	RTC participated in the 2020 CMM workshop that was conducted by NDOT and provided their feedback on the six maturity dimensions. Therefore, the action items developed as a result of the workshop analysis will provide additional opportunities for RTC to collaborate in TSMO implementation.

Items	NDOT TSMO Program Plan Category	Description
TSMO Steering Committee and Meetings	Programmatic Elements	There are representatives from RTC attending the quarterly meetings hosted by NDOT. These meetings provide RTC with the opportunity and a platform to engage in TSMO activities, participate in TSMO discussions, and stay involved in the decision-making process. Considering that the committee will be expanded to assume additional roles and responsibilities, RTC will have greater opportunities to directly engage in TSMO project planning, development, and management process.
NDOT-RTC FAST Interlocal Agreement Update	Programmatic and Tactical Elements	In 2020, NDOT and RTC FAST updated the interlocal agreement to include TSMO components, roles and responsibilities, performance measures, and business processes in alignment with the Statewide TSMO Program. Through this updated, RTC operates, manages, and maintains the transportation system, resources, and assets in alignment with the TSMO goals and objectives through formal adoption of TSMO business processes and procedures.
Project-Specific Collaboration	Tactical Elements	Examples of specific TSMO projects that NDOT and RTC have collaborated on include the Active Traffic Management, Traffic Incident Management, Transportation Asset Management Plan, Systems Engineering and Concept of Operations, ITS Strategic Deployment Plan, etc. RTC has been actively engaged in project development, planning, design, construction, management, operation, and maintenance of these TSMO strategies and Tactical Elements.

There are opportunities for further collaboration between NDOT and RTC for formal adoption and implementation of TSMO in Southern Nevada. Additional potential connections between the NDOT Statewide TSMO Program and the RTC TSMO Plan can be established following the RTC CMM workshop analysis and development of the RTC regional TSMO business case. These connections can be highlighted within the RTC Regional TSMO Plan guide and the associated next steps.

5 Conclusion

It is evident that Southern Nevada is well ahead of Federal efforts in formally defining programs' strategic direction, integration of TSMO into transportation planning, and collaboration with regional partners. However, the majority of planned and deployed TSMO strategies in Southern Nevada are focused on Bicycle and Pedestrian Crossings and Transit Management.

Although RTC and partnering agencies have implemented several other TSMO strategies, such as Active Traffic Management, Incident and Emergency Response Management, and Work Zone Management, the process for planning, budgeting, and implementation of these strategies is ad-hoc, project-driven, and not formally integrated. Therefore, the reviews highlight a need to capitalize on existing strengths to formally adopt TSMO and other IOP elements and actions for regional and collaborative implementation of TSMO strategies.

In addition, it is important to note that TSMO Strategic Elements should be the main driver in identification and prioritization of the strategies to be pursued by local and partnering agencies. The Strategic Elements specific to TSMO should be developed in collaboration with RTC's partnering agencies and should support the NDOT Statewide TSMO Program Plan.

RTC is supporting the statewide implementation of TSMO Program through formal collaboration with NDOT. Currently, the majority of RTC's support is focused on NDOT's Programmatic and Tactical Elements of TSMO. This is in alignment with the findings from the literature as it relates to the roles and responsibilities of local agencies supporting the statewide TSMO implementation with greater focus on program management components and project-specific activities. However, there are opportunities for further collaboration between NDOT and RTC for formal adoption and implementation of TSMO in Southern Nevada.

Additional potential connections between the NDOT Statewide TSMO Program and the RTC TSMO Plan can be established following the analysis of RTC CMM workshop and development of the RTC regional TSMO business case. These connections can be highlighted within the RTC Regional TSMO Plan guide and the associated next steps.

6 References

6.1 List of Federal/National documents and resources

No.	Article Name	Source/Contributing Authors	Publication Date
1	AASHTO TSM&O Guidance	AASHTO	February 2014
2	Advancing TSM&O Through Scenario Planning	US DOT / FHWA	November 2015
3	Association of Central Oklahoma Governments Congestion Management Process Update	Association of Central Oklahoma Governments	June 2016
4	California DOT TSM&O CMM Implementation Plan	Caltrans	November 2014
5	CDOT Division of TSM&O Reorganization Report	Colorado DOT	May 2013
6	CDOT Statewide TSM&O Plan, January 2015	CDOT	January 2015
7	Creating an Effective Program to Advance TSM&O	US DOT / FHWA	January 2012
8	DRCOG Regional Concept of Transportation Operations	DRCOG	August 2012
9	DVRPC Transportation Operations Master Plan	DVRPC	July 2009
10	Evaluating Alternative Operations Strategies to Improve Travel Time Reliability	SHRP 2	June 2012
11	Florida TSM&O Strategic Plan	Florida DOT	December 2013
12	Improving Transportation Systems Management and Operations – Capability Maturity Model Workshop White Paper – Business Processes	US DOT / FHWA	April 2015
13	Improving Transportation Systems Management and Operations – Capability Maturity Model Workshop White Paper – Collaboration	US DOT / FHWA	April 2015
14	Improving Transportation Systems Management and Operations – Capability Maturity Model Workshop White Paper – Culture	US DOT / FHWA	April 2015
15	Improving Transportation Systems Management and Operations – Capability Maturity Model Workshop White Paper – Organization and Staffing	US DOT / FHWA	April 2015
16	Improving Transportation Systems Management and Operations – Capability Maturity Model Workshop White Paper – Performance Measurement	US DOT / FHWA	April 2015
17	Improving Transportation Systems Management and Operations – Capability Maturity Model Workshop White Paper – Systems and Technology	US DOT / FHWA	April 2015
18	Improving TSM&O: An Implementation Plan for Missouri	Missouri DOT	October 2014
19	Institutional Architectures to Improve TSM&O	SHRP 2	February 2013
20	Iowa TSM&O Program Plan	Iowa DOT	February 2016
21	Iowa TSM&O Strategic Plan	Iowa DOT	February 2016
22	Minnesota Statewide Highway Systems Operations Plan	Minnesota DOT	September 2012

No.	Article Name	Source/Contributing Authors	Publication Date
23	NCTOG CMM Workshop Action Items	North Central Texas Council of Governments	July 2012
24	NCTOG TSMO Capability Improvement Workshop Summary	North Central Texas Council of Governments	July 2012
25	New Hampshire TSMO Strategic Plan	New Hampshire DOT	July 2016
26	New Mexico 2040 Plan	New Mexico DOT	September 2015
27	NOACA SHRP2 Implementation Plan	Northeast Ohio Areawide Coordinating Agency	July 2014
28	Oregon Metro Regional TSM&O Plan	Oregon Metro	June 2010
29	Organizing for Reliability--CMM Assessment and Implementation Plans Executive Summary	US DOT / FHWA	May 2015
30	Portland TSM&O Capability Improvement Workshop Summary	Oregon Metro	September 2012
31	Program Planning and Development for TSM&O in State Departments of Transportation	NCHRP	June 2014
32	Programming for Operations	US DOT / FHWA	September 2013
33	Regional Operations Plan for Southwestern Pennsylvania	Southwestern Pennsylvania Commission	2015
34	South Dakota DOT CMM Implementation Plan	South Dakota DOT	March 2014
35	Southeastern Wisconsin Regional Transportation Operations Plan	SWRPC	May 2012
36	Southwest Washington Regional TSM&O Plan	Southwest Washington Regional Transportation Council	June 2011
37	The Role of TSM&O in Supporting Livability and Sustainability: A Primer	US DOT / FHWA	January 2012
38	TSM&O Benefit-Cost Analysis Compendium	US DOT / FHWA	July 2015
39	TxDOT Traffic Management Improvement Initiative	Texas Department of Transportation	October 2015
40	Planning for Transportation Systems Management and Operations Within Corridors	US DOT / FHWA	September 2016
41	AZ Tech Operations Implementation Plan	AZ Tech	Dec-15
42	NCTOG CMM Workshop Action Items	North Central Texas Council of Governments	July 2012
43	NCTOG TSMO Capability Improvement Workshop Summary	North Central Texas Council of Governments	July 2012
44	Wisconsin DOT TSM&O Infrastructure Plan	Wisconsin DOT	September 2014
45	HGAC CMM Workshop Summary Report	Houston-Galveston Area Council	June 2015
46	HGAC Implementation Plan Summary	Houston-Galveston Area Council	June 2015
47	HGAC Implementation Plan Framework	Houston-Galveston Area Council	June 2015
48	Whatcom COG CMM Implementation Plan	Whatcom Council of Governments	August 2014

No.	Article Name	Source/Contributing Authors	Publication Date
49	TSM&O Program Planning - Experiences from the SHRP 2 Implementation Assistance Program	NCHRP	August 2016
50	RTCSNV FAST	NDOT/ RTC/ FAST	August 2012
51	Sitewide Transportation Plan_Moving Nevada Through 2028	NDOT	September 2008
52	FY 2008 ANNUAL REPORT FOR 2007 ASSEMBLY BILL 595	NDOT	2007
53	Status Reports for Major Transportation Projects	NDOT	N/A
54	TRAFFIC INCIDENT MANAGEMENT PERFORMANCE MEASUREMENT WEBINAR PRESENTATION	NOCoE	December 2015
55	USDOT_Designing for Transportation Management and Operations_ A Primer	FHWA	Feb-17
56	FDOT Decision Support Systems for TSM&O	FDOT	December 2015
57	SHRP2_L17_Gap-Filling_Project_2_DeploymentGuidanceFor_ TSMO_Strategies	SHRP 2	2014
58	TSM&O Through Corridor Management_SHRP2	SHRP 2 Division of Maintenance	January 2016
59	TM&O through Crowdsourced Data From Social Media	US DOT	February 2015
60	Replacing ITS with TSM&O	US DOT / FHWA	N/A
61	Relating TMS&O Strategies to policy Goals	Oregon State University/ Utah State University	September 2012
62	2021 Transportation System Management & Operations (TSMO) Strategy	Portland Metro	2021
63	Genesee-Finger Lakes Regional Transportation System Management and Operations (TSMO) Plan	Genesee-Finger Lakes Regional Planning Commission	2018
64	Treasure Valley Transportation Systems Management and Operations (TSMO) Strategic Plan 2020 - 2030 Update	Community Planning Association of Southwest Idaho	2020
65	MAG Systems Management and Operations Plan	Maricopa Association of Governments	2018
66	North Texas TSMO Approach	North Central Texas Council of Governments	2018
67	Transportation Systems Management & Operations	MetroPlan Orlando	In-Progress
68	NOCoE Asset Management Peer Exchange Proceeding Report	NOCoE	2021
69	ADVANCING TSMO: Making the Business Case for Institutional, Organizational, and Procedural Changes	FHWA	2018
70	Baltimore Regional Management and Operations (M&O) Strategic Deployment Plan	Baltimore Regional Transportation Board	2007
71	Transportation Systems Management and Operations (TSMO), Wichita Falls District Program Plan	Texas Department of Transportation	
72	Atlanta Regional TSMO Strategic Plan	Atlanta Regional Commission	2020
73	Regional Transportation Systems Management & Operations (TSMO) Plan	Wichita Area MPO	2019

No.	Article Name	Source/Contributing Authors	Publication Date
74	Beaumont District Transportation Systems Management and Operations (TSMO)	Texas Department of Transportation	2021
75	Transportation Systems Management and Operations (TSMO), Amarillo District Program Plan	Texas Department of Transportation	2021
76	Western RTMC Regional Operations Plan	Pennsylvania Department of Transportation	2019

6.2 List of Southern Nevada Documents and Resources

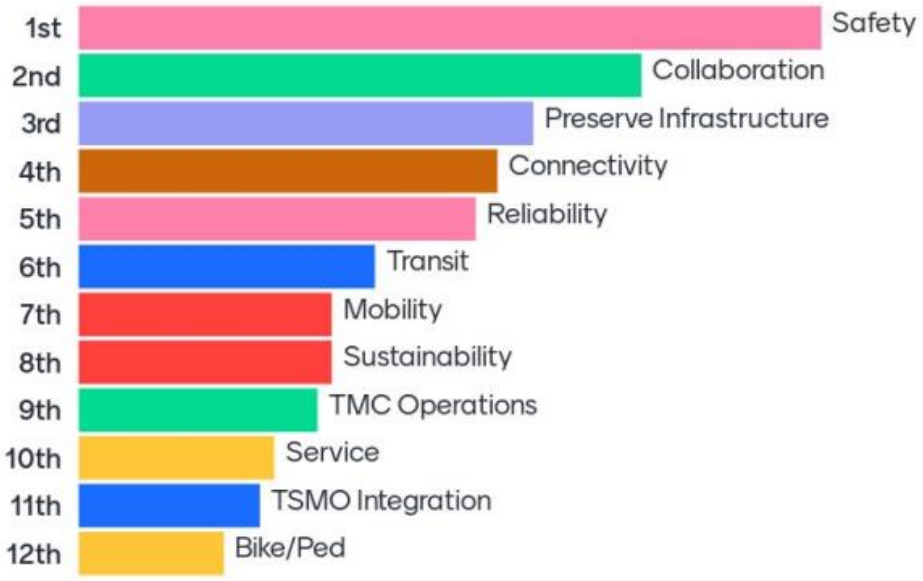
No.	Article Name	Source/Contributing Authors	Publication Date
1	Southern Nevada Transportation Safety Plan	RTC Southern Nevada	2015
2	RTC Strategic Plan	RTC Southern Nevada	2022
3	Congestion Management Process 2019	RTC Southern Nevada	2019
4	Southern Nevada Strong Regional Plan	RTC Southern Nevada	2015
5	Access 2050: Regional Transportation Plan	RTC Southern Nevada	2021
6	Southern Nevada Transportation Impacts on Health	RTC Southern Nevada	2022
7	Transportation Improvement Program (TIP) (2021-2025)	RTC Southern Nevada	2021
8	2020 Southern Nevada Coordinated Transportation Plan	RTC Southern Nevada	2020
9	Regional Bicycle & Pedestrian Plan for Southern Nevada	RTC Southern Nevada	2017
10	Traffic Signal Communication System Gap Analysis	RTC Southern Nevada	2021
11	Regional Walkability Plan	RTC Southern Nevada	2022
12	Regional Schools Multimodal Transportation Access Study	RTC Southern Nevada	2015
13	Northeast Valley Transportation Network Study	RTC Southern Nevada	2018
14	Complete Streets Design Guidelines for Livable Communities	RTC Southern Nevada	2013
15	On Board Mobility Plan	RTC Southern Nevada	2020
16	Southern Nevada Regional Goods Movement Master Plan	RTC Southern Nevada	2015
17	Performance Indicator Report	RTC Southern Nevada	2021
18	Community Mobility Study for Central Las Vegas	RTC Southern Nevada	2013
19	Transit Node Improvements in Southern Nevada	RTC Southern Nevada	2013
20	Las Vegas Valley Long Range Transit	RTC Southern Nevada	2005
21	Regional Bicycle Network Gap Analysis	RTC Southern Nevada	2014
22	Regional Pedestrian Infrastructure Inventory and Analysis	RTC Southern Nevada	2014
23	Bicycle and Pedestrian Plan	RTC Southern Nevada	2008
24	City of North Las Vegas Complete Streets Corridor Ranking Study	RTC Southern Nevada	2015
25	Complete Streets Evaluation Process for the City of Henderson	RTC Southern Nevada	2014
26	City of Mesquite Traffic Impact Study Policy Review	RTC Southern Nevada	2015

No.	Article Name	Source/Contributing Authors	Publication Date
27	Stadium District Plan (Clark County)	RTC Southern Nevada	2021
28	Southern Nevada Freight Plan Update	RTC Southern Nevada	2022
29	City of Las Vegas Mobility Master Plan	City of Las Vegas	2016
30	Las Vegas Vision Zero	City of Las Vegas	2022
31	Citywide Intersection Crash Mitigation Program	City of Las Vegas	2021
32	City of Las Vegas 2050 Master Plan	City of Las Vegas	2020
33	Smart Vegas: A Forward-Focused Plan	City of Las Vegas	2019
34	Vision 2045 Downtown Las Vegas Masterplan	City of Las Vegas	2017
35	The Hundred Plan for the Historic Westside Community	City of Las Vegas	2016
36	Transform Clark County Master Plan	Clark County	2021
37	2019-2023 Strategic Plan	City of Henderson	2018
38	Downtown Henderson Master Plan	City of Henderson	2020
39	Henderson Strong Comprehensive Plan	City of Henderson	2022
40	Smart City Strategy	City of Henderson	2018
41	Visioning 2025 Strategic Plan	City of North Las Vegas	2005
42	Citywide Pedestrian & Bicycle Plan	City of North Las Vegas	2019
43	City of North Las Vegas Comprehensive Master Plan	City of North Las Vegas	2011
44	City of North Las Vegas Downtown Master Plan & Investment Strategy	City of North Las Vegas	2009
45	Deer Springs District Livable Center	City of North Las Vegas	2020
46	North Fifth Street Transit Supportive Concept Plan	City of North Las Vegas	2006

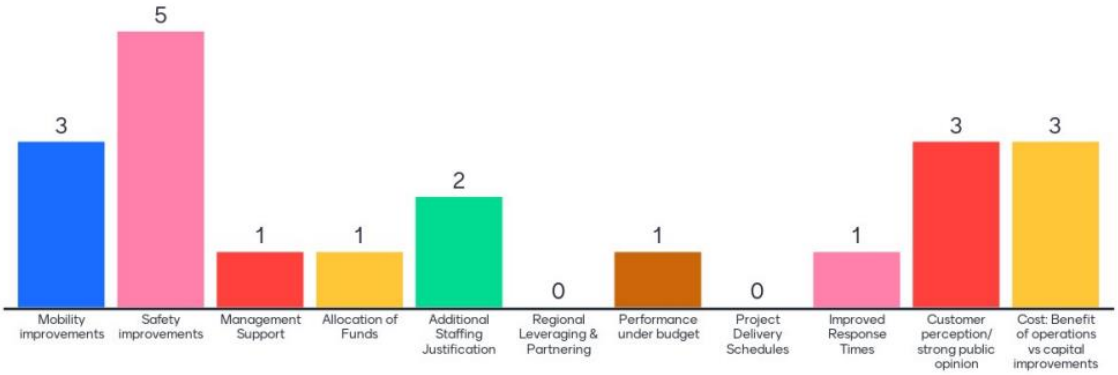
Appendix B. Stakeholder Feedback

TSMO PSC #1 - What are your agency's top three transportation challenges?

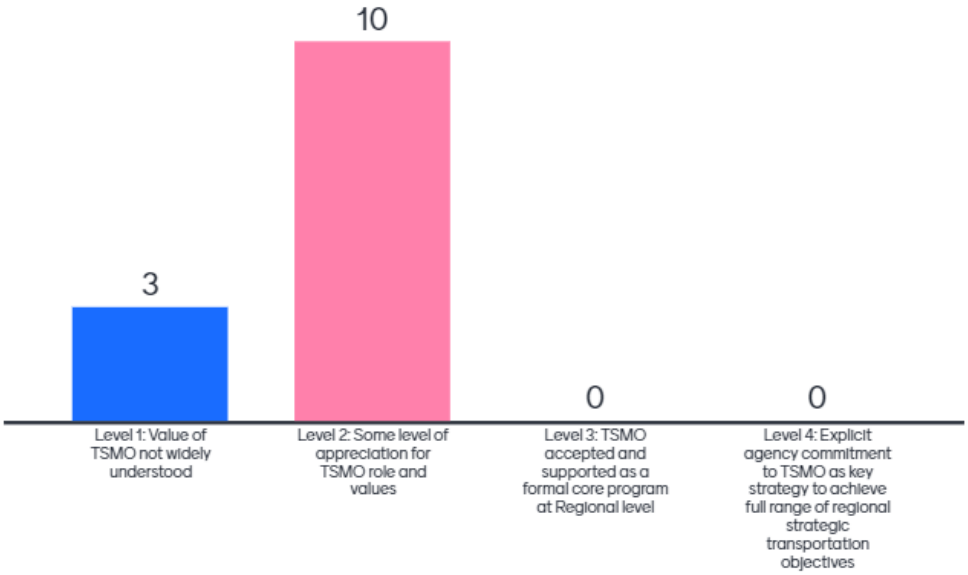
TSMO PSC #1 - Which components should be considered for TSMO Goals and Objectives in Southern Nevada?



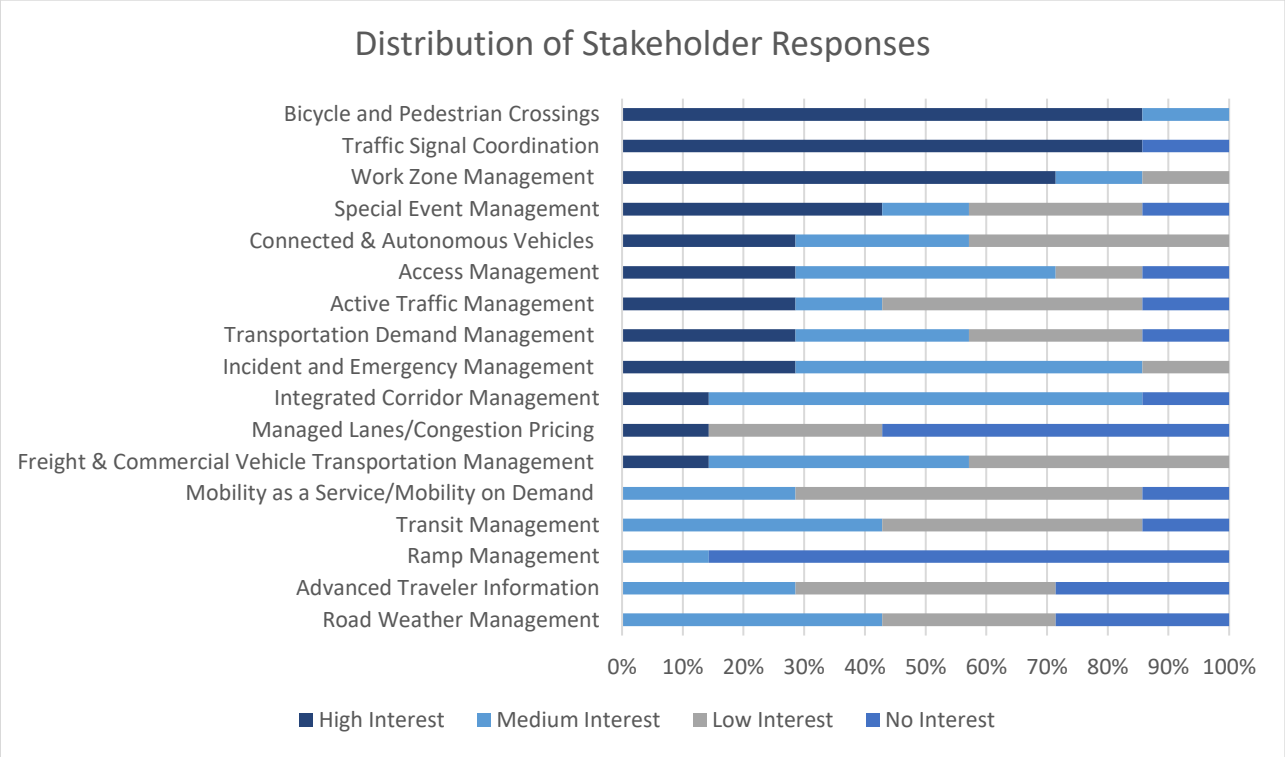
TSMO PSC #1 - What do you see as the biggest benefit to your organization to implement TSMO? (Choose One)



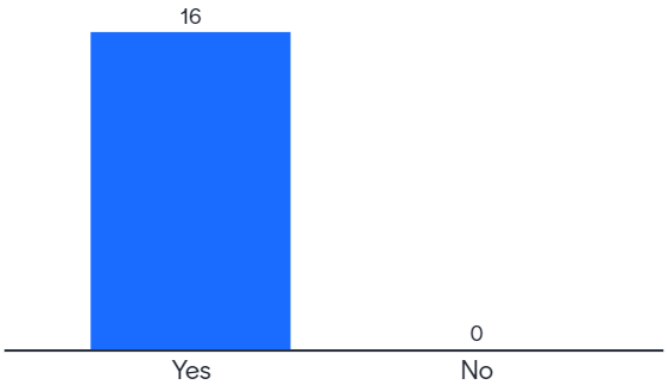
TSMO PSC #2 – What is your TSMO Culture maturity?



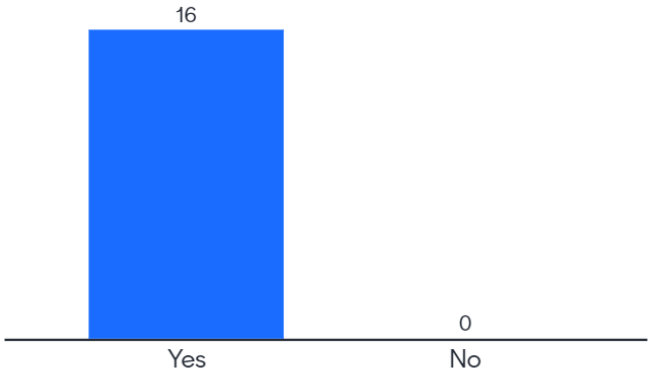
TSMO one-on-one interviews – Stakeholders' desired strategies and rankings



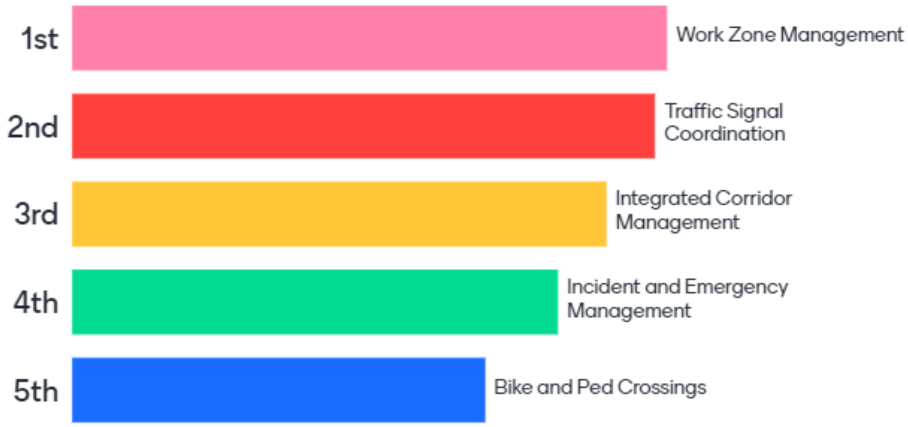
TSMO PSC #4 – Do you agree the Southern Nevada Region should move forward with Tactical Plans in lieu of a Regional TSMO Program Plan?



TSMO PSC #4 – Would you support RTC and assist with development of TSMO Tactical Plans?



TSMO PSC #4 – Please rank the order in which you would prioritize the recommended TSMO Tactical Plans.



Appendix C. CMM Self-Assessment Tech Memo

ATKINS
Member of the SNC-Lavalin Group

Technical Memo

To:	Joanna Wadsworth		
From:	Ati Abad	Date:	May, 2023
Project:	RTC TSMO Business case		
Subject:	RTC CMM Assessment Results		

ATKINS
Member of the SNC-Lavalin Group

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Tables

1. Introduction

The Regional Transportation Commission (RTC) of Southern Nevada has initiated the development of Transportation Systems Management and Operations (TSMO) Business Case to determine the desirability and benefit of a TSMO plan for regional adoption.

TSMO strategies aim 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 (FHWA, *What is TSMO*). Implementation of these integrated strategies often requires enhancements in institutional, organizational, and procedural (IOP) elements. A Capability Maturity Model Self-Assessment was identified to evaluate opportunities to enhance IOP elements.

The Capability Maturity Model (CMM) framework is a process driven approach to assess the current state and identify barriers for TSMO adoption and implementation. This approach aims to improve TSMO by establishing activities to optimize existing capabilities in the following focus areas:

- Business Processes
- Systems and Technology
- Performance Measurement
- Organization and Staffing
- Collaboration
- Culture

A CMM self-assessment workshop was held at the RTC Freeway and Arterial System of Transportation (FAST) in Las Vegas, Nevada on August 18, 2022. The purpose of the CMM Workshop was to assess RTC's capability maturity and readiness for regional TSMO adoption by evaluating the RTC's business processes, institutional capabilities, and technology systems. Findings from the CMM workshops will support development of the TSMO Business Case and regional TSMO Plan Guide.

2. Methodology

Review of Federal guidance documents regarding TSMO CMM Assessments was conducted to identify critical activities essential to the success of a regional TSMO Plan. The following resources were used to find the most up-to-date guidance related to TSMO and CMM:

- National Operations Center of Excellence (NOCoE), http://www.transportationops.org/
- American Association of State Highway and Transportation Officials (AASHTO), TSM&O Guidance, http://www.aashtotsmoguidance.org/
- Federal Highway Administration (FHWA), Office of Operations, FHWA Operations (dot.gov)

When developing RTC CMM workshop materials and performing final analysis, the project team used the following components:

1. **CMM Questionnaire** – This questionnaire asked participants to identify how deep specific TSMO processes and activities are integrated within RTC. An example activity-specific question is shown in **Figure 1**, with the full questionnaire provided in **Appendix A**.

Figure 1. Example Question from CMM Questionnaire

The specific TSMO applications and functions that will address regional needs have been:

Unknown	Identified	Documented	Standardized and implemented	Mainstreamed

Additional Comments: ----------

2. **TSMO Self-Assessment** – The self-assessment is the most widely used approach to performing CMM assessments. In the self-assessment, participants are asked to rate the overall level of maturity for each dimension as a Level 1 (Performed), Level 2 (Managed), Level 3 (Integrated), or Level 4 (Optimized).

   While the self-assessment can identify strengths and weaknesses for TSMO implementation, it is most reflective of an agency's TSMO culture because maturity levels taken in a short timeframe can vary based on participants knowledge. An example self-assessment question is shown in **Figure 2**, with the full self- assessment provided in **Appendix B**.

Figure 2. Example Question from TSMO Self-Assessment

CMM Dimension	Level 1 – Performed	Level 2 – Managed	Level 3 – Integrated	Level 4 – Optimized
Business Processes: Formal scoping, planning, programming, and budgeting	• Processes related to TSMO activities are ad hoc and un-integrated • Champion-driven	Multiyear regional TSMO plan and program has been developed with strategies addressing planning, programming, and budgeting	• Processes documented and integrated into the day-to-day business process • Performance measured • Organization/partners aligned • Programs budgeted	• Performance-based improvement and decision making • Formal program, formal partnerships

What do you think is the level of maturity of TSMO Business Processes? ------
Why? ----------

3. **Department-specific Evaluation** – The FAST Department of RTC is responsible for monitoring the arterial roadways and freeways in Southern Nevada through the extensive CCTV camera network in order to provide traveler alerts (pre-trip and en-route), incident management functions, and traffic management functions (i.e., ramp meter operations and traffic signal coordination) as well as maintenance of the fiber and ITS devices. Many of the current focus areas of the FAST Department are identified as TSMO strategies, although not formalized as a TSMO program. As such, results produced by participants from FAST are more likely to reflect RTC's progress and current efforts to formalize the TSMO program.

   Responses from FAST participants were separated out to better establish an understanding of TSMO within the RTC and identify other internal Departments that could be targeted for additional engagement.

4. **Strategy Implementation Status** – In the questionnaire, participants were asked to assess how specific FHWA Active Traffic Management (ATM) strategies processes and activities are undertaken in RTC. An example question is shown in **Figure 3** with the ATM-specific questionnaire provided in **Appendix C**.

Figure 3. Example ATM-specific Question from CMM Questionnaire

	Yes	No	Unknown
Major work zone traffic management for major projects includes ITS technology for motorist information, speed monitoring, and queue control.			

3. Workshop Details

Workshop participants were made up of multiple RTC Departments with facilitation by transportation consultants. The list of participants is provided in **Appendix D**. A breakdown of the participants is shown below.

- RTC, Other Departments – seven participants
- RTC, FAST Department – four participants
- External Partners – two participants

A questionnaire with 97 questions was developed to determine the agency's maturity level in six key dimensions which include:

- **Culture:** Technical understanding, leadership, policy commitment, outreach, and program authority.
- **Collaboration:** Relationship with public safety agencies, local governments, metropolitan planning organization, and the private sector.
- **Business Processes:** Formal scoping, planning, programming, and budgeting.
- **Organization and Staffing:** Organizational structure and staff capacity, development, and retention.
- **Performance Measurement:** Measures definition, data acquisition, analysis, and utilization.
- **Systems and Technology:** Systems architecture, standards, interoperability, standardization, and documentation.

The questionnaire also included questions to establish a better understanding of **specific FHWA TSMO strategy implementation** in the Southern Nevada region.

Following a brief presentation on the definitions of TSMO and its key objectives, workshop participants broke out into two groups which were guided by one to two project team facilitators through the workshop questionnaire. An online questionnaire was also provided to participants who were unable to join in-person and was distributed to the wider RTC divisions by the project team to record responses.

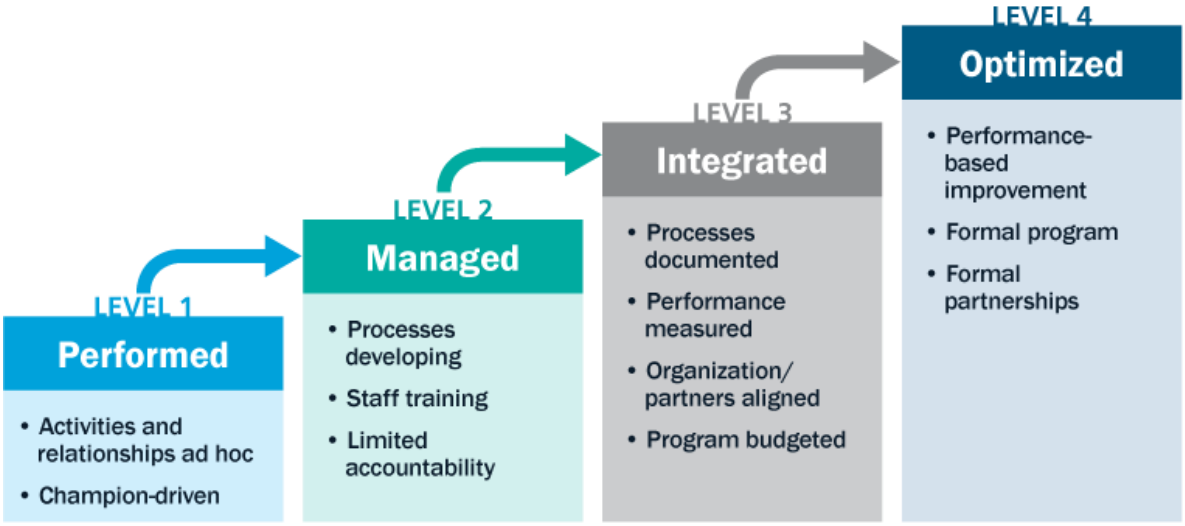
4. Summary of Results

Results considered in this summary include responses from ten in-person workshop participants from the workshop held on August 18, 2022, and three online responses collected from August 24, 2022, to September 22, 2022.

4.1. CMM Questionnaire

Questions focused mostly on whether specific TSMO activities within RTC were identified, documented, standardized and implemented, or mainstreamed. Some of the questions were also designed to recognize the participants' level of awareness of TSMO implementation and progress as unknown, yes, no, or somewhat. Responses to 71 activity-specific questions were analyzed and translated into the four levels of maturity (**Figure 4)**.

Figure 4. CMM Levels of Maturity (LOM)

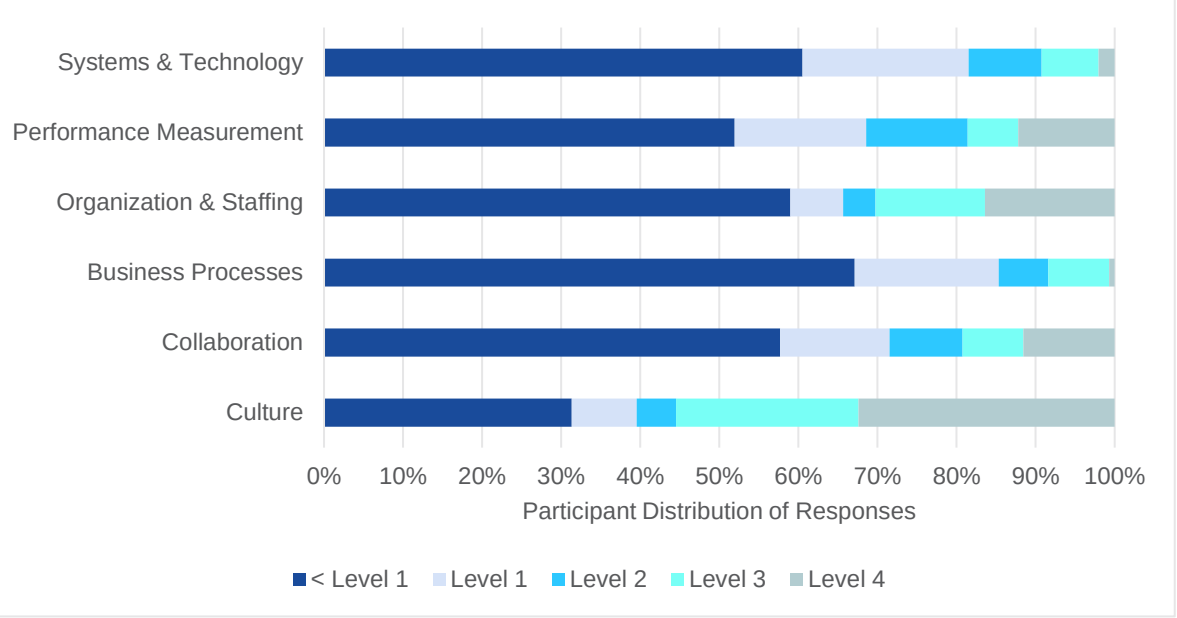


Distribution of responses per dimension and level of maturity is shown in **Table 1** and **Figure 5**.

Table 1. Distribution of Responses

Level of Maturity	Culture	Collaboration	Business Processes	Organization & Staffing	Performance Measurement	Systems & Technology
< Level 1	31%	58%	67%	59%	52%	61%
Level 1	8%	14%	18%	7%	17%	21%
Level 2	5%	9%	6%	4%	13%	9%
Level 3	23%	8%	8%	14%	6%	7%
Level 4	32%	12%	1%	16%	12%	2%

Figure 5. Distribution of Responses

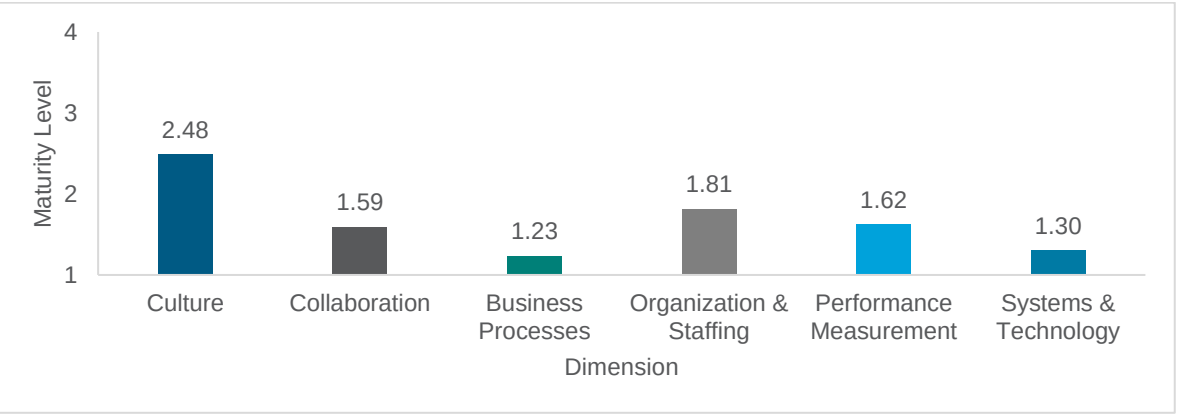


The distribution of responses was used to develop weighted averages to determine RTC's overall level of maturity for each capability dimension. This information is shown in **Table 2** and **Figure 6**.

Table 2. RTC CMM Level of Maturity

Dimension	Culture	Collaboration	Business Processes	Organization & Staffing	Performance Measurement	Systems & Technology
Questionnaire	2.48	1.59	1.23	1.81	1.62	1.30

Figure 6. RTC CMM Level of Maturity

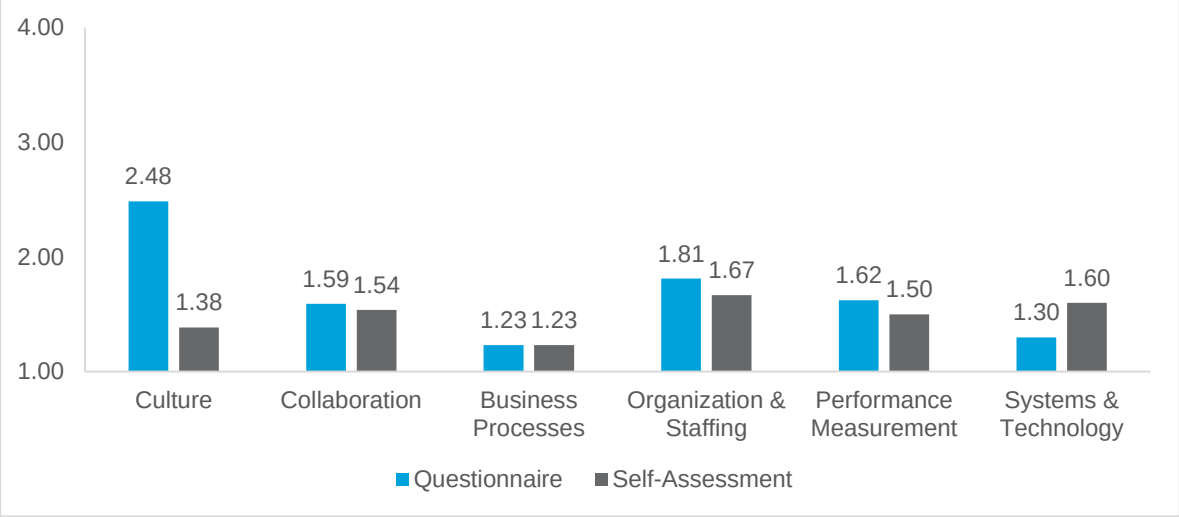


4.2. TSMO Self-assessment

Six of the 97 questions specifically asked participants to rate their TSMO maturity level in each dimension. The four levels of maturity across the dimensions are provided in **Appendix B.**

Figure 7 shows the comparison between RTC's CMM levels of maturity identified through responses to activity-specific questions versus the six self-assessments for each dimension.

Figure 7. Level of Maturity Comparison



When participants were asked to rate their maturity in a TSMO dimension, participants scored low as they are not fully confident of their maturity level. Yet, when asked about specific TSMO activities, participants scored higher as the RTC is putting efforts towards TSMO formalization. The key findings across the dimensions are as follows:

- **Culture:** For this dimension, the participants scored a considerably lower maturity level compared to the questionnaire assessment. This is because while RTC is in fact committed to embedding TSMO understanding in the region, participants are not fully content as they are seeking ways to improve and grow from a cultural perspective.
- **Collaboration and Business Processes:** Under these two dimensions, the participants scored an equal level of maturity for both the questionnaire and self-assessment. This means that FAST personnel are more aware and knowledgeable in these two dimensions compared to others.
- **Organization and Staffing and Performance Management:** It is concluded from the participants' responses under these two dimensions that they are critically rating themselves because they have major willingness to strengthen and improve their maturity. Although the questionnaire and self-assessment results are relatively close, the participants still rated themselves lower because they want to accurately articulate their challenges and highlight the potential improvement areas.
- **Systems and Technology:** Alternatively, when specifically asked about RTC's TSMO Systems & Technology, participants assessed a higher maturity. This is because participants viewed the maturity levels to be similar to a grade or score of completing activities under this dimension.

4.3. FAST Department Evaluation

The level of maturity established for each dimension varied among Departments. When analyzing this variance, it was found that level of maturity varied specifically between FAST and the rest of the RTC Departments. **Figure 8** and **Figure 9** below provide a comparison on the maturity ratings between the participants from other Departments versus FAST from both the questionnaire and the self-assessment, respectively.

Figure 8. Division Evaluation Questionnaire Results Comparison

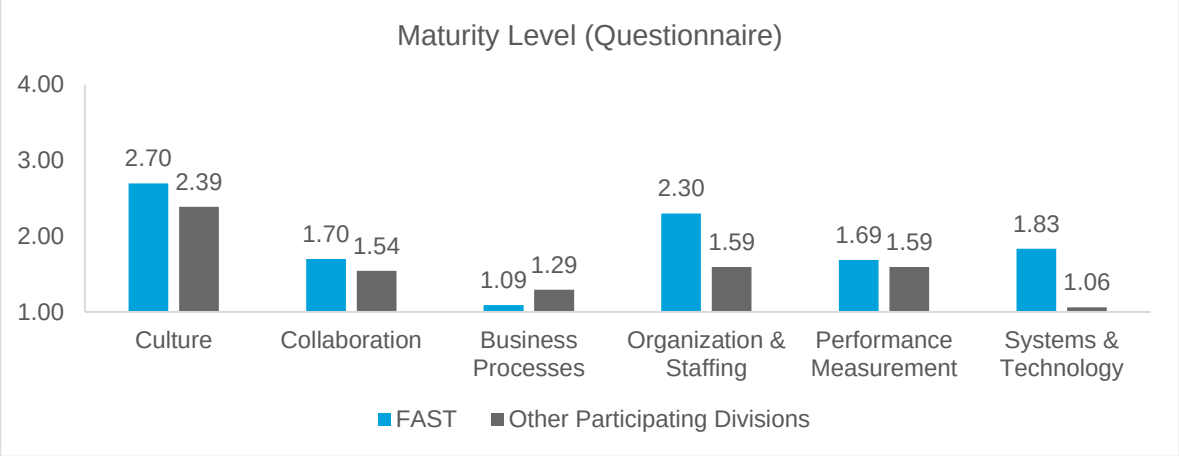
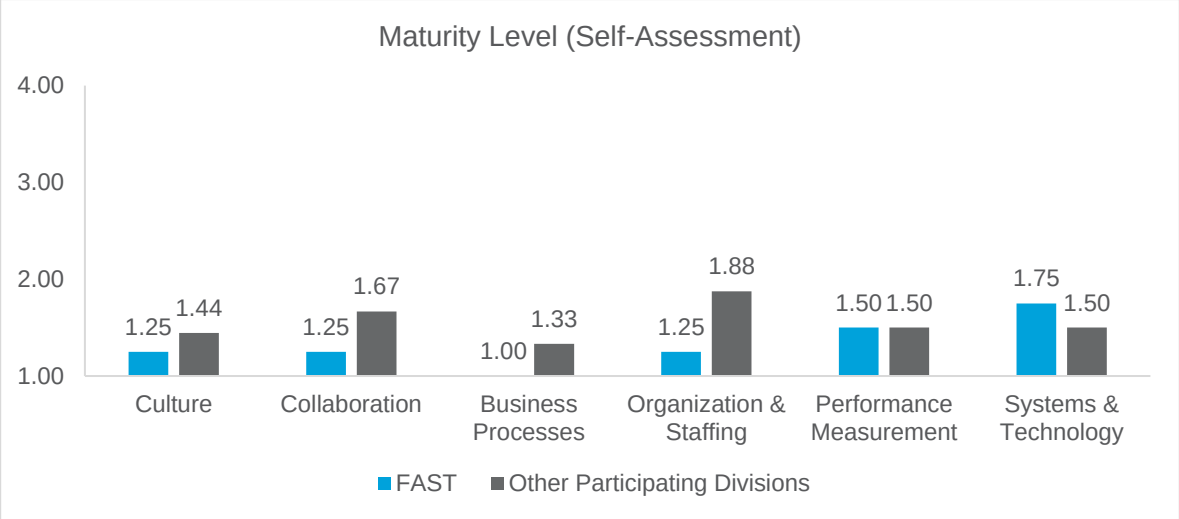


Figure 9. Division Evaluation Self-Assessment Results Comparison

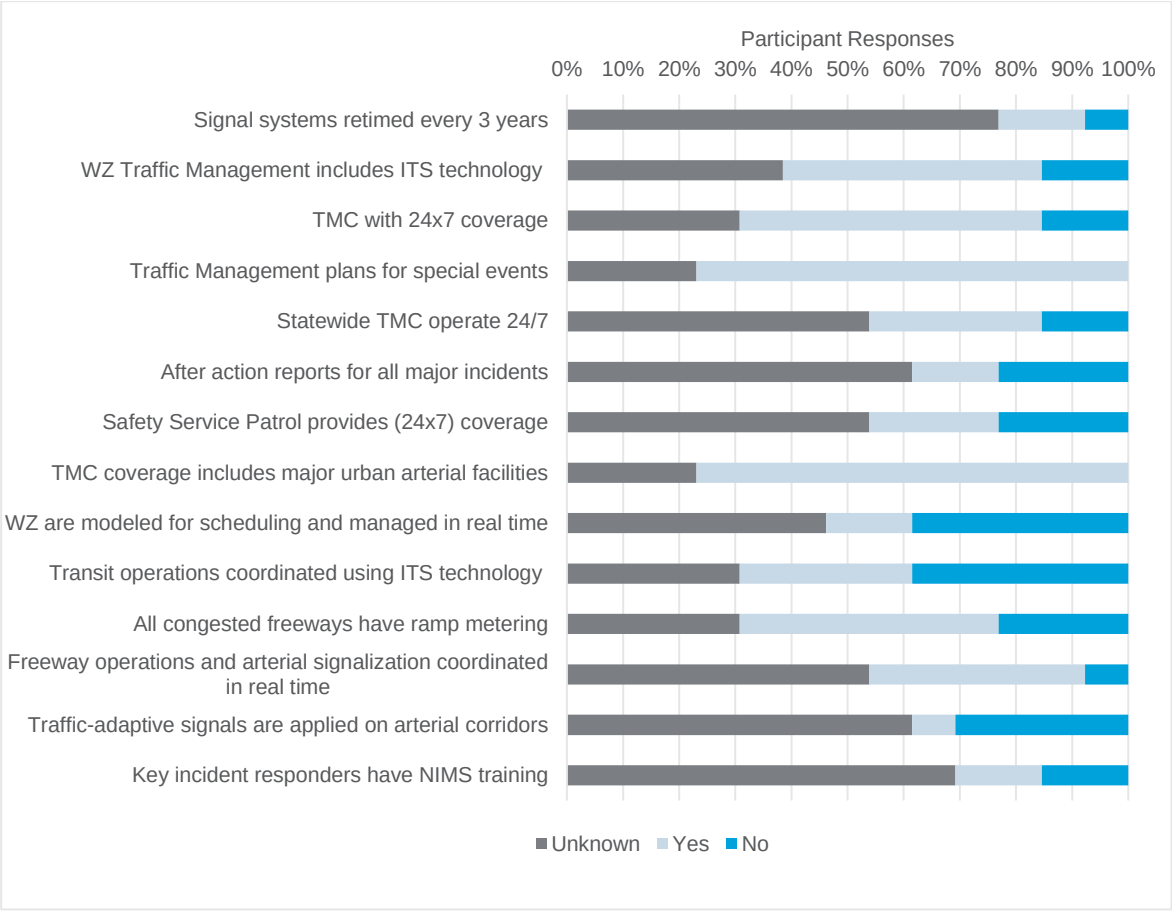


A common misconception is that CMM results accurately identify current standing, yet the assessment is more of an effective approach for agencies to identify where they stand in terms of institutional capabilities for TSMO. CMM assessments are ***self-assessments*** that identify levels of maturity for the key dimensions based on the ***participant's*** point of view. Accordingly, CMM assessment results will vary based on participants' institutional knowledge of TSMO as related activities within RTC. Additionally, not all dimensions are necessarily relevant to all participants. For example, unlike other CMM assessments performed nationally, the RTC team included internal partners such as Human Resources and Government Affairs, who may never need to be familiar with the Systems and Technology dimension.

4.4. Strategy Implementation Status

Fourteen of the 97 questions of the CMM questionnaire were focused on the implementation status of specific FHWA ATM strategies. The questions are provided for RTC to assess themselves and their maturity in Work Zone Management, Integrated Corridor Management, and Incident Management. The questions were designed to understand the participants' level of awareness of the specific strategies implementation as unknown, yes, or no. Responses collected are shown in **Figure 10**.

Figure 10. Strategy Implementation Status Results Comparison



In general, not all participants are fully aware of strategy-specific ATM activities that RTC is performing, which was anticipated since the workshop attendees included some of the RTC team internal partners such as Human Resources and Marketing.

As seen from the results, participants confirmed that the TMC activities and coverage are broadly aligned to FHWA standards, while there is a potential to improve the current operations for Work Zone Management, Incident Management, and Integrated Corridor Management. As RTC pursues any other strategies outside of the FHWA focus, a similar approach is recommended through an ATM CMM. Strategy specific CMMs can help RTC build a better understanding of the current state and attend to specific details prior the strategy implementation.

5. Conclusions

The RTC of Southern Nevada has initiated the development of a TSMO Business Case to determine the desirability and benefit of a TSMO plan for regional adoption. Overall, it is concluded that RTC is working towards maturing its TSMO capabilities. Results are evident that some TSMO activities and processes are in place, yet the challenges mostly revolve around the cultural shift and involvement of the wider RTC stakeholders beyond the RTC FAST Department.

Key findings from this assessment include:

- Stakeholders in general are not broadly familiar with the TSMO-specific activities.
- Internal stakeholders rated themselves at a low maturity level for each dimension compared to activity-specific responses which indicate there are more TSMO activities being performed than what the agency as a whole realizes.
- Responses generally indicated that participants are critically rating themselves because they have major willingness to strengthen and improve their maturity under the different dimensions of the assessment.
- TSMO is currently championed by the FAST department, as they are more aware of content about the TSMO-specific activities and strategies compared to the rest of the stakeholders.
- The RTC scored a maturity level below 2 in most categories based on the CMM findings. A TSMO Plan with prioritized strategies is essential for the RTC as an organization in order to streamline operations, serve the community efficiently, and enable collaboration with regional partners.

The FAST Department is found to be the most versed with TSMO activities, as anticipated, and they have laid the foundation to implement specific strategies, performance metrics, and business processes. While other Departments, such as the Planning or IT Departments, were not familiar with the strides FAST has made, it was clear during the workshop that the greater RTC supports the goals FAST is aiming to achieve via TSMO. **Table 3** provides a summary of key findings and gaps from the feedback received in the workshop.

Table 4 presents suggested action items to reduce gaps and enhance TSMO capabilities within RTC; aligning with the NDOT statewide TSMO plan; yet specific to the needs and opportunities in the Southern Nevada region. To establish a fully mature TSMO community, it is important to recognize that achieving all the desired objectives is not practical in a single year. Instead, it will require a well-coordinated plan and a phased approach to attain the ultimate TSMO goals. To that end, the actions in **Table 4** provide steps that can be taken to gradually develop a more robust local TSMO community.

Table 3. Self-Assessment Summary and Findings

Rating	0 = unalignment with NDOT state-wide TSMO → 4 = Full alignment with NDOT state-wide TSMO Program				Current Findings and Gaps
Dimension	**Level 1 – Performed**	**Level 2 – Managed**	**Level 3 – Integrated**	**Level 4 – Optimized**	
Culture	1.38				▪ Beyond FAST, TSMO is not widely understood or embraced within local jurisdictions. ▪ TSMO is supported informally by stakeholders as a core program. ▪ There is potential for improvement with the FAST Department educating internal stakeholders.
Collaboration		1.54			▪ There are efforts to collaborate internally; however, they are not formally documented. ▪ Internal/external roles and responsibilities relevant to TSMO implementation are undefined. ▪ Collaboration for TSMO is not formalized into the business processes.
Business Processes	1.23				▪ Currently, TSMO is championed by FAST, and processes are isolated. ▪ Limited and informal integration with the wider RTC strategies and plans. ▪ Limited efforts to develop a Regional TSMO Plan.
Organization & Staffing		1.67			▪ TSMO staff, roles, and responsibilities are under development. ▪ FAST staff informally understand and communicate the value of TSMO. ▪ Currently, sharing staff, skills, and abilities with NDOT for TSMO activities.
Performance Measurement	1.50				▪ TSMO plan development is on-going. ▪ Lack of cross-division collaboration on performance management, as performance management activities are currently ad-hoc. ▪ Current performance management processes support TSMO but do not communicate external performance needs or goals.
Systems & Technology		1.60			▪ Procedures and processes are under development; deployment approach for TSMO infrastructure, systems engineering processes. ▪ Not all divisions are aware of these ongoing efforts.

Table 4. Action Items

Dimension	Action Items
Culture	• TSMO leaders/champions should participate in national discussions. • Develop a TSMO Program and Plan to structure and sustain TSMO as one of RTCs core missions. • Communicate TSMO successes to the regional culture, and external agencies to see the value of TSMO. • Engage internal partners so they are more involved with TSMO activities. • Engage internal partners (as relevant) to enhance their technical understanding of the TSMO benefits and values. • Update the policy documents to refer to TSMO as a key strategy, at equal level to construction and preservation.
Collaboration	• Communicate the value of TSMO with regional partners. • Work with Southern Nevada Regional Partners to develop the TSMO Plan. • Coordinate with Regional Partners to advance the shared regional goals with TSMO Strategies.
Business Processes	• Develop a regional framework for TSMO planning and policy. • Identify funding strategies/mechanisms to deploy equipment for TSMO strategies. • Document how TSMO strategies will be accounted for during programming, budgeting, and project development. • Define roles and responsibilities for TSMO business processes. • Document relationship among stakeholders with regard to TSMO implementation. • Document processes and procedures for the procurement of TSMO infrastructure.

Dimension	Action Items
Organization & Staffing	• Document staff acquisition and retention processes and training needs to support TSMO implementation. • Update internal position descriptions to include TSMO knowledge, skills, and abilities and assess performance in these criteria on a re-occurring basis. • Develop clear career track/opportunities for advancement in operations for TSMO staff. • Develop TSMO positions or identify who will be responsible. The TSMO "manager" should be at equal organizational level with the senior maintenance manager and be no more than two organizational levels below Director/CEO. • Develop TSMO certification programs. • Document the skills required to operate, maintain, or deploy TSMO strategies. • Develop TSMO training plans for new hires and existing staff. • Develop training for TMC Staff in TSMO digital and physical infrastructure.
Performance Measurement	• Identify regional performance measures and measures' definitions for TSMO implementation. • Document plan for TSMO data collection analysis and utilization. • Perform before/after studies to document performance of deployed TSMO strategies. • Report and store performance of TSMO strategies. • Document process to streamline information sharing on performance measures.
Systems & Technology	• Develop Concept of Operations for prioritized regional TSMO strategies. • Develop a list of approved product vendors and material suppliers for TSMO strategies. • Document maintenance processes and responsibilities for TSMO systems. • Document process for equipment upgrades in anticipation of TSMO strategy implementation. • Define and document the role of data, tools, and technologies for the processing, storage, and use of TSMO data. • Identify ways to optimize digital integration and connectivity within existing systems and platforms.

Appendix D. Existing and Emerging Transportation Challenges

#	Source Name	Challenge	Challenge Description
1	Southern Nevada Transportation Safety Plan	Safety	The high number of fatal and serious injury crashes within Southern Nevada is a critical challenge.
2	RTC Strategic Plan	Lack of Resilience	Las Vegas is ranked as “the most intense heat island in the United States in both daytime and nighttime metrics.” Heat is already damaging roads, transit, and other infrastructures, and cities face increasingly expensive deterioration and maintenance costs. Las Vegas will need to better prepare for changing weather patterns and rising temperatures.
		Air Quality	Population growth and auto-oriented development resulted in increased greenhouse gas emissions.
		Funding Shortage	RTC faces significant fiscal and budgetary constraints that impact the mission and may compromise the vision for transformative mobility solutions.
		Safety	Decreasing the number of pedestrian and bicycle crashes has become challenging due to the rapid growth of the region.
		Traffic Congestion	Congestion caused by reaching the limits of available highway transportation networks slows the movement of goods and services between regions, reduces labor productivity, and impedes economic growth.
		Lack of Equity	Public transportation resources are often difficult for vulnerable citizens to access, particularly for persons with mobility limitations related to advanced age, persons with disabilities, and persons struggling for self-sufficiency.
3	Congestion Management Process 2019	Traffic Congestion	As a major metropolitan area and global tourist destination, Southern Nevada roads experience high levels of traffic congestion. Due to the region's growth, traffic congestion has worsened, resulting in significant delays and an increasing number of accidents.
4	Southern Nevada Strong Regional Plan	Auto-Oriented Development Pattern	The region’s growth patterns have focused on segregating uses and locating new development on the fringe, leading to an overreliance on the car.
		Poor Connectivity	The region is reliant on its highways and large arterials for local connectivity. However, local road connectivity is often poor outside the urban core. Design impediments, such as block walls, cul-de-sacs, and large distances resulted in weak connectivity between destinations.
		Traffic Congestion	Freeway congestion has increased 35 percent since 2000 and has led to longer trip times and increased vehicle emissions. Southern Nevada residents spend about 25 percent of their household income on transportation.
		Air Quality	Stemming from motor vehicles and poplulation growth, air pollution challenges have grown in proportion to the population and economic growth in the valley.
5	Access 2050: Regional Transportation Plan	Aging Infrastructure	With limited resources available for transportation infrastructure confronting the growing region, maintaining a safe and reliable system is difficult.
		Safety	The region experienced a significant increase in transportation fatalities, especially an increase in pedestrian and bicyclist fatalities.
		Traffic Congestion	Recently, miles traveled on regional roadways have grown much faster than population growth and the growth of road lane mileage over the same time.
		Commute Time and Delay	Southern Nevada ranked 34th in travel delay per commuter among the nation’s large regions, 41st in excess commuter costs, and a high of 23rd on the Travel Time Index..
		Lack of a Reliable Transit Service	Increased operating frequency and low reliability are among the main concerns of using transit.
		Funding Shortage	Funding is a common challenge for transit operators that has become even more pronounced as fare box and sales tax revenues, both used to operate and maintain the transit system, have experienced a significant drop.
		Lack of a Reliable Transit Service	This does not support transit connectivity, resulting in inconsistent access to social services and discouraging riders of the duration, frequency, safety, and reliability of the transit experience.
		Auto-Oriented Development Pattern	Due to the auto-oriented roadway design, people do not feel comfortable using travel modes other than automobiles.
		Increasing Freight Demand	This will contribute to increasing bottlenecks, which are exacerbated by underlying traffic congestion currently experienced on Southern Nevada roadways.
		The Increase of Suburban Employment Centers	This will result in the rise of suburb-to-suburb commute patterns, compounding existing congestion, safety, and cost of delivery issues for freight providers.
6	Southern Nevada Transportation Impacts on Health	Auto-Oriented Development Pattern	The reliance on personal vehicles can result in decreases in transport-related physical activity and increases in regional air pollution.
		Safety	Due to poor infrastructure and roads in disrepair, the rate of pedestrian and bike crashes is high in Southern Nevada.
		Poor Accessibility for All Modes	Access to Jobs, greenspaces, and health-related goods and services by active transportation modes is challenging.
7	Transportation Improvement Program (TIP) (2021-2025)	-	-
8	2020 Southern Nevada Coordinated Transportation Plan	Auto-Oriented Development Pattern	The landscape of South Nevada, in general, is not conducive to utilizing public transportation or active transportation such as walking and biking.
		Lack of a Reliable Transit Service	Infrequent service, long trip times, and concerns over safety and reliability deter would-be riders from using public transit
		Limited Shared Demand-Response and On-Demand Services	The productivity of shared demand-response services is limited by service hours and eligibility criteria.
		Traffic Congestion	Recently, miles traveled on regional roadways have grown much faster than population growth and the growth of road lane mileage over the same time.
		Funding Shortage	Funding constraints limit the availability of essential services and programs for seniors, people with disabilities, and people with low incomes.
		Rider Processes Not Standardized	Specialized transportation services in the Southern Nevada are somewhat siloed—each one has separate standards and selection process for its riders.
9	Regional Bicycle & Pedestrian Plan for Southern Nevada	Safety	Southern Nevada has one of the highest rates of pedestrian-automobile crashes for metropolitan areas in the United States.
		Comfort	Carrying too much stuff for a long time and along not well-maintained/unsafe sidewalks or bike lanes.
		Weather	Hot waeather and the lack of sufficient shade.
		Poor Accessibility for All Modes	Currently, nearly all trips to healthcare facilities, healthy food, parks, and community services are made by car in Southern Nevada.
		High Speed Roadways	High speed vehicles make the roadways unsafe and unappealing for pedestrians and bikes.
		Funding Shortage	Funding for active transportation often does not keep pace with existing, let alone target, bicycling and walking mode shares.
10	Traffic Signal Communication System Gap Analysis	Gaps in the fiber optic communication network of unconnected signals	As infrastructure complexity and data volume expands, communication via fiber optic is necessary due to data limitations of copper interconnect cable and wireless radio communications.
11	Regional Walkability Plan	Lack of Pedestrian-and Bike-Friendly Urban Design	Sidewalk widths vary throughout the region. Narrow sidewalks prevent people walking side-by-side, in opposing directions from passing one another, or even block passage all together for those using wheelchairs or other mobility aids. Utility poles, signs, street lights, utility boxes, and other infrastructure placed in the pedestrian zone on narrow sidewalks are common obstacles seen throughout the study area. They make passage difficult for pedestrians - especially for those using mobility devices. Also. slip lanes are a common occurrence at the intersection of two arterial roads. They can create hazardous environments for pedestrians and bikes by allowing faster vehicle turning movements and increased exposure to traffic for those attempting to cross.
		Gaps in Pedestrian Networks	Gaps in the sidewalk network are caused by intermittent development patterns - due to vacant parcels, or areas developed without installing sidewalks. Gaps in the network create barriers to pedestrian travel by making it unpleasant or entirely unpassable.
		Weather	In Southern Nevada, heat and sun exposure can make walking, biking, or waiting for transit unpleasant or even dangerous.
		Poor Connectivity	Large blocks and large distances between land uses create longer travel times and discourage people from choosing multimodal travel.
12	Regional Schools Multimodal Transportation Access Study	Lack of Safe and Direct Accesss Points to Schools for Pedestrians and Bicycles	Students continuously crossing a street, even at designated crosswalks, don’t allow for gaps that vehicles can pass through. Drivers can get impatient waiting and foolishly and unsafely enter the crosswalk close to children.
		Unsuitable School Locations	Schools located on the fringes of development make it more difficult for students to walk or bicycle to school.
		High Speed Roadways	High-volume and high-speed are not ideal for students to travel on and cross.
		Lack of Street Network on Multiple Sides of Schools	When a school can be accessed only from one street, the street becomes congested and creates a potential conflict between vehicles, pedestrians and bicyclists.
		Lack of Multiple Access Points at School Sites for Various Purposes and Modes	An inherent conflict zone exists where school buses, private vehicles, pedestrians, and bicyclists simultaneously converge in the same area at the same time – at the beginning and end of the school day. Lack of coordination between onsite and offsite pedestrian and bicycle facilities can lead to potential conflicts.
		Lack of Bicycle Facilities	Lack of bicycle parking and locking rack facilities
		Lack of Adequate Student Drop-off and Pick-up Areas	Heavy traffic during drop-off/pick-up in one location causes safety and congestion issues.
		Lack of Complete Street Designs for Adjacent Streets Near Schools	Many streets near schools have not been designed for all transportation modes. It is important to maintain pedestrian and bicycle connectivity to neighborhoods to allow students to walk and/or bike from their homes.
13	Northeast Valley Transportation Network Study	Lack of a Reliable Transit Service	Limited and infrequent transit service in the region discourages the users from its frequent use.
		Gaps in Pedestrian/Bike Networks	Numerous gaps in the pedestrian sidewalk network need to be filled to improve the quality of the pedestrian environment. Also. the existence of Bike lanes in a small portion of the area makes the use of bicycles challenging and unsafe.
		Traffic Congestion	The region is projected to have a significant number of additional warehouse and industrial park facilities in the near future. This could result in a large growth in the number of employees traveling to and from the region, which could worsen the traffic congestion.
14	Complete Streets Design Guidelines for Livable Communities	Lack of Equity	People who use scooters or those with mobility impairments range from those who use assistive devices, such as wheelchairs, crutches, canes, orthotics, and prosthetic devices, to those who use no such devices but face constraints walking long distances on non-level surfaces or on steep grades.
		Gaps in Pedestrian/Bike Networks	Gaps in sidewalk/bike networks discourage the use of active transportation modes.
		Lack of a Reliable Transit Service	Increased operating frequency and low reliability are among the main concerns of using transit.

		Lack of Transit Amenities	Lack of shelters, turnouts, sidewalks to bus stops.
		High Speed Roadways	As speeds increase, drivers are less attentive to what is happening on the side of the road, and the pedestrian has a higher chance of dying or becoming severely injured in case of a crash.
		Large Number of Access Points	The presence of many driveways, in addition to the necessary intersections, creates many conflicts between vehicles entering or leaving a street and bicyclists and pedestrians.
15	On Board Mobility Plan	Population Growth	The Southern Nevada region will be attracting 640,000 new residents by 2035. The growth had an adverse impact on traffic congestion and air quality.
		Traffic Congestion	The pace of growth in the region has been so fast that congestion was limiting access, impacting regional quality of life, and constrainingdevelopment.
		Lack of a Reliable Transit Service	Increased operating frequency and low reliability are among the main concerns of using transit.
		Security	Individuals' security in bus stops and moving bus shelters were identified as priority concerns throughout Southern Nevada.
		Safety	In 2017, 39,107 automobile collisions occurred in Clark County, resulting in 209 fatalities. Many of these collisions occur on the roads or at intersections that could be redesigned to be safer for drivers and other roadway users.
		Auto-Oriented Development Pattern	Currently, due to the auto-oriented roadway design, people in Southern Nevada do not feel comfortable using travel modes other than automobiles.
		Lack of Equity	Providing convenient and cost-effective services for people with special needs is challenging and calls for increasing regional investment so that the services would be available more often and for more people.
16	Southern Nevada Regional Goods Movement Master Plan	Traffic Congestion	Congestion caused by reaching the limits of available highway transportation networks slows the movement of goods and services between regions, reduces labor productivity, and impedes economic growth.
		Insufficient Intermodal Facilities	Las Vegas has very few intermodal facilities serving the region. Three are rail-truck facilities and one serves air-truck goods movement.
17	Performance Indicator Report	-	-
18	Community Mobility Study for Central Las Vegas	Gaps in Pedestrian/Bike Networks	Missing sidewalks and lack of bike lanes discourage the use of active transportation modes.
		Lack of Transit Amenities	Lack of shelters, turnouts, sidewalks to bus stops.
19	Transit Node Improvements in Southern Nevada	Gaps in Pedestrian/Bike Networks	There are large gaps in the existing network of sidewalks and bike lanes, which make walking or biking unattractive for Nevadans,
		Poor Connectivity	Some barriers, such as walls and fences along street blocks, create obstructions that make it difficult for pedestrians and cyclists to conveniently reach access corridors.
		Lack of Bicycle Facilities	For cyclists that are encouraged to bike to the transit stops, one of the principal concerns is the lack of safe bike storages near transit stops.
20	Las Vegas Valley Long Range Transit	Population Growth	Las Vegas is one of the fastest-growing urbanized areas in the United States, which could result in a significant increase in traffic congestion.
		Employment Growth	Travel demand increases at a rate that is geometric to population and employment growth, as well as the tourism industry. This results from the continuing trend for households to own more automobiles per person and to take more trips per person.
		Lack of a Reliable Transit Service	Infrequent service, long trip times, and concerns over safety and reliability deter would-be riders from using public transit
21	Regional Bicycle Network Gap Analysis	Gaps in Bike Networks	Lack of bike lanes and lack of bike network connectivity introduce challenge for the frequent use of bikes.
22	Regional Pedestrian Infrastructure Inventory and Analysis	Safety	Decreasing the number of pedestrian and bicycle crashes has become challenging due to the rapid growth of the region.
23	Bicycle and Pedestrian Plan	Weather	Hot weather and the lack of sufficient shade.
		Auto-Oriented Development Pattern	Much of the transportation planning emphasis has been narrowly focused on accommodating vehicle infrastructure and high speed travel.
		Traffic Congestion	While modest travel congestion has existed for some time in Southern Nevada, the doubling of population from 797,000 to 1,429,000 in the 1990's rapidly exacerbated the problem.
		High Speed Roadways	High vehicle speed is detrimental to all modes but particularly for pedestrians and cyclists.
		Large Number of Access Points	Too much access will increase the number and frequency of conflicts, reduce roadway capacity, and create impediments to development access for both vehicle and alternative modes of travel.
		Lack of Pedestrian-and Bike-Friendly Urban Design	Sidewalks with uneven surfaces, overgrown landscaping, and object-related obstacles all degrade the walking experience and may cause lower participation rates.
		Gaps in Pedestrian/Bike Networks	Gaps in sidewalk/bike networks discourage the use of active transportation modes, such as walking or biking.
24	City of North Las Vegas Complete Streets Corridor Ranking Study	Auto-Oriented Development Pattern	Street design has developed to primarily accommodate automobile travel.
		Lack of Pedestrian-and Bike-Friendly Urban Design	Walking and bicycling can feel uncomfortable due to sidewalks conditions, lack of connectivity, and long walking distances. Wide streets that carry high traffic volumes may be difficult for pedestrians to cross. Wide streets with low traffic volumes on largescale surroundings and low network density encourage high vehicular speeds and impact driver expectations for pedestrian or bicycle traffic. The perception of danger due to these factors can discourage walking, biking, or using transit.
		Lack of Equity	Limited access to various modes of transportation for minorities, low-income populations, people with no vehicle availability, the disabled, or the elderly is a significant challenge.
25	Complete Streets Evaluation Process for the City of Henderson	Auto-Oriented Development Pattern	Street design has historically developed to primarily accommodate automobile travel. The incorporation of multi-modal facilities and amenities has not been equally considered in the development of many street networks.
		Safety	As Southern Nevada becomes more congested, it has become more challenging to develop safe and efficient networks accommodating all modes.
		Security	One of the principal factors that influence whether potential users decide to use a specific mode choice is their security. Security concerns occur in areas where there is inadequate lighting, low activity areas, unsheltered areas, or known high crime areas with inadequate protection.
		Gaps in Pedestrian/Bike Networks	The presence of gaps in sidewalk networks introduces a critical issue for their frequent use. Moreover, bike lanes should not terminate abruptly and do not link to the other parts of the system.
		Poor Connectivity	Longer block lengths, poor-designed street networks, and dead-end streets or cul-de-sacs are unattractive to users on bikes or on foot because they increase the required distance to destinations and provide less direct access to properties.
26	City of Mesquite Traffic Impact Study Policy Review	-	-
27	Stadium District Plan (Clark County)	Lack of Pedestrian-and Bike-Friendly Urban Design	The district is an industrial zone, so pedestrians, particularly large crowds, have challenges walking around the neighborhood.
		Lack of Human-Scale Design	Given that the district is mostly industrial, there is also a challenge related to the scale of urban form throughout; it lacks human-scale amenities and is, instead, designed to accommodate large truck traffic, deliveries, and manufacturing and industrial activity.
		Lack of Public Transportation	There is a lack of public transportation, which is primarily related to the challenge of transitioning an industrial zone to a pedestrian-oriented commercial area.
28	Southern Nevada Freight Plan Update	The Rise in E-commerce Volumes	COVID and its resulting quarantines and stay-at-home orders exacerbated this exponential increase leading to higher transportation costs and lower availability of logistics providers/ carriers
		Lack of a Trained Workforce	Shortage of workforce and overall labor
		Lack of Transit Options to Industrial Areas	This reduces the potential labor pool by eliminating transit-dependent employees, is inequitable, and increases congestion because everyone is forced to drive personal vehicles to work, which also impacts the free movement of freight.
		The Imbalance Between Inbound and Outbound Freight	In the region, as high as 4:1 leads to higher shipping costs and lower response times by carriers
		Insufficient Rail Access	Lack of sufficient access to rail stations
29	City of Las Vegas Mobility Master Plan	Population Growth	The City of Las Vegas will see about 600,000 new residents by 2036. However, the street network is largely built out, leaving less opportunity for building new roads. The maxed-out network will impact travel time, safety, visitor experience, the cost of delivering goods, and our economy.
		Aging Population	By 2029, the number of Las Vegas residents aged 60 and over will more than double. An aging population means changes in travel patterns and more people with physical challenges are getting around the City.
		Lack of a Reliable Transit Service	The region needs a reliable expanded form of mass transit to ease mobility for visitors and commuters.
		Safety	Between 2009 and 2014, nearly 700 vehicle collisions involved a pedestrian incident or fatality within the City.
30	Las Vegas Vision Zero	Safety	The city of Las Vegas has seen a steady rise in vehicular crashes in the past few years, resulting in a critical safety issue for motorists and non-motorist.
31	Citywide Intersection Crash Mitigation Program	Safety	Las Vegas has a high rate of pedestrian- and bike-automobile crashes.
32	City of Las Vegas 2050 Master Plan	Weather	Las Vegas will need to better prepare for health crises, such as changing weather patterns and rising temperatures, by providing new transportation solutions to support higher densities.
		Poor Connectivity	Some barriers, such as walls and fences along street blocks, create obstructions that make it difficult for pedestrians and cyclists to conveniently reach access corridors.
		Lack of a Reliable Transit Service	Unreliable and unattractive transit discourages individuals from its frequent use.
		High Speed Roadways	High-speed and wide roadways put pedestrians and bicycles at a high risk of crash.
33	Smart Vegas: A Forward-Focused Plan	Population Growth	Anticipated population growth of an additional half a million residents by 2035 poses a risk of increased congestion.
		Aging Infrastructure	With limited resources available for transportation infrastructure confronting the growing region, maintaining a safe and reliable system is difficult.
		Safety	There is an immediate need to improve motorist, bicyclist, and pedestrian safety.
		Air Quality	Population growth and auto-oriented development resulted in increased carbon emissions.
34	Vision 2045 Downtown Las Vegas Masterplan	Auto-Oriented Development Pattern	Many streets in the Downtown area are heavily preferential to auto movement resulting in low-intensity development along the street corridor and extremely limited pedestrian activity.
		Poor Connectivity	Despite the concerted public effort to reverse the situation, Downtown still suffers from weak physical connectivity between activity nodes, inhibiting programmatic linkages and limiting shared economic benefits. Physical and perceptual barriers, namely freeway, railroad, degraded commercial corridors, separate districts, and poor accommodation of alternative modes of transportation, fail to bring them together.

		Lack of Pedestrian-and Bike-Friendly Urban Design	The designed streets are not pedestrian- or bike friendly and discourage users from walking and biking.
		Weather	Lack of enough trees to provide shelter for pedestrians and transit users from the excessive heat
35	The Hundred Plan for the Historic Westside Community	Lack of Pedestrian-and Bike-Friendly Urban Design	The inconvenient and unsafe pedestrian environment with long walking distances affects successful and functional community centers as well as transit services.
		Lack of Bicycle Facilities	Lack of bicycle amenities, including bike racks.
		High Speed Roadways	High vehicle speed is detrimental to all modes but particularly for pedestrians and cyclists.
		Weather	Lack of enough trees to provide shared for pedestrians and transit users from the excessive heat
36	Transform Clark County Master Plan	Poor Accessibility for All Modes	Clark county is vast, and accessing amenities that contribute to the high quality of life (e.g., libraries, parks, recreational and enrichment programs) can be a struggle for residents whose incomes and transportation options are limited.
		Traffic Congestion	The continued population growth contributes to traffic congestion.
		Auto-Oriented Development Pattern	From a physical standpoint, many residents struggle to get where they need to go in Clark County without an automobile.
37	2019-2023 Strategic Plan	Safety	As the City has grown, preventing vehicular accidents and fatalities has become a greater challenge. Safety concerns also lead to less walking and biking and more personal vehicle use, which has translated to increased congestion.
		Auto-Oriented Development Pattern	Transportation mode sharing within the City of Henderson is dominated by the personal vehicle, which can have adverse impacts on traffic congestion and the economic vitality of the City.
		Aging Infrastructure	As the City grows and ages, so does the need for replacement and rehabilitation of its infrastructure, such as roadways.
38	Downtown Henderson Master Plan	Lack of Pedestrian-and Bike-Friendly Urban Design	Restricted movement through the downtown area to discourage a walkable/Bikeable community.
		Auto-Oriented Development Pattern	Auto-oriented roadways contribute to a challenging environment for pedestrians and cyclists.
39	Henderson Strong Comprehensive Plan	Population Growth	Henderson is a desirable community that expects to add new residents and retirees to the tune of 100,000 by 2036.
		Traffic Congestion	The continued population growth contributes to traffic congestion.
		Auto-Oriented Development Pattern	Henderson's development patterns require residents to have a car to be able to travel easily and efficiently. Eighty percent of Henderson residents currently commute by car.
		Air Quality	Vehicle usage affects the air quality and greenhouse gas emissions.
		Poor Connectivity	Traditional development patterns have typically seen new growth expanding the edge of the community, with land uses often separated by block walls. This has made it difficult for people to walk or bike to jobs and services, which doesn't allow people to incorporate physical activity into their day.
40	Smart City Strategy	-	-
41	Visioning 2025 Strategic Plan	Poor Accessibility for All Modes	The City of North Las Vegas does not provide equal modal access to businesses, employment centers, shopping, schools, and community amenities.
		Lack of Pedestrian-and Bike-Friendly Urban Design	The design of roadways does not create friendly environments for pedestrians and bicycles.
		Traffic Congestion	The expected growth of North Las Vegas over the next twenty years will result in significant traffic congestion.
42	Citywide Pedestrian & Bicycle Plan	Lack of Equity	For some residents of North Las Vegas, walking, biking, and taking transit is not a choice but rather a function of their socio-economic situation or age.
		Lack of Bicycle Lanes	Many streets in North Las Vegas do not include high comfort facilities, like shared use paths and separated bike lanes which are appealing to people of all ages and abilities, especially on or as alternatives to high volume and/or high-speed streets.
		Poor Connectivity	Breaks in connectivity create "islands" and denote the lack of comfortable crossings such as traffic signals, mid-block crossings, or grade-separated crossings.
		Poor Accessibility for All Modes	In North Las Vegas' street network, local streets offer limited direct access to local destinations due to numerous dead ends and circuitous street patterns.
		Lack of a Reliable Transit Service	The existing active transportation network in North Las Vegas currently provides a few important core routes but lacks the sufficient density to ensure the network is resilient, reliable, and widely accessible to attract a wide user base.
		Safety	Southern Nevada has one of the highest rates of pedestrian-automobile crashes for metropolitan areas in the United States.
43	City of North Las Vegas Comprehensive Master Plan	Poor Connectivity	Individual subdivisions tend to be surrounded by walls that separate neighborhoods visually and physically from adjacent development. The presence of uninterrupted wall segments within and around neighborhoods limits pedestrian movement – both within and between neighborhoods and between neighborhoods and areas of commercial, civic, and employment activity.
		Gaps in Pedestrian/Bike Networks	Gaps in sidewalk/bike networks discourage the use of active transportation modes, such as walking or biking.
		Lack of a Reliable Transit Service	Unreliable and limited transit discourages individuals from its frequent use.
		Traffic Congestion	The expected growth of North Las Vegas over the next twenty years will result in significant traffic congestion.
		Auto-Oriented Development Pattern	The reliance on personal vehicles can result in decreases in transport-related physical activity and increases in regional air pollution.
44	City of North Las Vegas Downtown Master Plan & Investment Strategy	Poor Connectivity	The abundance of large parcels and large blocks results in a street network with a relatively low density. The street network is further disrupted by the introduction of streets that run at various angles to the regular east-west and north-south street grid.
		Lack of Pedestrian-and Bike-Friendly Urban Design	The majority of pedestrians walking in the Downtown area spend at least a portion of their trip along the major arterials. In general, the existing arterials provide a very unfriendly experience for walkers with sidewalks adjacent to the street, frequent obstructions, and few amenities.
		Lack of Bicycle Lanes	While people do ride their bikes in and around North Las Vegas, there are no dedicated or shared bicycle lane in the Downtown area. The safest locations to ride include designated bike lanes and low traffic local streets.
		High Speed Roadways	While wide travel lanes can move vehicles at higher speeds, higher speeds are less safe for all users, especially pedestrians and cyclists.
45	Deer Springs District Livable Center	Gaps in Pedestrian/Bike Networks	Gaps in sidewalk/bike networks discourage the use of active transportation modes, such as walking or biking.
		Comfort	Carrying too much stuff for a long time and along not well-maintained/unsafe sidewalks or bike lanes.
		Traffic Congestion	By 2025, Clark County's population is expected to grow to 2.7 million. North Las Vegas has potential to assume a majority of that growth due to its undeveloped residential areas. Congestion will continue to increase with population growth,
		Weather	Hot weather and the lack of sufficient shade.
		Lack of a Reliable Transit Service	There are no frequent service transit routes in the Deer Springs District or surrounding areas.
46	North Fifth Stret Transit Supportive Concept Plan	Traffic Congestion	Vehicle travel has been increasing faster than population growth. This introduces a significant increase in traffic congestion.
		Lack of a Reliable Transit Service	Infrequent service, long trip times, and concerns over safety and reliability deter would-be riders from using public transit
		Lack of Pedestrian-and Bike-Friendly Urban Design	The inconvenient and unsafe pedestrian environment with long walking distances affects successful and functional community centers as well as transit services.

Appendix E. TSMO Strategies and Associated Benefits

#	TSMO Strategies	Experienced Deployment Benefits	Reference
1	Incident and Emergency Management	• Reduced congestion • Boosted efficiency and productivity for local agencies • Increased safety • Reduced number required law enforcement staff • Promoted understanding of benefit to the community • Heightened driver confidence	User-Friendly Traffic Incident Management (TIM) Program Benefit-Cost Estimation Tool https://www.fhwa.dot.gov/publications/research/operations/16055/003.cfm
2	Road Weather Management	• Improved safety due to reduced crash risk • Increased mobility due to restored capacity, delay reductions, and more uniform traffic flow • Increased productivity due to reduced labor, treatment material, and equipment costs	Best Practices for Road Weather Management https://ops.fhwa.dot.gov/weather/q2_benefits.htm
3	Integrated Corridor Management	• Better management of congestion on the multimodal network • Enhanced TIM • Enhanced transit service the corridor • A more reliable revenue source for multimodal improvements in the corridor • Pre-trip travel decisions or travel motivations • Enhanced choice of mode • Enhanced travel route decisions • Vehicle flow along the entire network	ICM, Managed Lanes, and Congestion Pricing: A Primer https://ops.fhwa.dot.gov/publications/fhwahop16042/fhwahop16042.pdf
4	Active Traffic Management	• Reduced congestion • Increased travel time reliability • Improved traffic flow • Reduction in primary and secondary incidents • Reduced emissions • Improved transit and freight operations	Active Traffic Management Feasibility and Screening Guide https://ops.fhwa.dot.gov/publications/fhwahop14019/ch2.htm

#	TSMO Strategies	Experienced Deployment Benefits	Reference
5	Transportation Demand Management	• Mode shift • Reduced vehicle trips • Reduced vehicle miles traveled • Reduced congestion • Improved travel time reliability • Reduced emissions • Land use improvements and economic development	Known Effectiveness of TDM Strategies https://ops.fhwa.dot.gov/publications/fhwahop12035/chap10.htm
6	Bicycle and Pedestrian Crossings Improvements	• Improved community health and physical wellness/quality of life • Improved non-motorized modes of transportation and mobility • Reduced emissions and environmental benefits • Reduced congestion and associated costs • Reduced incidents involving certain types of vehicles	The Need for Bicycle and Pedestrian Mobility https://safety.fhwa.dot.gov/PED_BIKE/univcourse/pdf/swless01.pdf
7	Advanced Traveler Information	• Improved travel time reliability • Pre-trip travel decisions or travel motivations • Enhanced choice of mode • Enhanced travel route decisions • Reduced congestion and demand • Improved commuter behavior • Improved customer service and satisfaction ratings	Best-of-the-month Practices for Traveler Information https://ops.fhwa.dot.gov/travelinfo/practices/benefits.htm
8	Connected & Autonomous Vehicles	• Improved collaboration among stakeholders • Improved perception of risks and rewards • Improved connectivity • Enhanced investment in data sharing • Enhanced safety and reliability • Reduction in emissions • Energy efficiency • Enhanced access to opportunities • Improved quality of life • Improved congestion and demand management • Land use improvements and economic vitality	TSMO in Smart Communities https://ops.fhwa.dot.gov/publications/fhwahop19004/fhwahop19004.pdf

#	TSMO Strategies	Experienced Deployment Benefits	Reference
9	Work Zone Management	• Enhance safety and reduced fatalities • Reduced congestion • Improve efficiency during construction • Improved travel time reliability and traffic flow within work zones • Improved traveler information and driver awareness • Enhanced incident response during construction and within work zones	Enhancing Transportation: Connecting TSMO and Construction *https://ops.fhwa.dot.gov/publications/fhwahop18092/index.htm#:~:text=TSMO%20is%20integral%20to%20effective,through%20an%20active%20work%20zone.*
10	Freight & Commercial Vehicle Transportation Management	• More efficient use of resources • Improved reliability in movement of goods and services • Improved performance on highways • Economic vitality • Improved freight travel time reliability • Reduced emissions and environmental impacts • Improved freight asset management and performance • Improved freight policy and coordination with neighboring states • Reduced impacts to aging infrastructure	Freight Management Cost Benefit Analysis *https://ops.fhwa.dot.gov/freight/freight_analysis/cba/index.htm*
11	Access Management	• Improved traffic flow and speed • Improved land use and urban planning • Reduced incidents and fewer vehicle conflicts • Economic vitality • Increased roadway capacity • Maximized performance and efficiency on existing roadway • Improved air quality	Benefits of Access Management Brochure *https://ops.fhwa.dot.gov/access_mgmt/docs/benefits_am_trifold.htm#:~:text=The%20benefits%20usually%20identified%20with,depend%20on%20pass%2Dby%20traffic.*
12	Managed Lanes	• Improved traffic operations and system performance • Reduced congestion and demand on roadways • Improved incident management and response times • Improved travel time reliability • Improved multimodal mobility • Increased high-occupancy and ride share travel	Managed Lanes: A Primer *https://ops.fhwa.dot.gov/publications/managelanes_primer/*

#	TSMO Strategies	Experienced Deployment Benefits	Reference
13	Mobility as a Service/Mobility on Demand	• Improved collaboration among stakeholders • Promote multimodal, integrated, and connected transportation system • Increased mode choice alternatives to manage demand • Improved mobility along congested corridors • Improved traveler information access and trip planning • Increased efficiency in movement of people and services • Increased efficiency in corridor management as a multimodal system	TSMO in Smart Communities Integrated Corridor Management, Transit, and Mobility on Demand *https://ops.fhwa.dot.gov/publications/fhwahop16036/ch1.htm#s11*
14	Transit Management	• Promote alternative modes of travel • Improved travel time reliability and traveler information • Reduced emissions and vehicle miles traveled • Reduced travel and associated costs • Improved customer service and satisfaction • Increased efficiency in transit services • Improved transit infrastructure • Enhanced regional coordination • Improved management of special events	TSMO & Transit Management *https://ops.fhwa.dot.gov/plan4ops/resources/transit_agencies.htm*

Appendix F. FHWA Recommended IOPs for Local Agency Leadership

Agency Leadership Action Item Recommendations

INSTITUTIONAL			
Leadership Action Items	**Benefits/Payoffs**	**Leadership Commitment Level**	**Commitment Time Frame**
Familiarization Develop top manager and staff TSMO familiarization/justification program.	Essential as basis/framework for actions below.	Use of valuable time.	Short—at leader's initiative.
Policy support Adjust agency policy to place TSMO in the top tier of policy program and related objectives.	Required to support adjustments in program and organization.	Endowing TSMO with status that is not perceived as merited by established legacy (civil engineering) constituency and is perceived as diminishing their professional status/value.	Long and continuous.
Marketing TSMO Use personal influence and contacts to persuade key players both internally and externally of value.	Important to securing voluntary cooperation from key players.	Importance of demonstrating agency-level commitment.	Both short and long.
Agency Collaboration Negotiate objectives realignment with other agencies (public safety, local government).	Need for partner program and TSMO activities alignment to deliver program.	Time consuming—requires persuasive face-to face interactions.	Long—continuous reinforcement.
Private Partnerships Develop new relationships with private service and technology providers.	Improved applications effectiveness.	Perceived changes in conventional arms-length relationships.	Medium—may require senior management intervention.

ORGANIZATIONAL			
Leadership Action Items	**Benefits/Payoffs**	**Leadership Commitment Level**	**Commitment Time Frame**
Chain of Command Reorganize to elevate TSMO activities to appropriate and effective chain of command and organizational level.	Improvement of efficiency.	Reducing reports to specific manager as loss of status, control (change in role).	Medium—must be sold. Long—in order to persist.
Championship Identify and support a TSMO change manager champion.	Achieve momentum for change management.	Mentorship.	Short—but individual must be supported.
Staff Capabilities Identify needed management and technical positions.	More effective program development and execution and agency self-reliance. Clearer defined career paths for staff.	May involve pay scale changes and new position descriptions and levels.	Short—staff needed for program development.
Training Direct TSMO staff capability development.	Ability to stay on top of emerging technologies and research.	Use of staff resources.	Long—continuous reinforcement.

PROCEDURAL			
Leadership Action Items	**Benefits/Payoffs**	**Leadership Commitment Level**	**Commitment Time Frame**
Planning/Programming Insert TSMO into the legacy planning, programming, and project development process.	Development of appropriate sequence of improvements with needed resources.	Understanding the technical capability in planning staff.	Short (can be initiated as staff effort).
Systems Engineering Require Systems Engineering utilization to develop and manage TSMO applications and use of emerging technologies.	Assurance of effective operations.	Understanding the technical capacity in systems engineering.	Short—must become standard procedure for projects.
Budgeting Develop a formal TSMO budget line item.	Sustainable funding to support program development.	Need to reallocate existing resources.	Medium—related to budget cycles and repetition.
Performance Measurement Modify performance objectives and measures to accommodate TSMO.	TSMO management entirely performance- based outcome.	Change of traditional program output focus towards outcomes.	Short (can be initiated as staff effort).