MISSOURI DEPARTMENT OF TRANSPORTATION

Transportation Systems Management and Operations

Program and Action Plan

June 2024

Missouri Department of Transportation

Transportation Systems Management and Operations (TSMO) Program and Action Plan

Prepared for:

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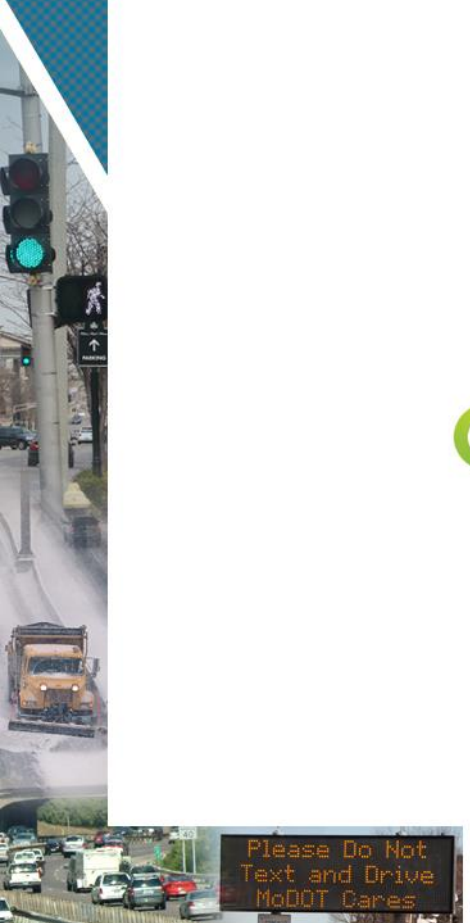

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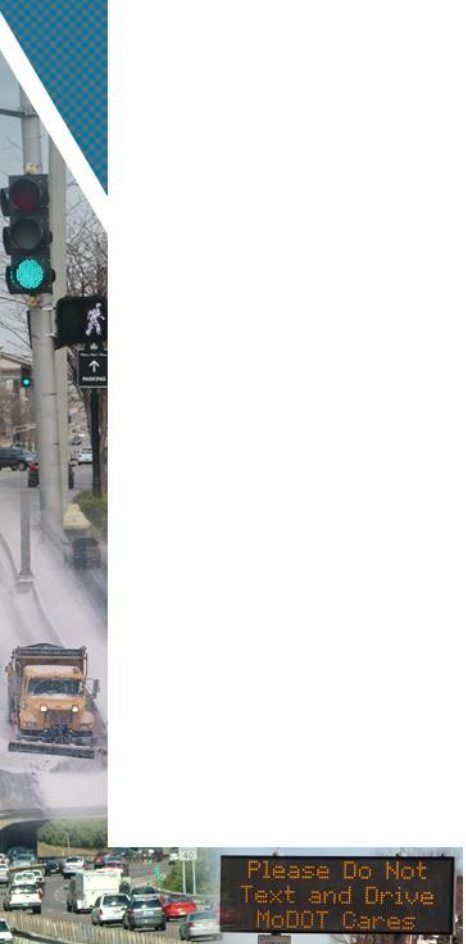


EXECUTIVE SUMMARY

The Missouri Department of Transportation (MoDOT) Transportation Systems Management and Operations (TSMO) Program and Action Plan establishes the strategic direction for the advancement of TSMO in Missouri. TSMO consists of operational strategies and systems that cost-effectively help optimize the safety, reliability, and capacity of the transportation system. MoDOT is continuously working to improve safety and alleviate congestion on its roadways. The effective application of TSMO strategies outlined in this plan will help to further improve MoDOT's roadways by directly addressing many of the root causes of recurring and nonrecurring congestion. The mission of the MoDOT TSMO program, as documented in this plan, is shown below.

MoDOT's TSMO program applies integrated strategies to optimize the performance of existing infrastructure through the implementation of systems, services, real-time information, and programs designed to preserve capacity and improve safety and reliability of transportation systems. MoDOT's TSMO program helps get people safely where they want to go.

The TSMO Program and Action Plan aligns directly with MoDOT's foundational mission and supports existing initiatives, such as Missouri's Show-Me Zero. It also builds on more than 10 years of MoDOT efforts to advance TSMO in the state starting in 2013, when MoDOT participated in a TSMO-focused Federal Highway Administration (FHWA) Capability Maturity Model (CMM) workshop, which helped MoDOT understand its strengths and areas that need development in institutional and process-based areas. Completing the self-assessment provided MoDOT with a base from which to further advance operations, and a high-level implementation plan was adopted in 2014. This implementation plan outlined seven priority actions, including a task to identify a core team of champions from across the organization to lead the advancement and integration of TSMO into MoDOT's structure and culture. The 2017 TSMO Program and Action Plan formalized these previous efforts and provided a roadmap to move forward with the advancement of TSMO in Missouri. This 2024 update of the TSMO Program Action Plan captures the significant progress made since 2017. The content and high-level takeaways of the plan are summarized below.

Section 1.0, Introduction, presents the transportation challenges specific to Missouri that the TSMO program will cost-effectively address, successfully making the business case for TSMO in the state.

Section 2.0, Moving the Missouri Department of Transportation (MoDOT) Forward: Where We Have Been, documents previous efforts, existing plans, and the organization of the TSMO Core Team, Senior Management Team (SMT), and supporting teams that resulted from the 2014 implementation plan.

Section 3.0, Moving the Missouri Department of Transportation (MoDOT) Forward: Where We Are Going, gives an overview of how MoDOT is organized for the advancement of TSMO into all facets of the organization. The efforts are overseen by the TSMO steering committee, which includes members from across MoDOT. The Steering Committee reports to various MoDOT senior leaders, including members from the Highway Safety and Traffic Division, Maintenance, Safety and Emergency Management, Information Systems, and one or more district engineers as needed.

The TSMO Steering Committee coordinates a group of liaisons assigned to champion TSMO principles and participate with various existing quality circles, working groups, and subcommittees. These organizations include the Work Zone Quality Circle, Traffic Signal Quality Circle, Traffic Incident Management (TIM) Statewide Committee, and the Traffic Management Centers (TMC) Working Group. The Steering Committee can also form dedicated TSMO teams that will focus on specific areas as needed. Currently this effort includes three teams: Advancing Technology (AT), TSMO Outreach and Education, and Connected

and Automated Vehicles (CAV). The Steering Committee meets regularly to review and advance TSMO implementation tasks, including the identification of additional task leads and support personnel as needed.

Section 4.0, Strategic Planning, goes beyond these focus areas and provides a broader strategic approach to advancing operations in Missouri. These themes, shown below, are not necessarily tied to specific actions and often involve greater integration with MoDOT activities.

Planning for Operations – Planning for operations places focus on how TSMO strategies and solutions, which support the improvement of transportation system reliability and efficiency, are incorporated into the planning processes.

Workforce Development – The workforce that will support TSMO should consist of traditionally trained MoDOT staff such as traffic engineers and designers, planners, and managers; it should also include staff members who are more technology-focused such as computer engineers, database specialists, communications engineers and technicians, and programmers. Staffing and training programs must develop and sustain the knowledge and talent needed for an effective application of TSMO. Job descriptions must accurately portray the skillset needed for the positions. Staff turnover must be accounted for and training programs in place to quickly replace staff with equivalent skill sets.

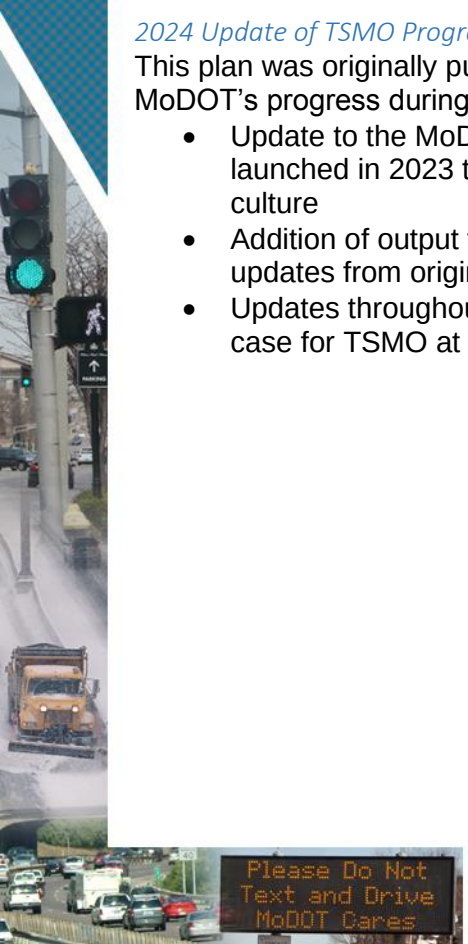
Performance Measurements – The performance management (PM) dimension of the CMM self-assessment scored very well, indicating a mature PM program meeting the criteria established for integrated PM programs. Areas to explore that will further advance PM are those that are expected to expand rural and arterial applications of PM through increased data collection to supplement existing data.

Section 5.0, Looking Ahead, highlights how the plan is designed as a living document. It is anticipated that as the TSMO program evolves, additional focus areas will be brought forward. Some of these may include more direct application to multi-modal operations, freight, traveler information, travel demand management, weather operations, or emergency management. It is recommended that this plan be revisited annually. To reflect significant progress between 2017 and 2024, this plan was formally revised in June 2024, as detailed below.

2024 Update of TSMO Program and Action and Plan

This plan was originally published in 2017, and in 2024, underwent a comprehensive revision to reflect MoDOT's progress during the intervening years. Key updates to the 2024 version include the following:

- Update to the MoDOT TSMO organizational structure description to reflect the new structure launched in 2023 to promote greater integration within broader MoDOT organizational structure and culture
- Addition of output from a CMM Reassessment Workshop held in early 2022, to show progress and updates from original workshop held in 2013
- Updates throughout the plan to include more current data in parts of the plan that make the business case for TSMO at MoDOT



1.0 INTRODUCTION

The Missouri Transportation Challenge

The Missouri Department of Transportation (MoDOT) is constantly working to alleviate congestion, enhance mobility, and provide a safe and efficient travel experience for drivers along Missouri's roadways. Meeting these challenges is an ongoing priority and is the motivation behind the advancement of the Transportation Systems Management and Operations (TSMO) program. This section gives a brief overview of the current state of these challenges.

Safety

In 2022, the Missouri State Highway Patrol (MSHP) and local police responded to 127,485 total crashes. Timely responses to crashes and vehicle safety improvements represent the continued efforts by MoDOT and emergency agencies to manage and reduce crash incidents. The total number of crashes in Missouri reached a high of 158,089 in 2016 before showing a general decline, hitting a low of 127,485 in 2022. Fatalities fluctuated over the years, peaking at 1,016 in 2021 and decreasing to 964 in 2022. Overall fatalities trended upward between 2013 and 2022, as shown in Figure 1. This trend shows the importance of combatting deadly crashes with all means necessary including tools like TSMO and intelligent transportation systems (ITS). Campaigns like "Show Me Zero" and "Buckle Up, Phone Down" highlight MoDOT's commitment to achieving zero deaths on Missouri roads. MoDOT's goal remains zero fatalities, and improving safety will continue to be a top priority until this goal is achieved.

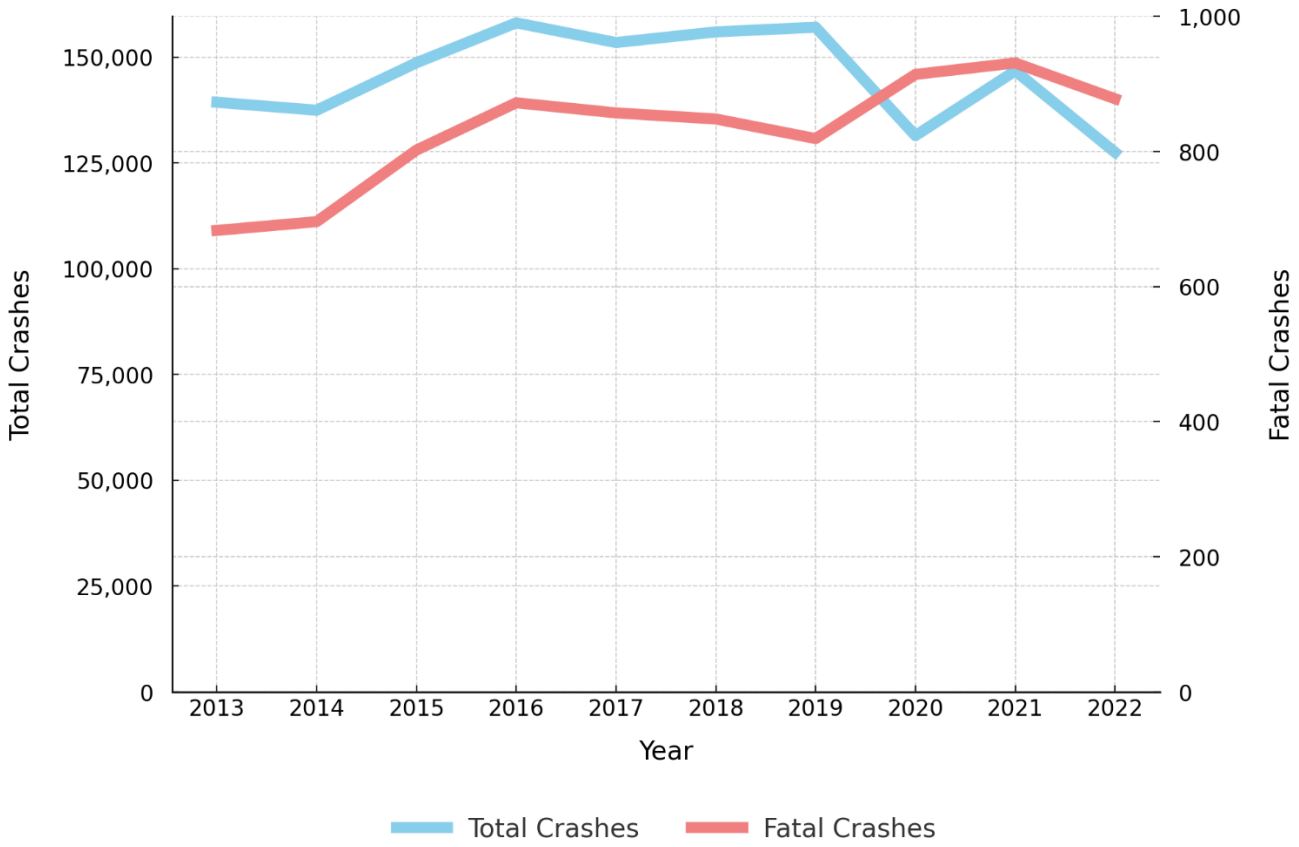


Figure 1. Total Missouri Crashes and Fatalities.[1]

[1] Historical data from Missouri Statewide Traffic Accident Records System (STARS) https://www.mshp.dps.missouri.gov/MSHPWeb/SAC/stars_index.html, 2024 data from the Missouri State Patrol Website https://www.mshp.dps.missouri.gov/MSHPWeb/SAC/Compendium/TrafficCompendium.html#

Congestion

Recent trends in the number of drivers, the number of miles those drivers travel, and the number of available lane miles indicate that levels of congestion are likely to increase. Figure 2 illustrates vehicle ownership and the total number of licensed drivers alongside the total population of Missouri. The chart indicates that though the number of registered vehicles has decreased from its peak in 2006, the population trend and the number of licensed drivers has steadily increased.

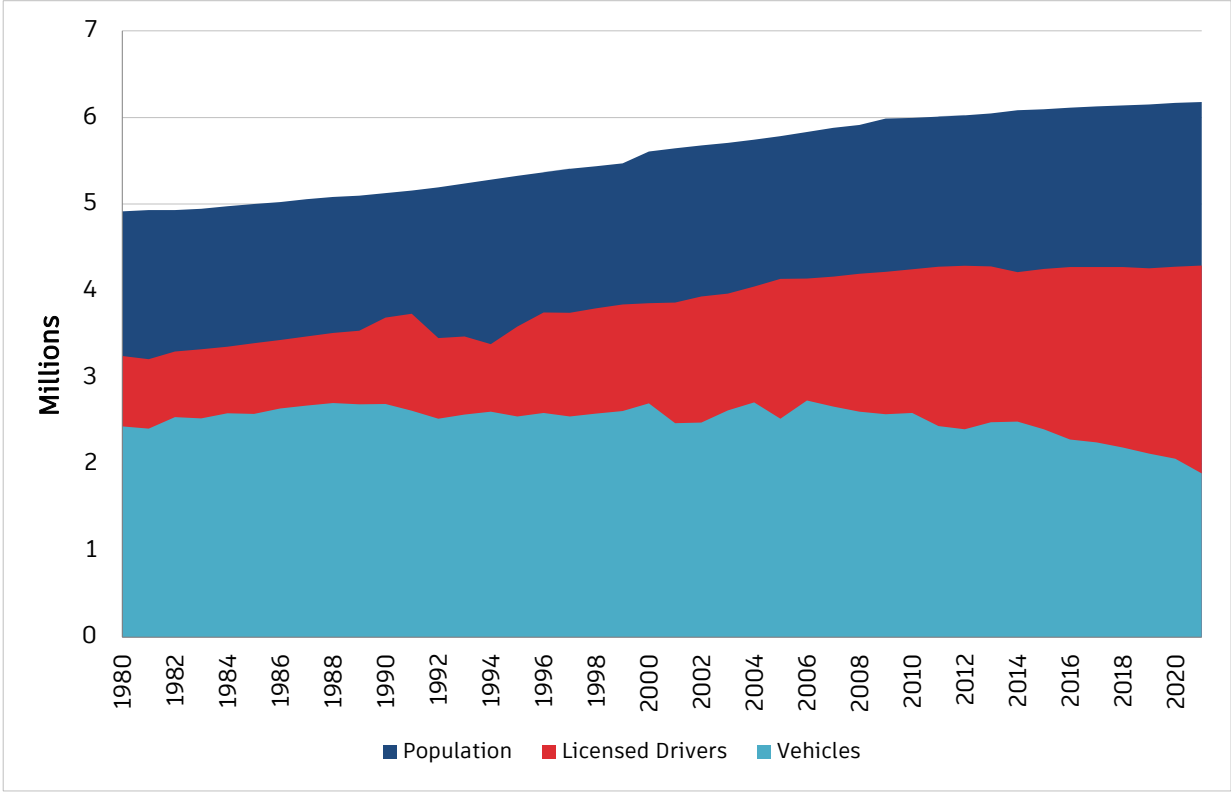


Figure 2. Missouri Population, Driver, and Vehicle Trends.[2]

The annual vehicle miles traveled (VMT) in Missouri showed significant growth from 2014 to 2019, reaching a peak of over 79,100 million miles. Although there was a decline in 2020 because of the COVID-19 pandemic, the VMT rebounded strongly to more than 79,400 million miles in 2022. Overall, the period saw a VMT increase of 7.31 percent with an average annual increase of nearly 1 percent per year.

Over the same period, the number of lane miles added to the overall system remained relatively flat between 2016 and 2022. As can be seen in Figure 3, the disparity between the growing VMT and the relatively stagnant expansion of lane miles underscores a network likely to see increased strain and one that will struggle to meet travel demand. Despite the slight decline in registered vehicles, the overall upward VMT trend, the continuous increase in licensed drivers, and the growing population suggest that pressure on Missouri's roadway networks will continue to persist.

As the number of vehicles traveling along MoDOT's roadways continues to increase, and the existing roadway infrastructure remains stagnant, capacity will grow increasingly strained. Without substantial improvements in roadway infrastructure and capacity, congestion levels are expected to worsen over the next decade. Proactive measures, including investments in TSMO and ITS, and supporting alternative modes, through transit supportive projects and Local Public Agency (LPA) programs like Congestion Mitigation and Air Quality (CMAQ) and Transportation Alternatives Program (TAP) will be critical in managing future congestion and maintaining efficient traffic flow.

[2] Licensed Drivers, Registered Vehicles, and Population - MO: Office of Highway Policy Information, FHWA, updated May 20, 2024. http://www.google.com/publicdata/explore?ds=gb66jodhlsaab_- Access May 2024

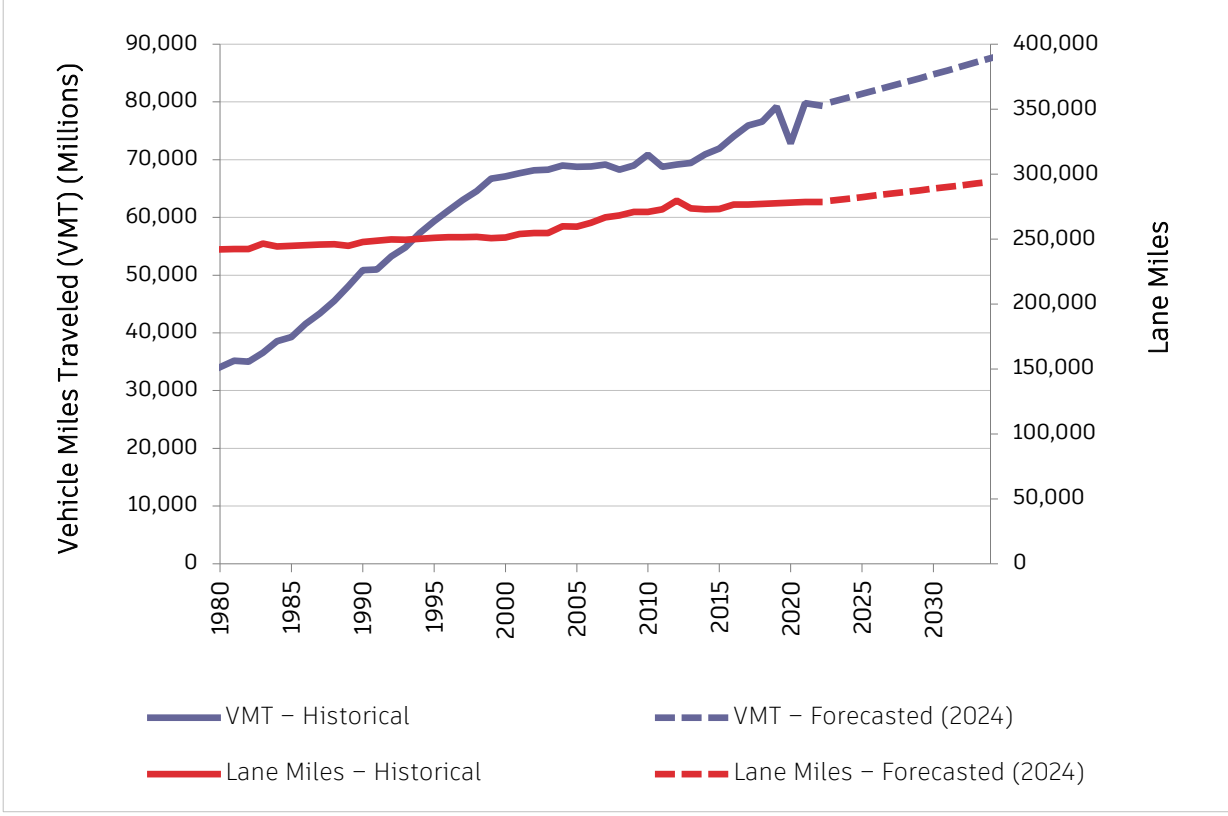


Figure 3. Missouri Vehicle Miles Traveled (VMT) and Lane Miles Added.[3]

The most significant mobility challenges experienced by drivers in Missouri each day are caused by temporary disruptions that reduce the roadway capacity, known as "nonrecurring" congestion. Factors such as inclement weather, traffic incidents, special events, and work zones continue to be the primary causes of nonrecurring congestion. Congestion caused by inadequate capacity on the roadway, generally occurring during the peak periods of the day, is known as "recurring" congestion and is primarily caused by bottlenecks and poor signal timing. Figure 4 illustrates the average sources of congestion nationwide, and Figure 5 illustrates average sources of congestion in Missouri. The data behind these statistics comes from a variety of sources compiled and presented by the University of Maryland Center for Advanced Transportation Technology (CATT) Lab[4] for 2019.

Missouri has less recurring congestion (38 percent vs. 52 percent) and more nonrecurring congestion (41 percent vs. 34 percent) than the nationwide average. Missouri also has more unclassified causes of congestion (21 percent vs. 12 percent); the tool does not provide an explanation.

Though nearly half of Missouri's congestion is nonrecurring (38 percent vs. 41 percent), most funding for transportation system improvements is allocated to addressing bottlenecks by adding capacity through capital improvements. Operations initiatives are generally less expensive than capital improvements; therefore, MoDOT will achieve more benefit per dollar by making a greater investment in TSMO. TSMO allows for better management of nonrecurring congestion, like clearing crashes and managing traffic flow around work zone-related delays.

[3] VMT and Historical Lane Miles for all Missouri Roads: Office of Highway Policy Information, FHWA, updated May 20, 2024. http://www.google.com/publicdata/explore?ds=gb66jodhlsaab_. Accessed May 2024 – Forecasted VMT based on avg percent increase between 2002 – 2022, Forecasted Lane Miles based on most recent STIP and Long Range Plan - VMT – Avg 0.8% Annual Increase and Lane Miles – Avg 0.5% Annual Increase

[4] https://ritis.org/archive/congestion

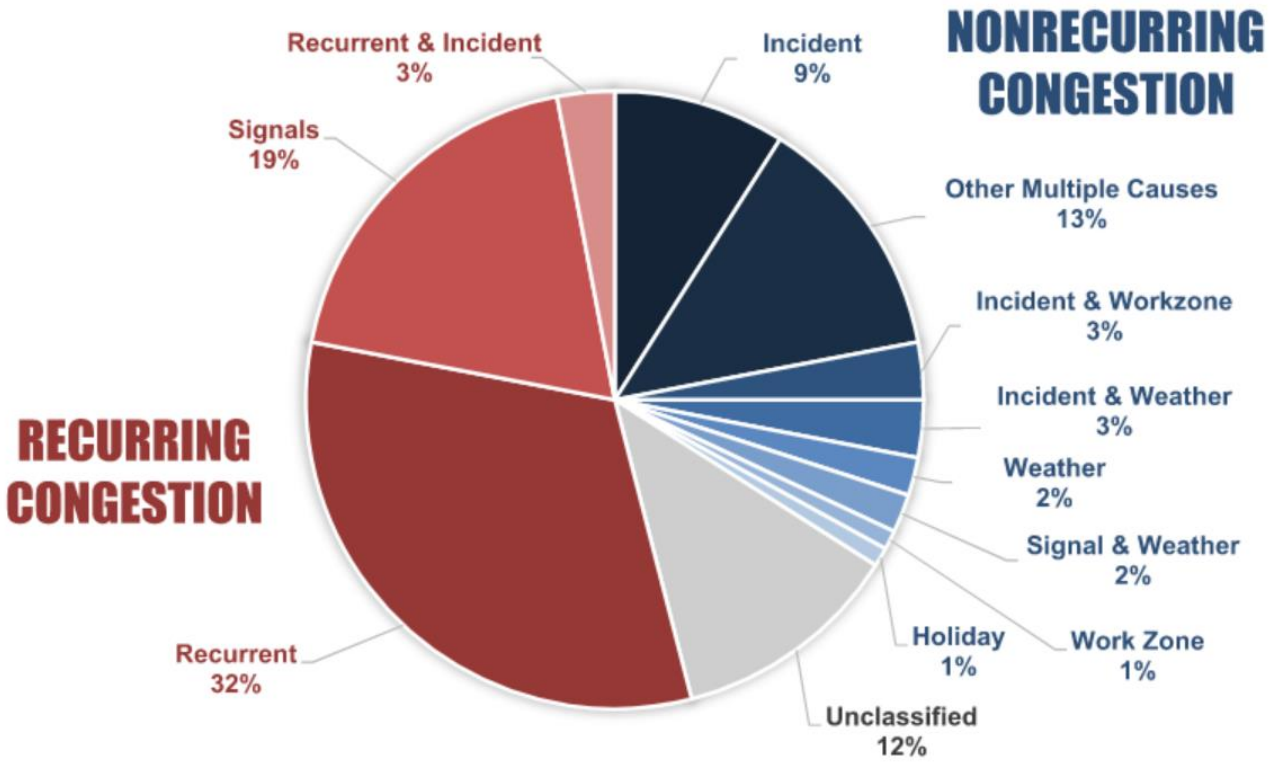


Figure 4. National Sources of Congestion.

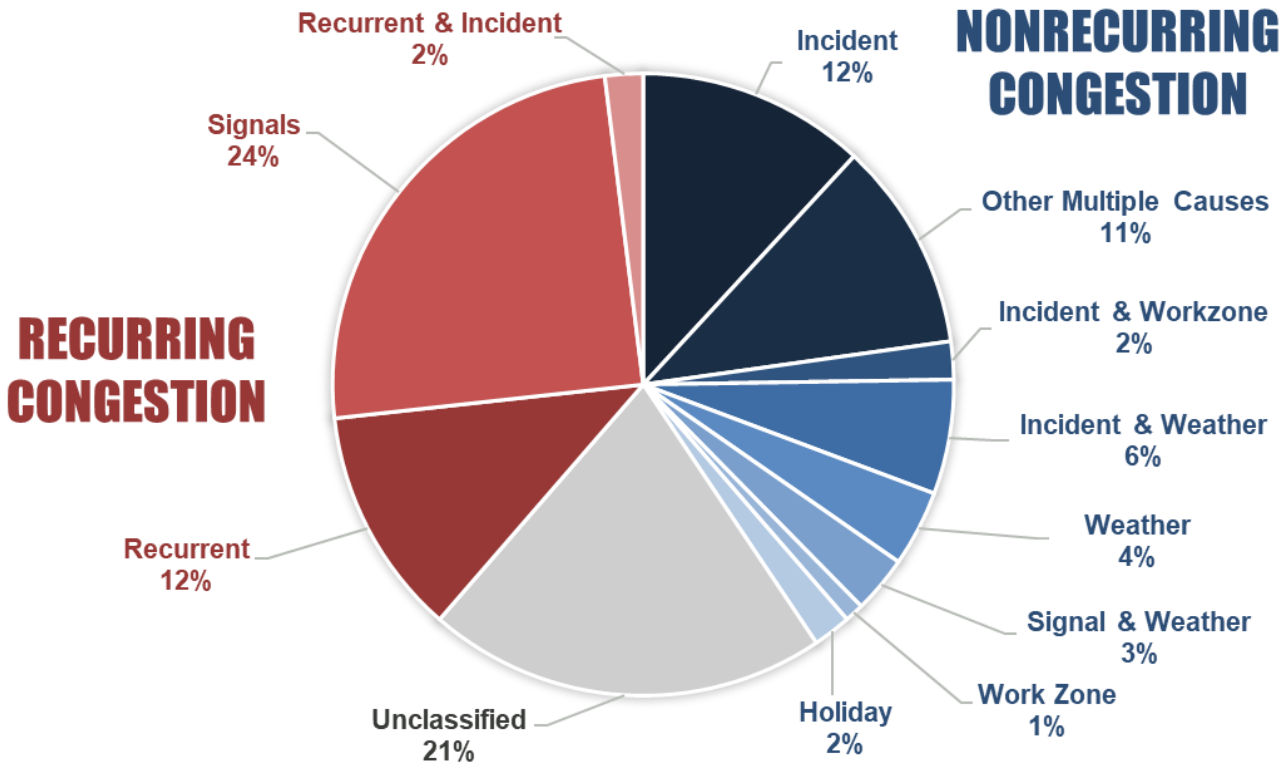


Figure 5. Missouri Sources of Congestion.

Cost

The cost of congestion on selected state roads in Missouri from 2019 to 2022 reveals notable trends. The congestion costs for rural sections of Interstate 44 decreased from $75 million in 2019 to $33 million in 2022, while rural sections of I-70 saw a similar reduction from $45 million to $22 million over the same period. This downward trend in rural areas mirrors the urban areas of Kansas City and St. Louis. In Kansas City, the cost of congestion dropped from $258 million in 2019 to $126 million in 2022, reflecting a significant decrease. St. Louis also experienced a substantial decline from $457 million in 2019 to $229 million in 2022.

The overall trend indicates a substantial reduction in the cost of congestion across all selected roadways in both rural and urban areas. The most significant reductions occurred between 2019 and 2020, likely because of the COVID-19 pandemic, which resulted in decreased travel and lower traffic volumes. Though there was some fluctuation in costs for specific roads in subsequent years, the general pattern points to a continued decrease in congestion-related expenses. This data suggests that efforts to manage and mitigate congestion may have been effective, particularly in urban areas, but it also highlights the impact of external factors such as the pandemic on travel behavior and congestion costs.

TSMO Can Help

MoDOT has refined its process of assessing, prioritizing, and executing infrastructure projects that address congestion and safety concerns through capital projects. However, capital projects are expensive and are not always the most effective solution to many types of congestion and safety challenges.

TSMO can help in many cases by directly addressing the root causes of congestion. TSMO strategies range from projects and tools to policies and procedures to organizational structure. Some examples of how TSMO can help extend the capacity of a roadway include expediting traffic incident clearance, optimizing traffic signal timing in real time, providing alerts to travelers, dispersing platoons as they enter a freeway, and prompting the prewetting of a roadway to prevent ice from forming. More generally, in 2006, an American Association of State Highway Transportation Officials (AASHTO) report[5] indicated that the benefit-cost ratio of technology-enabled operational improvements is estimated to be 9 to 1, compared to the addition of conventional highway capacity, which has a benefit-cost ratio of 2.7 to 1.

Moving Missouri's TSMO Forward

In recent years, MoDOT has placed significant focus on including TSMO as a consideration of many aspects of MoDOT. Some initiatives have included statewide traffic incident management (TIM) and safe work zone programs. Freeway and arterial traffic management programs with traveler information systems have also been established in the St. Louis, Kansas City, and Springfield areas. MoDOT has also worked to develop TSMO expertise within its workforce, sending many staff members to receive specific training at the National Operations Academy and engaging in Regional Operations Forums established by the second Strategic Highway Research Program (SHRP2) since 2007.

Even with these initiatives in place, there is still a heavy focus on pure infrastructure projects. Though TSMO is much better known than it was even a few years ago, operational considerations and projects can still be an afterthought during the planning and design processes. This program and action plan has been developed to help MoDOT realize the benefits of effective operational strategies. Its purposes are to do the following:

- Establish the mission, goals, objectives, and strategic direction for TSMO in Missouri
- Define a framework for the organizational procedures, resources, activities, and services that will be needed to achieve these goals
- Provide guidance to MoDOT, planning organizations, and partner agencies on the management and operations of the transportation system in the context of ever-changing demands and limited funding

[5] "The 21st Century Operations-oriented State DOT", the American Association of State Highway and Transportation Officials (AASHTO) 2006, http://stsmo.transportation.org/Documents/21stCenturyStateDOT.pdf

MoDOT's TSMO program applies integrated strategies to optimize the performance of existing infrastructure through the implementation of systems, services, real-time information, and programs designed to preserve capacity and improve safety and reliability of transportation systems. MoDOT's TSMO program helps get people safely where they want to go.

Though TSMO covers a wide range of areas, teams have been formed to focus on four areas for TSMO implementation during the past five years. In 2019, MoDOT formed three teams to focus on TIM, Work Zone Management (WZM), and Advancing Technology (AT). In 2021, a fourth team was added to focus on Connected and Automated Vehicles (CAV).

Each of these teams has significantly increased the focus on TSMO and achieved greater safety and operational benefits. Major tasks have included development of strategic TIM and CAV plans, modification and development of numerous sections of MoDOT's Engineering Policy Guide (EPG), preparation of many education and outreach materials, and development of other research, tools, and resources to support all aspects of TSMO in Missouri.

Transportation System Management and Operations (TSMO) Purpose and Goals

Mission

MoDOT's TSMO program applies integrated strategies to optimize the performance of existing infrastructure through the implementation of systems, services, real-time information, and programs designed to preserve capacity and improve safety and reliability of transportation systems. MoDOT's TSMO program helps get people safely where they want to go. Table 1 defines the goals and objectives of the TSMO program.

Goals and Objectives

Table 1. Transportation System Management and Operations (TSMO) Goals and Objectives.

Goals	Objectives
Operate MoDOT's existing system efficiently, reliably, and effectively through the application of TSMO strategies and programs.	Provide for TSMO deployments statewide.
Consider TSMO solutions and strategies in every MoDOT project.	Include TSMO proactively rather than opportunistically/reactively.
Include TSMO in the planning stages of projects and programs.	Include planning for operations principles in MoDOT planning process documents.
Strengthen TSMO related education and workforce development.	Provide new and supplement existing TSMO outreach, training, and recruitment resources for MoDOT staff and partners.
Document progress toward meeting each goal and MoDOT's stated tangible results.	Quantify and document TSMO performance measures.

TSMO Supports MoDOT's Mission

MoDOT's TSMO program is in direct support of and alignment with MoDOT's mission and values. Through their integrated approach, TSMO strategies help MoDOT deliver a world-class transportation system by directly affecting MoDOT's tangible results, which include the following:

- Improving safety (Moving Missourians safely)
- Providing impactful solutions at a low cost (Delivering efficient and innovative transportation projects; Managing our assets)
- Improving reliability and mobility (Operating a reliable transportation system; Building a prosperous economy for all Missourians)
- Providing useful and timely traveler information (Providing outstanding customer service)

2.0 MOVING THE MISSOURI DEPARTMENT OF TRANSPORTATION (MODOT) FORWARD – WHERE WE HAVE BEEN

Efforts To Date

For many years, MoDOT has recognized the value of adopting strategies to improve safety and operations, which is reflected in the implementation of the Emergency Response (ER) program and Traffic Management Centers (TMCs) and their respective systems and resources. More recently, staff has been working to realize the full benefit of these individual strategies by bringing them under the holistic umbrella of TSMO and making TSMO an integrated part of MoDOT's organization, culture, and processes. Figure 6 illustrates a timeline of these efforts since 1998.

The remainder of this section describes some of the initial steps MoDOT has taken to implement these changes at an organization and program level.

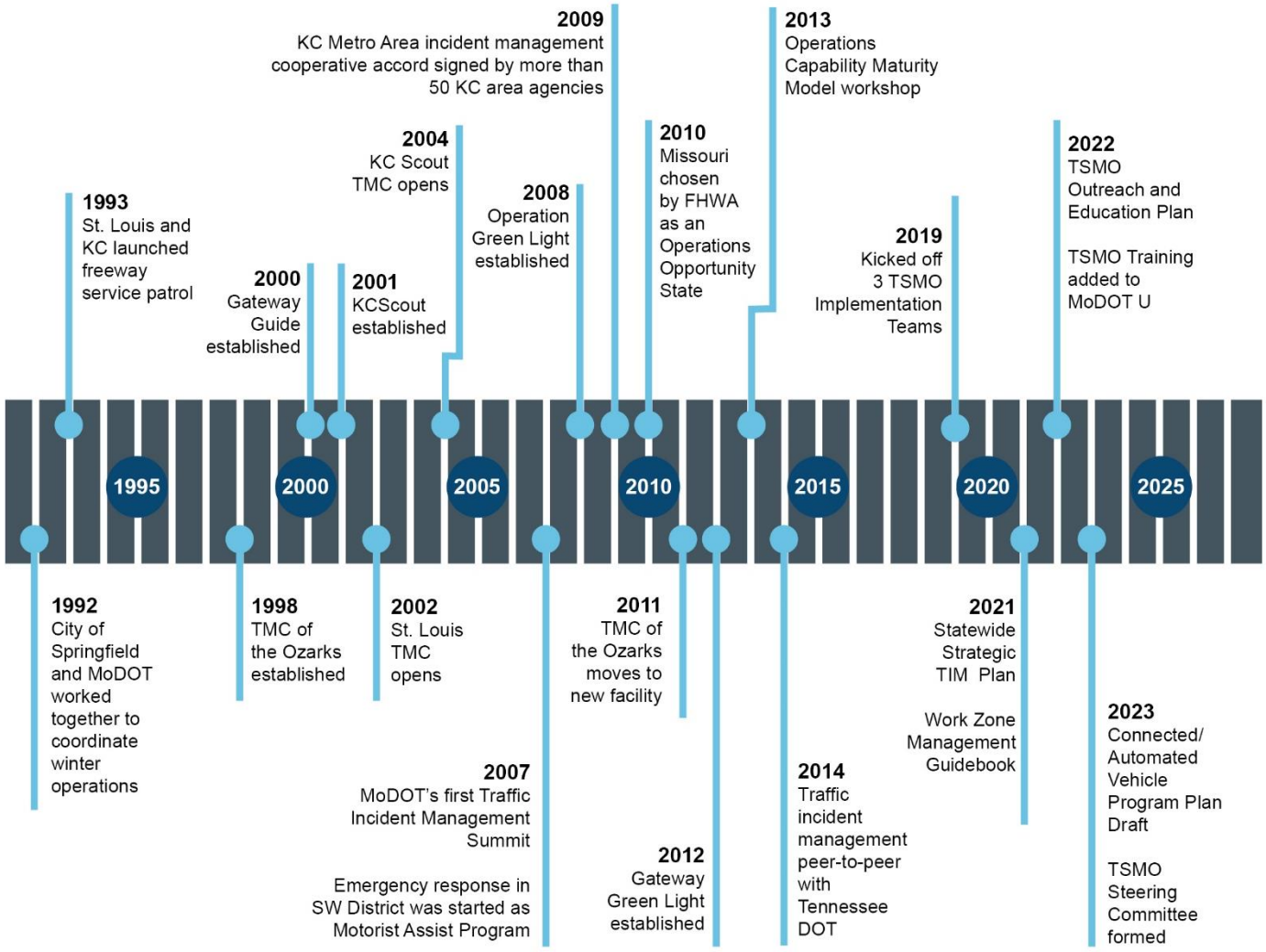


Figure 6. Missouri Department of Transportation's (MoDOT's) Timeline of Transportation Systems Management and Operations (TSMO) Efforts To Date.

Capability Maturity Model (CMM) Self-Assessment and Workshops

During several statewide capability self-assessment workshops in late 2013 and 2014, MoDOT and its partners prioritized actions to advance operations for Missouri. One workshop focused on the overall TSMO

program and advancing operations. Two others focused specifically on TIM, and work zones. MoDOT held an additional review workshop in February 2022 to re-assess the previous workshop outputs and actions in light of recent progress. The CMM workshop process is outlined below.

To assist in integrating TSMO into state agencies' existing programs, the Federal Highway Administration (FHWA) developed a TSMO-focused CMM self-assessment framework and workshop. The CMM framework identifies six key dimensions of process and institutional capability that relate to improving program effectiveness. It converts what were previously unclear concepts into specific manageable actions to improve capability. Table 2 outlines the six dimensions of capability; three dimensions are process-oriented and three are institutionally oriented.

Table 2. Six Dimensions of Capability.

	Dimension of Capability	Description
Process	Business Processes	Planning Programming Budgeting (resources)
	Systems and Technology	Systems engineering Systems architecture standards Interoperability Standardization
	Performance Measurement	Definition measurement Data acquisition Utilization
Institutional	Culture	Technical understanding Leadership Outreach Program legal authority
	Organization and Staffing	Programmatic status Organizational structure Staff development Recruitment and retention
	Collaboration	Relationships with public safety agencies Local governments Metropolitan planning organizations (MPOs) Private sector

To complete the self-assessment for the six dimensions of capability, FHWA developed four criteria-based "levels" of capability maturity that aid in identifying the course MoDOT should follow to execute changes that will generate a more effective TSMO program. Figure 7 displays the levels of capability, what should be accomplished within each level, where most agencies are today, and the future goal.

- **Level 1**: Performed – Activities and relationships are largely ad hoc, informal, and champion-driven and are outside the mainstream of other transportation activities.
- **Level 2**: Managed – Basic strategy applications are in place with key processes and needed staff capacities under development; however, there is limited accountability and collaboration and sustainable resources.
- **Level 3**: Integrated – Standardized strategy applications are implemented in priority contexts and are managed for performance; the TSMO technical processes are developed, documented, and integrated into the regional transportation agencies, and partnerships are aligned.
- **Level 4**: Optimized – The TSMO is a full and sustainable, region-wide program that is established on the basis of continuous improvement with all partners.

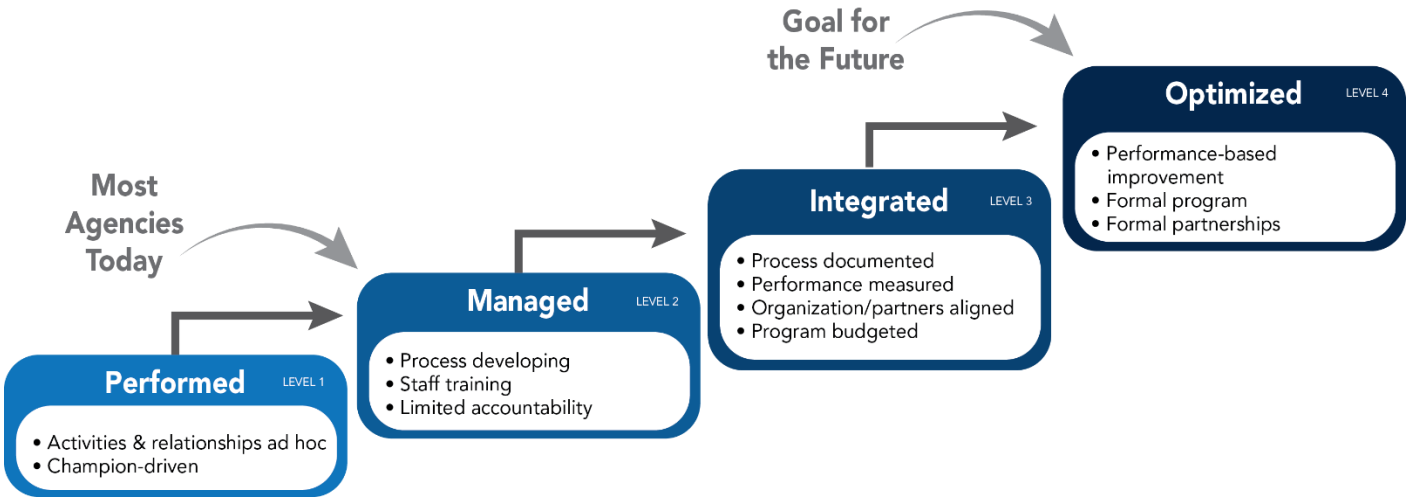


Figure 7. Capability Levels.

At the statewide CMM workshops, held in 2013 and again in 2022, MoDOT used FHWA's self-assessment procedures and analyzed which capability level MoDOT was on with each of the six dimensions of capability. Through the CMM criteria, the self-assessment provides MoDOT a metric to help evaluate the advancement of operations. Table 3 outlines where MoDOT was rated at the time of each workshop.

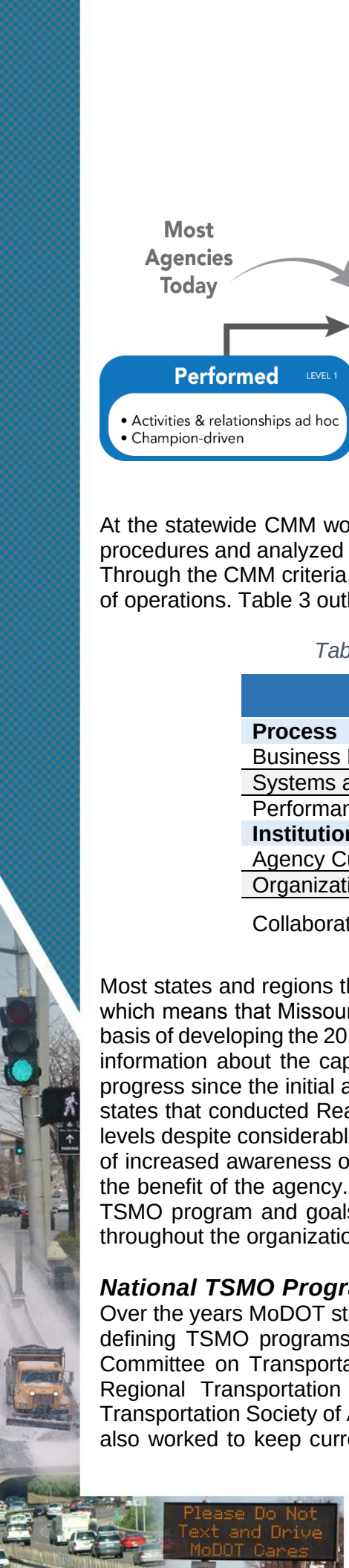
Table 3. Summary of Capability Maturity Model (CMM) Scoring.

Dimension	2013 Level	2022 Level
Process		
Business Process	1.5	2.5
Systems and Technology	2.0	2.25
Performance Measurement	2.5	2.5
Institutional		
Agency Culture	1.5	2.25
Organization/Staffing	1.75	1.5
Collaboration	1.0 - Internal 2.5 - External	2.0 - General 3.0 - TIM

Most states and regions that participated in this assessment averaged a capability level of approximately 2, which means that Missouri's 2013 results are like those of most other agencies. These results provided the basis of developing the 2017 TSMO Plan, and knowing which dimensions are at the lowest level gives MoDOT information about the capabilities that should be focused on first. The 2022 levels demonstrate excellent progress since the initial assessment. Anecdotally, the FHWA CMM workshop program observed that many states that conducted Reassessment Workshops scored similar, or in some cases, lower than their original levels despite considerable progress. Further discussion with participants revealed that this result is because of increased awareness of the importance of TSMO and the many ways to advance and leverage TSMO to the benefit of the agency. Simply put, states like Missouri have set higher standards when it comes to their TSMO program and goals and should continue to strive toward excellent TSMO program implementation throughout the organization.

National TSMO Program Development

Over the years MoDOT staff members have actively participated with committees and organizations that are defining TSMO programs at a national level. These committees and organizations include the AASHTO Committee on Transportation System Operations (CTSO), the Transportation Research Board's (TRB's) Regional Transportation Systems Management and Operations (RTSMO) Committee, the Intelligent Transportation Society of America (ITS America), and other local and national organizations. Personnel have also worked to keep current with related FHWA initiatives, including the application and award of a grant



through SHRP2, which funded the 2017 planning effort. MoDOT staff will continue to stay involved with these national organizations to remain abreast of rapid changes and to represent Missouri's interests in defining the national direction.

TSMO Implementation Plan for Missouri

Following the 2013 self-assessment, MoDOT developed an implementation plan to strengthen the less-developed dimensions. The plan identified seven priority actions that encompass tasks to help enhance TSMO by advancing and improving operations. The implementation plan also outlines tasks and subtasks to be completed. The seven priority actions are as follows:

1. Establish a statewide program for TIM and identify dedicated staff position(s) to oversee it.
2. Identify a team of TSMO champions from MoDOT's Senior Management Team (SMT).
3. Develop a statewide TSMO plan from which subsequent regional plans can be developed.
4. Define goals for effective performance measures related to TSMO and develop a plan for obtaining better data and creating efficiencies in data analysis.
5. Define processes to assure improved TSMO expertise-sharing and knowledge-banking.
6. Establish a common procurement process and develop a clearinghouse of standard specifications for frequently procured TSMO technology.
7. Revise job descriptions to include TSMO skills and responsibilities, where appropriate.

The first two action items were completed ahead of the 2017 Plan, and development of this 2017 Plan reflected progress on the third action item. MoDOT continued progress on the remaining actions between 2017 and 2024. The 2022 CMM Reassessment identified the following key items to help build on MoDOT's progress:

1. At the district level, explore having either a TSMO staff position, or TSMO staff liaison that would interface with the statewide TSMO team and advance TSMO efforts at the district level.
2. Standardize TSMO-supporting elements, in particular TIM data collection, performance metrics, and standard specifications for evaluating and testing TSMO technologies (continuing the work of the AT Team).
3. Highlight the success of having EPG 909 on TSMO strategies and applications in place and supplement the EPG for greater TSMO institutionalization.
4. Increase TSMO awareness by developing outreach products to educate and help staff to espouse TSMO benefits. Focal areas include onboarding of new staff, information on emerging technologies, and talking points for senior leaders to advance a TSMO program.
5. Use TSMO awareness-building efforts in training, education, and communications to strengthen collaboration with partners at the public (agencies), private (tech providers), and national (CTSO) levels.
6. Develop other internal TSMO coordination resources, including: an up-to-date directory of key TSMO contacts ("Who's Who") and a centralized portal for sharing TSMO information across MoDOT.

Missouri has embraced many types of new technology to improve its operations, primarily focusing in the three largest metro areas. This technology has been centered around the three TMCs.

Statewide Initiatives

MoDOT's Central Office manages operations and implements initiatives throughout the state. The Central Office provides support to the TMCs and supports existing rural ITS devices/services, which includes many cameras and dynamic message signs (DMS). The Central Office also maintains the existing traveler information website and continually works to improve traveler information services available to customers. Requests for proposals (RFPs) are completed by the Central Office for annual maintenance of Missouri's rural ITS devices. To support performance measures and traveler information, MoDOT partners with the University of Missouri to develop a data analytics and visualization platform, TITAN. Analytics from this platform and traffic data acquired from private sector organizations are used to understand the following:

- Cost and impact of traffic congestion
- Average time to clear traffic incidents
- Traffic incident impacts on major interstate routes
- Work zone impacts to the traveling public
- Travel times and reliability on major routes and rural interstates
- Whether MoDOT roadways follow federal management and operations requirements

Regional TMCs

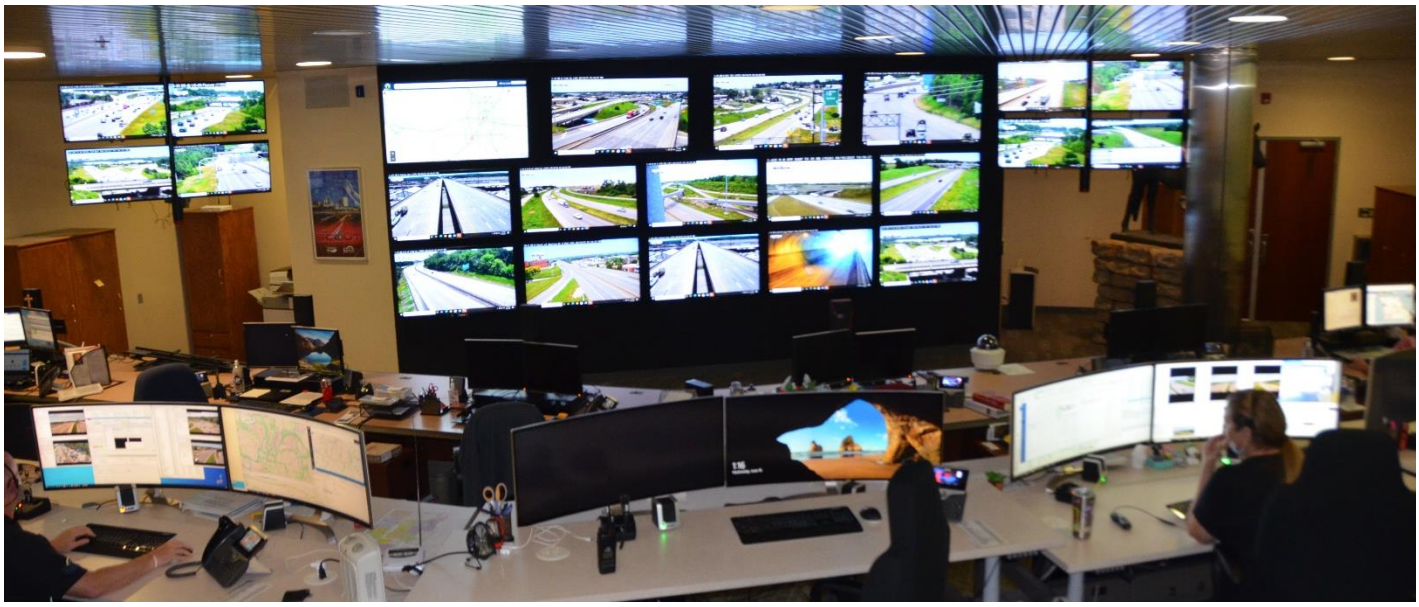
Three TMCs are located in Missouri: Gateway Guide in St. Louis, Kansas City Scout (KC Scout) in Kansas City, and TMC of the Ozarks in Springfield. The centers work within their regions by using cameras, DMS, and sensors to monitor the roadways. The centers also work to dispatch ER services, notify and coordinate with first responders, create electronic sign messages along affected routes, send updated information to local media, and broadcast traffic updates over the internet. The TMCs work to lessen highway congestion, incur fewer rush-hour traffic incidents, improve rush-hour speeds, quicken emergency response times, and create less air pollution from slow or idling traffic.

Gateway Guide – St. Louis District

MoDOT's Gateway Guide is the St. Louis metropolitan area's traffic system. MoDOT partnered with the Illinois Department of Transportation, Metro Networks, and the East-West Gateway Council of Governments in 1994 to establish ITS needs for the St. Louis region; they completed a TMC in 2002, which is currently equipped with advanced transportation management system (ATMS) software. The centralized signal system located in the TMC remotely regulates more than 1,000 signalized intersections. Gateway Guide formed a partnership with Gateway Green Light, which is an organization that coordinates traffic signals throughout St. Charles County. Currently, Gateway Guide's responsibilities include maintaining current ITS operational infrastructure, network devices, interfaces, and the communication network and managing ITS devices across the I-55 and I-44 corridors in Missouri. Gateway Guide is also working on expanding freeway and arterial ITS devices and network communications south of I-55 and west of I-44 and along various prioritized arterial routes. In conjunction with these efforts, overall integration between arterial, freeway, traffic incident, and WZM are also being improved.

Gateway Guide is using CMAQ funds through the FHWA for additional ITS improvements where available. To date, Gateway Guide has implemented initiatives such as the deployment of cameras, DMS, vehicle detector sites, a website, a mobile application, several media partnerships, emergency medical services (EMS) partnerships, ER programs, and tunnel monitoring and determining and displaying freeway and arterial travel times.

KC Scout – Kansas City District



KC Scout is a bi-state traffic system for the Kansas City metropolitan area. The Kansas Department of Transportation and MoDOT joined forces in 2000 to address traffic incidents and congestion problems along Kansas City metro highways. KC Scout's TMC was completed in 2001 and is currently equipped with ATMS software.

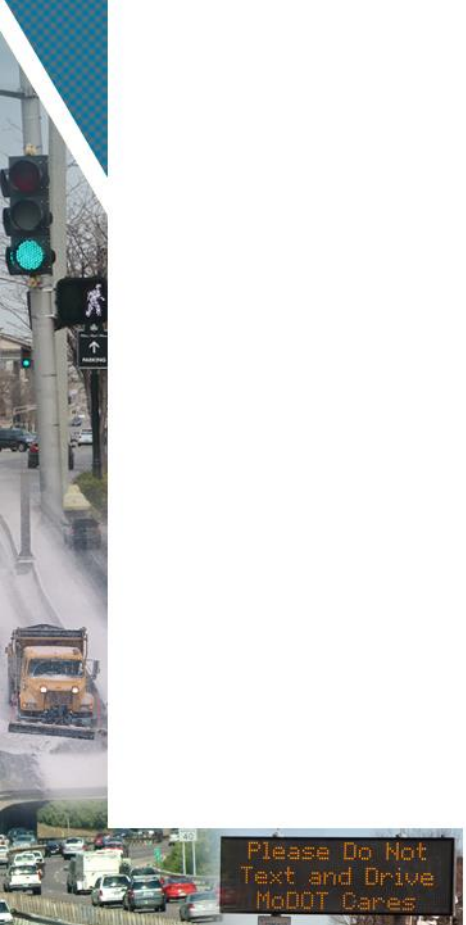
KC Scout works with the Mid-America Regional Council's Operation Green Light (OGL) program, an organization that helps coordinate traffic signals along arterial roadways throughout the Kansas City metro area. Together, they manage many of MoDOT's signalized intersections in the region, and MoDOT actively manages signals not on designated OGL routes through its own central system installation. Partnerships that KC Scout forms allow interoperability with hundreds of partner-owned cameras with no maintenance costs. Some of KC Scout's responsibilities include maintaining current ITS operational infrastructure, network devices, interfaces, and a communications network and managing ITS devices across the I-70, I-29, and I-35 corridors in Missouri.

To date, KC Scout has implemented initiatives to deploy cameras, DMS, vehicle detector sites, a website, a mobile application, several media partnerships, EMS partnerships, ER programs, and ramp metering. KC Scout also utilizes private sector traffic data to provide travel times on interstate routes throughout the region. KC Scout provides computer-aided dispatch integration. The Statewide Transportation Improvement Program (STIP) lists all funds from regional major projects and emerging needs funds.

TMC of the Ozarks – Southwest District

TMC of the Ozarks is Springfield's traffic system and was established in 1998 through a partnership with the City of Springfield and MoDOT. Here, city and state personnel work together to coordinate traffic flow throughout the metro area. A new TMC was completed in 2011 and currently has a centralized signal system with signalized intersections for MoDOT and the city. Signals along TMC of the Ozarks routes are both centrally and adaptively controlled. TMC of the Ozarks' responsibilities include maintaining current ITS operational infrastructure, network devices, interfaces, and a communications network.

To date, TMC of the Ozarks has implemented initiatives to deploy cameras, DMS, EMS partnerships, Motorist Assist program, city-wide arterial travel times, arterial/freeway monitoring, and a regional traveler information website (Ozarkstraffic.com). The STIP lists current operations/maintenance costs.



MoDOT currently has a multitude of programs and plans that will benefit from integrating TSMO standards and initiatives. A list of some of MoDOT's existing programs and plans are provided below.

Show-Me Zero

In 2021, MoDOT released Missouri's Show-Me Zero – Driving Missouri Toward Safer Roads[6]. This is the fifth edition of Missouri's Strategic Highway Safety Plan (SHSP); it provides strategies for 2021-2025. The plan outlines strategies that MoDOT believes will provide the greatest potential of saving more lives along Missouri roadways. Labeled the four focus areas, these strategies are outlined in Table 4. The emphasis areas apply to all road users in Missouri, although the plan stresses three demographics that are overrepresented in crash data: teen drivers, older drivers, and pedestrians along with other non-motorized users. By focusing on these four emphasis areas and three demographics, the plan aims to tackle the primary causes of fatal traffic crashes in the state.

Table 4. Missouri Department of Transportation's (MoDOT's) Four Emphasis Areas to Show-Me Zero.

Strategies	Description
Occupant Protection	- Increase safety belt/safety restraint use. - Make sure all children age 12 and under are properly secured in an appropriate car seat. - If riding a motorcycle, bicycle, or all-terrain vehicle (ATV), always wear a helmet.
Distracted Driving	- Decrease distractions from cellphone use while driving. (The Missouri legislature passed a new hands-free law effective August 2023 that prohibits handheld electronic device use while driving; texting and driving is already illegal for drivers aged 21 and under in the state.)
Speed and Aggressive Driving	- Speed and aggressive driving are the most common contributing circumstances for fatal crashes in Missouri.
Impaired Driving	- Though alcohol-impaired fatalities have declined in recent years by 33 percent, drug-impaired crashes have increased by 55 percent. - Fatigued driving is another source of impaired driving concern, especially for drivers 25 years and younger.

Improving safety is also a major objective of the TSMO program. Initiatives targeting safety include the TIM and ER programs, intelligent work zones, improved traveler information methods, training and education, and a host of TSMO-related technology solutions applied to specific problems. Using these strategies, TSMO can provide a major contribution to reduce highway congestion, clear traffic incidents more quickly, and create a safer transportation system.

[6] Missouri's Show-Me Zero (SHSP 2021-2025): https://www.modot.org/sites/default/files/documents/SHSP%20Blueprint%202023.pdf

Statewide Transportation Improvement Program (STIP)

Annually, MoDOT completes a STIP, which outlines projects committed for funding. The STIP reviews the following:

- Scoping and design projects
- Highway and bridge construction schedule
- Estimated financial summary
- Special programs
- Multimodal Operations Work Program
- Certification and federal-aid project oversight
- Missouri metropolitan planning organization (MPO) transportation improvement plans

The estimated financial summary section provides funding sources and transportation revenues for the highway and bridge construction schedule. The federal government provides MoDOT with the largest amount of funds for transportation followed by revenue from Missouri's state fuel tax. State sales tax, vehicle and driver's licensing fees, interest earned on invested funds and other miscellaneous collections, and the state general revenue fund are some of the additional sources of transportation revenue.

Currently, primary funding for Gateway Guide, KC Scout, TMC of the Ozarks, and the TIM program comes from the STIP. Funding for each TMC originates in the Highway and Bridge Construction Program funds and is allocated first to all other funding programs that fall under the Highway and Bridge Construction Program; the remaining funds are allocated to major projects and emerging needs, which encompass the TMCs. The funding given to each TMC is determined by the percentage of total population, employment, and VMT on the National Highway System. In addition to providing continued funding of these programs, there are many opportunities to advance and integrate elements of TSMO initiatives into existing projects during the planning phase.

ITS Architecture

MoDOT leads or contributes to the maintenance of regional ITS architectures in the St. Louis, Kansas City, and Springfield areas, and a related state business plan for its Commercial Vehicle Information Systems and Networks (CVISN) program. An ITS Architecture provides a framework for the planning and deployment of ITS in support of TSMO activities and strategies. The primary benefit of maintaining an ITS architecture is that it provides a high-level structure for systems, services, and interagency partnerships. It also satisfies the Federal Rule defined in 23 Code of Federal Regulations (CFR) 940, which allows access to available federal aid for eligible ITS projects. Information about the ITS Architecture is in section 910.4 of MoDOT's EPG. The ITS Architectures will continue to be maintained as the programs and systems evolve and will be referenced for any ITS projects because they fall within the broader TSMO program.

Safety Assessment for Every Roadway (SAFER)

In 2023, MoDOT released its SAFER program and toolkit with the goal to incorporate safety measures into all projects. It is part of MoDOT's implementation of USDOT's 2020 recommendation for a Safe System Approach. The tool provides a quick reference set of questions to consider for each project. The questions include appropriate consideration of ITS and TSMO approaches that can be applied to improve safety on roadways.

3.0 MOVING THE MISSOURI DEPARTMENT OF TRANSPORTATION (MODOT) FORWARD – WHERE WE ARE GOING

Overview

In 2023, MoDOT implemented a revised TSMO organizational structure that integrates TSMO activities and principles into MoDOT's organizational structure and culture. In general, this TSMO organizational structure, shown in Figure 8, seeks to fully leverage TSMO across MoDOT's existing structure by inserting TSMO champions into existing teams and groups. As shown, the layers of this organizational structure are connected through Liaisons and Task Leads that operate at multiple levels of the structure. MoDOT has assigned individual staff to the roles described in the TSMO organizational structure (e.g., coordinators, senior leadership, task leads, liaisons), although names are not included in this plan because the individuals assigned may shift over time. The following section provides additional details on the MoDOT TSMO organization.

TSMO Steering Committee

The TSMO Steering Committee determines TSMO priorities and direction for the rest of the TSMO organization structure. It is comprised of the following:

- TSMO Central Office Coordinators (approximately two staff members) who oversee all TSMO activities
- Senior Leadership appointees (approximately two to three senior leaders) who provide oversight and insight related to MoDOT-wide strategic priorities
- TSMO Liaisons (approximately 5 or more staff members) who coordinate between the TSMO Steering Committee and the middle organizational layer of MoDOT TSMO teams
- Additional staff members, partners, and consultants as needed

The TSMO Steering Committee meets several times per year to review and update its TSMO implementation tasks. Because the implementation is a continuous process, new tasks may be added as others are completed, or through additional planning processes when required. The Steering Committee will provide an update to the SMT members annually for their review and approval of overall direction and task prioritization.

The TSMO Steering Committee also oversees the completion of these tasks by making assignments to standalone teams, liaisons, and additional personnel or consultants to complete specific tasks. It is the intention of the committee and liaisons to delegate completion of most tasks to support personnel.

MoDOT Teams

The middle organizational layer of MoDOT TSMO teams is comprised of existing TSMO-related groups at MoDOT (e.g., quality circles, working groups, and committees) and standalone TSMO teams established by the TSMO Steering Committee. This structure promotes further integration of TSMO into MoDOT's organization through participation in existing groups with a TSMO perspective, and it allows the flexibility to create or modify TSMO implementation teams dedicated to a specific focus. The existing TSMO-related teams include the Work Zone Quality Circle, Traffic Signal Quality Circle, TIM Statewide Committee, and the TMC Working Group and leaders. The MoDOT TSMO organizational structure identifies TSMO Liaisons for each of these groups. Background on each of these teams is provided in the following subsections.

As of 2024, the standalone TSMO teams operating at this level of the organization are supplemental to the existing MoDOT teams and function as focus areas discussed in this plan: AT, Education and Outreach, and CAV. The MoDOT TSMO organizational structure also identifies liaisons (leads) for each of these groups. The liaisons for both types of teams are responsible for coordinating with the TSMO Steering Committee and supporting staff and consultants leading or working on individual tasks for these teams.

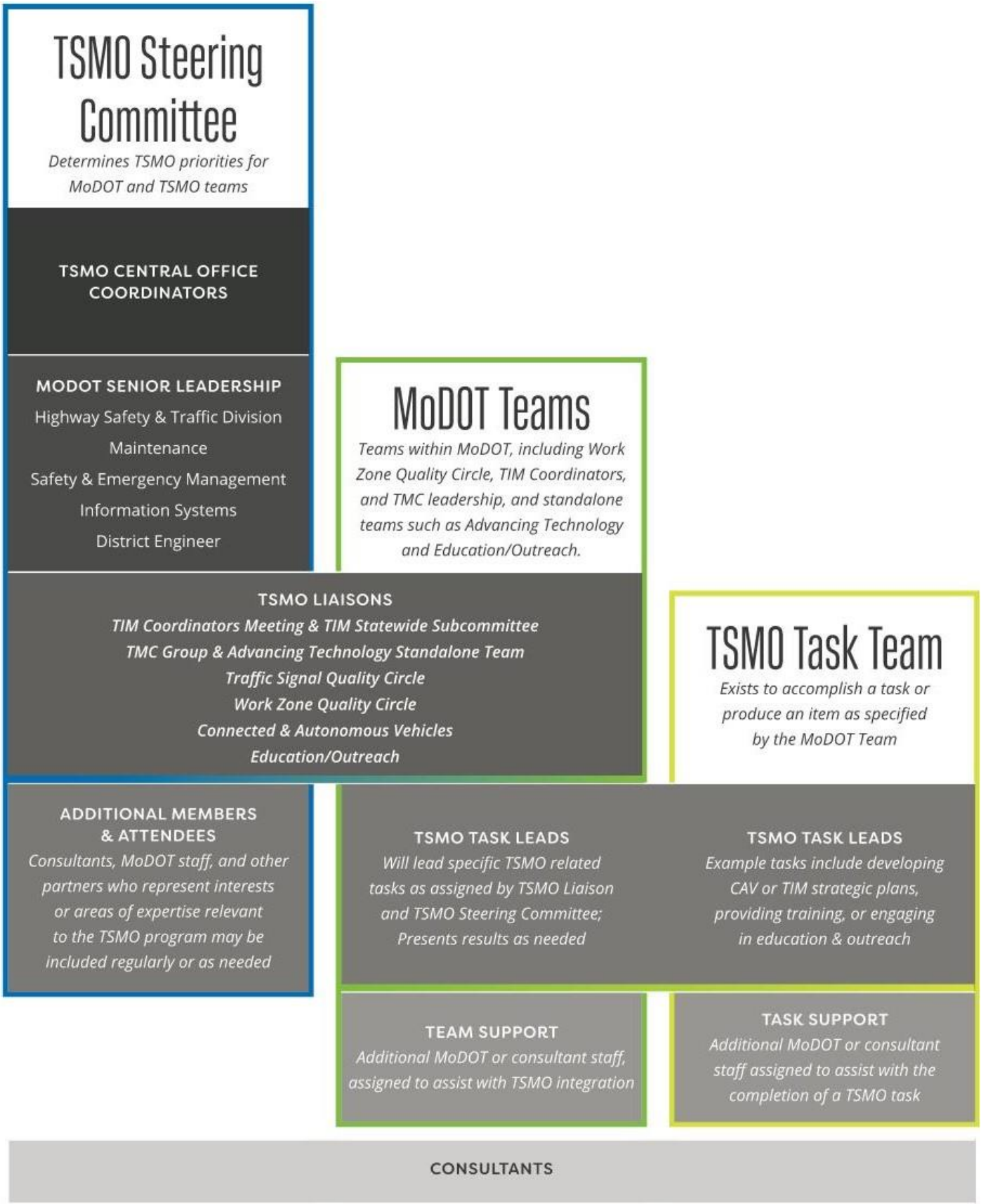


Figure 8. Missouri Department of Transportation (MoDOT) Transportation Systems Management and Operations (TSMO) Organizational Structure.

Work Zone Quality Circle

Formed under the Work Zone Safety and Mobility Policy, the Work Zone Quality Circle is responsible for reviewing trends, evaluating new methods, performing reviews, and disseminating this information. Because TSMO strategies have many work zone safety and mobility benefits, this committee also has responsibilities to the TSMO Core Team.

Traffic Signal Quality Circle

The Traffic Signal Quality Circle is identified in MoDOT's EPG as having responsibility for reviewing and approving products and equipment to be used in MoDOT's traffic signal systems. The members of this quality circle also have significant roles in the review and recommendation of TSMO strategies to improve the management and operations of arterial operations and traffic signal systems.

Traffic Incident Management (TIM) Subcommittee

As the priority action identified by the SMT, a TIM subcommittee and multiple working groups and quality circles assigned to focus on improving specific aspects of TIM within the department were formed under the Missouri Coalition for Roadway Safety (MCRS). Because TIM is also one of the focus areas for TSMO, this subcommittee reports to the MCRS but because TIM is also one of the focus areas for TSMO, it plays an important role in advancing TSMO solutions and strategies.

TMC Working Group

For several years, members from the Kansas City, Springfield, and St. Louis TMCs have regularly met as a working group to coordinate efforts and to share lessons learned in their day-to-day operational support functions. This group is tasked with the continual improvement of the TMC's role in monitoring conditions, providing real-time operational support and traveler information, reviewing standard operating procedures, and helping make operations consistent across the managed corridors.

TSMO Task Teams

The final layer of the MoDOT TSMO organizational structure is TSMO Task teams. These are assigned by the TSMO Liaisons to lead or support specific tasks or activities for a specific MoDOT team or for the TSMO Steering Committee. These tasks have a finite time frame and therefore, this layer engages a wide array of staff and consultants as needed.

MoDOT's Central Office Resources

TSMO is supported from MoDOT's Central Office through resources from several divisions. Individuals within these divisions are a resource to district personnel who have questions regarding the implementation or operation of TSMO strategies or tools. These individuals are also responsible for the changes to or implementation of related department-wide policies, procedures, or initiatives. Many of these individuals are represented on the TSMO Steering Committee. Funding for centrally led TSMO programs and projects is allocated from general project and operations budgets and is supplemented by federal program funds as they are made available.

District Resources

Each district has the responsibility to implement and conduct TSMO programs and strategies according to its specific needs and resources. Many of the same divisions in the Central Office also exist within each district and can serve as local resources and champions. The Kansas City, St. Louis, and Southwest districts are supported by a TMC with resources dedicated to operations according to their needs. Funding for district-level TSMO programs and projects is allocated from district project and operations budgets and is supplemented by federal programs as they are available. Some examples of the TSMO actions and responsibilities of district personnel are provided in Table 5.

Table 5. Actions & Responsibilities.

Action	Responsibilities
TMC	Execute and oversee real-time transportation operational support and dissemination of traveler information.
Maintenance	Implement maintenance related TSMO strategies; provide feedback and effort for continual improvement of these strategies and tools.
Traffic Operations	Implement traffic operations related TSMO strategies; provide feedback and effort for continual improvement of these strategies and tools.
Transportation Planning	Include TSMO and other traditional transportation improvement strategies in all planning efforts.
Design	Consider TSMO as an essential element of design, either as a direct improvement for the specific application or as an opportunity for the continuation of existing TSMO strategies.
Construction	Consult personnel who have the appropriate expertise when modifying a design or during construction inspection of TSMO support infrastructure.
Information Systems	Provide oversight and management of field and central communications systems, computer and software, and other information systems resources.
Human Resources	Incorporate relevant related skills and experience into position descriptions where TSMO expertise is needed; assist with training programs to improve the knowledge, skills, and abilities of existing operations personnel.

4.0 STRATEGIC PLANNING

Beyond the focus areas that comprise the program plan, additional strengths and weaknesses and associated action items identified in the CMM self-assessments provide a broader strategic approach to advancing operations in Missouri. To focus on the strategic themes necessary to advance operations, a broader approach to planning for operations and assessing specific workforce issues unique to TSMO is necessary. These themes are not necessarily tied to specific actions and often involve greater integration with MoDOT activities. TSMO plays a supporting or coordinating role, but it may not be able to lead the effort or change.

Planning for Operations

(CMM Self-Assessment Score: Business Processes = 1.5 in 2013, 2.5 in 2022)

Planning for operations places focus on how TSMO strategies and solutions are incorporated into the planning process in support of improving transportation system reliability and efficiency. The planning process can be defined broadly in this context; it includes the formal planning processes within DOTs and MPOs and the process that individual projects and programs execute. It also includes elements of the ITS architecture design and use of the systems engineering process. Areas to detail in this section include the following:

- Integrating TSMO into planning and programming processes
  - STIPs and TIPs
  - Congestion management processes
  - Regional concepts of transportation operations (often owned by MPOs)
- Performance measurement and management programs
- Statewide and regional ITS architecture development and maintenance
- Application of the systems engineering process
- Advancing operations through the application of the CMM

To advance TSMO, MoDOT identified several action items during the CMM self-assessments and in the development of this program plan. Underlying each action is the concept that TSMO needs to be more integrated into traditional planning and project development processes. For example, Figure 9 shows where TSMO projects and initiatives should be integrated into MoDOT's scope and design process as it is outlined in the STIP.

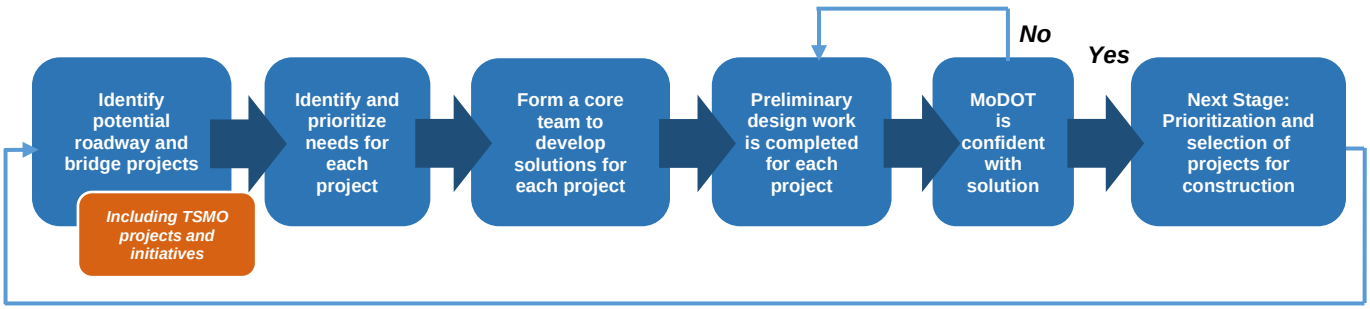


Figure 9. Integrating Transportation Systems Management and Operations (TSMO) into Missouri Department of Transportation's (MoDOT's) Scoping and Design Project Process.

Nationally, the need to improve integration of TSMO into state DOT and MPO planning programs was commonly brought forward as a priority action. Suggestions included development of a strategy to foster ongoing consideration and inclusion of TSMO on every project. Defining steps to improve TSMO integration into the planning phases with the roadway operations should remain on the action list as this TSMO program moves forward. Other suggested actions included the following:

- Train project managers and planning engineers to guide them in choosing which personnel and staff roles should be included in each project.
- Improve planning processes and educate engineers, planners, and other core team members about TSMO solutions (i.e., checklists or "menus" for TSMO suitability), so that they can integrate such concepts into projects during scoping meetings when appropriate.
- Conduct formal staff training of TSMO and provide associated analysis tools for staff.
- Dedicate budget, training, and time in each project for TSMO suitability analysis.
- Establish TSMO strategic plans at a regional level.

Workforce Development

(CMM Self-Assessment Score: Organization/Staffing = 1.75 in 2013, 1.5 in 2022)

The workforce necessary to successfully execute TSMO is unique and varied. Traditionally, ITS programs have been driven by a handful of staff members interested in technology applications but who often had backgrounds rooted in the traditional fields of study for transportation (engineers, planners, and managers). The workforce and staffing to support TSMO needs the traditionally trained DOT staff of traffic engineers and designers, planners, and managers, and staff members who are more technology-focused such as computer engineers, database specialists, communications engineers and technicians, and programmers. Staffing and training programs must develop and sustain the knowledge and talent needed for an effective application of TSMO. Job descriptions must accurately portray the skillset needed for the positions. Staff turnover must be accounted for and training programs in place to quickly replace staff with equivalent skill sets.

The organization and staffing dimensions of the CMM self-assessment scored near the national average. Table 6 outlines areas that should be examined when considering workforce development issues affecting advancing TSMO programs.

Table 6. Advancing Transportation Systems Management and Operations (TSMO) Programs Through Workforce Development.

Area	Consideration
Staffing Levels	Staffing constraints often limit program accomplishments
Champion Dependency	Reliance on highly committed individuals who drive a program without the formal authority or dedicated resources
Core Capacities	Understanding the needs for specialized technical and managerial skill sets to advance TSMO
Training	Access to special technical training tailored to advancing TSMO

During the CMM self-assessments, the following actions were brought forward to advance MoDOT's workforce development. Identifying needed TSMO-specific knowledge, skills, and abilities and developing job descriptions and career paths for TSMO staff were high-priority actions. In addition, these steps were defined as follows:

- MoDOT TSMO staff will discuss the requirements for roles they would like to see added to certain job descriptions or for new positions.
- Job descriptions will be expanded to target TSMO skills, and staff organization will be reviewed to consider TSMO career paths.

- MoDOT will explore establishing TSMO staff liaisons at the district level to coordinate with Central Office activities.
- MoDOT will set up and maintain a list of key TSMO contacts across the agency ("Who's Who") and a centralized portal for sharing TSMO information.

District traffic engineers will work directly with Human Resources to accomplish the above and to identify the qualified personnel needed for staff openings.

Many resources for training are available through various transportation associations and organizations, including through FHWA's Planning for Operations Program.[7] Specific training for each MoDOT focus area may be organized by region or through any of the other TSMO Core Team members on a statewide level.

Resources:

- Regional Operations Forum
- Operations Academy Senior Management Program, hosted by the University of Maryland's CATT Lab
- National Operations Center of Excellence
- Integrated Corridor Management (ICM) Scanning Tour
- Institute of Transportation Engineers (ITE)
- ITS Heartland
- MoDOT U

Performance Measurement

(CMM Self-Assessment Score: Performance Measurement = 2.5 in 2013 and 2022)

The Performance Measurement (PM) dimension of the CMM self-assessment scored well in 2013, indicating a mature PM program meeting the criteria established for integrated PM programs. However, staff did not see relative improvement during the 2022 CMM reassessment (although levels that are the same or even lower are not uncommon during reassessments as agencies increase their expectations and goals for TSMO). One area to explore to further advance PM was expanding rural and arterial applications of PM through increased data collection to supplement existing data. It was also noted that automated data processing and computation support for PM would further enhance the program. As this plan moves forward and actions are accomplished, a key objective is to evaluate which performance measures best communicate TSMO-specific information and bring these measures forward in Tracker and other reporting programs.

[7] https://ops.fhwa.dot.gov/plan4ops/resources/traing.htm

5.0 LOOKING AHEAD

This program plan provides the business case for TSMO in Missouri and details the program the agency commits to moving forward with to advance operations on the state roadway network. It will function as a guiding document for where TSMO actions are appropriate, detail the foundational understanding for TSMO, and document the existing traffic operations programs. This plan also formally presents the mission and vision for TSMO in Missouri moving forward, and details specific actions and steps the agency is going to accomplish and their associated timelines.

An important part of looking ahead includes staying aware of the rapidly changing landscape of needs, expectations, and constraints that the transportation system must meet. Through its involvement with national operations organizations such as TRB, AASHTO, ITE, and others, MoDOT staff has been able to stay informed about developments and help define national direction and standards. Such involvement becomes important, especially considering the current emphasis on CAV research, testing, and deployment, so that Missouri is prepared for these changes as they occur.

As Missouri's TSMO program continues to evolve, this plan will be monitored and revised to support the program moving forward and provide the necessary documentation to maintain it as a formal program for the DOT. It is intended as a living document so that revisions can occur as needed. It is recommended that this plan be revisited twice a year to close out actions that have been completed, introduce new actions for continuous improvement, and consider the addition of new focus areas as the program grows. Reflecting significant progress between 2017 and 2024, this plan was revised in June 2024 to include key updates such as the formation and progress of a CAV Team, the 2022 CMM reassessment workshop, and restructuring of MoDOT's TMSO organizational structure.