Scope of Services

Consultant services are requested to assist with the continued implementation of MoDOT's Transportation Systems Management and Operations (TSMO) Program and Action Plan, found in Exhibit 1. This will be a continuation of MoDOT efforts to implement identified strategies within the updated action matrices from the TSMO Program and Action Plan. This will be a one-year contract with options of two, one-year renewals. Thus far, four teams have been established: Advancing TSMO/Technology (AT), Work Zone (WZ), Traffic Incident Management (TIM), and Connected and Automated Vehicles (CAV). The services will consist of project management, team coordination, meeting set up and facilitation, and assistance with the completion of tasks identified throughout this document. In addition to the existing teams, the consultant will assist MoDOT with identifying what the next focus areas of TSMO implementation should be and, if necessary, form additional team(s) to focus on those new areas. The consultant will assist these new team(s) with the same type of tasks (outlined below), with the creation of an action matrix, and will assist with implementation of the tasks identified in each action matrix.

A large part of this effort is to produce deliverables through the completion of identified tasks and the updated action matrices; see Exhibit 2. The assistance required will vary from team to team. The tasks have varied from the creation of a smart work zone selection tool, to research about certain practices in other states, to drafting internal policy documents, among other tasks. The needs of the teams will change with time as they work through and complete tasks.

One team that does not have a formal matrix however is the CAV team. There will be various tasks that will still go along with this team just like the others; however, one of the main deliverables will be the creation of a CAV Plan. As part of the proposal include your agency's CAV expertise and experience.

Another responsibility are the meetings. Meetings will be held and will consist of monthly team meetings with each team, quarterly all-team coordination and update meetings, and at a minimum bi-weekly (every other week) meetings with TSMO team liaisons and biweekly (every other week) meetings with each individual team lead, or as necessary determined by the liaisons or individual team leads. At this time all meetings should be scheduled virtually. Meeting set up includes, but is not limited to, sending out meeting invites, creating agendas, taking minutes, and overall facilitation as needed. Until further notice all meetings will be held virtually.

Since the tasks do change and the progress being made needs to be shown, part of the project management includes maintaining team Gantt charts, keeping a TSMO implementation progress dashboard current, and creating reports of team progress on the completion of action items. Along with updating current tasks, the consultant will assist with team exercises to identify which tasks take priority to be completed next.

Finally, a yearly recap of what all the teams have accomplished shall be completed.
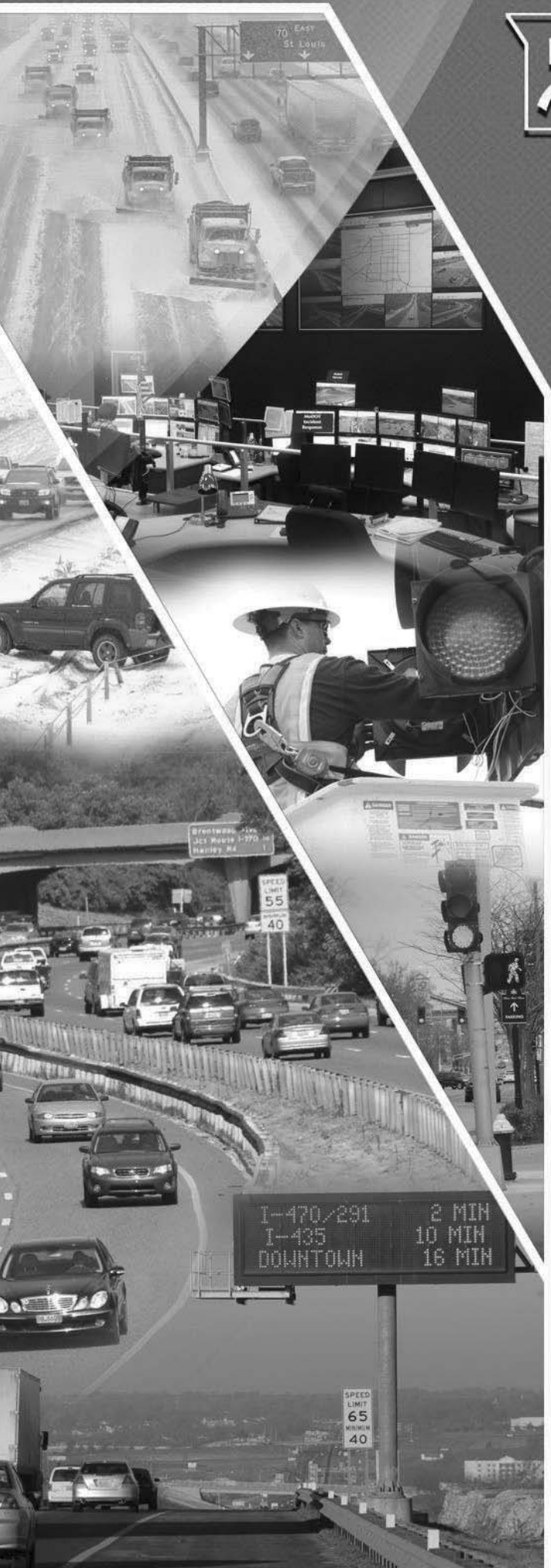
Exhibit 1

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MISSOURI DEPARTMENT OF TRANSPORTATION

Transportation Systems Management and Operations

Program and Action Plan

January 2017

Missouri Department of Transportation

Transportation Systems Management and Operations (TSM&O) Program and Action Plan

Prepared for:

Prepared by:

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EXECUTIVE SUMMARY

The Missouri Department of Transportation (MoDOT) Transportation Systems Management and Operations (TSM&O) Program and Action Plan establishes the strategic direction for the advancement of TSM&O in Missouri. TSM&O 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 TSM&O strategies outlined in this plan will help to further improve MoDOT's roadways by directly addressing many of the root causes of recurring and non-recurring congestion. The mission of the MoDOT TSM&O program, as documented in this plan, is shown below.

> **"MoDOT's TSM&O 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 TSM&O program helps get people safely where they want to go."**

The TSM&O Program and Action Plan both aligns directly with MoDOT's foundational mission and supports existing initiatives, such as Missouri's Blueprint ~ A Partnership Toward Zero Deaths. It also builds upon previous MoDOT efforts to advance TSM&O in the state. Most notably, in 2013, MoDOT participated in a TSM&O-focused Federal Highway Administration (FHWA) Capability Maturity Model (CMM) workshop which helped MoDOT understand its strengths and areas needing 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 TSM&O into MoDOT's structure and culture. The TSM&O Program and Action Plan formalizes these previous efforts and provides a roadmap to move forward with the advancement of TSM&O in Missouri. 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 TSM&O program will cost-effectively address; effectively making the business case for TSM&O in the state.

Section 2.0, Moving MoDOT Forward: Where We Have Been documents previous efforts, existing plans, and the organization of the TSM&O Core Team, Senior Management Team, and supporting teams that resulted from the 2014 implementation plan.

Section 3.0, Moving MoDOT Forward: Where We Are Going gives an overview of MoDOT's three initial priority focus areas for the TSM&O program—Traffic Incident Management (TIM), Work Zone Management (WZM), and Advancing Technology and Roadway Operations—and provides a set of detailed actions for advancing in each area. These actions comprise the work program for each focus area and are outlined in tables that document the actions; the larger objectives that they support; the steps needed to accomplish each action; the prioritization of the actions (high, medium, or low), the anticipated timeline to complete; potential measure of success; and the responsible MoDOT staff. Importantly, each action includes measures of success to highlight the importance of revisiting and updating the work programs in the tables—encouraging plan maintenance to ensure the program plan remains both dynamic and current. The work plans for each of the three priority focus areas are summarized below.

Traffic Incident Management (TIM) – TIM is a planned and coordinated program process to detect, respond to, and remove traffic incidents (such as a crash or an impaired vehicle), and restore traffic

capacity as safely and as quickly as possible. MoDOT coordinates with many partners such as law enforcement, fire and rescue, EMS, public safety, and towing and recovery to maintain an effective TIM program. For this focus area, the plan outlines 11 action items centered around refinement and expansion. The action items are organized by the following four categories of objectives:

- Get Organized: Form TIM Improvement Subcommittee under the Missouri Coalition for Roadway Safety (MCRS) Executive Committee.
- Get Trained: Provide TIM training to all MSHP and MoDOT team members who will be responding to traffic incidents.
- Improve on I-70 and I-44 First: Develop I-70 and I-44 corridor traffic incident response plans.
- Improve MoDOT TIM Policies: Jointly review and revise any MoDOT TIM policies that could improve traffic incident clearance times.

Work Zone Management (WZM) – WZM is a planned and coordinated process to manage traffic during construction to minimize traffic delays, ensure motorist and worker safety, and complete roadwork in a timely manner. MoDOT maintains processes and procedures during plan development to apply work zone design principles on roadway design and construction projects. For this focus area, the plan outlines 14 action items, organized by the six dimensions addressed in the CMM workshop:

- Collaboration: Provide guidance on building greater relationships with partners.
- Business Processes: Improve planning and programming processes for transportation management plans (TMP).
- Systems/Technology: Encourage the exploration, expansion, and application of technology in work zones.
- Performance Measurement: Enhance performance measurement reporting and data acquisition on work zones.
- Organization/Workforce: Assess staff capabilities and needs for a stronger work zone program.
- Agency Culture: Improve technical understanding and support to work zone strategies as part of the TSM&O program.

Advancing Technology and Roadway Operations – MoDOT has deployed a number of technology solutions to enhance the reliability of the transportation network through active management of the system in the urban areas and statewide. Statewide programs include TIM programs and road weather applications. MoDOT has focused programs to proactively manage traffic in major urban areas at TMCs in St. Louis (Gateway Guide), Kansas City (KC Scout), and Springfield (TMC of the Ozarks). Some of the current MoDOT technologies in use include: CCTV, ramp meters, DMS, traffic detectors, and the supporting communications systems. Data collected from these systems support many of the TSM&O strategies. Finally, autonomous and connected vehicles are quickly changing the way DOTs think about technology applications on the transportation network. This new generation of cars and trucks together with technologies on the transportation network will further capitalize on the investments MoDOT has made to advance operations. For this focus area, the plan outlines 25 action items, organized by the six dimensions addressed in the CMM workshop.

- Collaboration: Increase awareness and provide outreach opportunities and encourage the advancement of TSM&O within MoDOT and partner agencies.
- Business Processes: Improve planning and programming processes for increased focus on TSM&O.
- Systems/Technology: Encourage the application, integration, and expansion of TSM&O solutions.
- Performance Measurement: Enhance performance measurement reporting and data acquisition. Identify purpose and applications for each performance measure.
- Organization/Workforce: Assess staff capabilities and needs for TSM&O-specific staffing needs and assignments.
- Agency Culture: Improve agency technical understanding and support of the overall TSM&O program.

Section 4.0, Strategic Planning goes beyond these three focus area 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 DOT activities. To help facilitate the advancement of TSM&O within MoDOT, this section provides a table of actions that fall within each of the strategic planning themes.

Planning for Operations – Planning for operations places focus on how TSM&O strategies and solutions are incorporated into, broadly speaking, the planning processes that support the improvement of transportation system reliability and efficiency.

Workforce Development – The workforce and staffing to support TSM&O requires both the traditionally trained DOT staff of traffic engineers and designers, planners, and managers, as well as those staff 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 TSM&O. 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 to further advance PM were 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. Tables detailing specific actions and who is responsible to carry them out are included with the expectation that the document will be updated regularly as the program continues to evolve and additional focus areas are added. It is anticipated that as the TSM&O 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 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.

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 all modes of transportation 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 (TSM&O) program. This section gives a brief overview of the current state of these challenges.

Safety

In 2014, the Missouri State Highway Patrol (MSHP) responded to 137,432 total crashes[1]. Through significant efforts by MoDOT and emergency agencies combined with vehicle safety improvements, the total number of crashes and fatalities decreased steadily from 2005 until reaching a low in 2013 (See Figure 1). MoDOT's ultimate goal is to reach zero fatalities; improving safety will continue to be a top priority for MoDOT until this ultimate goal is reached.

Figure 1. Total Missouri Crashes and Fatalities

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 along with the total population of Missouri. The chart indicates that while the number of vehicles per licensed driver is decreasing and the VMT (shown in Figure 3) is increasing slowly, the number of registered vehicles has remained relatively steady.

As the number of vehicles traveling along MoDOT's roadways continues to increase, the existing roadway infrastructure and capacity cannot keep up. The annual vehicle miles traveled (VMT) in Missouri rose 37 percent from 1980 to 2013 (shown in Figure 3), rising sharply from 1980 to 1998, then at a slower rate since 1998[2]. Over the same period, the number of lane-miles increased only 13 percent[3]. Research has

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[1] Historical data from Missouri Statewide Traffic Accident Records System (STARS). http://www.mshp.dps.missouri.gov/MSHPWeb/SAC/stars_index.html, 2016 data from the Missouri State Patrol Website https://www.mshp.dps.missouri.gov/MSHPWeb/Root/index.html
[2] Historical VMT: Office of Highway Policy Information, FHWA, updated October 9, 2015. http://www.google.com/publicdata/explore?ds=gb66jodhlsaab_
[3] Historical Lane Miles for all Missouri Roads: Office of Highway Policy Information, FHWA, updated October 9, 2015. http://www.google.com/publicdata/explore?ds=gb66jodhlsaab_. Forecasted increase of 0.4% based on average increase from 2008-2013.

suggested that one of several likely factors for the slowing VMT growth is that volumes are approaching capacity limits
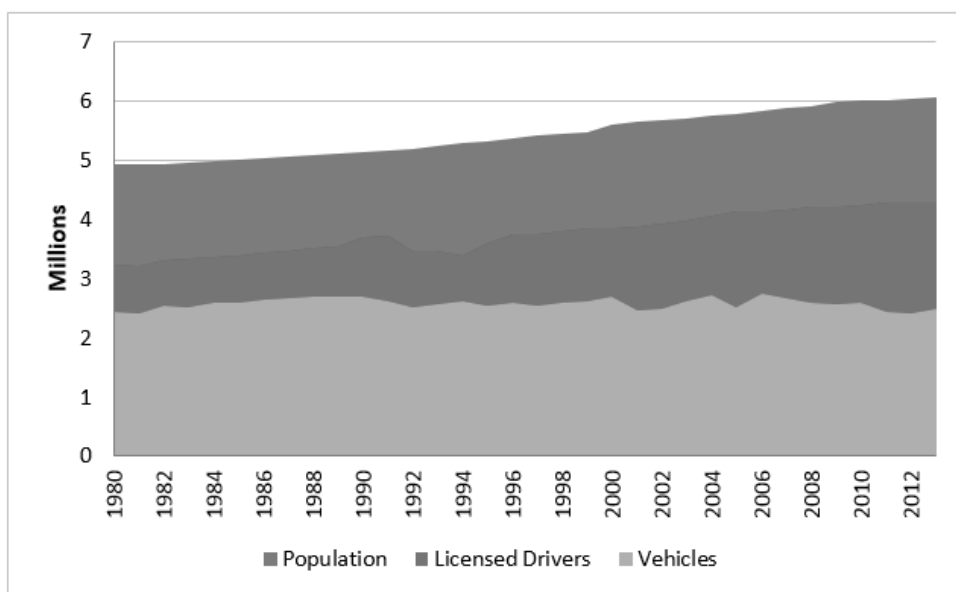
Figure 2. Missouri Population, Driver, and Vehicle Trends
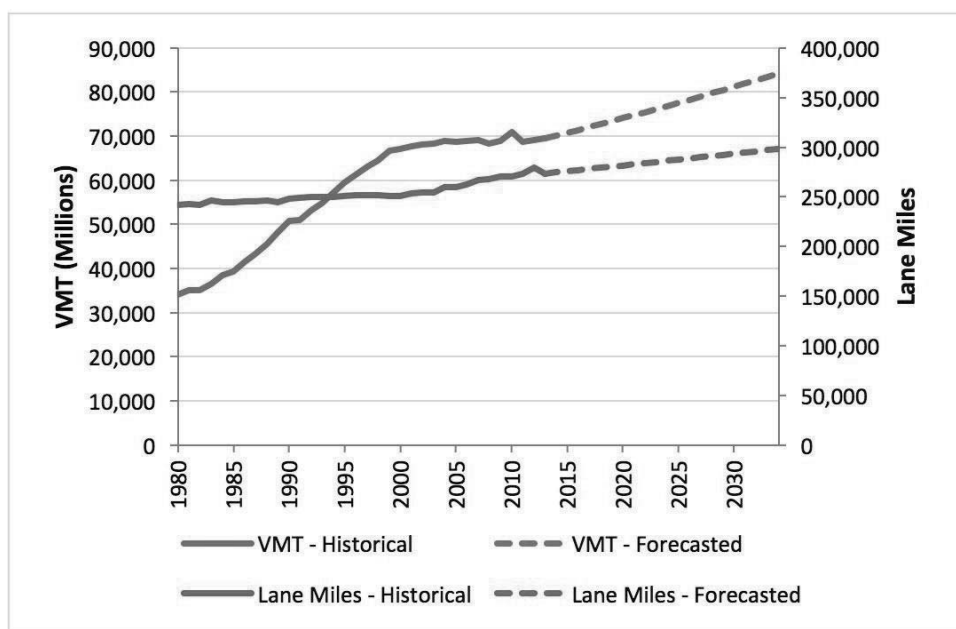
Figure 3. Missouri Vehicle Miles Traveled (VMT) and Total Lane Miles

in many areas[4]. Notwithstanding the current plateau, however, Federal Highway Administration (FHWA) is projecting VMT to grow at an annual rate of 0.92 percent over the next 20 years[5], with the biggest increase among freight vehicles.

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[4] McCahill and Sparr, "VMT Inflection Point: Factors Affecting 21st Century Travel", 2013, State Smart Transportation Institute, http://www.ssti.us/wp/wp-content/uploads/2013/10/VMT_white_paper-final.pdf

The most significant mobility challenges experienced by drivers in Missouri each day are caused by temporary disruptions that take away part of the roadway capacity, known as "non-recurring" congestion. Factors such as inclement weather, traffic incidents, special events, and work zones are the primary causes of non-recurring 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 timings. Figure 4 illustrates the average sources of congestion nationwide.
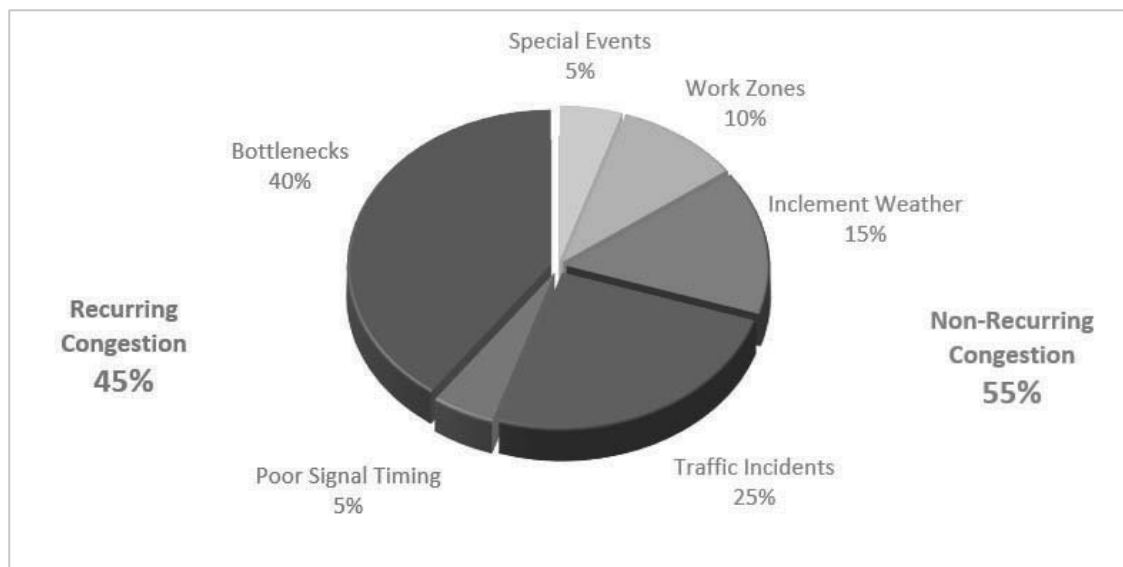
Figure 4. National Sources of Congestion

One significant note is that while most congestion (55 percent) is non-recurring, the vast majority of funding for transportation system improvements is allocated to addressing bottlenecks (40 percent) by adding capacity through capital improvements. Based on the 2017-2021 Statewide Transportation Improvement Program (STIP),[6] of the allocated $800 million per year in construction awards, less than $11.3 million per year (1.4 percent) is allocated to TSM&O statewide. In addition, operations initiatives are generally much less expensive than capital improvements; therefore, MoDOT will achieve more benefit per dollar by a greater investment in TSM&O.

Cost

In 2012, traffic congestion cost Missouri drivers an estimated $1.5 billion annually in lost time and wasted fuel[7]. In 2014, congestion cost an average Kansas City commuter an additional 39 hours and $933 in time and fuel and an average St. Louis driver 43 hours and $1,020[8].

Figure 5 illustrates the estimated total cost of congestion on the busiest Missouri state roadways and regions from 2013 to 2015. Note also on Figure 5 that while there is only an estimated 9% difference in the cost per driver in St. Louis vs. Kansas City, this adds up to a greater total cost difference because of the approximately 25% greater population in the St. Louis metro area than the Kansas City metro area.

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[5] FHWA Forecasts of VMT: Spring 2016 - compound annual growth rate based on the 20 year forecast at the Baseline Economic Growth Outlook. https://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_forecast_sum.pdf
[6] MoDOT STIP 2017-2021: http://www.modot.org/plansandprojects/construction_program/STIP2017-2021/index.htm
[7] Missouri Transportation by Numbers: Meeting the State's Need for Safe and Efficient Mobility: http://www.tripnet.org/docs/MO_Transportation_by_the_Numbers_TRIP_Report_April_2015.pdf
[8] Texas Transportation Institute, 2015 Annual Urban Mobility Report: http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/mobility-scorecard-2015.pdf
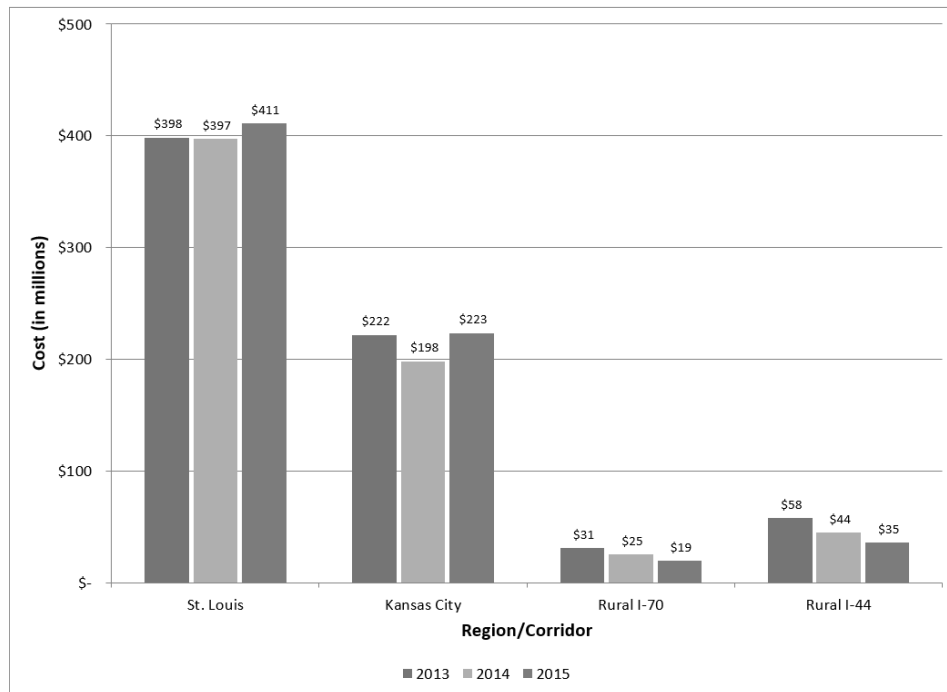
Figure 5. Costs of Congestion on Missouri Roadways

Congestion also has a significant impact on freight. Table 1 shows the estimated costs of congestion on major freight corridors in Missouri[9] taking into account the entire corridor route. This has a direct impact on Missouri's economy, because trucking and manufacturing companies strongly consider mobility and the cost of transportation when choosing routes and facility locations.

Table 1. Effects of Congestion on Freight in Missouri

Route	Minutes of delay per trip	Annual cost to the freight industry
I-70	13.3	$45.7 M
I-44	29.2	$58.1 M
I-55	12.7	$16.9 M
I-35	8.6	$12.3 M

TSM&O 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.

TSM&O can help in many cases by directly addressing the root causes of congestion. TSM&O strategies range from projects and tools, to policies and procedures, to organizational structure. Some examples of how TSM&O can help extend the capacity of a roadway include expediting traffic incident clearance, optimizing traffic signal timing in real time, providing alerts to travelers, disbursing platoons as they enter a freeway, and prompting the prewetting of a roadway to prevent ice from forming in the first place. More generally, in 2006 the American Association of State Highway Transportation Officials (AASHTO) report[10]

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[9] 2016 MoDOT Tracker: http://modot.org/about/Tracker.htm
[10] "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

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 TSM&O Forward

In recent years, MoDOT has placed a greater focus on TSM&O efforts. Some initiatives have included statewide traffic incident management 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 TSM&O expertise within its workforce, having sent 15 staff members to receive specific training at the National Operations Academy and through the SHRP2 Regional Operations Forums since 2007.

Even with these initiatives in place, much of MoDOT is still focused on pure infrastructure projects, and is unfamiliar with the capabilities and benefits of most TSM&O strategies. Operational considerations and projects are generally an afterthought during the planning and design processes, if they are considered at all.

This program and action plan has been developed to help MoDOT realize the benefits that come from the effective application of operational strategies. Its purposes are to:

- establish the mission, goals, objectives, and strategic direction for TSM&O in Missouri;
- define a framework for the organizational procedures, resources, activities, services, and projects that will be needed to achieve these goals;
- outline specific steps and action items to advance and institutionalize TSM&O into all aspects of the Department, including planning, design, construction, and maintenance, such that operations is considered for every project and initiative; and
- to provide guidance to MoDOT, planning organizations, and partner transportation agencies on the management and operations of the transportation system in the context of ever-changing demands and limited funding.

"MoDOT's TSM&O 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 TSM&O program helps get people safely where they want to go."

While TSM&O covers a wide range of areas, the following three focus areas have been selected as the first priorities. Sections for each of these areas are included in this document, and specific action items are identified for their advancement within each section.

- Traffic Incident Management (TIM)
- Work Zone Management (WZM)
- Advancing Technology and Roadway Operations

Mission

MoDOT's TSM&O 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 TSM&O program helps get people safely where they want to go.

Goals and Objectives

Table 2. TSM&O's Goals and Objectives

Goals	Objectives
Operate MoDOT's existing system efficiently, reliably, and effectively through the application of TSM&O strategies and programs	Provide for TSM&O deployments statewide
Consider TSM&O solutions and strategies in every MoDOT project	Include TSM&O proactively rather than opportunistically/reactively
Include TSM&O in the planning stages of projects and programs	Include planning for operations principles in MoDOT planning process documents
Strengthen TSM&O related education and workforce development	Provide new and supplement existing TSM&O 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 TSM&O performance measures

TSM&O Supports MoDOT's Mission

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

- Improving safety (Keep customers and ourselves safe);
- Providing impactful solutions at a low cost (Deliver transportation solutions of great value; use resources wisely); and
- Improving reliability and mobility (Operate a reliable and convenient transportation system; advance economic development).

For many years, MoDOT has recognized the value of adopting strategies to improve safety and operations, reflected in the implementation of the Emergency Response program and traffic management centers, along with 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 TSM&O and making TSM&O an integrated part of MoDOT's organization, culture, and processes. Figure 6 illustrates a timeline of these efforts since 1998 and Figure 7 provides MoDOT training efforts since 2007. A list of trained MoDOT members is provided in Appendix A.

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

2009
KC Metro Area incident management cooperative accord signed by more than 50 KC area agencies

KC launched first ramp metering project

2013
Applied for SHRP2 L01/L06 Operations Program Implementation

Operations Capability Maturity Model workshop assistance

2004
KC Scout TMC opens

2008
Operation Green Light established

2010
Missouri chosen by FHWA as an Operations Opportunity State

1993
St. Louis and KC launched freeway service patrol

2000
Gateway Guide established

2001
KCScout established

1992
City of Springfield and MoDOT worked together to coordinate winter operations

1998
TMC of the Ozarks established

2002
St. Louis TMC opens

2011
TMC of the Ozarks moves to new facility

2014
MoDOT began utilizing HERE data

Traffic incident management peer-to-peer with Tennessee DOT

2007
MoDOT's first Traffic Incident Management Summit

Emergency response in SW District was started as Motorist Assist Program

2012
Gateway Green Light established

Created ITS direction

Hosted an Operations Summit

Figure 6. MoDOT's Timeline of TSM&O Efforts to Date
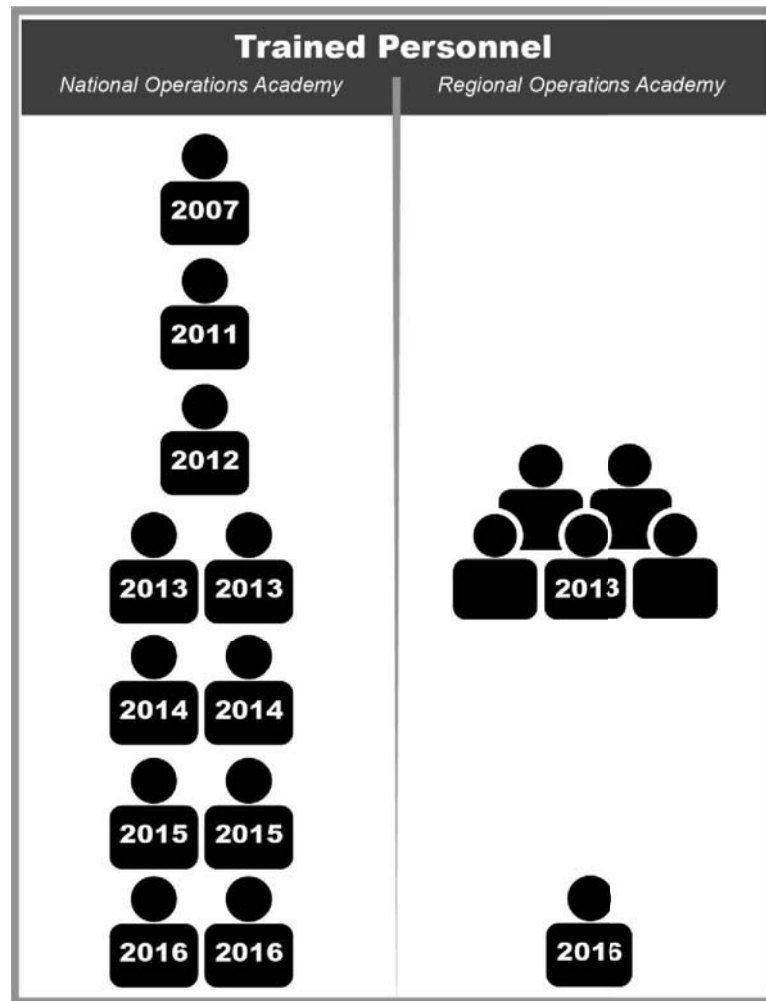
Figure 7. MoDOT's Training Efforts to Date

Capability Maturity Model Self-Assessment and Workshop

During several statewide capability self-assessment workshops in late 2013 and 2014, the Missouri Department of Transportation (MoDOT) and its partners prioritized actions to advance operations for Missouri. One workshop focused on the overall Transportation Systems Management and Operations (TSM&O) program and advancing operations. Two others focused specifically on traffic incident management (TIM), and work zones. The Capability Maturity Model (CMM) process followed in the workshop brought forward actions specific to advancing operations for MoDOT and its partners, provided in Appendix B. It should be noted that the actions are scribed from the inputs of the participants of the workshops. The process in which MoDOT is working on integrating TSM&O into its program is outlined below.

To assist in integrating TSM&O into state agencies' existing programs, the FHWA developed a TSM&O-focused Capability Maturity Model (CMM) self-assessment framework and workshop, in which MoDOT participated in 2013. The CMM framework identifies six key dimensions of process and institutional capability that directly relate to improving program effectiveness. It converts what were previously unclear concepts into specific manageable actions to improve capability. Table 3 outlines the six dimensions of capability; three dimensions are process-oriented and three are institutionally oriented.

Table 3. 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 in which MoDOT should execute changes in order to generate a more effective TSM&O program. Figure 8 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 substantially 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 TSM&O technical processes are developed, documented, and integrated into the regional transportation agencies, and partnerships are aligned.
- **Level 4**: Optimized – The TSM&O is a full and sustainable, region-wide program that is established on the basis of continuous improvement with all partners.
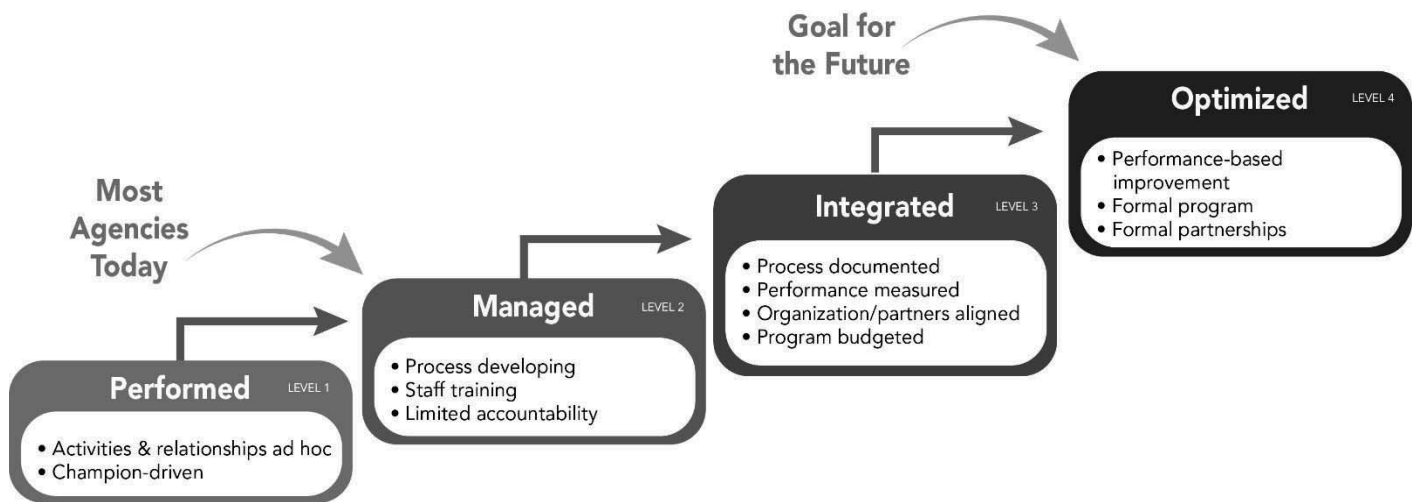
Figure 8. Capability Levels

At a statewide CMM workshop, held in 2013, MoDOT utilized 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 4 outlines where MoDOT was rated at the time of the workshop.

Table 4. Summary of CMM Scoring

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

Most states and regions who participated in this assessment averaged a capability level of approximately 2, which means that Missouri's results are like those of most other agencies. Knowing these results provides the basis of developing a program plan, and knowing which dimensions are at the lowest level gives MoDOT information about the capabilities that should be focused on first.

National TSM&O Program Development
Over the years MoDOT staff members have actively participated with committees and organizations that are defining TSM&O program at a national level. These include the AASHTO Subcommittee on Transportation System Management and Operations (STSMO), the Transportation Research Board's (TRB) 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 part two of the Strategic Highway Research Program (SHRP2), which funded this planning effort. MoDOT staff will continue to stay involved with these national organizations in order to remain abreast of rapid changes and to represent Missouri's interests in defining the national direction.

TSM&O Implementation Plan for Missouri

Following the 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 TSM&O by advancing and improving operations. The implementation plan also outlines tasks and subtasks to be completed. The seven priority actions are:

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

The first two action items have been completed, and development of this plan reflects progress on the third.

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

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 Intelligent Transportation Systems (ITS) devices/services, which includes 75 cameras and 66 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. Request for Proposals (RFP) are completed by the central office for annual maintenance of Missouri's rural ITS devices. To support performance measures and traveler information, traffic data acquired from private sector agencies is utilized 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 are in compliance with 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 Emergency Response services, notify and coordinate with first responders, create electronic sign messages along affected routes, send updated information to local media and highway advisory radio, and broadcast traffic updates over the Internet. The TMCs work to lessen highway congestion, have 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 (IDOT), 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 traffic management system (ATMS) software. The centralized signal system located in the TMC remotely regulates around 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 communication network and managing ITS devices across the Interstate 55 (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, improvements to overall integration between arterial, freeway, traffic incident, and WZM are also being worked on.

Gateway Guide is utilizing Congestion Mitigation and Air Quality (CMAQ) funds through the FHWA for additional ITS improvements where available. To date, Gateway Guide has implemented initiatives such as 631 cameras, 158 DMS, 544 vehicle detector sites, a website, a mobile application, several media partnerships, emergency medical services (EMS) partnerships, Emergency Response programs, tunnel monitoring, and determining and displaying freeway and arterial travel times. Approximately $4 million per year is spent from CMAQ, Surface Transportation Program (STP), and STIP funds to maintain and improve ITS infrastructure in the area.

KC Scout – Kansas City District

KC Scout is a bi-state traffic system for the Kansas City metropolitan area. The Kansas Department of Transportation (KDOT) 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.

Signals along KC Scout routes are both centrally and adaptively controlled. 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 region. Together, they manage 208 of MoDOT's signalized intersections. MoDOT actively manages 55 signals not on designated OGL routes through their 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, a communications network and managing ITS devices across the I-70, I-29, and I-35 corridors in Missouri. KC Scout is also working on improving coverage of freeway ITS devices and network communications in various parts of Kansas City.

MoDOT's Kansas City District is utilizing CMAQ funds to bring another 28 signals under central control, provide 18 new arterial cameras, and provide additional ITS improvements in the region. To date, KC Scout has implemented initiatives such as 151 cameras, 36 DMS, 351 vehicle detector sites, a website, a mobile application, several media partnerships, EMS partnerships, Emergency Response programs, and ramp metering. KC Scout utilizes private sector traffic data to provide travel times on at least 50 miles of the interstates. KC Scout also provides computer-aided dispatch integration. The STIP lists all funds from regional major projects and emerging needs funds.

TMC of the Ozarks – Springfield District

TMC of the Ozarks is Springfield's traffic system established by the City of Springfield and MoDOT. Since traffic in Springfield's metro area moves primarily along arterial roadways instead of freeways, a partnership between the city and MoDOT was essential to provide initiative needs to the region. TMC of the Ozarks had the first operating TMC in the state, which was established in 1998. 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 334 out of 404 signalized intersections connected to a centralized signal system. Signals along TMC of the Ozarks routes are both centrally and adaptively controlled. TMC of the Ozarks is currently working on expanding ITS deployments in western Springfield. Possible expansion projects that currently do not have funds obligated to them include the Nixa region, Ozark and Republic regions, and Branson region. 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 such as 99 cameras, 20 DMS, 79 vehicle detector sites, EMS partnerships, city-wide arterial travel times, and freeway monitoring. The STIP lists current operations/maintenance costs. There is a city-wide deployment of Wi-Fi devices in Springfield, the costs of which are shared between MoDOT, the City and the Ozarks Transportation Organization. The Wi-Fi devices allow for arterial travel times, performance measures, and improved arterial signal operations.

Incorporating TSM&O into MoDOT's current policies and principles is not expected to be a difficult task because of the correlations between what MoDOT wishes to accomplish and what the TSM&O program is planned to be. MoDOT currently has a multitude of programs and plans that will benefit from integrating TSM&O's standards and initiatives. A list of some of MoDOT's existing programs and plans are provided below.

Missouri's Blueprint ~ A Partnership Toward Zero Deaths

In 2016, MoDOT released Missouri's Blueprint ~ A Partnership Toward Zero Deaths[11]. This is the fourth edition of Missouri's strategic highway safety plan, providing strategies for 2016-2020. The blueprint mentions how Missouri previously focused on reaching a lower goal of fatalities each year; the ultimate goal set forth by this blueprint is "that NO lives are lost due to a traffic crash". The Missouri Coalition for Roadway Safety (MCRS) added a new TIM subcommittee, bringing the coalition to: an executive committee, 11 state-level subcommittees, and seven regional coalitions. The blueprint outlined strategies, which MoDOT believes provide the "greatest potential" of saving more lives along Missouri roadways. Labeled "the Focused Five," these strategies are outlined in Table 5.

Table 5. MoDOT's "Focused Five" Strategies to Save More Lives

Strategies	Description
Change the Traffic Safety Culture	Increase safety belt/safety restraint use Educate roadway users on their roles and responsibilities Expand outreach efforts to new traffic safety partners Educate on the dangers of aggressive, distracted and substance-impaired driving Create safe and efficient clearance of roadway impacts
Highway Safety Legislation	Pass a primary safety belt law Pass a cell phone ban law for all drivers Maintain and enhance existing traffic safety laws Increase transportation funding
Increase Enforcement Efforts	Focus on high-crash corridors and work zones Expand efforts to stop aggressive driving Increase sobriety checkpoints/saturation patrols Expand multi-jurisdictional task forces
Implement Engineering Solutions	Install shoulders with rumble stripes Improve curve safety Increase use of innovative intersection designs Enhance roadway visibility
Enhance Pedestrian Safety	Install/improve signage, pavement markings and signals Educate pedestrians on safe habits

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[11] Missouri's Blueprint ~ A Partnership Toward Zero Deaths:
http://s3-us-west-2.amazonaws.com/modot-pdfs/Blueprint_2016-2020.pdf

Six focus areas are analyzed to determine how many crashes occur with each category. The focus areas included:

- serious crash types
- high-risk drivers and unrestrained occupants
- special vehicles
- vulnerable roadway users
- special roadway environments
- data and data system improvements

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

Statewide Transportation Improvement Program (STIP)

Annually, MoDOT completes a STIP, which outlines projects committed for funding. The most recent STIP, 2017–2021, outlines planned work and projects for the next five years. The STIP reviews:

- Scoping and Design Projects
- 2017–2021 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

Two main project lists are included in the STIP: scoping and design projects and highway and bridge construction schedule projects. Projects typically begin in the scoping and design phase and go through the process shown in Figure 9, eventually arriving in the highway and bridge construction schedule list.
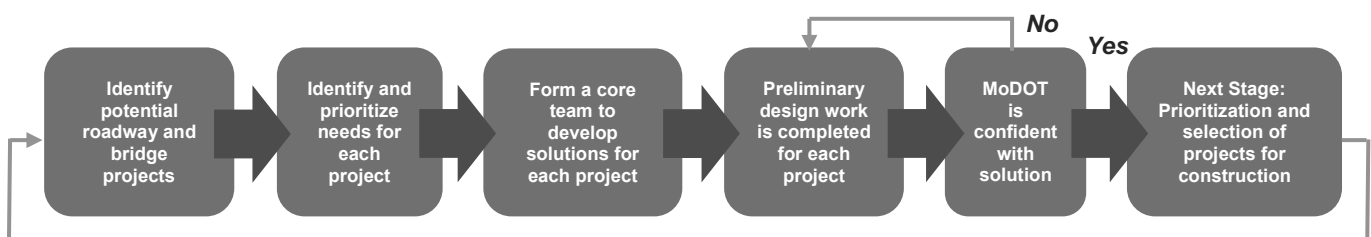
Figure 9. Scoping and Design Project Process

Projects listed in the highway and bridge construction schedule list are funded, and MoDOT is obligated to complete the improvements, purchase right-of-way, and construct these projects. A few assumptions must be considered and a few requirements must be met before construction can begin on a project; not all projects will need to meet all of the requirements. The assumptions and requirements are as follows:

- The assumed funding levels from the state and federal sources are available.
- All environmental requirements and clearances are obtained.
- Any legal matters are resolved.
- Right-of-way acquisition and utility relocation occur as scheduled.
- MPO concurrence is obtained for projects in the Cape Girardeau, Columbia, Fayetteville-Springdale-Rogers AR-MO, Jefferson City, Joplin, Kansas City, St. Joseph, St. Louis, and Springfield areas.

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 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. MoDOT's expenditures are dispersed between several different programs shown in Figure 10.[12]

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[12] MoDOT's STIP 2017-2021: http://www.modot.org/plansandprojects/construction_program/STIP2017-2021/index.htm
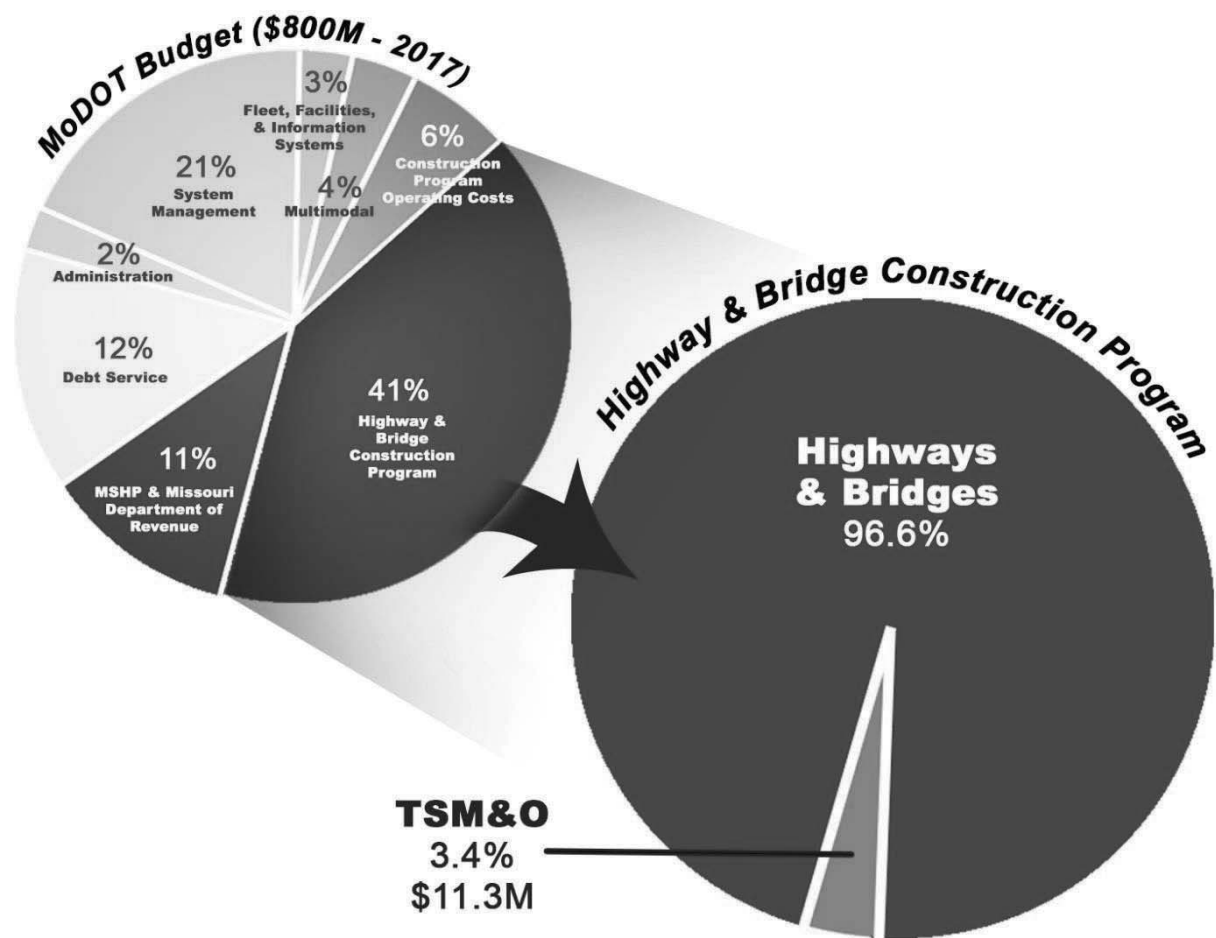
Figure 10. TSM&O within MoDOT's Budget

Currently, the funding for Gateway Guide, KC Scout, TMC of the Ozarks, and the traffic incident management program comes from the STIP. The TMC's funding 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. For the 2017-2021 STIP, the total annual funding for the TMCs and the Emergency Response program is $11.3M, only 3.4% of the $330M awarded yearly for construction. In addition to providing continued funding of these programs, there are many opportunities to advance and integrate elements of TSM&O initiatives into existing projects during the planning phase.

ITS Architecture

MoDOT developed and maintains a statewide ITS architecture, and leads or contributes to the maintenance of regional ITS architectures in St. Louis, Kansas City, and Springfield. An ITS Architecture provides a framework for the planning and deployment of ITS systems in support of TSM&O 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 CFR 940, which in turn allows access to available federal aid for eligible ITS projects. The Statewide ITS Architecture has been integrated into MoDOT's Engineering Policy Guide as section 910.4. The ITS Architectures will continue to be regularly maintained as the programs and systems evolve, and will be referenced for any ITS projects because they fall within the broader TSM&O program.

MoDOT has identified multiple teams and working groups at various levels to advance TSM&O within the organization. Each group includes a cross-section of members across relevant portions of the entire organization. These groups have various responsibilities from overseeing the program to advancing specific aspects of the program such as WZM and TIM. The organization of these cross-sectional teams is shown in Figure 11, followed by a description of the responsibilities of each group.

Senior Management Team (SMT) Champions

MoDOT has identified members of its senior management team (SMT) to serve as TSM&O program champions and to provide program oversight. Following the TSM&O CMM workshop, the SMT adopted a TSM&O implementation plan to guide the establishment of the program. This 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 TSM&O into MoDOT's structure and culture.

Figure 11. TSM&O Organizational Support Structure

TSM&O Core Team Champions

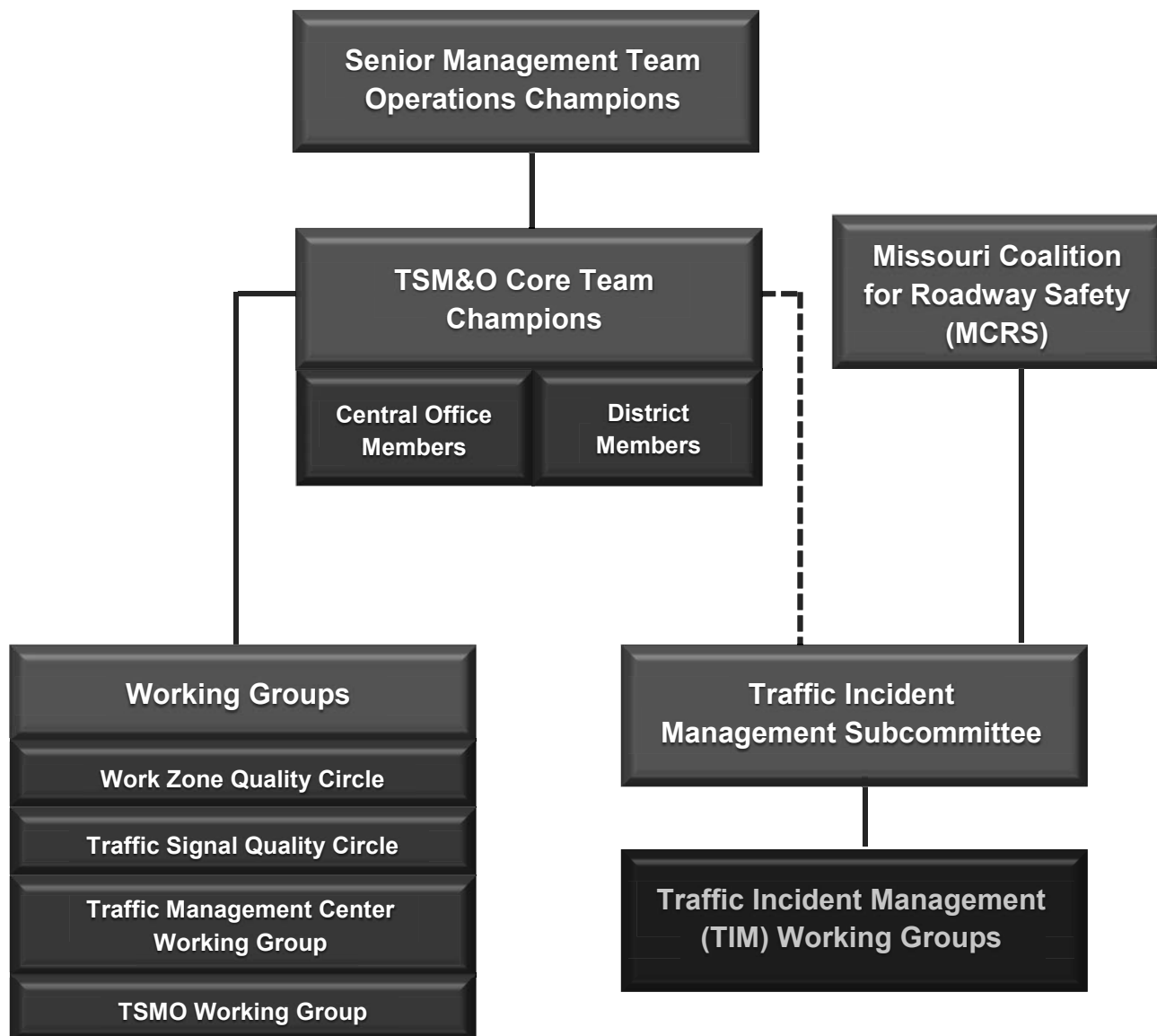The SMT recognizes that TSM&O touches many different disciplines and divisions within the department. Therefore, they have identified a cross-section of individuals across the agency to serve on a core team tasked with the following responsibilities:

- Support efforts aimed at improving TSM&O activities throughout the state
- Develop and adopt a charter or policy that supports continued improvement of TSM&O programs
- Oversee the development of a TSM&O plan

The TSM&O core team is constituted as shown in Table 6. Members of MoDOT's founding TSM&O team are provided in Appendix C.

Table 6. TSM&O Core Team Members

Position	Division / Department
Central Office	
Traffic Liaison Engineer (**Core Team Lead**)	Traffic and Highway Safety
Traffic Management and Operations Engineer	Traffic and Highway Safety
Statewide Incident Response Coordinator	Traffic and Highway Safety
Liaison Engineer	Construction and Materials
Liaison Engineer	Design
Liaison Engineer	Maintenance (Emergency Response)
Liaison Engineer	Maintenance (Winter Operations)
Transportation Planning Specialist	Transportation Planning
District	
Kansas City Assistant District Engineer	Operations
Kansas City TMC Manager	TMC Operations
St. Louis Assistant District Engineer	Operations
St. Louis TMC Manager	TMC Operations
Southwest Assistant District Engineer	Operations
FHWA	
Safety and Mobility Engineer	FHWA Missouri Division Office

Traffic Incident Management Subcommittee

As the first priority action identified by the SMT, a TIM subcommittee was formed under the MCRS, along with multiple working groups and quality circles assigned to focus on improving specific aspects of TIM within the department. Because TIM is also one of the focus areas for TSM&O, this subcommittee reports to the MCRS but because TIM is also one of the focus areas for TSM&O, it plays an important role in advancing TSM&O solutions and strategies as well.

TSM&O Working Group

The TSM&O working group was formed to help integrate TSM&O into the department's day-to-day operations. They meet regularly to discuss specific strategies and technologies, reviewing plans and exploring ideas for how to help other teams and groups to consider TSM&O strategies. They are also responsible for setting the overall ITS direction and upkeep of the Statewide ITS Architecture. Examples include exploring how to make work zone traffic management plans more effective, reviewing the usefulness of existing traveler information tools, organizing training and workshops, evaluating the approach to regional and statewide TMC operations, and contributing to or advancing many other TSM&O-related initiatives.

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.

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 TSM&O strategies have many work zone safety and mobility benefits, this committee also has responsibilities within the TSM&O core team.

Traffic Signal Quality Circle
The traffic signal quality circle is identified in MoDOT's Engineering Policy Guide 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 TSM&O strategies to improve the management and operations of arterial operations and traffic signal systems.

MoDOT's Central Office Resources
TSM&O is supported from MoDOT's Central Office through resources from several divisions, as shown in Table 6. Individuals within these divisions are a resource to district personnel who have questions regarding the implementation or operation of TSM&O 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 TSM&O core team. Funding for centrally led TSM&O 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 carry out TSM&O programs and strategies according to its specific needs and resources. Many of the same divisions described 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 all are supplemented with a TMC with resources dedicated to operations according to their needs. Some examples of TSM&O actions and responsibilities of district personnel are provided in Table 7.

Table 7. Actions & Responsibilities

Action	Responsibilities
TMC	Execute and oversee real-time transportation operational support and dissemination of traveler information
Maintenance	Implement maintenance-related TSM&O strategies; provide feedback and effort for continual improvement of these strategies and tools
Traffic Operations	Implement traffic operations-related TSM&O strategies; provide feedback and effort for continual improvement of these strategies and tools
Transportation Planning	Include TSM&O along with other traditional transportation improvement strategies in all planning efforts
Design	Consider TSM&O as an essential element of design, either as a direct improvement for the specific application or as an opportunity for the continuation of existing TSM&O strategies
Construction	Consult personnel with the appropriate expertise when modifying a design or during construction inspection of TSM&O 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 TSM&O expertise is needed; assist with training programs to improve the knowledge, skills, and abilities of existing operations personnel

Funding for district-level TSM&O programs and projects is allocated from district project and operations budgets and is supplemented by federal programs as they are available.

3.0 MOVING MODOT FORWARD – WHERE WE ARE GOING

Overview

The CMM self-assessment MoDOT completed in 2013 identified the strengths and weaknesses specific to TSM&O, and through the application of the CMM criteria set forth a number of concrete actions the agency should consider. The actions brought forward during the self-assessment are the foundation of this program plan. The criteria scoring of MoDOT's existing TSM&O program are presented in Table 4. These criteria provide a priority of where resources should focus in advancing MoDOT's TSM&O program.

A foundational component of formalizing TSM&O program planning within a state DOT involves identifying the core team and ensuring that a feasible plan is in place to govern and drive the work steps defined in the plan. Through MoDOT's focused work efforts, a core team, along with working groups and subcommittees (Figure 11), has formed to provide the formal structure to the organization, documentation, and maintenance of the program plan. This programmatic direction (and presentation) will facilitate an ongoing, iterative process within the context of each initiative and track the progress of accomplishing the actions. In addition, as the program advances, revisions and adjustments will be made to account for completion of various action items, provide for other departmental plans and initiatives, account for planning cycles, align with department directions, and accommodate relationships with partners and other stakeholders.

This section of the program plan provides details associated with three TSM&O areas selected as the highest priority for MoDOT to address. These areas are TIM, WZM, and advancing technology and roadway operations. For each of these areas, underlying background information and summary materials on national activities are provided. Most importantly, this section includes MoDOT's work program (outlined in tables) that details the actions MoDOT TSM&O's subcommittee and working groups will move forward with to accomplish these tangible initiatives. Each of the three areas mentioned above provide the high-level TSM&O objectives that are to be addressed, along with the steps needed to accomplish each action; the priorities specific to that action; anticipated timeline to complete; potential measure of success; and the roles and responsibilities needed to accomplish the actions. Importantly, each action includes measures of success so that a clear need for revisiting the work program in the tables and updating them encourages the maintenance of the plan to ensure the program plan remains both dynamic and current.

It is anticipated that as the TSM&O 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. Such expansion should be considered during plan maintenance, as action items are reviewed and updated and as circumstances, priorities, and resource levels change over time.

What is Traffic Incident Management?

TIM is a major component of an effective TSM&O program. TIM is a planned and coordinated program process to detect, respond to, and clear traffic incidents (such as a crash or an impaired vehicle), and restore traffic capacity as safely and as quickly as possible.[13] MoDOT coordinates with many partners such as law enforcement, fire and rescue, EMS, public safety, and towing and recovery (just to name a few) to maintain an effective TIM program.

What are TIM Programs?

A TIM program is a logical, structured, and integrated set of TIM activities tailored to a specific geographic area. It includes policies, strategies, and technologies integrated into a multiagency, multijurisdictional environment aimed at reducing the occurrence and impact of traffic incidents. Figure 12 shows actions needed to build a successful TIM program.

To be successful, a TIM program should be ongoing and actively managed. A TIM program should be developed and managed in conjunction with the area's freeway management and operations program.[14]

What are the Goals of an Effective TIM Program?

Effective TIM programs manage traffic incidents and emergencies on the roadway to allow clearing of crashes more safely and quickly. Efforts to improve and define TIM for Missouri began as early as 2007 when FHWA hosted a Missouri Traffic Incident Management Summit. More recently, Missouri's TIM team has documented specific goals and targets for its statewide TIM program activities.
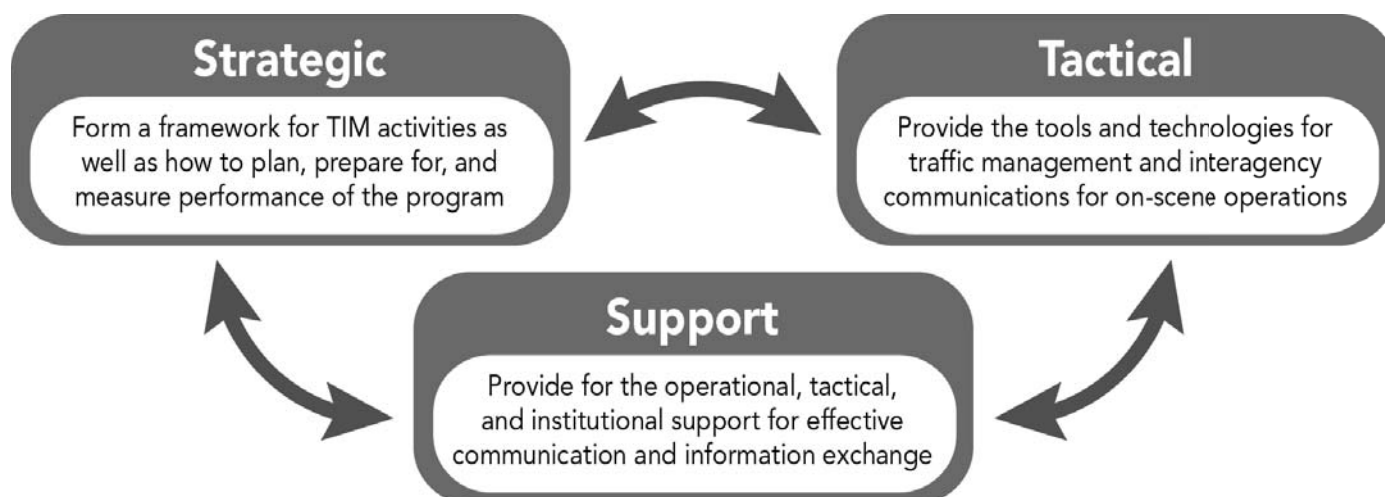
Figure 12. TIM Program Actions

TIM programs strive to reduce the duration and impacts of traffic incidents and improve the safety of motorists, crash victims, and emergency responders. TIM program goals[15] are to:

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[13] FHWA Emergency Transportation Operations: http://ops.fhwa.dot.gov/eto_tim_pse/about/tim.htm

[14] Freeway Management and Operations Handbook:
www.ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/toc.htm

- Promote the safety of motorists, crash victims, and traffic incident responders.
- Reduce the time for traffic incident detection and verification.
- Reduce response time (the time for response personnel and equipment to arrive at the scene).
- Exercise proper and safe on-scene management of personnel and equipment, while keeping as many lanes open to traffic as possible.
- Conduct an appropriate response, investigation, and safe clearing of a traffic incident.
- Reduce clearance time (the time required for the traffic incident to be removed from the roadway).
- Provide timely and accurate information that enables the public to make informed choices.
- Get traffic moving again as soon as possible after a partial or complete roadway closure, all while managing the affected traffic until normal conditions are restored.

Why Should TIM Programs be Prioritized?

Non-recurring traffic incidents (such as crashes and impaired vehicles) dramatically reduce the available capacity and reliability of the entire transportation system. When a traffic incident occurs, congestion can quickly build, resulting in the chances of a secondary traffic incident. The earlier traffic incidents are detected, the faster personnel can respond to the traffic incident and clear it from the roadway, allowing traffic lanes to reopen and resume normal operations.[16] A secondary crash is often more severe than the initial traffic incident. Ten to 25 percent of all traffic incidents are secondary crashes caused by backups and inattentive drivers in the crash area. Every minute spent clearing a traffic incident increases the likelihood of a secondary crash by 2.8 percent.[17]

The safety of the traveler and roadway network is MoDOT's first priority, and TIM programs are a supporting function of the operation of roadway networks. According to MoDOT's Blueprint Crash Statistics,[18] between 2012 and 2014, there were 46,306 crashes with serious injuries and 2,349 fatalities on Missouri's highway system statewide, including all public roadways. Sixty-seven of these fatalities occurred within areas covered by the TIM[19]. Statistics such as these emphasize the importance of TIM programs. Through the application of TIM strategies, KC Scout has reported a 42 percent decrease in secondary traffic incidents from 2013 to 2014.

Various incident performance measures are tracked and reported on through the Missouri Tracker performance management program. These consist of tracking the total numbers of incidents resulting in serious injuries and fatalities, work zone incidents, seat belt usage, incidents with commercial motor vehicle, and incidents involving MoDOT personnel or vehicles, and liability costs. Tracking these values is important because they are positively impacted by the effective execution of TIM strategies.

The effective application of TIM strategies positively impacts these tracked performance measures, and is measured and tracked independently in each district. For example, in 2015 KC Scout reported that the Emergency Response teams responded to 35,439 total incidents[20], 19,615 of which were located in Missouri, and for May-June 2016 St. Louis Gateway Guide reported the average time to clear an incident from lanes was just over 20 minutes.

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[15] FHWA Traffic Incident Management Gap Analysis Primer:
http://ops.fhwa.dot.gov/publications/fhwahop15007/chapter1.htm#chap1
[16] FHWA Traffic Incident Management Gap Analysis Primer:
http://ops.fhwa.dot.gov/publications/fhwahop15007/chapter1.htm#chap1
[17] New Traffic Incident Management: https://c.ymcdn.com/sites/mocities.site-ym.com/resource/resmgr/march_review_files/newtrafficincidentmanagement.pdf
[18] MoDOT's Missouri Crash Statistics: http://www.modot.org/safety/BlueprintCrashStatistics.htm
[19] Missouri's Blueprint ~ A Partnership Toward Zero Deaths:
http://s3-us-west-2.amazonaws.com/modot-pdfs/Blueprint_2016-2020.pdf
[20] KC Scout's 2015 Annual Report: http://www.kcscout.net/Reports.aspx

Typical TIM Strategies
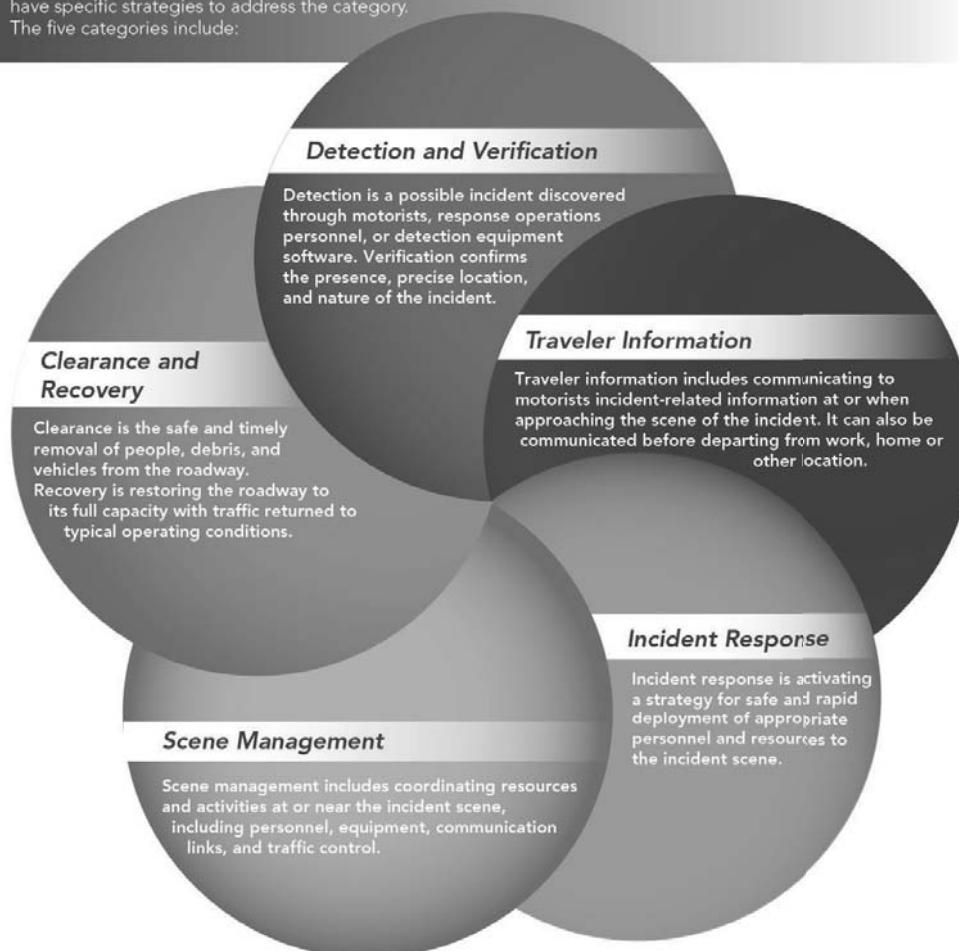
Figure 13. TIM Activities and Strategies

Actions to Advance TIM in Missouri

During the CMM workshop, MoDOT and its partners prioritized several actions to advance TSM&O for the state. One of the priority items was to improve and expand MoDOT's TIM program, especially along rural interstates. A statewide team of MoDOT staff was then assembled to discuss MoDOT's TIM program throughout the state. This group participated in a second self-assessment workshop specifically focused on TIM. Both self-assessment workshops discussed the strengths and challenges that exist in current operations and brought forward actions to advance operations for the state. The TIM-focused workshop brought forward actions specific to improving MoDOT's TIM activities. The recommended actions and outputs from these workshops are presented in Appendix D. Ultimately, the TIM team shared their recommendations with MoDOT and MSHP leadership, and the two agencies agreed to focus on four priorities for improving TIM in Missouri. The priorities include the following:

- Get organized
- Get trained
- Improve on I-70 and I-44 first
- Improve MoDOT TIM policies

Table 8 summarizes those actions that were brought forward in both self-assessment workshops. It should be recognized that these actions are a result of a facilitated discussion and consensus-building approach with those participants in the workshop. Table 8 presents the various actions in a matrix that also captures how to measure and move forward with implementing each action. This table is formatted so that future

revisions to this document and updates in the MoDOT TSM&O Program Plan can be easily incorporated and tracked.

Table 8. TSM&O Traffic Incident Management Action Matrix

Action	Steps to complete the action	Priority (H,M,L)	Status/ Timing	Measure of Success	Responsible MoDOT Staff
Objective 1: Get Organized					
Form TIM Improvement Subcommittee under the *Missouri Coalition for Safer Roadway Safety Executive Committee*	Establish TIM committees (with strategic partners) at statewide, regional, and local levels to provide oversight and promote cooperation.	H	Completed	TIM committee formed	Get Organized Implementation Team
	Dedicate (assign) a traffic incident management coordinator in the northwest, northeast, central, and southeast districts.	H	Q4 2016		Get Organized Implementation Team
	Implement a robust towing management system in cooperation with MSHP.	M	Q2 2017		Get Organized Implementation Team
	Establish performance goals and measures for TIM in both rural and urban environments.	M	Q2 2017		Get Organized Implementation Team
Objective 2: Get Trained					
Provide TIM training to all MSHP and MoDOT team members who will be responding to traffic incidents	Provide Second Strategic Highway Research Program (SHRP2) TIM training throughout the state, especially in rural areas.	M	Ongoing		Get Trained Implementation Team
	Initiate conversation for standard operating procedures (SOP) between first/emergency responders and MoDOT/MPOs/TMCs.	M	Q3 2016		Get Trained Implementation Team
	Promote cities and regions to hold "train-the-trainer" (TtT) sessions for towing operators.	L	Q2 2017		Get Trained Implementation Team
Objective 3: Improve on I-70 and I-44 First					
Develop I-44 and I-70 corridor traffic incident response plans.	Place dedicated traffic incident response equipment in MoDOT facilities along the interstates and other major routes.	H	Q3 2016		Improve on I-70 & I-44 First Implementation Team
Objective 4: Improve MoDOT TIM Policies					
Jointly review and revise any MoDOT TIM policies that could improve traffic incident clearance times.	Produce a formal document for Missouri's Statewide Traffic Incident Management Plan.	M	Q3 2016		Improve MoDOT TIM Policies Implementation Team
	Hold capability self-assessment workshop with traffic incident management personnel to identify critical needs and improvement areas.	L	Q3 2017		Improve MoDOT TIM Policies Implementation Team
	Clarify legal and liability issues associated with traffic incident clearance to reduce traffic incident durations.	M	Q3 2016		Improve MoDOT TIM Policies Implementation Team

TIM Resources

The Second Strategic Highway Research Program (SHRP2) delivered two products to improve traffic incident on-scene management. The first product is a multidisciplinary training course that safeguards responders and motorists and promotes a shared understanding of the requirements for quick clearance. This training brings police, firefighters, DOTs, towing, medical personnel, and other traffic incident responders together to engage in interactive, hands-on traffic incident-resolution exercises. Learning to coordinate response activities and optimize operations in the classroom improves the real-world environment when addressing traffic incident management. As of October 2016, more than 7,600 Missouri first responders had participated in the National TIM Responder Training Program sponsored by FHWA.[21] Missouri's participation relative to the rest of the nation is shown in Figure 14.

	MoDOT	National Average
# Responders Trained	31,000	
% Responders Trained	24.6%	18.4%
# Trainers Trained	342	
% Trainers Trained	1.1%	0.7%
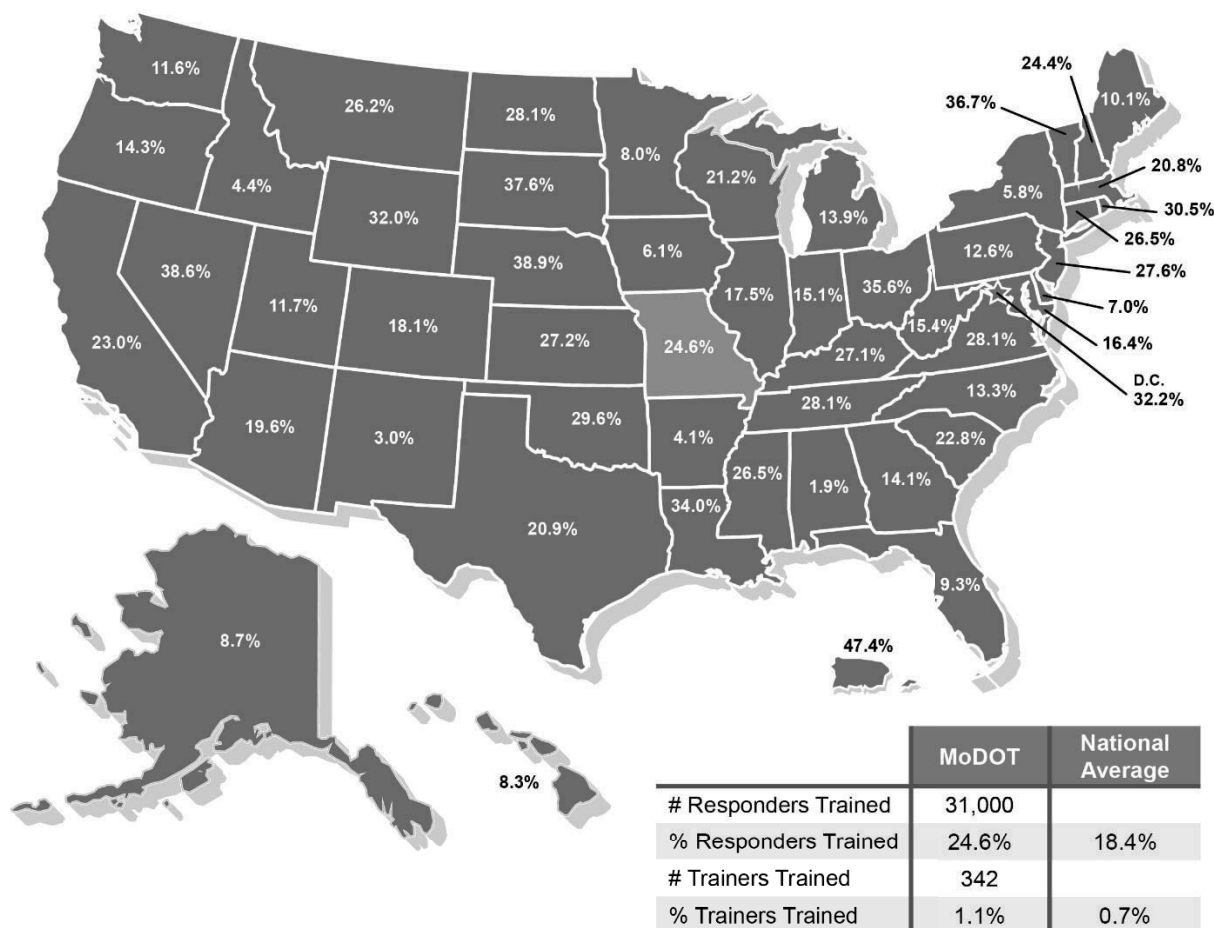
Figure 14. TIM Training Status as of October 2016

The second SHRP2 product is a two-day "train-the-trainer" (TtT) course that facilitates widespread use of the multidisciplinary training. As of June 2016, MoDOT has conducted five TtT sessions, training nearly 330 responders of various disciplines on the fundamentals necessary to deliver the training course to all disciplines. As part of the Missouri TtT initiative, annual TtT courses are held to maintain an active and diverse group of trainers. When planning efforts for the TtT session in southwestern Missouri were initiated, MoDOT made a special effort to reach out to the senior leadership of all invited organizations. This effort included contacting local police and fire chiefs as well as the owners of local towing and recovery companies. The local MPO was also included. This direct communication helped obtain buy-in for the program and to ensure that the appropriate personnel attended the TtT session.[22] In an effort to promote

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[21] FHWA TIM Newsletter: https://www.fhwa.dot.gov/goshrp2/Content/Documents/TIM_Training_Newsletter.pdf
[22] FHWA TIM Responder Training Program:
http://www.fhwa.dot.gov/goshrp2/Content/Documents/Factsheets/TIM%20Training%20Good%20Practices.pdf

the TIM training, MoDOT worked with the media, resulting in very positive coverage of their TtT session in Kansas City.

What is Work Zone Management (WZM)?

WZM is a planned and coordinated process to manage traffic during construction to minimize traffic delays, ensure motorist and worker safety, and complete roadwork in a timely manner. MoDOT maintains processes and procedures during plan development to apply work zone design principles on roadway design and construction projects.

WZM strategies should be identified based on the project constraints, construction phasing/staging plan, type of work zone, and anticipated work zone impacts. Processes include permitted lane closure times, maintenance of traffic plans, and an alternatives analysis process.

Once work zones are in place and active, MoDOT maintains several programs to increase public awareness and information regarding work zones. A webpage that provides Missouri traveler information includes work zone status information such as locations with closures, delays, and future work status.[23] MoDOT also maintains an online tool for the public to provide feedback on how work zones might be improved.[24]

TSM&O Solutions and Strategies Specific to Work Zone Programs

Work zones are defined as one of six sources of traffic congestion (Figure 4). Congestion caused by work zones is estimated to constitute 10 percent of the congestion on our nation's transportation network. The top five contributing circumstances for work zone crashes are following too closely; driver inattention; improper lane use or changing lanes; driver failing to yield; and driving too fast for conditions. A crash in or approaching a work zone will further affect traffic flow and reduce the capacity of the roadway in an area of already-reduced capacity.

In Missouri, 3,222 people were injured and 54 people were killed in work zone crashes on state routes between 2010 and 2015. Since 2000, 17 MoDOT employees have been killed in the line of duty. These sobering statistics have kept work zone safety as a priority for MoDOT, and WZM is one focus area to advance operations through TSM&O.

Using MoDOT's TMCs to support, monitor, and respond to work zone traffic may improve overall mobility and safety in the region. Support can be provided in the following areas:

- Use the tools and resources, along with TMC staff's knowledge within the TMC, to analyze corridors or regional performance and support the work zone planning process
- Collect and process real-time travel times to monitor the flow of traffic within the work zone and to respond to travel disruptions
- Provide traffic incident management responses utilizing detection such as closed-circuit television (CCTV) and DMS to manage, inform, and respond quickly to interruptions in work zone traffic flow in real time

Other WZM strategy applications include:

- Queue management systems that allow for alerts to be sent to the approaching travelers when backups occur
- Speed management solutions such as variable speed limits that allow for smoothing traffic flow in the approach to work zones
- Work zone intrusion alarms and reporting to provide work crews notifications of errant vehicles entering a protected work area

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[23] http://traveler.modot.org/map/
[24] http://www.modot.org/workzones/

- Automated speed enforcement within work zones to introduce the potential to improve driver attention in the work zone

MoDOT Best Practices

Nationally, nearly 24 percent of non-recurring freeway delay is attributed to work zones.[25] Non-recurring traffic incidents dramatically reduce the available capacity and reliability of the transportation system when an incident occurs; this is especially true when a work zone is involved. Congestion and queues can quickly build, resulting in an increased likelihood of a secondary traffic incident and putting highway workers at risk. MoDOT has a robust program to address work zone mobility and safety. Two nationally recognized case studies from MoDOT on work zone management include the following:

- In order to ensure that routine equipment is maintained and operational or that it is supplemented with portable devices during work zone periods, MoDOT includes incentives in work zone contracts. The TMC typically specifies that at least 75 percent of detectors remain operational in the work zone area. Similarly, the TMC often requires that CCTV and DMS remain 100 percent operational. Another requirement is that any communication of existing devices or temporary devices be tied back to the TMC. The contractors are given liberties with figuring out how to establish communications to the TMC.[26]
- When MoDOT selects a contractor, the contractor works together with the construction inspector and the TMC to monitor the work zone daily and weekly. Information about the work zone is shared both ways from the contractor and from the TMC. Details about lane closures (e.g., travel information, travel times, etc.) are shared so that information can be maintained in TMC systems and then displayed to travelers through information dissemination tools.[27]

MoDOT provides an "Advanced Work Zone Training" course that contains modules on work zone policy; transportation management plans (TMPs); law enforcement; traffic capacity; travel time information; designing for the driver; pedestrians and bicyclists; nighttime work zones; and several modules on standards and temporary traffic control. Upon completion of the course, a participant is trained as a "Work Zone Specialist". These specialists are then involved in every aspect of the traffic control plan, from preliminary to post-construction work on MoDOT projects. MoDOT has also developed training courses focused on specific roles within work zones, such as flaggers and truck-mounted attenuator drivers.

Actions to Advance Work Zone Activities in Missouri

During a statewide capability self-assessment workshop in late 2013, MoDOT and its partners prioritized several actions to advance work zone activities for the state. In addition, MoDOT held a self-assessment workshop solely focused on work zone activities. Actions were defined and categorized in each of the six dimensions of the CMM framework. The work zone-focused workshop brought forward actions specific to improving MoDOT's work zone activities. Of the actions defined by the stakeholders, two general focus areas arose: (1) to increase efforts on developing criteria and processes both internally and externally for work zone operations, TMPs, and real-time data; and (2) to increase outreach activities for internal MoDOT staff and partners to raise awareness and encourage innovation in work zone operations.   The detailed recommended actions and outputs from these workshops are presented in Appendix E.

Table 9 synthesizes those actions that were brought forward in both self-assessment workshops. It should be recognized that these actions are a result of a facilitated discussion and consensus-building approach with those participants in the workshop. Table 9 presents the various actions in a matrix that also captures

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[25] FHWA Work Zone Management Program: http://www.ops.fhwa.dot.gov/wz/resources/facts_stats/mobility.htm
[26] Guidance on Using Traffic Management Centers for Work Zone Management, FHWA-HOP-15-032, October 2015. http://www.ops.fhwa.dot.gov/publications/fhwahop15032/chap2.htm#4AMiss
[27] Guidance on Using Traffic Management Centers for Work Zone Management, FHWA-HOP-15-032, October 2015. http://www.ops.fhwa.dot.gov/publications/fhwahop15032/chap2.htm#4AMiss

how to measure and move forward with implementing each action. This table is formatted so that future revisions to this document and updates in the MoDOT TSM&O Program Plan can be easily incorporated and tracked.

Table 9. TSM&O Work Zone Action Matrix

Action	Steps to complete the action	Priority (H,M,L)	Status/ Timing	Measure of Success	Responsible MoDOT Staff
Area 1: Collaboration					
Provide guidance on building greater relationships with partners.	Develop/enhance criteria/policy for determining when and how to use law enforcement for work zone purposes.	H	Q3 2016	MoDOT staff is routinely requesting law enforcement for work zones in a systematic, effective, and efficient way in accordance with developed policies.	
Area 2: Business Process					
Improve planning and programming processes for transportation management plan (TMP).	Develop criteria/procedures for TMP from design to construction and discuss TMP at the post-construction meeting.	M			
	Develop check-in processes for continuous TMP quality improvement.	H			
Area 3: Systems/Technology					
Encourage the exploration, expansion, and application of technology in work zones.	Educate MoDOT personnel on availability of existing and emerging work zone technology for projects.	H			
	Designate an advocate for advancing work zone technology and application within the core team.	H			
	Develop procedures to identify work zone funding early in the planning/design process.	M			
	Ensure MoDOT staff are familiar with the FHWA publication, *Work Zone ITS Implementation Guide*.	H			
Area 4: Performance Measurement					
Enhance performance measurement reporting and data acquisition on work zones.	Provide a better breakdown of the quarterly data.	M			
	Explore use and application of real-time data	H			
	Provide general work zone crash details to the public (seatbelt use, inattention, etc.).	M			
Area 5: Organization/Workforce					
Assess staff capabilities and needs for a stronger work zone program.	Ensure that one traffic control standard is used for all applications and by: local agencies, permit offices, MoDOT, and contractors.	H			
	Develop tracking mechanism or requirement to submit work zone certification for permit work.	M			
	Develop refresher/update for revisions to work zone policy/flagger.	H			
Area 6: Agency Culture					
Improve	Distribute results of recent and	H			

Action	Steps to complete the action	Priority (H,M,L)	Status/ Timing	Measure of Success	Responsible MoDOT Staff
technical understanding and support to work zone strategies as part of the TSM&O program.	ongoing innovative work zone efforts to MoDOT staff in partner agencies to raise awareness and encourage further innovations in Missouri's WZM.				

Work Zone Management Resources

The FHWA Work Zone Management Program provides numerous resources for state DOTs expanding and enhancing work zone programs. The FHWA's office of operations' website[28] contains links to resources on best practices, fact sheets, case studies, and other areas to advance the practice of work zone programs. In addition, the office offers webinars, peer exchanges, and other training activities to support work zone innovation.

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[28] http://ops.fhwa.dot.gov/wz/index.asp

Advancing Operations by Advancing Technology

Many operations improvement strategies are based in technology. MoDOT has deployed a number of these technology solutions and TSM&O strategies to enhance the reliability of the transportation network through active management of the system in the urban areas and statewide. Statewide programs include TIM programs, WZM programs, and road weather applications. MoDOT has focused programs to proactively manage traffic in major urban areas at TMCs in St. Louis, Kansas City, and Springfield. Existing technology solutions include CCTV, ramp meters, DMS, traffic detectors, and the supporting communications systems. Data collected from these systems support many of the TSM&O strategies. Autonomous and connected vehicles are quickly changing the way DOTs think about technology applications on the transportation network. The new generation of vehicles together with robust data sets and technologies on the transportation network are anticipated to further capitalize on the investments MoDOT has made to advance operations and provide the next safety breakthrough.

Advancing Day-to-Day Operations

Over the past decade, MoDOT has built out TMC operations and functions in the three large metro areas and has expanded and enhanced statewide programs. Funding constraints and tight budgets have prevented major expansions, and there are few stand-alone technology procurements. Day-to-day operations entail managing the system in real time, securing and applying ad-hoc resources, and closely coordinating with partners (local and regional transportation agencies, highway patrol, traffic incident response). In order to advance MoDOT's TSM&O program, the following emphasis should be taken in day-to-day operations in the agency:

- Opportunistically expand the system in a project-by-project manner by including the consideration of TSM&O solutions in every MoDOT design project.
- Recognize that the real-time nature of TSM&O requires ongoing monitoring, management, and maintenance; provide the necessary resources to allow for this.
- Manage and maintain the existing technologies used in the day-to-day TMC operations.
- Integrate and coordinate existing and newly deployed technologies within MoDOT and with partner agencies.

Performance Management

MoDOT's core mission is to manage the transportation system and meet the challenges associated with roadway operations in order to deliver the services and products expected by the traveling public. For years, MoDOT has issued, and posted quarterly online, the Tracker,[29] which presents an analysis for the assessment of performance and condition of the roadway network. This reporting procedure thereby ensures accountability to the customer. TSM&O-specific performance management is contained in the *Operate a Reliable and Convenient Transportation System* section of the report. This section provides clear accountability and tracking of travel time and reliability measures, traffic congestion measures, TIM measures, work zone impact measures, and management of winter storm events.

Moving Ahead for Progress in the 21st Century Act (MAP-21)[30] transformed the federal-aid highway program by establishing new requirements for performance management to ensure the most efficient investment of federal transportation funds. Some will say that MoDOT is ahead of the national program of TSM&O performance management with the current reporting and tracker system. On August 19, 2016, FHWA published the Performance Management Final Rules.[31] By continuing to track and report: travel time

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[29] http://modot.org/about/Tracker.htm
[30] https://www.fhwa.dot.gov/map21/
[31] https://www.fhwa.dot.gov/tpm/rule.cfm

Please Do Not Text and Drive MoDOT Cares

and reliability measures, traffic congestion measures, TIM measures, work zone impact measures, and management of winter storm events, MoDOT will maintain a strong performance management program.

Advancing Operations in the Long Term

Traditional highway expansion projects are well understood and easily incorportated in the planning cycles of state DOTs and MPOs. National data indicates that non-recurring congestion (special events, work zones, inclement weather, and traffic incidents) make up 55% of all congestion on freeways and are areas where traditional expansion does not address the issue. TSM&O strategies directly address these types of non-recurring congestion. The need to identify components of a TSM&O program that fit into the larger planning process is necessary to advance TSM&O solutions and strategies in the long term. A necessary step in advancing overall operations focused technology deployments in Missouri is identifying how and where TSM&O fits into a STIP and at the MPO-level Transportation Improvement Program (TIP) not only in the context of an initial deployment but to include the longer term operational expenses for TSM&O activities.

One complexity in funding technology projects is that they are often categorized as operational components of the system (therefore funded from operating funds) versus the DOTs' larger funding sources, which are the capital improvements budgets. Since many technology projects do not fit the definition of a capital improvement (e.g. WZM technology), are not included in capital budgets, making them challenging to fund. This lack of a solid funding stream constrains the expansion, upgrade, and maintenance of the existing system. Once technology projects are deployed, the maintance of these systems further draws from already-tight operating budgets. Having TSM&O solutions and strategies fully included in the planning process and documented in the STIP will provide for long-term suppport of technology deployments and the entire TSM&O program.

Working with local agencies and MPOs so that TSM&O is considered in the more local and regional plans will also solidify TSM&O programs. Successful TSM&O programs involve coordinating with local agencies to encourage technology deployments and providing for the coordination and integration with MoDOT assets and resources. Having TSM&O solutions and strategies fully included in the local planning process (such as TIP) will provide for long-term support of operations focused technology deployments at the local level.

Actions to Advance Operations

During a statewide capability self-assessment workshop in late 2013, MoDOT and its partners prioritized several actions to advance operations for the state. The CMM process followed in the workshop brought forward actions specific to advancing operations for MoDOT and its partners. These included such actions as integrating TSM&O considerations into general MoDOT business processes, strengthening TSM&O through better acquisition and analysis of performance measures, and improving inter-agency operations collaboration. The full list of recommended actions and outputs from these workshops are presented in Appendix B.

Table 10 synthesizes those actions that were brought forward in the statewide CMM self-assessment workshop. It should be recognized that these actions are a result of a facilitated discussion and consensus-building approach with those participants in the workshop. These actions followed the six dimensions of the CMM framework to advance statewide operations. Table 10 presents the various actions in a matrix that also captures how to measure and move forward with implementing each action. This table is formatted so that future revisions to this document and updates in the MoDOT TSM&O Program Plan can be easily incorporated and tracked.

Of the actions defined by the stakeholders, two general focus areas arose: (1) to increase awareness of TSM&O to further integrate into the culture of the agency; and (2) actions to incorporate TSM&O into MoDOT's formal planning processes.

Table 10. TSM&O Advancing Technology and Roadway Operations Action Matrix

Action	Steps to complete the action	Priority (H,M,L)	Status/ Timing	Measure of Success	Responsible MoDOT Staff
Area 1: Collaboration					
Increase awareness and provide outreach opportunities and encourage the advancement of TSM&O within MoDOT and partner agencies.	Improve planning processes and educate engineers, planners, and other core team members about TSM&O solutions.	H			
	Train project managers and planning engineers to guide them in choosing which personnel and staff roles should be included in each project.	M			
	Implement a formal staff training program of TSM&O and associated analysis tools.	H			
	Dedicate budget, training, and time in each project for TSM&O suitability analysis.	H			
	Establish TSM&O strategic plans at a regional and/or statewide level to encourage TSM&O collaborative efforts.	H			
Area 2: Business Process					
Improve planning and programming processes for increased focus on TSM&O.	Consider TSM&O on STIP side of agency operations, budgeting, and planning.	H			
	Use urban operations and TSM&O strategies to support and inform rural operations.	M			
	Establish performance goals for TSM&O in both rural and urban environments.	M			
Area 3: Systems/Technology					
Encourage the application, integration, and expansion of TSM&O solutions.	Integrate different TSM&O systems (road weather information system [RWIS], motor carrier services, oversize/overweight permits/AVL, TMC operations, computer-aided design [CAD] software, probe vehicle data, etc.) into a single, coherent, integrated, rational system.	H			
	Develop standard specifications for technology on a statewide level and identify a team to lead it.	H			
	Establish a common procurement process and set of language for proposals and other documents. (a kind of "clearinghouse" for standard boilerplate and common templates) among different agencies within Missouri.	H			
Area 4: Performance Measurement					
Enhance performance	Obtain richer data sets (including	M			

Action	Steps to complete the action	Priority (H,M,L)	Status/ Timing	Measure of Success	Responsible MoDOT Staff
measurement reporting and data acquisition. Identify purpose and applications for each performance measure.	arterial data and rural data) to supplement existing data.				
	Define goals for the performance data that the performance metrics can be measured against, and identify needs in the system and bottlenecks in the network.	H			
	Use descriptive benchmarks to quantitatively and qualitatively describe system performance.	H			
	Automate data processing and computation of performance measures.	H			
	Focus on relevant and appropriate performance measures for drivers (e.g., travel time savings), instead of reporting everything possible.	M			
	Inform management and the public about the performance benefits of TSM&O as compared to traditional infrastructure projects.	H			
Area 5: Organization/Workforce					
Assess staff capabilities and needs for TSM&O-specific staffing needs and assignments.	Garner upper management support to define TSM&O roles within the organization.	H	Completed		
	Define what responsibilities fall under which region's jurisdiction with respect to TSM&O.	H			
	Establish standard job titles/descriptions for common TSM&O positions.	M			
Area 6: Agency Culture					
Improve agency technical understanding and support of the overall TSM&O program.	Encourage appreciation of TSM&O through discussion and inclusion of TSM&O via key champions at SMT meetings.	H			
	Identify a TSM&O champion at the senior management and division head levels.	H			
	Educate staff, upper management, officials, and the public about TSM&O concepts, benefits, and analysis tools.	H			
	Consider and evaluate TSM&O alternatives during project planning (e.g., early on in the project timeline), scoping, and implementation stages.	M		TSM&O strategies should be considered in any project and included unless exclusion can be justified, rather than the other way around.	
	Establish TSM&O peer exchanges and quarterly TSM&O meetings to share best practices learned from each of the regional agencies.	H			

Advancing Operations Resources

Advancing operations has been a national focus of AASHTO, the TRB SHRP2, and FHWA in the past five years. One clearly defined need pinpointed from the research and associated outreach was for a comprehensive one-stop location for resources that state DOTs could access for information and resources

on TSM&O. A partnership of AASHTO, the Institute of Transportation Engineers (ITE), and ITS America, with support from FHWA, formed this resource in the National Operations Center of Excellence (NOCoE). This center's vision is to improve surface transportation system reliability by lending exceptional support services to TSM&O practitioners. Missouri contributes to the Operations Pooled Fund that supports the center.

This center is designed to offer a suite of resources to serve the TSM&O community. The center offers an array of technical services such as peer exchange workshops and webinars, ongoing assessments of best practices in the field, and on-call assistance. The center has two primary components—the Operations Technical Services Program, funded through contributions from state transportation agencies and FHWA; and a web portal (www.transportationops.org), which contains case studies, resources, links to an array of information, discussion forums, and a calendar of TSM&O-related events.

Another resource that MoDOT has used to help drive positive change is the National Traffic Signal Report Card and Self-Assessment tool. The self-assessment was first performed in 2007, which assisted MoDOT staff to identify strategic areas where traffic signal operations could be improved.   When the self-assessment was conducted again in 2011, their efforts yielded a 10% improvement in signal operations across all areas. The results of the self-assessments are shown in Figure 15. MoDOT will continue to use this tool to help improve traffic signal operations overall.
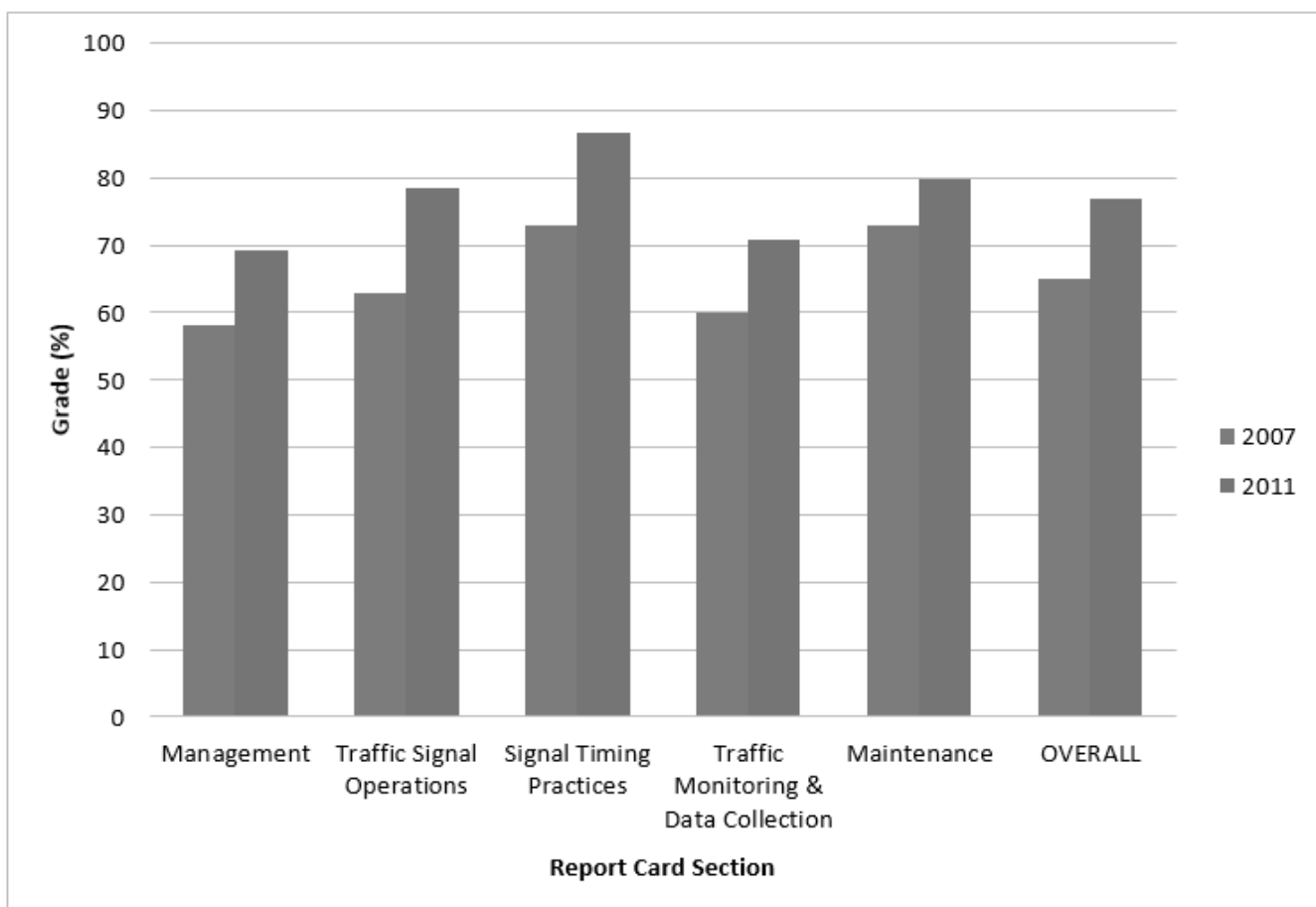
Figure 15. Traffic Signal Report Card Results

4.0 STRATEGIC PLANNING

Beyond those focus areas that comprise the program plan, additional strengths and weaknesses and associated action items identified in the CMM self-assessment provide a broader strategic approach to advancing operations in Missouri. In order to focus on those strategic themes necessary to advance operations, a broader approach to planning for operations and assessing specific workforce issues unique to TSM&O is necessary. These themes are not necessarily tied to specific actions and often involve greater integration with DOT activities. TSM&O 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 / 5)

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

- Integrating TSM&O 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 TSM&O, MoDOT identified several action items during the CMM self-assessment and in the development of this program plan. Underlying each action is the concept that TSM&O needs to be more integrated into traditional planning and project development processes. For example,

Figure *16* shows where TSM&O projects and initiatives should be integrated into MoDOT's scope and design process as it is outlined in the STIP.
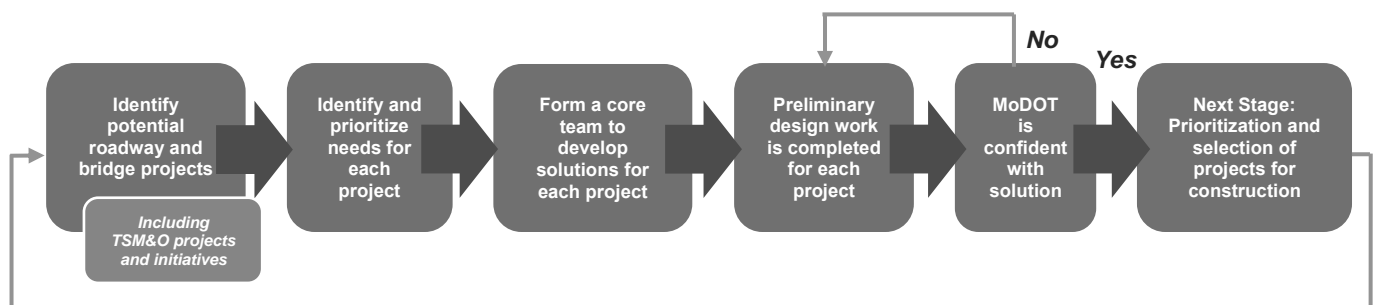
Figure 16. Integrating TSM&O into MoDOT's Scoping and Design Project Process

Nationally, the need to improve integration of TSM&O into state DOT and MPO planning programs was commonly brought forward as a priority action. As TSM&O becomes a more formal program at MoDOT, a greater integration for formal planning processes will need to be established. Suggestions encouraged developing a strategy to foster ongoing consideration and inclusion of TSM&O on every project. Defining steps to improve TSM&O integration into the planning phases with the roadway operations should remain on the action list as this TSM&O program moves forward. Other suggested actions included:

- 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 TSM&O solutions (e.g., checklists or "menus" for TSM&O suitability), so that they can integrate such concepts into projects during scoping meetings when appropriate.
- Conduct formal staff training of TSM&O and provide associated analysis tools for staff.
- Dedicate budget, training, and time in each project for TSM&O suitability analysis.
- Establish TSM&O strategic plans at a regional and/or statewide level.

Workforce Development

(CMM Self-Assessment Score: Organization/Staffing = 1.75 / 5)

The workforce necessary to successfully execute TSM&O is unique and varied. Traditionally, ITS programs have been largely champion-driven by a handful of staff interested in technology applications but often with backgrounds rooted in the traditional fields of study for transportation (engineers, planners, and managers). The workforce and staffing to support TSM&O needs both the traditionally trained DOT staff of traffic engineers and designers, planners, and managers, as well as those staff 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 TSM&O. 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 along the national average of a managed capability meeting the basic strategy applications with the core capabilities under development. Table 11 outlines areas that should be examined when considering workforce development issues in advancing TSM&O programs.

Table 11. Advancing TSM&O 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 TSM&O
Training	Access to special technical training tailored to advancing TSM&O

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

- MoDOT TSM&O 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 TSM&O skills, and staff organization would be reviewed to consider TSM&O career paths.

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

There are many resources for training available through various transportation associations and organizations, including through FHWA's Planning for Operations Program.[32] Specific training for each MoDOT focus area may be organized by region or through any of the other TSM&O core team members on a statewide level.

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

Performance Measurements

(CMM Self-Assessment Score: Performance Measurement = 2.5 / 5)

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 to further advance PM were to expand 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 TSM&O-specific information and bring these forward in the Tracker tool and other reporting programs.

Advancing TSM&O within MoDOT

The three priority focus areas have outlined action items and performance measures to help advance TSM&O within each focus area. In order to integrate the TSM&O program into MoDOT's organization it is useful to determine action items that apply to specifically to this process and these are synthesized in Table 12. Advancing TSM&O Action Matrix. Table 12 presents the various actions in a matrix that also captures how to measure and move forward with implementing each action. This table is formatted so that future revisions to this document and updates in the MoDOT TSM&O Program Plan can be easily incorporated and tracked.

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[32] http://www.ops.fhwa.dot.gov/ /plan4ops/resources/traing.htm

Table 12. Advancing TSM&O Action Matrix

Action	Steps to complete the action	Priority (H,M,L)	Status/ Timing	Measure of Success	Responsible MoDOT Staff
Area 1: Planning for Operations					
Integrate TSM&O into planning and programming processes.					
Performance measurement and management programs.					
Statewide and regional ITS architecture development and maintenance.					
Application of the systems engineering process.					
Advance operations through the application of the CMM.					
Train project managers and planning engineers to guide them in choosing which personnel and staff roles should be included in each projects.					
Improve planning processes and educate engineers planners, and other core team members about TSM&O solutions.					
Conduct formal staff training of TSM&O and provide associated analysis tools for staff.					
Dedicate budget, training, and time in each project for TSM&O suitability analysis.					
Establish					

Action	Steps to complete the action	Priority (H,M,L)	Status/ Timing	Measure of Success	Responsible MoDOT Staff
TSM&O strategic plans at a regional and/or statewide level.					
Area 2: Workforce Development					
Staffing Levels					
Champion Dependency					
Core Capacities					
Training					
MoDOT TSM&O 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 TSM&O skills, and staff organization would be reviewed to consider TSM&O career paths.					
Area 3: Performance Measurements					
Expand rural and arterial applications of PM through increased data collection to supplement existing data.					
Consider automating data processing and computation support for PM.					

5.0 LOOKING AHEAD

This program plan provides the business case for TSM&O 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 TSM&O actions are appropriate, details the foundational understanding for TSM&O, and documents the existing traffic operations programs. This plan also formally presents the mission and vision for TSM&O in Missouri moving forward, and details specific actions and steps the agency is going to accomplish along with 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 to help define national direction and standards. Such involvement becomes important especially in light of the current emphasis on connected and autonomous vehicle research, testing, and deployment, so that Missouri is prepared for these changes as they occur.

As Missouri's TSM&O 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 structured as a living document (for example action tables throughout the document are only partially completed) so that revisions to the detailed action tables and sections can occur. 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.

Individuals Sent by MoDOT to Receive Formal
Transportation Operations Training

Member	Year
Regional Operations Academy	
Chris Redline	2013
Brian Umfleet	2013
Laurel McKean	2013
Brandon Campbell	2013
Amy Twellman	2013
Danny Behl	2016
National Operations Academy	
Tom Blair	2007
Julie Stotlemeyer	2011
Jonathan Nelson	2012
Rebecca Allmeroth	2013
Jason Sims	2013
Randy Johnson	2014
Michael Middleton	2014
Lisa Vieth	2015
Michelle Voegele	2015
Marc Lewis	2016
Derek Olson	2016

Please Do Not
Text and Drive
MoDOT Cares

Advancing TSM&O Self-Assessment Workshop

During a statewide capability self-assessment workshop in late 2013, MoDOT and its partners prioritized several actions to advance operations for the state. Actions were defined by the participants in each of the six dimensions of the capability maturity model framework and are presented here, by dimension:

Business Process - including planning, programming and budgeting (resources), and project development and procurement.

- Consider TSM&O on the Statewide Transportation Improvement Program (STIP) side of agency operations, budgeting, and planning.
- Use urban operations to support and inform rural operations.
- Establish performance goals for TSM&O in both rural and urban environments.

Systems/Technology - including use of systems engineering, concepts of operations, systems architecture standards, interoperability, and standardization.

- Integrate different TSM&O systems (road weather information system [RWIS], motor carrier services, oversize/overweight (OS/OW) permits/AVL, TMC operations, computer-aided design [CAD], probe vehicle data, etc.) into a single, coherent, integrated, and rational system. Because of the scope of this task, start by focusing on establishing a timeline and plan of action for accomplishing this. Ultimately, we need to provide better communications between these various systems and the data they provide.
- Develop standard specifications for technology on a statewide level and identify a team to lead it. Establish a common procurement process and set of language for proposals and other documents (a kind of "clearinghouse" for standard boilerplate and common templates) among different agencies within Missouri.

Performance Measurement - including measures definition, data acquisition, analytics, communication, and utilization.

- Obtain richer data sets (including arterial data and rural data) to supplement existing data. Define goals for the performance data that the performance metrics can be measured against, and identify needs in the system and bottlenecks in the network. Use descriptive benchmarks to quantitatively and qualitatively describe system performance.
- Automate data processing and computation of performance measures.
- Focus on relevant and appropriate performance measures for drivers (e.g., travel time savings), instead of reporting everything possible. Identify purpose and applications for each performance measure.
- Inform management and the public about the performance benefits of TSM&O as compared to traditional infrastructure projects.
- Establish financing mechanisms for the long-term maintenance and operation of TSM&O projects.
- Evaluate projects holistically (e.g., safety, costs, and public benefits combined), rather than evaluating on a set of discrete and disconnected performance categories.

Organization/Workforce - including agency's organizational structure and lines of reporting, staff capabilities, training/development programs, and recruitment and retention of staff.

- With upper management support, define TSM&O roles within the organization to facilitate hiring of TSM&O staff, and establish associated training programs.
- Define what responsibilities fall under which region's jurisdiction with respect to TSM&O.
- Obtain flexibility in defining new job titles and job descriptions, deleting ones that are no longer relevant and updating descriptions.
- Establish standard job titles/descriptions for common TSM&O positions to facilitate recruiting and to identify what each staff member is responsible for.

Agency Culture - including technical understanding and agreed-upon business case, level of leadership, outreach, and program support for TSM&O.
- Encourage discussion and inclusion of TSM&O via key champions at SMT meetings for trickle-down recognition and appreciation of TSM&O throughout organization.
- Identify a TSM&O champion at the senior management and division head levels. Define dedicated roles within the organization for TSM&O expertise-sharing and knowledge-banking. Establish a TSM&O cohort.
- Educate staff, upper management, officials, and the public about TSM&O concepts, benefits, and analysis tools.
- Consider and evaluate TSM&O alternatives during project planning (e.g., early on in the project timeline), scoping, and implementation stages. TSM&O strategies should be considered in any project and included unless exclusion can be justified, rather than the other way around.
- Establish TSM&O peer exchanges and quarterly TSM&O meetings to share best practices learned from each of the regional agencies.

Collaboration - including relationships with public safety agencies, local governments, MPOs, and the private sector.
- 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 TSM&O solutions (e.g., checklists or "menus" for TSM&O suitability), so that they can integrate such concepts into projects during scoping meetings when appropriate. Update strategic plan to support these improved processes.
- Formal staff training of TSM&O and associated analysis tools for staff.
- Dedicate budget, training, and time in each project for TSM&O suitability analysis.
- Establish TSM&O strategic plans at a regional and/or statewide level.

Of the actions defined above by the stakeholders, two general focus areas arose: to increase awareness of TSM&O to further ingrain it into the culture in the agency, and to identify actions to incorporate TSM&O into MoDOT's formal planning processes.

Appendix C

Founding and Current Core Team Members

Position	Founding Members	Current Members
Central Office		
Traffic Liaison Engineer (**Core Team Lead**)	Julie Stotlemeyer	Julie Stotlemeyer
Traffic Management and Operations Engineer	Jon Nelson	Alex Wassman
Statewide Incident Response Coordinator	Lisa Vieth	Lisa Vieth
Liaison Engineer	Jason Vanderfeltz	Sarah Kleinschmit
Liaison Engineer	Rick Bennett	TBD
Liaison Engineer	Tim Chojnacki	TBD
Liaison Engineer	Dennis Brucks	TBD
Transportation Planning Specialist	Mike Henderson	TBD
District		
Kansas City Assistant District Engineer	Chris Redline	Chris Redline
Kansas City TMC Manager	Jason Sims	Randy Johnson
St. Louis Assistant District Engineer	Tom Blair	Tom Blair
St. Louis TMC Manager	Jeanne Olubogun	Jeanne Olubogun
Southwest Assistant District Engineer		Laurel McKean
TMC of the Ozarks Manager	-	Marc Lewis
FHWA		
Safety and Mobility Engineer	Marc Thornsberry	Marc Thornsberry

Traffic Incident Management Action Items

During a statewide capability self-assessment workshop, MoDOT and its partners prioritized several actions to advance TSM&O for the state. One of the priority items was to improve and expand MoDOT's TIM program, especially along rural interstates. A statewide team of MoDOT staff was assembled to improve MoDOT's TIM program throughout the state. Ultimately, this team's recommendations were shared with MoDOT and Missouri State Highway Patrol (MSHP) leadership. Together, the two agencies agreed to focus on four priorities for improving TIM in Missouri: get organized; get trained; improve on I-70 and I-44 first; and improve MoDOT TIM policies. The actions that participants brought forward during the workshop were categorized in these four priority areas.

Get Organized
Form TIM Improvement Subcommittee under the Missouri Coalition for Safer Roadway Safety Executive Committee.

- Establish a formal TSM&O program plan that includes a comprehensive TIM program with operations and management, towing, etc. Utilize Second Strategic Highway Research Program (SHRP2) resources on statewide and regional levels, and seek additional funding once actions are defined.
- Dedicate an incident management coordinator in the northwest, northeast, central, and southeast districts. Utilize existing job specifications, and add the following duties:
  - Set district direction for interstate and corridor coverage
  - Serve as the coordinator and primary trainer for TIM training and "train-the-trainer" (TtT) training
  - Track data related to TIM for the district
  - Serve as the single point of contact for all reported incidents within the district
  - Meet regularly with MoDOT district staff responsible for TIM activities
- With strategic partners, establish TIM committees at statewide, regional, and local levels to provide oversight and promote cooperation, including the following:
  - Executive Statewide Steering Committee
  - Regional Teams
  - Local Teams
  - Statewide TIM Training Steering Committee
- Develop and maintain relationships with TIM partners in the following ways:
  - Enter into Memorandums of Understanding (MOUs) with local responders
  - Work with agencies to create a local executive steering committee
  - Solicit endorsement and support from other state government agencies/associations
  - Solicit trainers from partner state agencies' staff and state associations' membership
  - Conduct "after action" reviews on major incidents
  - Attend multidisciplinary TIM training sessions
- Implement a robust towing management system in cooperation with MSHP and look to successful peer systems for guidance.
- Identify investment needs for TIM support systems. In particular, MoDOT's TIM program should collect more detailed incident data and improve incident reporting reliability.
- Establish performance goals and measures for TIM in both rural and urban environments (evaluate the performance of tow truck operators and emergency responders as well). Add all interstates to the MoDOT tracker measure and the traffic impact closures on major interstate routes. Expand the MoDOT tracker measure (travel times and reliability on major routes) to incorporate system-wide information. Create new measures to track and report on the economic impact of closures, capture performance on response and lane clearance time, and determine how well MoDOT responded to notifications from partner agencies.

Get Trained
Complete TIM Training of all MSHP and MoDOT team members who will be responding to traffic incidents.

- Provide SHRP2 TIM training throughout the state, especially in rural areas.
- Establish interagency guidance for TIM training; educate senior management about the importance of cross-agency training.
- Initiate conversation for standard operating procedures (SOP) between first/emergency responders and MoDOT/metropolitan planning organizations (MPOs)/transportation management centers (TMCs).
- Establish SOP specifically for urban and rural incidents.
- Require cities and regions to hold TtT sessions for towing operators.
- Require multidisciplinary TIM training for MoDOT safety-sensitive employees.
- Host an annual statewide TIM conference.

Improve on I-70 and I-44 First
Develop I-70 and I-44 corridor traffic incident response plans.

- Place dedicated incident response equipment in MoDOT facilities along the interstates and other major routes.

Improve MoDOT TIM Policies
Jointly review and revise any MoDOT TIM policies that could improve incident clearance times (such as push/pull or emergency lighting).

- Establish a formal, statewide TIM program (as part of the TSM&O program plan) and a dedicated MoDOT staff position to oversee it. (See actions items under "Get Organized," above.)
- Produce a formal document for Missouri's Statewide Traffic Incident Management Plan.
- Hold capability self-assessment workshop with incident management personnel to identify critical needs and improvement areas.
- Clarify legal and liability issues associated with incident clearance to reduce incident durations.
- Apply the capabilities and experiences of urban TIM operations to support and inform rural TIM operations.
- Establish standard statewide goals for incidents as follows:
  - Response Time Goal (from notification):
    - 30 minutes for normal working hours
    - 60 minutes for after-work hours
  - Clearance Time Goal: 90 minutes from arrival of the first responding unit until lanes cleared
- Investigate where MOUs are needed to further support and enhance TIM (e.g., to better coordinate incident response efforts among agencies).
- Enter into an MOU (Open Roads Policy) with MSHP that:
  - Facilitates joint efforts by emphasizing urgent and safe clearance of incidents
  - Sets goals and objectives related to TIM
  - Identifies responsibilities for each agency as well as shared responsibilities
  - Includes statutory references
- Revise current MoDOT policy to allow:
  - MoDOT personnel to pull and/or push vehicles to the shoulder (versus "push" only per current policy)
  - MoDOT personnel to respond to incidents as true "emergency" vehicles
  - Enhanced lighting on Emergency Response vehicles, similar to patrol vehicles
- Propose changes in legislation that support to the proposed changes in MoDOT policy and clarify MoDOT's ability to move forward with recommendations.

Work Zone Self-Assessment Outputs and Actions

During a statewide capability self-assessment workshop in late 2013, MoDOT and its partners prioritized several actions to advance work zone management (WZM) for the state. In addition, a self-assessment solely focused on work zone activities was held. Actions were defined in each of the six dimensions of the capability maturity model framework and are presented here, by dimension:

Collaboration - including relationships with public safety agencies, local governments, MPOs, and the private sector.

- Develop/enhance criteria for determining when and how to use law enforcement for WZM purposes.
- Take steps to ensure that agency WZM staff is requesting law enforcement for WZM systematically, effectively, efficiently and in accordance with developed policies.

Business Process - including planning, programming, and budgeting (resources) and project development and procurement.

- Develop criteria/procedures for transportation management plans (TMPs) from design to construction and discuss TMP at the post construction meeting.
- Continually improve quality for TMP.

Systems/Technology - including use of systems engineering, concepts of operations, systems architecture standards, interoperability, and standardization.

- Educate on availability of existing and emerging WZM technology for projects.
- Have an advocate of WZM technology within the core team.
- Identify funding early in planning/design process.
- Consider creating a Work Zone Intelligent Transportation Systems (ITS) Implementation Guide.

Performance Measurement - including measures definition, data acquisition, analytics, communication, and utilization.

- Provide a better breakdown of the quarterly data (share the fatality SharePoint data, set up alerts).
- Determine how to use real time data to get better.
- Provide general work zone crash details to public (seatbelt use, inattention, etc.).

Organization/Workforce - including agency's organizational structure and lines of reporting, staff capabilities, training/development programs, and recruitment and retention of staff.

- Use one traffic control standard for all applications; local public agency, permits, MoDOT, contractor.
- Develop tracking mechanism or requirement to submit work zone certification for permit work.
- Develop refresher/update for revisions to work zone policy/flagger.

Agency Culture - including technical understanding and agreed-upon business case, level of leadership, outreach, and program support for TSM&O.

- Distribute results of recent and ongoing innovative WZM efforts to WZM staff in partner agencies to raise awareness and encourage further innovations.

Of the 15 actions defined above by the stakeholders, two general focus areas arose: to increase efforts on developing criteria and processes, both internally and externally, for work zone operations, TMPs, and real-time data; and to increase outreach activities for internal MoDOT staff and partners to raise awareness and encourage innovation in work zone operations.

Exhibit 2

MoDOT TSMO Implementation Plan | *Team Action Matrix (Revised)*

Advancing TSMO and Advancing Technology & Roadway Operations (AT Team)

Action	Task	Subtask
Priority Area 1 | Business Process / Integration		
Improve planning and programming processes for increased focus on TSMO.	**(3)** **1.** Integrate TSMO into planning, programming, and design processes at the statewide and district levels	1. Identify potential TSMO strategies
		2. Cost per Strategy
		3. When to use Strategy
		4. Give to planning, then to district
		5. Use TSMO Perf Msrs to drive the selection of TSMO solutions.
	(1) **2.** Establish TSMO ~~committee~~ position within each district	1. Coordinate activities with statewide TSMO committee
	3. Continually update ITS architectures and plans	1. Where are we at today?
		2. Statewide and Regional Both needed 2a. Invention/We use today

		3. Always moving target (where do we want to be?)
		     3a. Needs to be adaptable
		     3b. Need a vision

		4. Need to establish routine update process w/committees
		     4a. Which group? Statewide? Leadership?
		     4b. Internal/External workforce

		5. Asset Mgmt – limiting factor?
		     5a. Define Replacement cycle time
		     5b. Funding
		     5c. Formalize ITS direction
		     5d. Centralized storage for date and kept up-to-date

		6. Integrate into current jobs/workforce

Advancing TSMO and Advancing Technology & Roadway Operations (AT Team)

Action	Task	Subtask
Priority Area 2 | Technology / Traffic Management		
Expand MoDOT's investment into Connected and Autonomous Vehicle (CAV) capabilities	**(4)** **4.** Establish a CAV corridor in Missouri	1. Identify candidate CAV corridors
		2. Select pilot corridor to invest in CAV technologies
		3. Deploy CAV technologies on pilot corridor

Encourage the application, integration, and expansion of TSMO solutions.	**5.**
	 Integrate different TSMO systems (RWIS, motor carrier services, signal coordination, CAD, predictive analytics, etc.) into a single, coherent, integrated, rational data repository
		1. Integrate
		  1a.Live data
		    i.Traffic incident to website
		    ii.CC TV
		    iii.Operational awareness
		      a.Snow ops
		  1b. Historical data
		    i. Measure performance
		    ii. Planning for future

		2. Challenges
		  2a. Data "Scientists"
		  2b.Bandwidth issue/IT Staff
		  2c.Automate the data

		3. Integrate ATMS data (3 TMCs)
	6. Develop predictive analytics programming	Develop predictive analytics programming to aid in anticipating occurrences on the highway system (such as crashes, weather, work zone crashes and congestion, recurring and nonrecurring congestion, etc).
	7. Employ and integrate crowdsourcing technologies	1. Expand use of HAAS Alert/Make way for traffic incident management and other fleet operations activities.

	8.
	 Develop standard specifications for technology on a statewide level / Establish a guide for the use of technology to solve traffic problems
		1. Develop unified platform
		  1a. Software (ATMS)
		  1b. CC TV – compatibility
		  1c. Provide a service

		2. Technology = ITS related
		3. Network communications
		4. Determine a common process for evaluating and testing new products and technology solutions
	9. Establish a common procurement process and set a language for proposals and other documents	1. EPG 9.10.5
		2. Check with other states on procurement, build, maintain
		3. OA contracts
Priority Area 3 | Funding		
Provide funding for stand alone TSMO projects.	**10.** Consider TSMO on STIP side of agency operations, budgeting, and planning	1. Figure out how to compare TSMO projects with standard projects - B/C equivalent - including projects that have both traditional and TSMO elements
		2. Explore the possibility of including "operational condition" to the asset management process

Advancing TSMO and Advancing Technology & Roadway Operations (AT Team)

Action	Task	Subtask
Allocate funding for TSMO within each project.	**11.** Develop a program and guidelines to implement TSMO to mitigate adverse traffic impacts of construction projects.	In the project development process, establish procedures to: a) evaluate traffic impacts of project construction, b) implement TSMO features to mitigate traffic impacts, c) provide funding for TSMO features, and d) provide training/guidance for design engineers & planners.

Priority Area 4 | Agency Culture

Action	Task	Subtask
Improve agency technical understanding and support of the overall TSMO program.	**12.** Establish TSMO peer exchange (internal and external)	NOTE: Host a peer exchange meeting in MO and invite other states to participate. FHWA has resources to assist with this.
	13. Add TSMO as a new Innovations Challenge category	NOTE: Include in next year's Innovations Challenge. Also, internal training and education should occur prior to launching in the Innovations Challenge program.
	14. Determine how to incorporate TSMO successes into a rewards system	- ribbon-cuttings - newspapers - slide show of the week, etc.

Priority Area 5 | Performance Measures / Data

Action	Task	Subtask
Enhance performance measurement reporting and data acquisition. Identify purpose and applications for each performance measure.	**15.** Evaluate what data exists, how it can be used, and determine what is still needed	1. Reach out to divisions/districts 1a.TMC's (dist.)
		2.National data (HERE) probe data (speeds)
		3.Smart WZ data (especially rural WZ)
		4.Division-Planning-Statewide counters
		5.Add to central data warehouse?
		6.TMS
		7.WAZE App data

	(2) **16.** Establish TSMO performance measurement metrics and goals at the statewide and district levels	1. Statewide
		    1a. Research other agencies (states/nation)
		    1b. Delay/Reliability metrics for projects
		    1b. Determine strategies based on goals
		    1c. How measure
		    1d. Outcome you desire

		2.Section 5 of Tracker – Add Perf. Meas.

		3.District Level (≈ D Tracker)
		    3a."Similar" to statewide but may add based on dist.
		    Needs

		4.Review Safety/Traffic Division Tracker

Advancing TSMO and Advancing Technology & Roadway Operations (AT Team)

Action	Task	Subtask

	17.
	Determine the benefits of TSMO vs the cost of TSMO
		Benefit/Cost
		    1a.Determine ROI
		    1b.Comm. Soft Cost (sitting in traffic) vs. STIP Proj.
		    1c. MoDOT perspective – Impact Economic $
		    1d. Public perspective – Save them $ and time
		    1di. Can't always see TSMO strategies

	18. Determine how to communicate TSMO performance measures to the public (NOTE: Involve CR in finalization of these subtasks)	1. Dashboard
		2. "Bucket Style" graphs or Wheel Graph (citizen guide)

		3. Videos
		    3a. Cartoon like
		    3b. Recorded live and demo

		4. Social Media
		5. Infographics

Advancing TSMO and Advancing Technology & Roadway Operations (AT Team)

Action	Task	Subtask
Priority Area 6 | Educate / Training		

Increase awareness and provide outreach opportunities and encourage the advancement of TSMO within MoDOT, with partner agencies, and with the public.	**19.** Educate upper management and staff about TSMO concepts	1. Identify Audiences
		    1a. SMT
		    1b. Dist. Engineer + ADE Mtgs
		    1c. Department/Division Heads

		2. Level of Education
		    2a. TSMO Video
		    2b. Presentations

		3. Frequency of Education Discussions
		    3a. SMT + PE – 2x/yr.
		    3b. Division + Dept. Heads – 2x/yr.

	20. Inform general MoDOT staff about benefits of TSMO.	1. MoDOT Minute
		2. Weekly Update
		3. Lunch + Learns w/PDH's
		4. Organized Trainings over benefits
		5. Quarterly Division Mtgs + Hot Topic to focus on
	21. Create a formal training program for engineers, planners, and core staff for TSMO solutions	1. SMT 1a. Broad Benefits of TSMO
		2. District + AE's 2a. Intro to TSMO

		3. Staff Level
		    3a. Tailored Plans to certain depts.
		    3b. Traffic vs. Planning vs. Design

	22. Inform public about benefits of TSMO and their driving behaviors	1. Social Media – Public level 3a. Videos
		2. TSMO Maps – Similar to STIP Map

	23. Educate legislature on benefits of TSMO	1. Urban vs Rural
		    1a.Work Zone Management
		    1b.DMS Messaging
		    1c.Report Card/Map

		2.Integrating
		    2a.Infographic Sheet
		    2ai."Here's your problem, here are solutions + costs vs.

		3. Integrate During FOCUS Document + TRACKER
		4. Political Sensitivity Issues (i.e.: Color DMS Travel Times G/Y/R)
		5. Merge mobility report, traveler info, press releases
		6. Shift driver departure and arrival times
		7. Map w/ suggested and expected times to travel
Priority Area 7 | Organization / Work Force		
		1. Document skills and needs

Advancing TSMO and Advancing Technology & Roadway Operations (AT Team)

Action	Task	Subtask
Assess staff capabilities and needs for TSMO specific staffing needs and assignments.	24. Evaluate where TSMO fits into MoDOT's organization.	2. Evaluate job descriptions and organization structure and needed skills for advancing TSMO
		3. Consider where positions fit into MoDOT's organizational structure
		4. Establish standard job titles for TSMO positions
		5. Implement training courses (NOTE: MoDOT HR does NOT develop training)
		6. Include TSMO in career ladders

MoDOT TSMO Implementation Plan | *Team Action Matrix (Revised)*

Work Zone Management (WZM Team)

Action	Task	Subtask
Priority Area 1 | Collaboration		

Provide guidance on building greater relationships with partners.	**(1)** 25. Develop/enhance criteria/policy for determining when and how to use law enforcement for work zone purposes.	1. Law Enforcement (LE) Handout
		   a. Create document
		   b. Engage HP & Agencies for comment
		   c. Incorporate in LE and internal training classes
		2. LE Projects
		   a. Create centralized list of projects being used
		   b. Ensure current recommendations for project use exist in EPG
		   c. Prioritize Work Zones for LE use

	(2) 26. Contractor Involvement	1. Work Zone Traffic Control (TC) Flyer
		   a. Create Document (Identify top deficiencies and sources of information)
		   b. Engage contractors & interal staff for comments
		   c. Have available for contractor training classes
		   d. Distribute at Preconstruction Meetings & Pre-Activity meetings with contractor's TC staff
		
		2. Contractor Expectation Review
		   a. Propose Contractor Performance Rating (CPR) refinements
		   b. Obtain internal comments on proposed changes
		   c. Seek comments from external associations
		   d. Implement refinements to Contractor Performance Rating

Priority Area 2 | Business Process		
Improve project delivery processes of TMP document .	27. Develop criteria/procedures for TMP from design through construction and discuss TMP at the post-construction meeting.	TMP JSP Refinement 1. Draft JSP refinements 2. Distribute to internal staff for comment 3. Distribute to internal working groups including (WZQC) for discussion 4. Submit refinements for JSP
	28. Develop check-in processes for continuous TMP quality improvement.	Post Construction Review (include Design and Construction)
Reduce incidents on project/events	29. Conduct Post Incident Construction Reviews	Develop checklists to be used on Post Incident Construction Reviews NOTE: Check with WZ Quality Circle and Districts to determine what bi-weekly checklists are presently available.

Work Zone Management (WZM Team)

Action	Task	Subtask
Priority Area 3 | Systems/Technology		
Encourage (and engage in) the exploration, expansion, and application of technology in work zones.	30. Educate MoDOT personnel on availability of existing and emerging work zone technology for projects.	Promote Work Zone Technologies 1. Identify JSP's which need refinement

		2. Draft JSP refinements
		    1. Speed Trailer
		    2. CMS with rumble strips

		3. Incorporate application of technologies into internal designer training

Work Zone Management (WZM Team)

Action	Task	Subtask
Priority Area 3 | Systems/Technology (continued)		
Encourage (and engage in) the exploration, expansion, and application of technology in work zones. (continued)	**31.** Designate an advocate for advancing work zone technology and application within the core team.	Assigned to the Project Manager - To be discussed at each core team meeting **NOTE: This item is completed. Cross-reference to the training section to provide training to PMs for this work**

	(3) 32. Develop procedures to identify work zone funding early in the planning/design process.	1. Promotion of Technologies at Planning Stage
		   a. Establish a Priority Map based on volume, congestion and accident criteria.
		   b. Plot priorities, with focus on high volume sections of roads.
		   c. Consider ranking system for priorities and obtain comments on rankings
		   d. Plot state map with prioritizations for system
		   e. Publish map for use in planning stage to ensure TSMO funding is established early for high priority areas within given regions

		2. Policy Refinement
		   a. Identify Areas needing updating
		   b. Draft revisions
		   c. Obtain comments on proposed changes
		   d. Submit changes for approval and inclusion in Policy.

	33. Create a MoDOT WZ TSMO Guide (which incorporates the FHWA publication),	1. MoDOT Work Zone TSMO Guide
		   a. Cover pages created delivering overview
		   b. Document content includes descriptions of TSMO & technology options to improve traffic flow and safety on construction projects. The descriptions should include pertinent details of the options as well as criteria for selection.

	(4) 34. Implementation and review of new Work Zone technologies	1. Updated JSP's available for identified technologies
		2. Piloting and review of emerging technologies
		3. Deployment
	35. Zipper Merge	1. Improved JSP Wording - Post First Draft a. simplified Queue warning and speed detection
		2. Post list of actions needed for this item.
Priority Area 4 | Performance Measurement		
Enhance performance measurement	**36.** Enhance use and application of real-time data	Propose new metrics to measure performance (Average WZ crashes in Smart WZ's mentioned)

Work Zone Management (WZM Team)

Action	Task	Subtask
reporting and data acquisition on work zones.	37. Provide general work zone crash details to the public (seatbelt use, inattention, work zone etc.).	1. Post information currently shared on DMS signs, social media and coalitions.
		2. Determine the statistics which are important to share with the public, the legislature, and others.

Work Zone Management (WZM Team)

Action	Task	Subtask
Priority Area 5 | Organization/Workforce		
Assess staff capabilities and needs for a stronger work zone program.	**38.** Develop refresher/update for revisions to work zone policy/flagger.	1. Review state of practice, ensure utilization of flagger certification renewal process
	39. Ensure that one traffic control standard is used for all applications (by local agencies, permit offices, MoDOT, and contractors)	1. Compare and revise documents for uniformity between contractor, permit, and MoDOT work zone policies.
		2. Review proposed changes with the various groups for their review and approval.
	40. Develop tracking mechanism or requirement to submit work zone certification for permit work.	1. Review current state of practice, ensure streamlined use of TMS where applicable
Priority Area 6 | Agency Culture		
Improve technical understanding and support to work zone strategies as part of the TSMO program.	**41.** Distribute results of recent and ongoing innovative work zone efforts to MoDOT staff and partner agencies to raise awareness and encourage further innovations in Missouri's WZM.	1. By working in cooperation with the AT team, new resources and existing pertinent information will be published to the applicable sites and shared in applicable meetings and trainings.

MoDOT TSMO Implementation Plan | *Team Action Matrix (Revised)*

Traffic Incident Management (TIM Team)

Action	Task	Subtask
Priority Area 1 | Promote TIM Training		
	42. TIM training throughout the state, especially in rural areas.	-Responder Training
		-Train-The-Trainer Training
		-Update Training Plan (and target groups)
Priority Area 2 | Strategic Planning		
Business Processes	**(3)** **43.** Conduct TIM CMM exercises for urban and rural regions/corridors. TIM self-assessment completed annually. Work with MSHP and other members of TIM	-Use results from self assessment to determine needs, priorities and steps for improvement of TIM program
(2) Organizational Structure	**44.** Review organizational structure within MoDOT to support TIM. The organizational structure to support TIM is better defined in the urban districts, but not as defined in the rural districts.	-Make the business case for TIM (costs, benefits, etc)
		Review TIM coordinator job description. Committee to work with District leadership.
	45. Establish Regional TIM committees on interstate corridors and at statewide, regional and metro/local levels to provide oversight and promote cooperation.	NOTE: For interstate corridors, focus on I-44 and I-70 first.
Develop Policies, Guidelines & Best Practices	**(1)** **46.** Review existing TIM documents and update to accurately reflect MoDOT's priorities and commitment to traffic incident management and TSMO.	Update and adopt **Missouri Open Roads Policy** a) Review draft policy and update as appropriate b) Take steps to gain approval of policy Update and adopt **MoDOT Strategic TIM Plan** a) Review draft strategic plan and update as appropriate b) Take steps to gain approval of Strategic TIM Plan
Review/Change Laws & Policies	**47.** Encourage/require all responders to participate in TIM responder training prior to working incidents.	NOTE: Determine recommendations and refer to TIM Executive Committee
	48. Clarify legal and liability issues associated with traffic incident clearance to reduce traffic incident durations. Coordinate with external parties such as MSHP, towing companies, and CMV to clarify their legal responsibilities.	NOTE: Determine recommendations and refer to TIM Executive Committee
Priority Area 3 | Promote TIM Best Practices		
	49. Develop guidelines and promote best practices for quick clearance.	-Develop Best Practices for TIM (for MODOT, partners, and public)

Traffic Incident Management (TIM Team)

Action	Task	Subtask
	50. Initiate development of standard operating procedures (SOP) between first/emergency responders, MoDOT/TMCs, and Partner Agencies.	-Review statewide SOPs already developed and update for urban and rural areas.
		-Take steps to approve SOPs
	51. Execute MOUs to ensure adoption of CRPs.	

Traffic Incident Management (TIM Team)

Action	Task	Subtask
	52. Update & implement performance goals and measures for TIM in both rural and urban environments.	-Review current performance goals and measures for TIM in both rural and urban environments.
		-Consider additional performance goals & measures for TIM in both rural and urban environments.
		-Update performance goals & measures for TIM in both rural and urban environments.
Priority Area 5 | Corridor TIM Plans		
	53. Develop corridor response plans - for interstate highways and metropolitan areas.	-Define objectives
		-Define components of a corridor CRP
		-Prioritize corridors
		-Develop CRPs

Priority Area 4 \| Monitor Performance Measures