ITS AND TSMO STRATEGIC PLAN

January 2024

Regional - Tulsa

OKLAHOMA Transportation

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List of Acronyms

ACOG	Association of Central Oklahoma Governments
ADAS	Advanced Driver Assistance System
ASCT	Adaptive System Control Technology
APC	Automatic Passenger Counter
API	Application Programmer Interface
ATMA	Autonomous Truck-mounted Attenuators
ATMS	Advanced Traffic Management System
ATR	Automatic Traffic Recorder
AV	Automated Vehicles
AVL	Automatic Vehicle Location
BABS	Broken Arrow Bus System
BRT	Bus Rapid Transit
CAD	Computer–aided Dispatch
CAV	Connected and Automated Vehicles
CMM	Capability and Maturity Model
CVISN	Commercial Vehicle Information Systems and Networks
DOT	Department of Transportation
DMS	Dynamic Message Signs
DPS	Department of Public Safety
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FMS	Freeway Management System
GGEDA	Grand Gateway Economic Development Association
GPS	Global Positioning System
HAR	Highway Advisory Radio
HOT	High Occupancy Toll
HQ	Headquarters
ICM	Integrated Corridor Management
ICS	Incident Command System
IMO	Integrating Mobile Observations
INCOG	Indian Nations Council of Governments
IT	Information Technology
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
lidar	Light Detection and Ranging
LMR	Land Mobile Radio
MOE	Measures of Effectiveness
MPO	Metropolitan Planning Organization
MSA	Metropolitan Statistical Area
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
NHTSA	National Highway Traffic Safety Administration
ODOT	Oklahoma Department of Transportation
OHP	Oklahoma Highway Patrol
OHSO	Oklahoma Highway Safety Office
OKTIM	Oklahoma Traffic Incident Management
OMES	Office of Management and Enterprise Services
OMPT	Office of Mobility and Public Transit
ORI	Office of Research and Innovation
OTA	Oklahoma Turnpike Authority
OU	Oklahoma University
PTZ	Pan-tilt-zoom
RTKS	Real-time Kinematics Systems
RTMC	Regional Transit Management Center
RWIS	Roadway Weather Information System
RWM	Road Weather Management
SaaS	Software as a Service
SAFE-T	Statewide Analysis for Engineering & Technology
SLA	Service Level Agreement
SSO	State Safety Oversight
STIP	Statewide Transportation Improvement Plan
SWZ	Smart Work Zone
TI	Traveler Information
TIM	Traffic Incident Management
TM	Traffic Management
TMA	Truck-mounted Attenuator
TMC	Traffic Management Center
TRPS	Traffic Responsive Plan Selection

TSM	Traffic Signal Management
TSMO	Transportation Systems Management and Operations
UAV	Unmanned Aerial Vehicle
USDOT	U.S. Department of Transportation
VOT	Value of Time
VMT	Vehicle-miles Traveled
VSL	Variable Speed Limit
WZDX	Work Zone Data Exchange
WZM	Work Zone Management

1 Executive Summary

The Tulsa Intelligent Transportation Systems (ITS) and Transportation Systems Management and Operations (TSMO) Regional Strategic Plan is a comprehensive plan that outlines the current state of the region's ITS program and provides a road map for its future development and implementation of ITS and TSMO activities. The plan was developed through a collaborative process involving stakeholders from various agencies and organizations, including the city of Tulsa, the Oklahoma Department of Transportation (ODOT), and local transit agencies. It has also been developed in parallel with a statewide ITS and TSMO strategic plan.

The business case for this plan is clear: *ITS technologies have the potential to significantly improve the safety, efficiency, and reliability of the transportation system in the Tulsa region.* By implementing these technologies, we can reduce congestion, improve mobility, and enhance the overall quality of life throughout the region.

The strategic plan development process began with a thorough analysis of the current ITS program in the Tulsa region. This effort included a review of existing ITS technologies and services and an assessment of the strengths and weaknesses of the current programs. Based on this analysis, a set of priorities and a road map for the development of the ITS program were developed. The current ITS program in the Tulsa area includes a wide range of technologies and services, including traffic management, public transportation, traveler information, and emergency response.

The plan also prioritizes the development of TSMO programs, which aim to optimize the use of existing transportation infrastructure and resources using advanced technologies and data analytics. To support the implementation of the TSMO programs, the plan outlines a series of business processes and resource allocation strategies. To fully benefit from TSMO and ITS technologies, the Tulsa region has invested in personnel, systems, and infrastructure to support its focus on TSMO, which has allowed for the integration of these technologies into the organization's current structure and processes. However, as the emphasis on operations increases, it may be necessary for the organization to make added changes to its structure and processes to fully support the advancement of TSMO activities. The proposed system will include a set of metrics and targets to measure the effectiveness of the plan and regular reporting and feedback mechanisms to confirm that the plan is on track and meeting its goals.

The plan also includes a detailed implementation road map, which outlines the specific actions and milestones that will be needed to achieve the goals of the TSMO programs. This effort includes the establishment of a dedicated ITS governance structure, the development of partnerships and collaborations with other agencies and organizations, and the identification of funding sources to support the implementation of the plan.

Overall, the Tulsa ITS and TSMO Regional Strategic Plan provides a clear and comprehensive vision for the future of the region's ITS program and a road map for achieving that vision through the implementation of TSMO programs and other innovative technologies and services.

2 Business Case

This strategic plan provides the business case for Intelligent Transportation Systems (ITS) and Transportation Systems Management and Operations (TSMO) in the Tulsa, Oklahoma, region. According to the U.S Census Bureau[1], the Tulsa Metropolitan Statistical Area (MSA) includes seven Oklahoma counties: Creek, Okmulgee, Osage, Pawnee, Rogers, Tulsa, and Wagoner (**Figure 1**). The Tulsa region is home to approximately 25.2 percent of the state's population, and it covers 6,460 square miles[2].

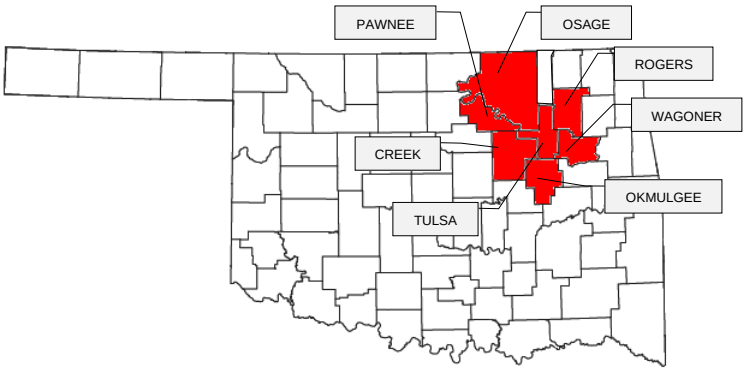

Figure 1. Tulsa Metropolitan Statistical Area Region.

The Oklahoma Department of Transportation (ODOT) and the Indian Nations Council of Governments (INCOG) have previously named growing needs for improved traffic management and operation in the Tulsa region. This ITS and TSMO strategic plan details the program that the region will commit to moving forward so it can advance operations on the region's roadways' network. The goal of TSMO is to optimize the performance of the existing transportation system and improve safety and mobility for all users.

2.1 Tulsa Region Challenges

The Tulsa MSA is a thriving hub of activity in Oklahoma, with a population of over 1 million (M) people. The region is known for its vibrant economy, diverse culture, and beautiful natural surroundings.

As the world becomes increasingly connected, cities are looking for ways to become more efficient and livable. Tulsa is no exception. In recent years, the Tulsa MSA has been working to improve its transportation infrastructure through the development of a regional transportation plan called Connected

> *"The vision of Connected 2045 is to meet the needs of future TMA [Transportation Management Area] travelers focusing on improving roadways, transportation safety, bicycle-pedestrian mobility, and new technologies."*
>
> - *Connected 2045 Regional Plan (Vision)*

[1] Source: U.S. Census Bureau (2022). American Community Survey 1-year estimates. Retrieved from Census Reporter Profile page for Tulsa, OK Metro Area <http://censusreporter.org/profiles/31000US46140-tulsa-ok-metro-area/

[2] Source: Tulsa MSA Briefing, October 2017. (https://oklahomaworks.gov/docs/2017/12/Tulsa-MSA-Briefing-October-2017.pdf)

2050 Tulsa Regional Transportation Plan [3] that incorporates ITS and TSMO activities. Prior to the Connected 2050 Tulsa Regional Transportation Plan, the region published the 2045 Connected Regional Transportation Plan[4]. At a high level, both plans anticipate the need to upgrade the region's transportation infrastructure and make it more responsive to future traffic demands. For example, the plans recognize the need to deploy regional architecture-based systems to equip implementing agencies with the necessary resources for enhancing the use of ITS in the context of travel monitoring. A key part of the plan is the deployment of advanced technologies, which will help the Tulsa region manage transportation safety and bicycle-pedestrian mobility and improve the connectivity of the roadway network.

The transportation challenges that Tulsa road users face are numerous and addressed broadly in the Connected 2050 Tulsa Regional Transportation Plan goals and objectives in **Table 1**. These challenges can be rolled into four categories: safety, mobility, freight, and active transportation; these have been the cornerstones for the region.

To address these challenges, agencies within the Tulsa region have recommended the integration of ITS and TSMO into the transportation network in their Connected 2050 Tulsa Regional Transportation Plan. The plan aims to improve traffic flow and safety, reduce congestion, and promote the use of sustainable modes of transportation.

One of the key plan components is the development of ITS to monitor and manage traffic flow. This step can include things like traffic cameras, sensors, and advanced traffic management systems that can provide real-time information to drivers and other road users.

The other key aspect of the plan is the implementation of TSMO, which includes strategies and tactics for the effective management and operations of the transportation system. Some examples of TSMO strategies and tactics for effective management and operations of the transportation system include implementing technologies such as real-time traffic information dissemination to better manage traffic flow and lessen congestion; leveraging data from various sources to make informed decisions about transportation system operations; and establishing partnership and collaboration with local agencies to better coordinate and manage transportation system operations.

Despite these challenges, the Tulsa region has several strengths that can be leveraged to overcome these obstacles. For instance, the region has a strong commitment to improving transportation, which has led to the development of innovative transportation solutions. Worth noting, the Tulsa region has existing ITS infrastructure projects that can be used as a foundation for future projects and several partners (stakeholders) that are committed to working together to improve transportation in the region.

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[3] Source: Connected 2050 Tulsa Regional Transportation Plan, November 2022 (https://www.incog.org/Transportation/Connected2050/Connected2050Plan.pdf)
[4] Source: Connected 2045 Regional Transportation Plan, November 2017 (https://oklahoma.gov/odot/programs-and-projects/transportation-programs/lrtp.html)

Safety and mobility are considered major regional challenges. According to stakeholders these challenges include the significant traffic congestion during peak travel times, lack of alternative modes of transportation, and limited infrastructure for pedestrians and bicyclists.

Table 1. Connected 2050 Tulsa Regional Transportation Plan Goals.[5]

Goal Area	Goal
Safety and Security	Provide a safe transportation system for all users.
Infrastructure Preservation	Preserve and maintain the condition of Oklahoma's multimodal transportation system through risk-based, data-driven decision-making processes.
Mobility and Accessibility	Facilitate the movement of people and goods, improving connectivity between regions and activity centers and increasing travel mode choice.
Economic Vitality	Provide a reliable multimodal transportation system that coordinates with land development patterns, strengthens communities, and supports a healthy and competitive Oklahoma economy.
Environmental Responsibility	Minimize and mitigate transportation-related impacts to the natural and human environments.
Efficient Intermodal System Management and Operation	Maximize system performance and operations.
Fiscal Responsibility	Sustainably fund and efficiently deliver quality transportation projects while continuing to leverage additional resources in coordination with the Oklahoma Department of Transportation's partners.

2.1.1 Safety

To gain a deeper understanding of the safety-related challenges experienced in the Tulsa region, a review of the available crash data was conducted. INCOG can evaluate historical crash data by using the ODOT Collision Database (SAFE-T) in combination with various mapping tools to produce a regional crash map[6]. **Figure 2** shows a 10-year crash period for the region. This analysis shows that after a crash peak in 2008 (12,544 total crashes), there was a decline in crashes through 2010. In 2011 and 2012, a second peak

[5] Source: Connected 2045 Regional Transportation Plan, November 2017 (https://oklahoma.gov/odot/programs-and-projects/transportation-programs/lrtp.html)
[6] Source: INCOG Regional Crash Map (2008-2017) (https://incog.maps.arcgis.com/apps/MapSeries/index.html?appid=55f30e03c88b4dd79d2fe0c99d419bd6)

was observed, but with an overall decrease in crashes every year after until 2017, with upticks in 2015 and 2017.

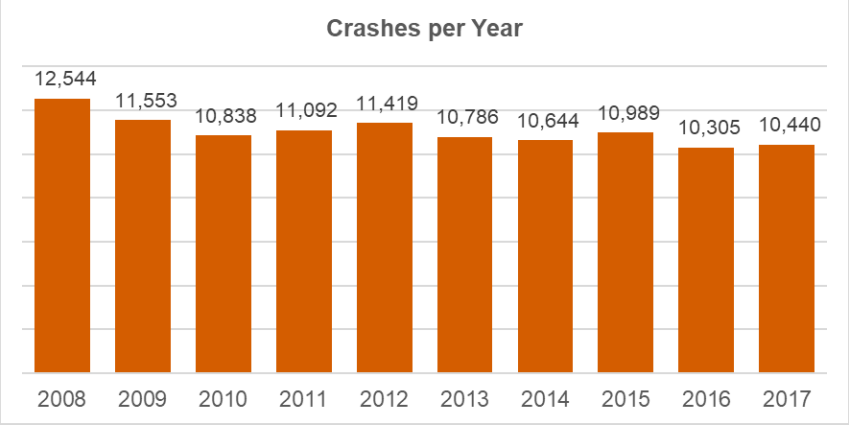

Figure 2. Indian Nations Council of Governments / Oklahoma Department of Transportation Collision Database Crashes per Year (2008-2017).

The Oklahoma Highway Safety Office (OHSO) has provided recent crash data counts for the years 2018 through 2021 for the counties in the Tulsa region[7]. The reports show an overall increase in crashes in the region, with a slight decrease in crashes in 2021; the total number of crashes were reported as 10,877 (2018), 10,926 (2019), 8,915 (2020), and 5,756 (2021). However, it is important to note that the trends in the years 2020 and 2021 may be influenced by several factors, which include reduced vehicle miles traveled (VMT) or fewer vehicles in the roads because of COVID-19[8]. Nevertheless, TSMO and ITS technologies can play a significant role in improving safety and reducing overall crashes by optimizing the use of existing infrastructure and improving communication and coordination among key stakeholders in the region.

Data was also analyzed to better understand the crash trends and differences in urban and rural areas. For an area to be considered urban in this analysis, it must have a population of 5,000 or more, as designated by the U.S. Census Bureau. For an area to be considered rural, it must have a population of 4,999 or fewer. These urban and rural designations have been defined in the 2020 Oklahoma Highway Safety Crash Facts Book[9].

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[7] Source: Oklahoma Highway Safety Crash Data, 2018-2021: Crash Data | Oklahoma Highway Safety Office
[8] Source: Overview of Motor Vehicle Crashes in 2020 https://crashstats.nhtsa.dot.gov/Api/Public/Publication/813266
[9] Source: 2020 Oklahoma Crash Facts, Fall 2021 (2020_s1_summarybackground.pdf (ok.gov), Accessed in November 2022)

Figure 3 shows the breakdown of highway miles in the Tulsa region for 2020, including the Tulsa, Creek, Osage, Rogers, and Wagoner counties. **Figure 4** illustrates the distribution of crash frequencies of various characteristics from the most recently available one year of crash data (2021) [10]. Both figures show the rural/urban designations of the respective data. The data is not normalized for volume data along specific segments; however, high-level comparisons can be made. For example, Tulsa's urban highways represent an approximate 52 percent of highway miles and account for 94 percent of the severe crashes in 2021. This statistic shows that most severe crashes per highway-mile occur in urban areas; this can be expected because of their higher traffic volumes. The data mirrors the statewide trend showing that most severe crashes occur along urban highways.

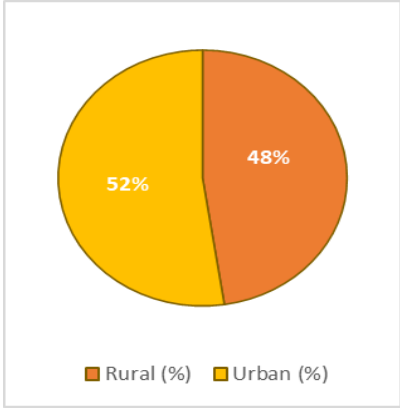

Figure 3. Tulsa Region Highway Mileage (Rural vs. Urban).

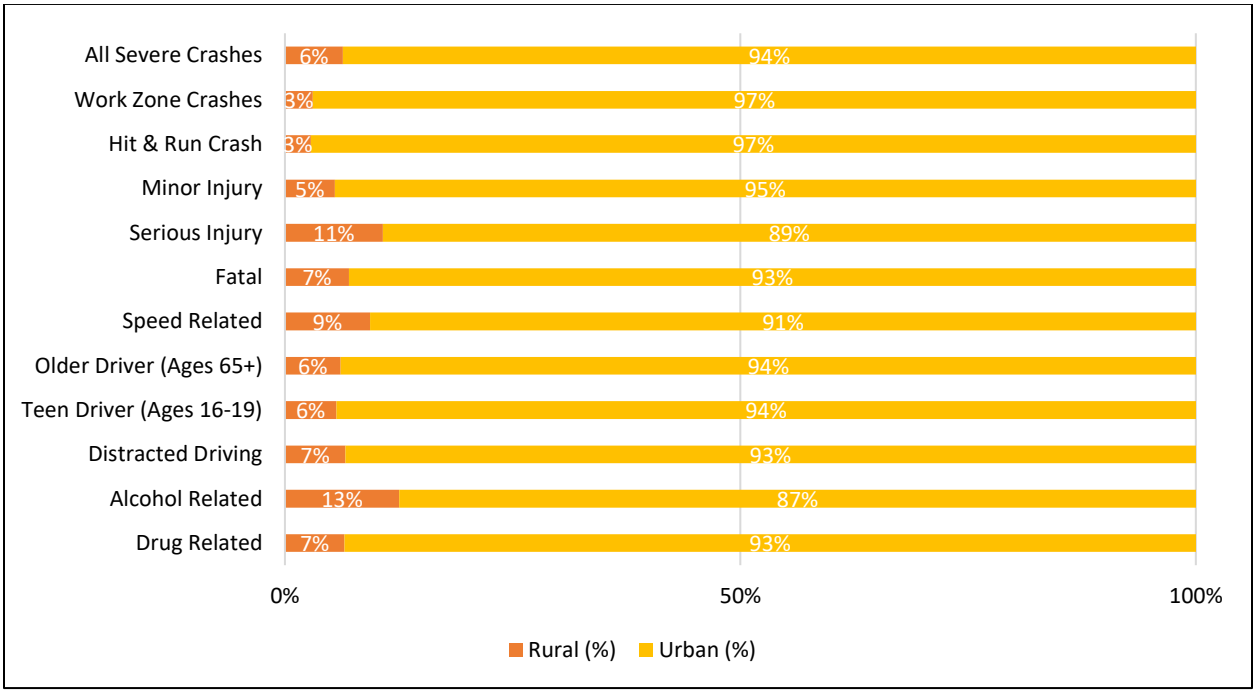

Figure 4. Tulsa Metropolitan Region 2021 Severe Crash Data Summary (Rural vs. Urban).

[10] Source: Oklahoma Interactive Crash Maps, https://ohso.ok.gov/crash-data2, summarized November 23, 2022.

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2.1.2 Mobility

The mobility challenges in Tulsa that ODOT can tackle stem from both recurring and nonrecurring traffic congestion affecting all users of the road network. Recurring congestion is caused by an ongoing problem, such as construction or maintenance. Nonrecurring congestion is caused by a one-time event, such as a large event (i.e., sporting event or a county fair) or traffic accidents. Recurring congestion poses significant challenges in urban areas, resulting in driver delays, frustration, heightened pollution, and increased fuel consumption while nonrecurring congestion remains a persistent concern for cities and regions alike.

At a national level, it has been estimated that 55 percent of congestion is caused by nonrecurring events11. As shown in **Table *2,*** it is now estimated that of the nearly 1.5 million vehicle-hours of delay experienced by Tulsa motorists in 2019, 52 percent of that congestion was nonrecurring. **Figure 5** illustrates recurring and nonrecurring incidents in rural and urban areas. This analysis revealed that the urban areas experience the majority of both congestion types that Oklahoma road users experience (51 percent and 45 percent of nonrecurring and recurring congestion, respectively).

Table 2. Tulsa Metropolitan Area Congestion by Source (2019).

Source of Congestion		Estimated Vehicle-Hours of Delay[12]	% Of Total
Recurring	Holiday	32,258	5%
	Recurrent	112,891	17%
	Signals	263,729	39%
	Unclassified	266,681	39%
	Recurring Sub-totals	***675,559***	***48%***
Nonrecurring	Incident	171,428	23%
	Incident & Weather	40,255	5%
	Incident & Work Zone	15,016	2%
	Other Multiple Causes	124,304	17%
	Recurrent & Incident	19,095	3%
	Signal & Weather	22,469	3%
	Unclassified	266,681	36%
	Weather	60,490	8%
	Work Zone	25,306	3%
	Nonrecurring Sub-totals	***745,044***	***52%***
	Total	**1,420,603**	**100%**

[11] Source: https://ops.fhwa.dot.gov/aboutus/opstory.htm
[12] Source: RITIS, Congestion Causes for the National Highway System (NHS), www.ritis.org/archive/congestion, accessed January 18, 2022)

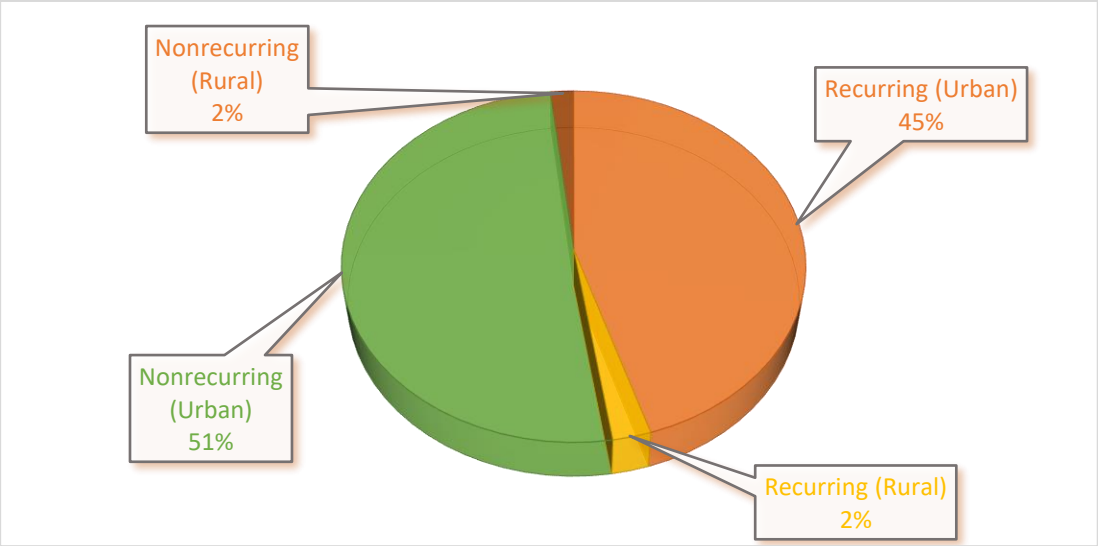

Figure 5. Tulsa Region's Approximate Congestion Sources (Rural vs. Urban; 2019).

2.1.3 Freight

The Tulsa region is facing several transportation freight challenges. The 2045 and 2050 regional long-range transportation plans seek to address these issues. Freight planning is an important part of this plan, which tackles parts of the work that is still to be done. The most pressing freight-related challenge is the lack of efficient freight transportation options and access to freight terminals through intermodal connectors. Currently, most freight is shipped by truck, which is costly and time consuming. To make the most of the region's resources, there must be enhanced integration and connectivity of the transportation system for freight as defined in the regional goals for roadways in the Connected 2050 Tulsa Regional Transportation Plan. In this plan, recommendations to advance regional connectivity and economic competitiveness include working with the Tulsa ports of Catoosa and Inola, Tulsa International Airport Authority, Metropolitan Tulsa Transit Authority, and public and private freight entities.

Other challenges facing the Tulsa region are the increasing demand for goods and services and planning for future infrastructure needs. According to the Connected 2050 Tulsa Regional Transportation Plan, the region is home to several manufacturing, distribution, and retail businesses, which all rely on a robust transportation network to move goods and materials. This demand is expected to continue to grow, putting further pressure on the region's transportation infrastructure.

To address these challenges, the Tulsa region is turning to ITS and TSMO. Technologies, such as traffic sensors and advanced traffic management systems, can help improve the efficiency and safety of the region's roads and highways. The Connected 2050 Tulsa Regional Transportation Plan recommends working with ODOT and other agencies to continue development and maintenance of the roadway and bridges of the area and to support development of regional ITS applications for truck facilities and operations in the region.

2.1.4 Active Transportation

The Tulsa region is facing significant challenges when it comes to active transportation and the need for effective use of ITS and TSMO. The Connected 2050 Tulsa Regional Transportation Plan is a key step in addressing these challenges and making certain that the city can support the needs of all road users, regardless of their mode of transportation.

The region has a growing number of pedestrians and cyclists who are seeking more options for active transportation. This has led to a need for more nontraditional infrastructure, such as bike lanes and pedestrian-friendly streets, to support these modes of transportation. Looking ahead to the year 2050, the Tulsa region has ambitious plans for its regional transportation network. The region's Connected 2050 Tulsa Regional Transportation Plan includes a focus on sustainability with an emphasis on promoting alternative modes of transportation, such as biking and walking. The plan also calls for the expansion of public transit options, including the development of bus rapid transit (BRT) systems.

In addition to these initiatives, the Connected 2050 Tulsa Regional Transportation Plan includes a strong emphasis on the integration of ITS technologies and TSMO. By continuing to invest in these technologies and strategies, the Tulsa region hopes to create a transportation network that is efficient, safe, and sustainable and can support the region's continued growth and development.

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2.1.5 Cost

To explore the financial ramifications of congestion in the Tulsa region, an average value of time (VOT) has been applied to road users. Details of the Tulsa metropolitan area by congestion source is previously presented in **Table *2***. This method provides insights into the economic impact of congestion. **Figure 6** depicts the Tulsa region's cost of congestion, totaling an estimated $30.7M annually for both recurring and nonrecurring cost of congestion. An estimated VOT of $25 per hour for passenger vehicles and $35 per hour for commercial vehicles[13] were used, along with truck traffic percentages of 23 percent (rural) and 6 percent (urban)[14].

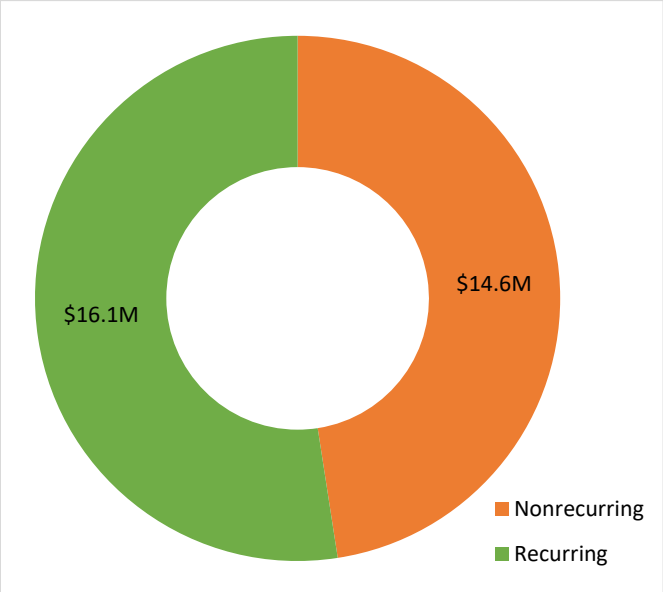

Figure 6. Estimated Annual Cost of Congestion (Tulsa 2019).

A total of 212 construction projects totaling $1 billion (B) are currently planned along several highways in ODOT's recent eight-year work plan budgeted for 2021 to 2028[15]. Each of these projects is an opportunity to incorporate TSMO strategies. **Figure 7** shows the project locations highlighted in green for each of the counties that are part of the Tulsa region.

[13] Based on an estimated 2%/year annual inflation to arrive at 2019 VOT, applied to values of time used by TX in 2014, as reported in https://static.tti.tamu.edu/tti.tamu.edu/documents/PRC-2016-4.pdf
[14] https://www.fhwa.dot.gov/policyinformation/statistics.cfm
[10] Source: ODOT ESRI shapefile data downloaded September 2022 from the 2021-2028 Roads Work Plan, at https://gis-okdot.opendata.arcgis.com/datasets/okdot::odot-workplan-roads-2021to2028/about

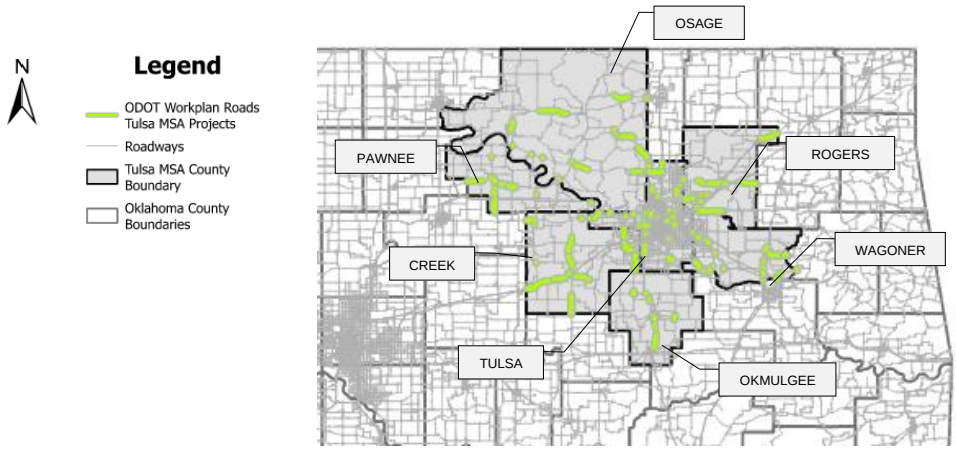

Figure 7. Tulsa Regional Area Eight-year Construction Plan Projects.

Delving into the challenge of rural traffic fatalities and the potential solutions, it's essential to recognize that according to data from the National Highway Traffic Safety Administration (NHTSA), nearly 50 percent of all traffic fatalities occur in rural areas[16]. It is also pointed out that rural areas face several transportation challenges related to safety, usage, and infrastructure conditions. The cost of these fatalities in rural areas can be significant, both in terms of the human toll and the financial cost. For example, the lifetime cost to society for each fatality is $1.4M[17].

One way to help reduce traffic fatalities in rural areas is by using ITS. These systems use technology to improve the efficiency and safety of transportation networks. For example, traffic cameras, sensors, and other technologies can help to monitor and control traffic flow. These measures can help reduce the risk of accidents and improve the safety of rural roads.

Other potential solutions for reducing traffic fatalities in rural areas include increasing the use of public transportation, encouraging carpooling, and investing in infrastructure improvements. Ultimately, the key to reducing fatalities in rural areas is a combination of technology, education, and improved infrastructure.

2.2 How TSMO and ITS Can Help

ITS consists of advanced technologies used to improve the safety and efficiency of transportation systems. TSMO is a broader umbrella that includes ITS and other strategies and programs focused on optimizing the overall management and operations of the multimodal transportation network. ITS and TSMO are often used together to improve the efficiency of transportation systems. For example, ITS technologies can be used to monitor traffic conditions and provide real-time information to drivers. This

[16] Source: NHTSA Rural Safety, Trends and Data. Rural Safety | NHTSA
[17] Source: NSC Injury Facts. Costs of Motor-Vehicle Crashes - Injury Facts (nsc.org)

information can be used to help drivers make better decisions about their route to avoid congestion and delays. Under the overall TSMO program, regional partners will collaborate to make this information accurate and consistent across jurisdictional boundaries and provide a coordinated response to changing conditions and incidents.

TMSO program areas considered by the Tulsa Metropolitan Area are described in **Table 3**. Note that each of the programs listed below primarily address nonrecurring congestion, but they also have positive impacts on recurring congestion.

Table 3. Common Transportation Systems Management and Operations Program Areas.[18]

Example Transportation Systems Management and Operations Program Areas	Program Area Description	Tulsa Existing Program Areas	Tulsa Future Program Areas
Active Transportation & Demand Management	The dynamic management, control, and influence of travel demand and traffic flow.		✓
Arterial Management	The management of arterial streets provides users with a safe, efficient, and reliable trip (i.e., Access Management, Traffic Signal Timing).	✓	
Bottleneck Mitigation	Strategies that focus on recurring bottlenecks (sections of roadway that are routinely over capacity).		✓
Congestion Pricing	A strategy that varies toll price by time of day and level of congestion.		✓
Integrated Corridor Management	An approach for collaborative management of all assets in a transportation corridor as a system (e.g., multiple roadways and transit facilities), rather than managing each asset individually to improve the overall operation of the corridor.		✓
Emergency Transportation Operations	Providing users with a safe and efficient transportation system during an emergency.	✓	
Freeway Management	The implementation of policies, strategies, and technologies to improve freeway performance by minimizing congestion (and its side effects), improving safety, and enhancing overall mobility.	✓	

[18] Source: https://ops.fhwa.dot.gov/plan4ops/focus_areas/integrating/operations_strategies.htm

Table 3 Common TSMO Program Areas (continued)

Example Transportation Systems Management and Operations Program Areas	Program Area Description	Tulsa Existing Program Areas	Tulsa Future Program Areas
Freight Technology & Operations	The effective management of the transportation system for freight to move goods safely, efficiently, and reliably throughout the region.		✓
Planned Special Events Traffic Management	Special event management to provide users with a safe and efficiently managed transportation system during a planned special event.	✓	
Road Weather Management	Systems and strategies focused on providing users with information before, and a safe and efficient transportation system during and after, weather events.	✓	
Real-time Traveler Information	Information provided to travelers to help them choose the safest and most efficient mode and route of travel.	✓	
Traffic Incident Management	Verifying, responding to, and clearing traffic incidents in a manner that provides transportation system users with the least disruption.	✓	
Traffic Signal Management (TSM)	Programs, processes, and systems for the effective monitoring and operation of traffic signals.	✓	
Transit Management	Operation and management of a safe and efficient transit system.	✓	
Travel Demand Management	Providing users with effective travel choices to shift or reduce the demand for travel in congested conditions.	✓	
Work Zone Management	Organizing and operating areas affected by road or rail construction to minimize traffic delays, maintain safety for workers and travelers, and accomplish the work efficiently.	✓	

ODOT and INCOG currently support various initiatives that are considered ITSs, such as Road Weather Information Systems (RWIS), dynamic message signs (DMSs), cameras, regional transportation management centers (RTMC), data-collection devices, traffic signal management system, and more. These systems provide operational awareness about the state of the infrastructure, allowing ODOT to implement strategies that improve mobility and reduce congestion.

This ITS and TSMO Strategic Plan for the Tulsa Region aims to improve the management and efficiency of the transportation system with existing and planned ITS programs that ODOT and INCOG support. TSMO and ITS technology deployment can help to improve the safety of the roads by providing real-time information on traffic conditions and road closures. This information can be used to alert drivers to

potential hazards and help them make informed decisions about their route and reduce the amount of time vehicles spend idling in traffic.

Overall, these systems are essential in supporting the smooth operation of roads in the Tulsa region. They provide valuable data and information that help inform decisions about traffic flow and congestion. These systems have a proven record of improving and reducing congestion.

2.3 Transportation Systems Management and Operations Mission, Goals, and Objectives

One key component of the Tulsa region's efforts to address its challenges is the Connected 2050 Tulsa Regional Transportation Plan. This plan, developed by INCOG, outlines a vision for the region's transportation network over the next 30 years. It includes several initiatives aimed at improving the region's transportation needs, including the following:

- Investing in ITS technologies
- Implementing TSMO strategies
- Expanding and improving the region's freight transportation infrastructure
- Developing new freight corridors and intermodal facilities
- Working with local, state, and federal partners to promote the development of sustainable and resilient transportation systems.

These initiatives are essential to addressing Tulsa's regional challenges and paving the way for the region's businesses to grow and thrive. By investing in ITS and TSMO technologies and implementing the Connected 2050 Tulsa Regional Transportation Plan, the region can further develop a transportation network that is efficient, safe, and sustainable.

The purpose of the ITS and TSMO Strategic Plan for the Tulsa Region is to identify a clear vision for TSMO and provide actionable steps for the Tulsa metropolitan region to achieve that vision. This section defines the TSMO vision, mission, goals, and objectives that are in alignment with INCOG's vision, mission, goals, and objectives. Vision, mission and core values are shown in **Figure 8.**

Vision	Main Components
• The paramount purpose of the transportation system is to enhance and sustain the quality of life and economic vitality of the region. This will be accomplished by developing, maintaining, and managing a transportation system that meets the accessibility needs of people and goods in the region through safe, environmentally prudent, and financially sound means.	• Evaluation of all major transportation modes and connections among modes: bike, pedestrian, transit, automobile, freight, rail, air, and water transport • Population and employment forecasts to identify future improvements or needs • Review of existing and proposed transportation systems • Asset/system preservation • Energy and environmental considerations • Prioritized list of short- and long-range transportation needs • Funding alternatives to implement the plan

Figure 8. Connected 2045 Long Range Transportation Plan Vision and Main Components.

2.3.1 TSMO Mission

The TSMO mission for the region of Tulsa focuses on optimizing the transportation network to improve performance and reduce congestion. This objective involves implementing strategies such as incident management, traffic signal coordination, and congestion pricing to manage and optimize the region's roads and highways.

The mission also includes working with local, state, and federal partners to promote the development of sustainable and resilient transportation systems. This objective could involve investing in ITS technologies to improve the efficiency and safety of the region's roads and highways. In line with the Connected 2050 Tulsa Regional Transportation Plan, the TSMO mission is to accomplish the following:

Work together to improve the safety and efficiency of the Tulsa region's transportation system for all travelers and businesses by implementing effective TSMO strategies and investing in ITS technologies.

2.3.2 TSMO Goals and Objectives

Overall, the goal of the ITS and TSMO Strategic Plan for the Tulsa Region is to enhance the transportation experience for all users while also supporting the economic growth and livability of the region. **Table 4** presents the Tulsa region TSMO goals and objectives developed to guide the region's ITS and TSMO strategic plan. **Section 5** includes discussions about the current TSMO activities and recommendations that center around the goals and objectives listed here.

Table 4. Tulsa Transportation Systems Management and Operations Goals and Objectives.

Goals	Objectives
Enhance Mobility and Accessibility	Improve the transportation system in the region to support the movement of people and goods and to make sure that all residents have access to the transportation options they need.
Promote Safety and Security	Reduce the number of transportation-related crashes and incidents and make sure that the transportation system is safe and secure for all users.
Increase Efficiency and Reliability	Maximize the use of the transportation system and reduce congestion, delays, and other disruptions to improve the reliability and efficiency of the system.
Increase Sustainability	Reduce the environmental impact of transportation using cleaner technologies, alternative fuels, and more efficient land use patterns.
Support Economic Growth and Development	Use the transportation system to support the economic growth and development of the region and to connect businesses and residents to the opportunities they need.
Foster Innovation and Technology	Use innovative technologies and approaches to improve the performance of the transportation system and to support the development of new transportation solutions and services.

3 Strategic Plan Development

The development of a strategic plan is critical for any organization. It is especially important for organizations involved in ITS technology deployments because technology is constantly changing and evolving, and organizations need to be able to adapt and change with it. A well-developed strategic plan provides a clear and concise road map for the future.

One of the most important aspects of developing a strategic plan is stakeholder engagement. It is essential to involve all stakeholders in the process, from senior management to frontline staff. This approach allows everyone to have a clear understanding of the goals and objectives and buy-in to the plan. Once the strategic plan is developed, it is important to review and update it on a regular basis so that it remains relevant and responsive to changing technologies and agency needs. Nine organizations were represented during the statewide stakeholder engagement. The responses and insights shared during this engagement have been integrated throughout this plan.

3.1 Outreach

Key stakeholders that participated in the Tulsa ITS planning process to identify needs and direction include the following:

1. City of Broken Arrow
2. Grand Gateway Economic Development Association (GGEDA) Pelivan Transit
3. INCOG
4. City of Jenks
5. ODOT
6. This Machine Tulsa Bike Share
7. City of Tulsa
8. Tulsa Transit
9. Tulsa County

The stakeholders were invited to name existing ITS elements and discuss their needs and requirements and ongoing and planned ITS programs. The means of gathering this information included meetings, online surveys, live feedback sharing sessions, and take-home surveys.

3.2 Stakeholder Input

Stakeholder needs were elicited through a stakeholder engagement meeting. Key stakeholders mentioned in **Section 3.1**, met virtually, and online engagement tools were used to gather feedback during a presentation to the stakeholders. Additionally, information about existing and proposed ITS elements were collected via a take-home worksheet sent to stakeholders following the virtual meeting.

The stakeholder engagement process was successful in finding several needs and requirements for the ITS deployment in Tulsa. Some found key needs include improved traffic management and incident response, better integration of ITS elements, improved data collection and analysis, and greater consideration for

the needs of nonmotorized users. The participation of key stakeholders was critical to the success of the Tulsa region TSMO and ITS outreach effort and helped to make sure that the region's transportation planning and investment decisions are informed by a diverse range of perspectives and interests.

3.3 Intelligent Transportation Systems Architecture

The ITS architecture for the ITS and TSMO Strategic Plan for the Tulsa Region outlines various components and systems necessary for the improvement of regional transportation operations. It provides a common language and framework for stakeholders to use when discussing, planning, and implementing related projects and initiatives in the region.

The ITS architecture is based on the National ITS Architecture, which is a standardized model for ITS architectures developed by the U.S. Department of Transportation. It encourages interoperability between regional ITSs to provide a more integrated transportation system and is being updated in parallel to this strategic plan.

3.4 Existing Plans

This plan is being developed along with an Oklahoma statewide TSMO and ITS plan and an Oklahoma City regional plan. Several other documents have guided the Tulsa region in the past years, including the following:

- 2003 Tulsa Regional ITS Architecture[19]
- 2003 Tulsa Regional ITS Implementation Plan[20]
- 2022 Connected 2050 Tulsa Regional Transportation Plan[21]

[19] Tulsa Regional Intelligent Transportation Systems (ITS) Architecture, March 2003: https://www.odot.org/hqdiv/p-r-div/itscvo/pdfs/tulsaarch.pdf
[20] Tulsa Regional Intelligent Transportation Systems (ITS) Implementation Plan, March 2003: https://www.odot.org/hqdiv/p-r-div/itscvo/pdfs/tulsaimplplan.pdf
[21] Connected 2050 Regional Transportation Plan, November 2022: https://www.incog.org/Transportation/Connected2050/Connected2050Plan.pdf

3.5 Program Prioritization

The ITS and TSMO Strategic Plan for the Tulsa Region included several program prioritization methods to confirm that transportation projects and initiatives are carefully evaluated and prioritized based on their potential impact and feasibility. Through these steps, the program prioritization method used in this strategic plan helped make sure that transportation projects and initiatives were carefully evaluated and prioritized, and resources were allocated in a way that maximized their impact on the region's ITS.

Research and assessments were conducted to gather data and information on the current transportation system, including traffic patterns, congestion, safety concerns, and existing infrastructure. This method allows identification of areas of the region that may need improved transportation services or ITS deployments. Then, a workshop with stakeholders was also held to gather input and feedback on transportation priorities and needs. During this workshop, stakeholders shared their perspectives and ideas, which were incorporated into the prioritization process.

Based on the research and assessment and input from stakeholders, recommendations for existing programs and initiatives were made. Recommendations for new initiatives and projects that aligned with the region's TSMO and ITS transportation goals and priorities were also made and shown in this plan.

The development of prioritized recommendations found in **Section 5** was formed through a process of gathering ODOT's and INCOG's existing capabilities, needs, and desired priorities and recommendations and best practices from the Federal Highway Administration (FHWA). This analysis resulted in the selection of six existing program areas and six potential future program areas.

4 Current Intelligent Transportation Systems Program

Tulsa region stakeholders have identified the transportation systems that are already in operation. These include ITS technologies such as traffic management systems, incident management systems, and traveler information systems. The analysis uses a range of technologies like sensors, cameras, and GPS to collect data on traffic patterns, congestion, and accidents, which will contribute to the enhancement of transportation operations for the benefit of the region's 50,000 or more residents.

4.1 Existing Intelligent Transportation Systems

The ITS and TSMO Strategic Plan for the Tulsa Region notes several existing ITSs, including the following:

1. **Traffic Management Center (TMC):** The TMC is a centralized facility that monitors and manages traffic flow across the region. It uses real-time traffic data, video monitoring, and advanced algorithms to optimize traffic signals, adjust speed limits, and divert traffic to alternate routes during congestion or incidents.
2. **Intelligent Transportation System (ITS):** The ITS uses advanced technologies such as sensors, cameras, and communication systems to provide real-time information to drivers, transit agencies, and traffic operation centers. It includes services such as traffic incident management, traffic signal coordination, and traveler information.
3. **Freeway Management System (FMS):** The FMS is a network of sensors, cameras, and variable message signs that monitor and manage traffic flow on the region's freeways as part of the TMC. It provides real-time traffic information and detour recommendations to drivers and alerts to congestion, incidents, and other potential hazards.
4. **Advanced Transportation Management System (ATMS):** The ATMS is a web-based platform that allows traffic managers to monitor and control traffic flow across the region in real time. It uses advanced algorithms to optimize traffic signals, adjust speed limits, and divert traffic to alternate routes during congestion or incidents.
5. **Traveler Information Services:** The traveler information services consists of a web-based service that provides real-time traffic information to drivers, which is provided by ODOT. It includes alerts on congestion, incidents, road closures, and construction projects and detour recommendations and alternative routes.

4.2 Concepts of Operation and Field Devices

This section provides an overview of the types of devices and systems that have been deployed in the Tulsa region, including several that are currently being piloted. Each of the concepts of operation and field devices in this section were obtained from the 2003 Tulsa Regional ITS Implementation Plan and verified as existing programs from stakeholders' input. Each category described below includes subsets of elements and assets containing the ITS technology. Some existing ITS field devices in the Tulsa region for the ITS and TSMO Strategic Plan for the Tulsa Region include the following:

Broadcast Traveler Information

The Tulsa region uses DMS to provide real-time traffic information to drivers on heavily transited roads. These electronic signs are placed in strategic locations to improve traffic flow and provide important updates, such as construction updates or accident alerts. The deployment tactics for DMS signs are determined based on the specific needs of the region. Stakeholders have verified the effectiveness of this program in improving safety and reducing congestion.

Network Monitoring

Network monitoring consists of cameras, traffic signal control systems, and RWIS. The Tulsa region uses traffic signal control systems, which use sensors and other technologies to detect traffic patterns and adjust signal timing to improve the flow of traffic. These systems can also be integrated with other ITS technologies, such as cameras and RWIS, to provide a more comprehensive view of traffic conditions and enable more effective traffic management.

In addition to these technologies, the Tulsa region relies on law enforcement communications to gather information about incidents that affect the transportation system. This effort includes reports from drivers and other individuals who call in to report accidents, construction, or other incidents. Stakeholders have verified that these systems are critical components of the region's ITS infrastructure, enabling better detection and response to incidents, improved traffic management, and enhanced safety for all users.

Incident Management

The incident management program in the Tulsa region aims to minimize the impact of traffic incidents on the transportation network through emergency response efforts. These efforts are carefully planned and coordinated to result in efficiency and effectiveness, with emergency response teams having clear protocols for diverse types of incidents.

The incident management program includes both capital improvements and a management and operations element and is essential for the effective operation of the incident management system in the region. The program has been implemented and runs in parallel with the deployment and operation of the ITS. Stakeholders, including ODOT, the Oklahoma Highway Patrol (OHP), and other local agencies have been involved in the development and implementation of the incident management program.

Regional Transportation Management Center (RTMC)

The RTMC is a central facility that coordinates and oversees the transportation system in the region. It uses various tactics, such as deploying ITS technologies and incident management systems and developing transportation demand management strategies to improve efficiency, safety, and sustainability.

The RTMC is operated under the supervision of a board consisting of ODOT, INCOG, the Oklahoma Department of Public Safety (DPS), the City of Tulsa, and a rotating seat representing suburban communities. It is responsible for managing the regional freeway and arterials systems and sharing data and video with other agencies and the public through a regional communications network.

Traffic Operations

The Tulsa region has implemented several traffic operations programs, including the surface street control program, to improve safety and efficiency on its roads, which local city public works departments continue to operate and maintain in their jurisdictions. These programs use traffic signals and cameras to monitor and control traffic flow on major surface streets in the region. The traffic signals are connected to a central traffic management system that allows operators to adjust signal timing and settings in real time based on traffic conditions. Other functions of the local TMC include signal preemption for buses, highway/rail intersection controls; real-time communication to the RTMC, other local TMCs, and transit centers; maintenance and construction activity coordination; and others. Positive feedback has been received from stakeholders about the effectiveness of these programs in reducing congestion and improving the overall driving experience in the region.

Traveler Information Services

The Tulsa region has implemented various traveler information systems, including DMS and highway advisory radio (HAR), to improve traffic flow and mobility. The region has also deployed additional DMS and interactive traveler information kiosks at key locations to provide real-time traffic updates and access to a range of services. The program has been operated by RTMC staffing. Feedback from stakeholders suggests that these strategies have been successful in improving traffic flow and providing valuable information to travelers.

Transit Management Center

The Metropolitan Tulsa Transit Authority (MTTA) and the Broken Arrow Bus System (BABS) are the two transit agencies in the Tulsa region. MTTA currently has an automatic passenger counter (APC) system and plans to implement an automatic vehicle location (AVL) system, demand response transit, and kiosks at bus stations. They are also considering an electronic payment system and using buses as traffic probes. The operating agreement outlines the capital, operating, and maintenance costs; staff and maintenance resources; and system control and data usage for each agency.

The functions that may be included in the transit management center include vehicle tracking, fixed-route and demand-responsive operation and management, real-time video display and control, passenger counting, fare management maintenance and fleet management, security, traveler information dissemination, and real-time communications with the RTMC and local TMCs. These plans for the transit management center are currently in place, as verified with stakeholders.

5 Transportation Systems Management and Operations Program Area Prioritization and Road Map

The Tulsa region has a strong focus on ITS to improve mobility and safety for all road users. The road map for each of these program areas includes a range of prioritized actions, including the development of innovative technologies and policies, the deployment of pilot projects, and the expansion of existing programs. By collaborating with stakeholders and partners, the Tulsa region is committed to making progress in these key areas and improving transportation for all.

5.1 Needs and Priorities

The stakeholders in the Tulsa Region have identified several key needs and priorities for ITS implementation. These priorities include the need for increased funding to support the development and deployment of advanced TSMO technologies and infrastructure. In addition, stakeholders emphasized the importance of coordination and cooperation among different agencies and organizations to result in the effective and efficient deployment of ITS solutions. Some of the top priorities and needs identified by stakeholders for the Tulsa region's ITS infrastructure includes the following.

Improving safety and reducing crashes: Many stakeholders emphasized the need to prioritize safety and reduce the number of accidents on the region's roads. These goals could be achieved through the deployment of advanced safety technologies, such as ITS, and through improved road design and better driver education.

Enhancing mobility and congestion management: Stakeholders also identified a need to improve the flow of traffic in the region, particularly in high-traffic areas. This flow could be achieved through the implementation of ITS solutions that allow for real-time traffic management and congestion pricing and through the development of alternative modes of transportation, such as public transit and bike/pedestrian paths.

Promoting economic growth and sustainability: Another key priority for the region is to support economic growth and sustainable development. This goal could be achieved through the deployment of ITS technologies that improve the efficiency of the transportation network, such as ITSs that reduce fuel consumption and emissions. Additionally, the development of alternative modes of transportation can help support sustainable development.

Enhancing intermodal connectivity: Stakeholders also identified a need to improve connectivity between different modes of transportation in the region. This goal could be achieved through the implementation of ITS technologies that allow for seamless integration between different modes of transportation, such as ITSs that support real-time information sharing between buses, trains, and cars.

Additionally, stakeholders highlighted the importance of creating dedicated bike lanes and implementing ITS solutions that can help improve the safety and accessibility of biking in the region. Overall, the priorities and needs identified by stakeholders for the Tulsa region's ITS infrastructure reflect a strong focus on improving safety, enhancing mobility and congestion management, promoting economic growth and sustainability, and enhancing intermodal connectivity. These priorities will be key considerations as the region moves forward with its TSMO efforts.

5.1.1 Program Area Prioritization

Based on guidance from the FHWA office of operations, six existing and six future TSMO program areas have been identified as the most relevant for the Tulsa region. These program areas are shown in **Table 5**.

Table 5. Existing and Potential Future Transportation Systems Management and Operations Program Areas.

Existing Transportation Systems Management and Operations (TSMO) Program Areas	Potential Future TSMO Program Areas
A. Work Zone Management	G. Freight Management
B. Road Weather Management	H. Special Event Management
C. Traffic Incident Management	I. Transit Management
D. Traveler Information System	J. Congestion Pricing
E. Traffic Management	K. Integrated Corridor Management
F. Traffic Signal Management	L. Connected / Automated Vehicles

For the Tulsa region, ITS program area prioritization was determined through a workshop with stakeholders. Results are shown in **Table 6**. The resulting priority levels for each program area ranged from medium to high, with Traffic Management and Traffic Signal Management services being the top priority for all stakeholders. The Road Weather Management program area scored lowest for existing programs.

In terms of future program areas, Integrated Corridor Management (ICM) scored the highest, while the lowest scoring initiatives consisting of Congestion Pricing and Freight Management. In both categories, these functions are managed by other agencies, which will provide regional support to local efforts in these areas. Overall, the prioritization of ITS program areas will continue to support and expand services in existing program areas while also considering the needs and priorities of stakeholders in the region.

Table 6. Transportation Systems Management and Operations Priorities of Existing and Future Program Areas.

	Program Area	Tulsa Region (Stakeholder Scoring)
Existing	A. Work Zone Management	3.7
	B. Road Weather Management	3.6
	C. Traffic Incident Management	3.9
	D. Traffic Management	4.1
	E. Traffic Signal Management	4.1
	F. Traveler Information	3.9
Future	G. Freight Management	3.1
	H. Special Event Management	3.2
	I. Transit Management	4.0
	J. Congestion Pricing	2.7
	K. Integrated Corridor Management	4.3
	L. Traveler Information	3.8

5.1.2 Program Area Needs

The Tulsa region currently has initiated several ITS programs, including a traffic operations center and a traveler information system. These programs are focused on improving traffic flow, reducing congestion, and providing real-time information to travelers. However, there are still areas that need improvement, such as enhancing the interoperability of these systems and increasing the availability of data to support decision-making. Additionally, there is a need for more robust incident management capabilities and advanced technology solutions to address emerging challenges, such as connected and automated vehicles.

5.2 Existing Programs

When evaluating proposed directions for ODOT's TSMO programs moving forward, it is essential to understand the existing organizational structure, proposed future program areas, and roles and responsibilities. This section presents an overview of the current practices and procedures of ODOT's operational, technological, and administrative functions for implementing and managing TSMO programs in a manner that supports and complements the many operations and safety initiatives in place.

Advancing existing and new TSMO programs by leveraging technologies to cost-effectively address congestion is one of the main objectives of this plan. This section describes the existing program areas. First it outlines the prioritization process and structure of existing programs from the stakeholders' point of view, then it provides a list of actions to expand the existing programs, listing recommendations of the steps needed to accomplish each lead action and defining a set of new TSMO programs with recommended actions.

Stakeholder priorities for each potential new area are shown in **Figure 9**.

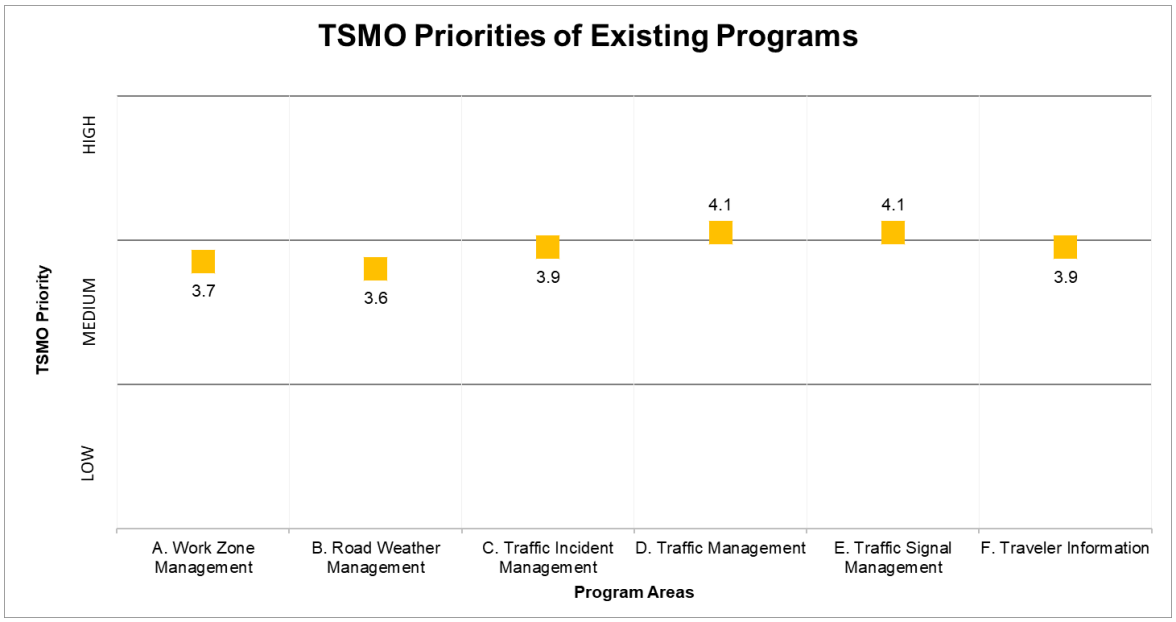

Figure 9. Existing Program Area Priorities.

5.2.1 Work Zone Management

Work Zone Management in the Tulsa Region	Recommended Actions
• Work zone management (WZM) focuses on the safety and operational efficiency of temporary construction and maintenance work areas. Under Transportation Systems Management and Operations TSMO, agencies are looking to technology and other strategies to provide greater benefits to all who work in and travel through a work zone. • The Oklahoma Department of Transportation's (ODOT's) Intelligent Traffic Systems and Traffic staff have worked to leverage technology into the state's work zones for many years. Notwithstanding the efforts to-date, there is much yet to do to vet and develop new technologies and strategies and to mainstream their use into ODOT's regular statewide operation.	• Tulsa region staff have collaborated to identify and prioritize numerous actions and areas that can further advance the implementation of WZM to improve traffic operations and increase safety for travelers and transportation workers. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Work Zone Location Reporting – Enact policies to require reporting on work zone locations as changes occur for documentation, inspection, and information to the public.	Ongoing	
Work Zone Safety Education for the Public – Develop a work zone safety outreach program for the traveling public.	Ongoing	
Coordination with Law Enforcement – Develop guidelines for when to include law enforcement as part of work zones and guidance on how officers should be deployed within the work zone. Develop and implement training on these guidelines.	Ongoing	
Evaluation of Work Zone Impacts – Develop methods to map, evaluate, and select coordination strategies of multiple projects by agency where project impacts are expected to overlap.	New	
External Funding – Seek additional external funding opportunities to advance WZM efforts.	New	
Work-specific Incident Management – Include work zone-specific incident management response plans for high-risk and high-profile projects.	Ongoing	

5.2.2 Road Weather Management

Road Weather Management in the Tulsa Region	Recommended Actions
• Road Weather Management (RWM) consists of systems, processes, and personnel working to actively monitor, manage, and communicate road conditions during weather events. • RWM is needed not just during winter weather events, but also year-round for high winds, storms, floods, or other natural phenomena that affect the ability to drive on Oklahoma roadways. RWM is important because weather cannot only cause travel delays but can also sometimes be deadly.	• The Tulsa region has identified three new priority initiatives and two ongoing projects to improve RWM in the region. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Lidar Debris Detection – Implement lidar technologies for debris detection from flooding and bridges. Prepare a plan to deploy this technology at scale.	New	
Initiative-taking Operations during Adverse Weather – Define level of operator interaction and approvals required for automated messaging of weather alerts and other control strategies.	Ongoing	
Coordinated Jurisdictional Boundaries – Define operational procedures to allow Traffic Management Center operators to provide coordinated response across jurisdictional boundaries.	Ongoing	
Leverage New Sources of Transportation Funding – Increase linkage with the Statewide Transportation Systems Management and Operations Plan to prioritize projects and fundings. For example, adding weather-responsive components to traffic management projects.	New	
Reassess Sensor Locations – Reassess weather forecasting sensors' locations through Road Weather Information System technologies to help identify possible solutions for hazardous weather-related conditions in the roadway. For example, develop a structured plan that details common weather-related trouble spots, and study the feasibility of installing a sensor at these locations for future weather forecast efforts.	New	

5.2.3 Traffic Incident Management

Traffic Incident Management in the Tulsa Region	Recommended Actions
• Traffic Incident Management (TIM) consists of multidisciplinary methods to plan and coordinate the process of rapid detection, verification, response, and safe clearance of traffic incidents. • Transportation and public safety agencies take on the responsibility of facilitating safe and rapid clearance of traffic incidents that affect the normal traffic flow while managing the affected traffic until normal traffic conditions are reinstated.	• The Tulsa region has identified several new priority initiatives to improve TIM in the region. Many of these items focus on how to share information throughout the area to best improve TIM services. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Implement tools to rapidly remove debris following incidents.	New	
Automate the Traffic Incident Management (TIM)-related broadcast traveler information regarding presence of fleet vehicles with an active HAAS Makeway alert system.	New	
Emergency Responder Presence Broadcasts – Investigate participation with the HAAS Makeway alert system.	New	
Standard Communication Protocol – Identify a standardized, on-scene communications protocol to adopt an integrated organizational structure designed to aid in the management and operation of resources and personnel during incidents. For example, the Federal Emergency Management Agency (FEMA) offers an interactive online course about the use of incident command system (ICS) for on-scene response as a primary source of communication across agencies.	New	
Organizational Chart – Define respective roles and responsibilities by agencies. By doing this, commitment and organization of common resources and facilities can be allocated.	New	
Annual TIM Conference – Participate at the annual conference with TIM stakeholders to debrief on lessons learned, including a keynote speaker to motivate; redirect the TIM group; and provide informal touch points among stakeholders.	New	

5.2.4 Traffic Management (TM)

Traffic Management in the Tulsa Region	Recommended Actions
• Traffic Management (TM) involves a broad range of strategies for actively monitoring and managing travel by implementing appropriate policies, systems, and actions to provide safe and efficient travel. • Primary strategy categories are as follows: monitor real-time traffic conditions; manage traffic control systems and data; communicate with all stakeholders, including field staff, management, partner agencies, emergency responders, the media, and the public; connect systems, devices, and partners digitally through fiber-optic and wireless communications infrastructure.	• The Tulsa region has identified four new initiatives to best improve TM in the region. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Traffic Infrastructure Inspection and Maintenance Priorities – Support inspection and monitoring approach to identify maintenance issues with traffic infrastructure and equipment as a preventive method.	New	
Preventive Maintenance Program – Establish preventive maintenance program to provide maximum performance for not only equipment, but also operational settings. For instance, timing plans.	New	
Active Warning Systems – Implement advisory strategies including active warning systems on travel times and incident notifications.	New	
Incident Management Tracking Database – Support the creation of a regional incident tracking database to improve situational awareness and traffic management decision-making.	New	

5.2.5 Traveler Information

Traveler Information in the Tulsa Region	Recommended Actions
• Traveler Information (TI) programs consist of gathering and disseminating information valuable to travelers so they can make more informed route decisions.	• The Tulsa region has identified several new priority initiatives to facilitate the distribution of TI in the region. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Improve the Efficiency of Messaging Systems – Expand pilot projects to automate dynamic message signs (DMS) messaging from portable boards to permanent DMS.	New	
Prioritize – Define the Tulsa region's priorities for consistent implementation of Traveler Information (TI). For example, in-route updates for those who do not have access to a mobile phone.	New	
Develop Approach to Introducing Upgraded and State-of-the-practice Concepts and Systems – Track state-of -the-art research and developments in advancing technology and applications. For example, vehicle-to-infrastructure wireless communications and probe data.	New	
Establish Data Validation Guidelines – Formalize data validation guidelines to have a better representation of changes in a graphing system.	New	
Provide Joint TI Data Sharing – Establish an operating structure for joint TI data sharing across jurisdictional boundaries along adjoining transportation facilities.	New	

5.2.6 Traffic Signal Management

Traffic Signal Management in the Tulsa Region	Recommended Actions
• Traffic Signal Management (TSM) includes the planning and coordination of the personnel involved in the proactive management and operation of traffic signals. It comprises the planning, layout, integration, maintenance, and operation of an effective traffic signal system to meet the needs of motorists, traffic signal operators, transit agencies, emergency operations staff, and emergency personnel. • Proactive and periodic assessments of the traffic signal system in the context of emerging technologies is important for maintaining and improving the safety and efficiency of signal operations.	• The Tulsa region has identified four new priority initiatives to streamline the design and management of traffic signals in the region. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Implement a Preventive Maintenance Program – Implement a program that includes inspecting and/or replacing equipment before it fails. This type of program generally includes semiannual or annual inspection and testing of control equipment, intersection hardware, vehicle and pedestrian detection systems, signal poles, signal heads, and mounting hardware.	New	
Develop a Performance Management/Monitoring Plan – Identify the measures and data to be used to assess how traffic signal performance will be evaluated in the region. This step includes developing specific performance measures and time frames for collecting data for measuring performance.	New	
Develop a Traffic Signal Plan Design Checklist – Develop a list of items to be reviewed to make sure that all new traffic signal designs conform to the formal design policies and practices of the agency.	New	
Develop Regional Standards for Maintaining Traffic Signal System Technologies and Systems in a State of Good Repair – Work with regional partners to establish a minimum standard at which all traffic signals must be maintained.	New	

5.3 New Program Areas

The stakeholders prioritized several new program areas for ODOT to pursue. The following sections describe and briefly address the actions recommended to advance each of the programs.

Stakeholder priorities for each potential new area are shown in **Figure 10**.

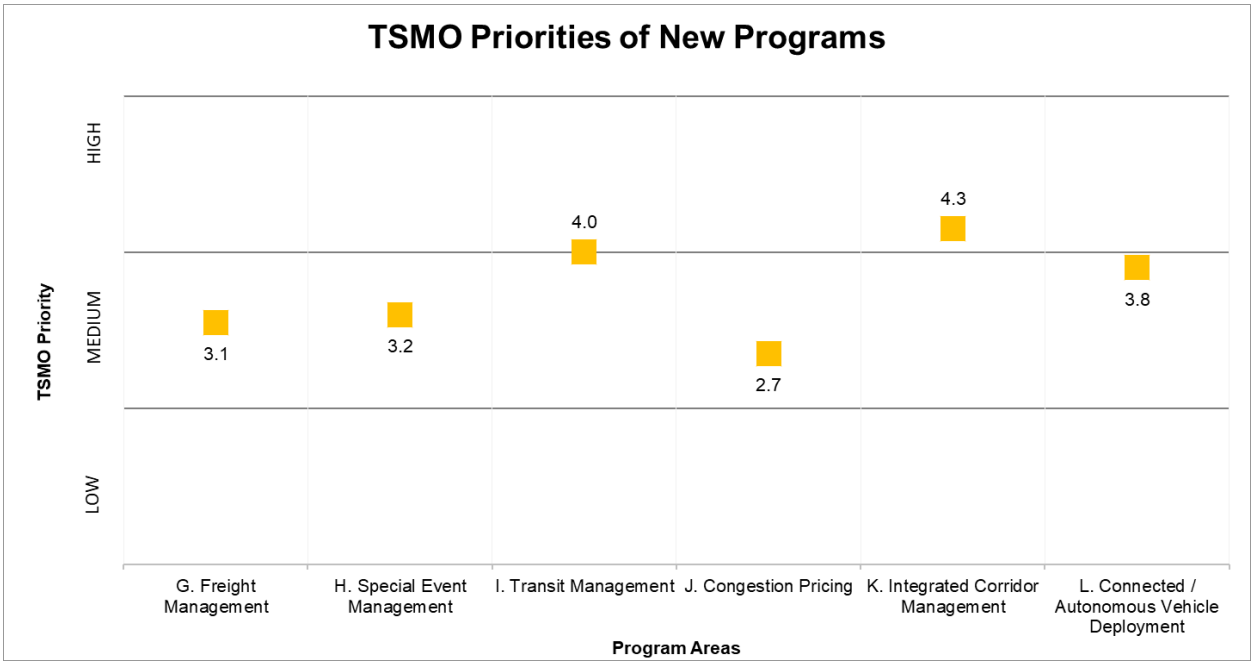

Figure 10. Potential Future Program Area Priorities.

5.3.1 Freight Management

Freight Management in the Tulsa Region	Recommended Actions
• Safe, reliable, and efficient freight transportation boosts exports, enhances commerce, and powers economic growth. A robust multimodal freight system in Oklahoma supports state and national economies by lowering costs to businesses and consumers and boosting the competitiveness of American goods abroad.	• The Tulsa region has identified three new priority initiatives to improve freight management in the region. Because it is a new program area, it is critical to take steps to analyze and improve any existing systems. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Level of Service – Improve freight level of service both in terms of mobility and safety programs included in formal agency documents, including management of congestion, reduction of delay, and improvement of reliability – especially in relationship to nonrecurring congestion.	New	
Modernization Efforts – Modernize freight-related security protocols and safety oversight.	New	
Freight Safety Technologies – Support the creation and uptake of new freight safety technologies, such as automation and communication.	New	

5.3.2 Special Event Management

Special Event Management in the Tulsa Region	Recommended Actions
• A planned special event creates an intense and often brief increase in travel demand and may require temporary traffic control measures to manage event traffic. Planned special events affect freeway operations, arterial and other street operations, transit operations, and pedestrian flow. • Unlike roadway construction activities or traffic incidents that constrain travel within a single corridor, planned special events affect travel in all corridors serving the event venue.	• The Tulsa region has identified three new initiatives to manage special event traffic in the region. These items will help prevent event traffic from taking over streets in the region. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Schedule of Planned Special Events – Establish and uphold a calendar of the region's planned special events and follow an established event operations planning process.	New	
Coordination for Special Events/ Work Zones – Coordinate transit for special events / work zones by adding extra services, for instance, during times of sporting events or while a roadway is under construction.	New	
Standard Special Event Routes – Develop standard street-use event routes and traffic flow routes. For example, deploy messages to through traffic that right lanes are blocked, backing from off-ramps.	New	

5.3.3 Transit Management

Transit Management in the Tulsa Region	Recommended Actions
• Managing transit systems is essential for meeting the increasing demand for mobility, reducing traffic congestion and environmental impacts, and providing affordable and equitable transportation options for the Tulsa region.	• The Tulsa region has identified two new priority initiatives and three ongoing projects to improve transit management in the region. These items include how to provide accurate information to users and how to work across jurisdictions to offer the best possible transit services. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Accurate Information – Provide passengers with accurate arrival/departure information for buses and/or rail.	Ongoing	
On-demand Mobility Service – Incentivize efforts to improve the on-demand mobility service transit program.	New	
Coordination for Special Events/ Work Zones – Coordinate transit for special events / work zones. Add extra services, for instance, during times of big events or while a roadway is under construction.	New	
Transit Information Sharing – Add technologies into cabs for drivers and information-sharing to coordinate among the various bus and/or rail services within a region to reduce transfer times and enable more efficient transit connections.	Ongoing	
Transit Network Operations – Examine opportunities for better transit network operations across jurisdictional boundaries and facility types. For instance, improve roadway network and corridor operations and make related improvements that support transit operations.	Ongoing	

5.3.4 Congestion Pricing

Congestion Pricing in the Tulsa Region	Recommended Actions
• Congestion pricing is a method of shifting traffic away from congested roadways by varying the tolling price along that route based on the current level of congestion. • Although drivers unfamiliar with the concept of congestion pricing initially have questions and concerns, surveys show that drivers more experienced with congestion pricing support it because it offers them a reliable trip time, which is very valuable, especially when they need to be somewhere on time.	• The Tulsa region has identified several new priority initiatives regarding congestion pricing for the region. Because it is a new program area, many of these initiatives include the identification of potential candidate areas to use different pricing strategies. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Agency Policy Objectives – Determine the connections between the agency's policy goals and the present improvement efforts in terms of the possibility for enhanced Transportation Systems Management and Operations (TSMO) and Intelligent Transportation Systems (ITS) to achieve goals with particular emphasis on congestion relief, reliability enhancement, and safety.	New	
Pricing Entire Toll Facilities – Identify corridors that may benefit from pricing of entire roadway facilities	New	
Zone-based Pricing – Identify areas that may benefit from zone-based pricing.	New	
Parking – Identify areas that may benefit from parking pricing.	New	
Legal Framework for Pricing – Identify the legal framework required for potential congestion pricing strategies and policies.	New	
Vehicle and Ridesharing – Identify areas that may benefit from priced vehicle sharing and dynamic ridesharing.	New	
Congestion Pricing Policy – Establish policy regarding agency involvement in regional planning and ways to support further inclusion of TSMO and ITS improvements within the Metropolitan Planning Organization's (MPO's) regional multimodal transportation planning and programming processes including designation of agency representation and objectives.	New	

5.3.5 Integrated Corridor Management

Integrated Corridor Management in the Tulsa Region	Recommended Actions
• Transportation corridors often contain underused capacity while facilities and services on a corridor are independently operated, and efforts to date to reduce congestion have focused on the optimization of the performance of individual assets. • The vision of integrated corridor management (ICM) is that transportation networks will realize significant improvements in the efficient movement of people and goods through institutional collaboration and aggressive, proactive integration of existing infrastructure along major corridors.	• The Tulsa region has identified two new priority initiatives and two ongoing projects to facilitate integrated corridor management in the region. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Joint State/Local Projects – Consider joint state/local projects on a corridor or network basis such as integrated corridor management and improved arterial signalization and coordination.	New	
Active Management of Integrated Corridors – Advance the level of active management and integration of each integrated corridor over time to increase the address corridor issues over time.	Ongoing	
Cross-region Data Sharing – Strengthen data-sharing with key agencies and use dynamic message sign (DMS) control across the region. Promote additional coordination with agencies and traffic signals.	Ongoing	
Additional Funding Investments – Consider more funding investments. For instance, a freeway closure scenario and incident management scenario on parallel arterials.	New	

5.3.6 Connected and Automated Vehicles (CAV)

Connected and Automated Vehicles in the Tulsa Region	Recommended Actions
• Oklahoma Department of Transportation (ODOT) has actively monitored the state of connected and automated vehicles (CAV) technologies. Efforts are focused on being proactive to both connected and automated vehicles to benefit from the anticipated advantages of the technologies and mitigate impacts from the technology to infrastructure and operations.	• The Tulsa region has identified four new priority initiatives to prepare for CAV in the region. Top-ranked items are included in the table below, and all actions are provided in the Appendix.

Initiatives	Initiative Status	Assigned to
Emerging Technologies Preparedness – Prepare for addressing emerging technologies, including automated vehicles, third-party data advances, and others that have the potential to transform mobility.	New	
Connected and Automated Vehicles (CAV) Impacts – Identify potential CAV impacts on traffic signal operations, arterial operations, safety, and mobility. Use readily available real-time data to make real-time operational decisions.	New	
Freeway/Highway Infrastructure – Explore CAV technologies along freeway managed lanes. The challenge may include the testing of these innovative products.	New	
Public Engagement – Continue to engage with the public and commerce. For example, support initiatives that address real-time strategies for work zone safety improvements.	New	

6 Regional Considerations

The full potential of TSMO and ITS strategies and technologies can only be realized if it is supported by the right organizational structure, processes, and resources. In recent years, the Tulsa region has invested in staffing, systems, and infrastructure to support its focus on TSMO. These investments have helped to integrate ITS and TSMO into each regional organization's existing structure and processes. However, as the focus on operations continues to grow, these organizations may need to consider making additional changes to their structure and processes to fully support the advancement of TSMO. This section explores some of the organizational and business process areas that may be affected by this focus on operations.

6.1 Regional Transportation Systems Management and Operations Coordination

This plan recognizes the need for strong regional coordination of TSMO efforts. To support this effort, the plan recommends establishing a regional TSMO steering and coordination committee. The committee should be responsible for coordinating all TSMO activities in the region, including education and outreach to stakeholders, training for the transportation community, targeted education for senior management and elected officials, and use of social media and conferences to promote TSMO.

The committee should be representative of all regional agencies, with the chair position rotating through member agencies. Tulsa regional agencies are listed in **Section 3.1**. If the Metropolitan Planning Organization (MPO) is unable to take on the leadership role, ODOT or the City of Tulsa can spearhead the committee and establish bylaws. By implementing this coordination committee, the Tulsa region aims to foster a culture of innovation and collaboration within the transportation community and make sure that TSMO is understood and embraced as a critical component of the region’s transportation system.

Collaboration with other organizations is crucial for the success of TSMO strategies and involves verbal collaboration on projects, the development of collaborative procedures or software applications, the exchange of relevant operational data, and joint efforts to use multiple sources of data for better decision-making. It is recommended that this regional ITS committee be given a formal charter and meet on a regular basis to advance TSMO and improve transportation operations throughout the region. External partners, such as ODOT, the Oklahoma DPS, and other local agencies may also be invited to facilitate fully integrated transportation system operations.

To safeguard the success of the TSMO program in the Tulsa region, it is important for all key stakeholders to be fully committed to the program and work together to achieve its goals. This cooperation can involve providing the necessary resources and support, collaborating with other organizations, and regularly reviewing and adapting the program as needed. By working together and leveraging the strengths and expertise of all involved, the TSMO programs can effectively improve transportation operations throughout the region.

6.2 Workforce Development

The Tulsa region understands the importance of having a well-trained and specialized workforce for the success of its ITS initiatives. To support this desire, the plan recommends investing in workforce development initiatives such as recruitment, training programs, and professional advancement paths specifically for ITS and TSMO staff. These initiatives will attract and retain top talent and provide opportunities for professional growth. By building a highly skilled and specialized workforce, the Tulsa region can make certain of the success of ITS efforts and broader goals.

The region may also consider regional and interagency initiatives, such as having the MPO and the Association of Central Oklahoma Governments (ACOG) host regional training to raise workforce skill levels. The National Cooperative Highway Research Program's (NCHRP's) Transportation Systems Management and Operations Workforce Guidebook (NCHRP-20-07)[22] may be used to guide and inform these workforce and development efforts.

6.3 Programming and Budget

Programming and budget are crucial for achieving the Tulsa region's goals. The region should work with ODOT to make sure TSMO/ITS projects are included on the Statewide Transportation Improvement Program (STIP) and the Capital Improvement Plan (CIP). The region should also consider funding regional TSMO/ITS projects through the MPO. All agencies should allocate some funding for these projects and review their planning processes to give equal consideration to operational projects alongside capital improvement projects.

To safeguard the success of the organization, it is recommended to identify and allocate funding for specific training needs and opportunities for the TSMO workforce. This training should cover the systems, procedures, and technologies used by the organization and its regional partners and broader external training opportunities related to all aspects of TSMO and ITS operations.

Effective programming and budget management are essential for the success of the Tulsa region. In addition to dedicated funding sources, the region should consider allowing larger ITS and TSMO initiatives to compete for funding through the STIP process, potentially requiring accommodations to show the value and benefit of TSMO projects in similar terms to capital investment projects.

6.4 Performance Measurement and Management

Performance measurement and management are essential for effective transportation system management in the Tulsa region. By using data to produce performance measures, the region can inform operational decisions and optimize system operations. The Tulsa region has already used various TSMO-related data

[22] Source: National Cooperative Highway Research Program, Transportation Systems Management and Operations Workforce Guidebook (NCHRP-20-07), 1st ed. (Washington, D.C.: Transportation Research Board, 2023), 15.

sources to monitor system performance, including data on roadway operations and the ITS itself. Some examples of these data sources include volume/occupancy/classification data from permanent count stations; incident response times from the ATMS system; speed, volume, and occupancy data from detector stations connected to the ATMS system; and travel times from the INRIX probe data product.

In addition to these measures, the Tulsa region should continue to evaluate emerging data sources and performance management techniques for applicability to the TSMO program. It may also be beneficial to evaluate the feasibility and benefits of implementing a data repository and real-time data exchange system. This system could potentially be used to share data among different agencies and organizations within the region, facilitating more effective collaboration and decision-making.

Tulsa agencies within the region should also consider the importance of data storage, analytics, and management in the field of TSMO and ITS. Currently, the region has typically stored its own data in on-site databases, and it accesses procured data through available data feeds and application programmer interfaces (APIs). However, as data technology continues to advance, it is recommended that the region periodically evaluate the benefits and drawbacks of evolving data management strategies for each of its data sets and develop a data management plan that includes policies for storage, aggregation, and retention. This protocol will make certain that the region is able to keep its data up to date and easily accessible, while also considering the various data and formatting needs of all divisions.

Tulsa regional agencies should continue to use data to inform their TSMO and transportation system management decisions while also staying up to date on emerging data sources and technologies. By developing a data management plan and exploring the potential benefits of a data repository and real-time data exchange system, the region can effectively use data to support the ongoing improvement of transportation operations and support the mobility needs of the region.

6.5 Plan Implementation

To fully integrate TSMO and ITS across the region, transportation agencies must prioritize the implementation of these technologies across their entire organization. This implementation will require a dedicated effort over time, with regular review and updates to check progress and effectiveness. By following these steps, transportation agencies can unlock the full potential of TSMO and ITS to improve mobility and safety in the Tulsa region.

6.6 Organize for Implementation

The Tulsa region is considering implementing a TSMO/ITS program through the establishment of a regional steering committee. This committee will be responsible for overseeing the implementation of the program and will include representatives from key stakeholders' organizations within the region. The TSMO steering committee will work to make sure that TSMO and ITS concepts are integrated into the practices and standards of each organization and will facilitate communication and collaboration among the various agencies involved.

6.7 Prioritize and Execute Tasks

In the Tulsa region, the recommended actions to advance the operational capability of the TSMO/ITS technology deployment in existing and new program areas are outlined in **Section 5**. Because there are more actions than can be undertaken at once, the regional steering committee will prioritize and execute selected tasks in a systematic manner, starting with those that provide the greatest benefit for the available budget and resources. The process will involve researching and adding detail to each task, estimating costs and benefits, prioritizing tasks, reviewing resources, developing an implementation schedule, assigning responsibility for implementation, establishing performance measures, and regularly reviewing resource needs and adjusting programming as needed.

6.8 Plan Maintenance

The Tulsa region has seen significant advancements in the field of TSMO/ITS in recent years, and innovative technologies are constantly emerging. It is important for the regional steering committee to regularly review and update the TSMO and ITS regional strategic plan to reflect the latest progress and developments. The recommended action items in **Section 5** should be reviewed annually, and the plan should be assessed every five years, or sooner if necessary. This will safeguard that the region's TSMO and ITS program remains effective and responsive to the changing needs of the transportation system.

7 Conclusion

The ITS and TSMO Strategic Plan for the Tulsa Region is a comprehensive document that outlines the current state of the region's ITS program, prioritizes the key areas of focus for TSMO, and provides a road map for implementing improvements in business processes and resource allocation.

The strategic plan was developed through a collaborative effort involving key stakeholders and partners and includes the recommendation to create a regional TSMO steering committee to oversee the implementation program and safeguard effective communication and collaboration among the various agencies involved. The plan itself is comprehensive and forward-looking, with a clear focus on leveraging technology to address the region's transportation challenges. This plan is intended to serve as a guide for decision-making and investment in the coming years.

The business case for the ITS and TSMO Strategic Plan for the Tulsa Region was compelling, highlighting the potential benefits of ITS and TSMO in terms of improved safety, mobility, and economic development. By implementing advanced technologies such as traffic management systems, freight management, and integrated corridor management, the Tulsa region could expect to see reduced congestion, faster travel times, and enhanced emergency response capabilities.

The current ITS program in the Tulsa region is well established and has achieved notable successes. The implementation of the ITS and TSMO Strategic Plan for the Tulsa Region has been built on the foundation of focusing on expanding and enhancing existing ITS capabilities. This focus has included recommendations for the deployment of advanced work zone management and traffic signal management so that the Tulsa region experiences improvements in traffic flow and congestion management and enhanced safety and emergency response capabilities.

TSMO program area prioritization and road map development are critical to the success of the ITS and TSMO Strategic Plan for the Tulsa Region. By prioritizing specific program areas and mapping out a clear timeline for implementation, the plan provides a framework for focused and effective investment in TSMO initiatives. Key priorities include the deployment of advanced traffic management systems, the development of smart transportation infrastructure, and the integration of connected vehicle technologies. These priorities are supported by a robust road map that outlines the specific actions and resources needed to achieve the plan's objectives.

The creation of a regional TSMO steering committee is an important recommendation of the ITS and TSMO Strategic Plan for the Tulsa Region. This committee will be responsible for overseeing the implementation of the program and will include representatives from key stakeholder organizations within the region. This committee will be instrumental in providing effective communication and collaboration among various agencies involved in the region's TSMO efforts.

By following the recommendations outlined in this plan, the Tulsa region can continue to advance its transportations system and unlock the full potential of ITS and TSMO technologies to improve mobility and safety for all users.