Safety Applications

The intent of System Layers is to define in further detail recommendations that would serve toward the goals of how ADOT should be operating and managing their network. This System Layer Plan is focused on:

- **Safety Applications** – Safety applications include projects, initiatives, and infrastructure directly related to preventing incidents.

Context of Existing Capabilities

ADOT currently has a number of ITS features and systems that support increased safety. In addition, the TSMO Division has a robust safety group/program that is well managed relative to crash data processing and analysis, traditional safety studies, and HSIP funding. This group supports activities across most aspects of ADOT including support of projects within MPD (planning), IDO (design), and Administration's coordination with GOHS and DPS. In addition, the group manages the funding and programming of HSIP dollars across the State, coordinating with many local agencies.

While there are a number of Safety Applications and processes in place, there are challenges and gaps in the deployment, maintenance, and sustainability of Safety Application capabilities that drive the recommendations outlined in this System Layer Plan.

Current Issues

Through a variety of meetings, workshops, and review of existing conditions and applications utilized by the state, current issues were uncovered that provide insight into the direction that ADOT should focus on addressing. The following are some of the current issues identified as related to Safety Applications:

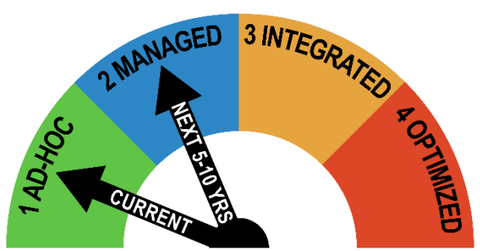
- Need to evaluate crash modification factor (CMF) for ITS elements to support federal fund use.
- Need to track TSMO safety improvements against Statewide Safety Goals.
- No predictive analysis is available based on historical data to identify potential safety issues.
- Need more coverage to detect wrong-way drivers.
- Limited real time information to alert road users, TOC operators to achieve Strategic Safety Goal: Vison Zero (Zero Crashes, Injuries, and Fatalities).

Future Direction

The project team conducted a series of individual workshops with ADOT for each System Layer Plan to identify the perceived existing readiness and future direction within the functional areas. The workshop included an interactive, online (JamBoard) activity in which ADOT staff provided specific feedback following a similar structure to the TSMO Capability Maturity Model (CMM) Framework. For Safety Applications, the workshop was held on March 25, 2022.

CMM levels for consideration of ADOT staff for their current capabilities, where they see progress in the next 5 years, and where there is desire to move toward in the next 10 years.

- **Level 1 – Ad-Hoc** – Activities are ad-hoc, informal, champion-driven
- **Level 2 – Managed** – Basic strategy application is understood with limited internal accountability or coordination
- **Level 3 – Integrated** – Standardized strategy applications that are managed for performance and aligned
- **Level 4 – Optimized** – Full and sustainable program based on prioritized data-driven process of continuous improvement



A summary of the feedback for the state is that the current capabilities are at the ad-hoc Level 1 state and in the future can be moved toward the Level 2 managed state.

ADOT currently has a robust safety group/program that is well managed relative to crash data processing and analysis, traditional safety studies, and HSIP funding. However, the safety staff/processes are not fully integrated with the other TSMO groups, ITS efforts specifically. ADOT should increase the coordination between the Traffic Safety Group and other ITS staff in the future and increase the capability/readiness through establishing new internal processes and increasing education relative to the benefits among other efforts.

Recommendations

This section provides a summary of important steps that will be used as building blocks for achieving the ultimate vision that extends to the five- to ten-year horizon. Because ADOT is looking at the three- to five-year horizon for implementation, these recommendations will focus on investments that are foundational technologies needed to support ADOT's future. The remaining gaps between what ADOT has today and where ADOT needs to be in the future becomes the recommended changes/additions that are needed.

ADOT's initial request for the ITS Master Plan included a number of specific areas in which potential recommendations were anticipated. For each area, the team has provided a summary of the current direction based on the research, interviews, and evaluation conducted during this study.

- Wrong-way vehicle detection
  - The application of WWD infrastructure has increased staff workload both in operations and maintenance. While the system has been refined, there is little data on the need in terms of location and the benefit in terms of crash reduction. Recommendations related to WWD focus on data collection, analysis, and hot spot evaluations prior to any systemic expansion of the system.
- Dangerous Slow Down
  - ADOT has developed a VSL application on I-10 for dangerous slow down conditions during a dust storm. Another application can be variable speed limits for significant changes in traffic volume and congestion – such as the weekend peak travel on SR 89A between I-17 and Sedona.
  - Similar speed feedback applications are recommended on rural interstate routes that approach and/or traverse isolated communities that have increased local traffic that operates at slower speeds. Speed feedback systems are recommended for I-17 as it approaches and terminates at Flagstaff and I-40 as it crosses Kingman.
- Back of Queue
  - Rear-end collisions related to queuing are common in the more urban areas during peak periods. However, the locations and extent can regularly vary and therefore it is not recommended that ADOT provide additional detection beyond the existing loop detection or additional messaging beyond the existing DMS in these dense areas. Initial application is seen to be more beneficial at rural locations where queuing may not be expected but is recurring – such as the border crossing at SR 85.
- Conflict Warning Systems
  - Intersection conflict warning systems benefit through traffic on highways by warning of waiting vehicles on side streets. There was little discussion on the need for this through the workshops and other opportunities for input.
- Intersection Near-Miss
  - Near-miss crash detection has not been utilized by ADOT in the past and potential systems would generate new data streams that would have to be monitored and evaluated. It is recommended that ADOT increase coordination and reporting efforts on reported crash data prior to expanding efforts to near-miss data.

Table 1 provides recommendations that can assist ADOT in improving their readiness level to move toward Level 3 capabilities for Safety Applications on a statewide basis. The consultant team also reviewed existing ADOT Road Safety Assessment (RSA) recommendations for ITS components. While many of the recommendations are independent and can be accomplished in a short timeframe, ADOT should focus on a few key recommended activities (denoted in bold) to ensure adequate resources are available and generate the greatest benefits in progressing their readiness level.

Table 1 – Safety Applications System Layer Plan Recommendation Summary (STIP level information)

PROCESS Recommendation Title	Description	Steps and Outcomes	Context for Recommendation	Recommended Champion	Recommended Stakeholder Involvement in Implementation	Total Funding Required	Annual Funding Required	Contracting Mechanism
DATA MANAGEMENT								
Improve Crash Data Platform	Enhance the existing online crash data platform for ADOT staff with easily accessible queries. Primary additions include more flexibility in bounding of ACIS tool and automatic crash diagrams.	**Steps:** Work with RTE and other ADOT groups to determine the most frequent crash requests. Identify the user-interface that is preferred (tabular or spatial). Identify the best output format(s) for ease of use. Work with ITG to improve the platform. **Outcomes:** Enhanced online interface.	Current version of Data Query Mart was large improvement over initial database but is still run primarily by Safety staff due to lack of training and consistency of use by ADOT staff. Access to the program is difficult to maintain unless it is utilized regularly.	TSMO Traffic Safety Engineer	ADOT RTE staff to provide guidance on typical query requests. ADOT ITG to identify options for upgrade.	$40K	$10K	In-house
Setup Predictive Crash Data Analysis Tool	Replace AASHTOWare Safety Analyst with a solution that supports advanced HSM analysis such as predictive crash evaluation.	**Steps:** (Continue) research on available software systems that are available, supported, and utilized by other State DOTs. Evaluate systems and determine the most appropriate in terms of compatibility with ADOT data and user needs. Work with ITG to determine hardware and software needs. Install and integrate the ADOT data into the software system. **Outcomes:** Advanced crash analysis software	AASHTOWare Safety Analyst is no longer supported nationally. However, ADOT has invested significant resources in developing the underlying data for the predictive approach. TSMO requires ITG support in setting up a new software to continue predictive analysis.	TSMO Traffic Safety Engineer	ADOT ITG to assist in software options and support. ADOT MPD to assist with input data management.	$500K	$20K	Out-source - Procurement
PERFORMANCE MEASURES								
Develop CMF for ITS Funding Support	Develop crash modification factors (CMF) for ADOT applications of technology (WWD, VSL, queue warning) that can be applied to future funding opportunities. Develop a formal study so that it can be shared nationally as formal research.	**Steps:** Research and locate similar safety studies if available and utilize associated data. Query and summarize crashes related to ADOT applications of technology including 3-5 years before and after activation. Advertise for consultant support through the TSMO On-call. Manage the consultant in developing a CMF specific to ADOT applications. Compare to nationally available data. **Outcomes:** Guidance.	HSIP funding opportunities, as well as other competitive processes, rely on benefit-cost analyses and demonstrated safety benefits. A documented and approved CMF would increase the applicability of technology applications within these funding opportunities.	TSMO Traffic Safety Engineer	-	$100K	-	Out-source – University technical support through CATS or Research

PROCESS Recommendation Title	Description	Steps and Outcomes	Context for Recommendation	Recommended Champion	Recommended Stakeholder Involvement in Implementation	Total Funding Required	Annual Funding Required	Contracting Mechanism
PERFORMANCE MEASURES								
Generate Quarterly Safety Metrics	Develop safety statistics (crash summaries) on ADOT applications of WWD, PHB, VSL, signal coordination, advanced detection, and other ITS. Along with simple frequency data, coordinate available data from TOC and traffic volumes to develop relationship for identifying hot spots.	*Steps and Outcomes have been incorporated in the **Develop and Utilize TSMO Performance Measure Platform** action item in the **Data and Performance Management System Layer Plan***	ADOT has deployed various systems and countermeasures for safety issues that have not been regularly tracked. Standardized reporting of crashes would allow the identification of larger trends and/or hot spots.	ADOT TSMO Director and TSMO Operational Traffic & Safety Group Manager	ADOT ITG to assist in possible database development, all TSMO Group Managers to contribute	$50K	-	In-House
Track TSMO Safety Goals to Align with Statewide Traffic Safety Plans	Align and track TSMO safety goals with Strategic Traffic Safety Plan (STSP) goals and Governor's goals.	**Steps:** Summarize all existing safety goals/performance metrics from the required Federal target setting, STSP, and ADOT Director/Governor level. Determine commonality and identify appropriate TSMO safety goals that align with other programs. Utilize the ADOT database queries to generate recurring reports highlighting trends. **Outcomes:** Performance measures/statistics.	Safety concerns have been approached in several activities/programs and each have different focus. Coordinating and consolidating TSMO safety goals with the larger political/statewide goals will streamline the update process. A dashboard currently exists to track emphasis areas within the current STSP - continue STSP tracking on a macro scale but add micro scale measures to enhance reporting.	TSMO Traffic Safety Engineer	-	-	-	In-house
STAFFING STRUCTURE								
Establish Formal ITG Support	Identify ITG support staff with adequate knowledge and skill for database management and query development.	**Steps:** Review TSMO Safety programs and databases and develop a list of required support that is IT-based (outside traditional transportation professionals). Coordinate with ITG to determine available staff resources. Establish an internal process for technical support - recurring intervals, as-needed, ticketing system, etc. **Outcomes:** Staff support.	ADOT Traffic Safety is heavily reliant on large databases and data management/analysis. Staff within TSMO are adept at running processes but more advanced database skills are needed to support initial setup and maintenance. There is a need to have ITG provide broad support or specific staff to assist in ongoing operations and not necessarily tied to a specific deliverable/recommendation.	TSMO Traffic Safety Engineer	ADOT ITG to identify available staff resources and assist in coordination; all TSMO Group Managers.	-	-	In-house

PROCESS Recommendation Title	Description	Steps and Outcomes	Context for Recommendation	Recommended Champion	Recommended Stakeholder Involvement in Implementation	Total Funding Required	Annual Funding Required	Contracting Mechanism
PROCESS STRUCTURE								
Identify Safety Funding for ITS and ITG projects	Identify a safety funding stream for short-term (less than 3 years) ITS and ITG improvements for ADOT TSMO Division.	**Steps:** Determine the magnitude of likely annual need in terms of ITS deployment and ITG projects. Assess TSMO funding including TSMO subprogram and HSIP for set-aside. Coordinate with ADOT Finance and Programming staff to identify other funding stream opportunities and flexibility. Create a dedicated program for ITS and ITG projects along with an internal process for call-for-projects. **Outcomes:** Programming.	TSMO-led ITS improvements can often be more extensive than TSMO maintenance groups can install but lower cost than typically programmed through P2P. ITG-based projects are often not P2P compatible. Having a funding pool that allows more flexibility would benefit standalone ITS and ITG projects.	TSMO Traffic Safety Engineer	None	-	-	In-house
Review Scoping Documents	Ensure TSMO Division is reviewing project scoping documents for ITS features associated with safety - speed feedback signs, DMS, traffic signals, etc.	**Steps:** Coordinate with key MPD and IDO managers and identify existing ADOT processes within the project planning and design stages that would benefit from TSMO review. Evaluate the range of options for adding ITS improvements within project restrictions based on funding type, schedule, or other. Create a formal process for TSMO review including routing requirements, review checklists, and internal TSMO review staff. Coordinate with the ADOT Workfront platform. **Outcomes:** Project development.	Many ITS improvements can be installed with larger infrastructure projects if they are identified early in the process. Consistent coordination with MPD and IDO can increase TSMO ITS inclusion in projects and reduce the need for standalone efforts.	TSMO Division Director	ADOT IDO; ADOT MPD; all TSMO Group Managers	-	-	In-house
Develop an ADOT TGP for Speed Feedback Signs	Create a new ADOT-specific TGP to provide guidance on when, where, and how to install dynamic feedback signs for traffic speed.	**Steps:** Review prior ADOT installations and determine best practices. Draft a TGP that includes guidance on application, design, and operation. Circulate within TSMO for review. Submit to the Standards Committee for voting approval. **Outcomes:** Clear and documented guidance on speed feedback sign installation and operation.	ADOT has gained considerable experience in speed feedback signs and would benefit from transferring the gained knowledge to a guidance document for future use.	TSMO Traffic Safety Engineer	TSMO System Maintenance Group Manager	-	-	In-house

INFRASTRUCTURE DEPLOYMENT Recommendation Title	Description	Steps and Outcomes	Context for Recommendation	Recommended Champion	Recommended Stakeholder Involvement in Implementation	Quantity	Cost Per Unit	Total Capital Cost	Total O&M Cost	Contracting Mechanism
LIFECYCLE REPLACEMENT										
None										
EXPANSION OF ADOT TECHNOLOGY DEPLOYMENT										
Expand Installation of Wrong Way Counter Measure / WWD Detection	Expand WWD system within the urban Phoenix and Tucson areas as currently designed. Incrementally add WWD detection to rural areas using a modified approach at existing DMS locations. Locations as provided in the **Prioritization Tool**.	**Steps:** Evaluate existing WWD system in terms of locations, costs for capital, costs and staffing for operation and maintenance prior to further deployment. Conduct incident analysis on statewide roadways to identify areas of recurring WWD. Create a standard installation for urban and rural locations. When minimal (camera only), install using internal forces as available. When larger, work with procurement to solicit design and construction. Manage construction with assistance from designer and make sure process for notifications is established prior to project completion. **Outcomes:** Additional WWD detection and warning statewide in incremental manner.	ADOT has developed and refined a WWD detection and warning system in urban Phoenix that can be scaled and deployed elsewhere in the State. ADOT to determine if the deployment is systemic or data-driven.	TSMO Systems Technology Group Manager	TSMO Traffic Management Group Manager	12	$25K	$300K	$30K	In-house (TSMO maintenance) if camera only installation. Out-source (TSMO On-Call) if larger installation.
Install Queue Management	Install queue warning systems at locations with recurring backups and historically long and difficult to manage queues. Develop plan to deploy queue management. Assess need for queue warning detection and deploy in warranted areas.	**Steps:** Conduct bottleneck and congestion analysis using INRIX data to identify areas with recurring backups and queuing. Cross-check with planned ITS maps what infrastructure is already proposed or planned for those areas identified. Work with procurement to solicit design and construction. Manage construction with assistance from designer and make sure process for notifications is established prior to project completion. **Outcomes:** Design and construction of queue management technologies statewide in incremental manner.	Specific areas throughout the State can experience recurring queue such at borders, ports of entry, and various other locations during seasonal activities. Strategic technology can be deployed to address these queuing areas. Queue management technologies can be considered as real-time detection, CCTV, lane control signs, and DMS, or some combination thereof for queue condition notification purposes.	TSMO Systems Maintenance Group Manager	TSMO Operational Traffic & Safety Group Manager, TSMO RTEs and District Maintenance personnel	7	$400K	$2.8M	$140K	Out-source – ECS (design) C&S (construction)

INFRASTRUCTURE DEPLOYMENT Recommendation Title	Description	Steps and Outcomes	Context for Recommendation	Recommended Champion	Recommended Stakeholder Involvement in Implementation	Quantity	Cost Per Unit	Total Capital Cost	Total O&M Cost	Contracting Mechanism
EXPANSION OF ADOT TECHNOLOGY DEPLOYMENT										
Address Pedestrian Safety	Utilize leading pedestrian intervals at traffic signals to increase pedestrian visibility.	**Steps:** Create a standard approach for leading pedestrian interval times and application. Work with traffic signal technicians to implement changes within the controller. Develop educational material, or utilize nationally available documentation, and have PIO release social media posts. **Outcomes:** Traffic signal timing.	Pedestrian fatalities continue to increase and are a leading concern in the State. Signalized intersections provide a relatively easy opportunity to implement a proven countermeasure.	TSMO Operational Traffic & Safety Group Manager	ADOT RTE to identify locations.	-	-	-	-	In-house
Install Variable Speed Limits	Install variable speed limit system on SR 89A between Sedona and I-17.	**Steps:** Define the scope of the project with District. Write request for proposals for advertising design through ECS. Manage consultant throughout the project design to achieve goals. Coordinate with IDO to advertise construction through C&S and manage installation. **Outcomes:** Infrastructure.	District has identified this location as an issue with speed management and highly variable traffic/congestion during peak visitor seasons.	TSMO Operational Traffic & Safety Group Manager	ADOT Districts to assist in scoping. ADOT IDO will manage construction.	1	$4M	$4M	$100K	Out-source – ECS (design) C&S (construction)
Install Variable Speed Limits	Install variable speed limit system on I-10 within the Deck Park Tunnel.	**Steps:** Define the scope of the project with District. Write request for proposals for advertising design through ECS. Manage consultant throughout the project design to achieve goals. Coordinate with IDO to advertise construction through C&S and manage installation. **Outcomes:** Infrastructure.	District has identified this location as an issue with crashes within a confined corridor with limited visibility.	TSMO Operational Traffic & Safety Group Manager	ADOT Districts to assist in scoping. ADOT IDO will manage construction.	1	$4M	$4M	$100K	Out-source – ECS (design) C&S (construction)
Install Queue Warning	Install advanced queue warning system on SR 85 at Lukeville.	**Steps:** Define the scope of the project with District. Write request for proposals for advertising design through ECS. Manage consultant throughout the project design to achieve goals. Coordinate with IDO to advertise construction through C&S and manage installation. **Outcomes:** Infrastructure.	District has identified this location as an issue with queuing approaching the international border crossing.	TSMO Operational Traffic & Safety Group Manager	ADOT Districts to assist in scoping. ADOT IDO will manage construction.	1	$4M	$4M	$100K	Out-source – ECS (design) C&S (construction)

INFRASTRUCTURE DEPLOYMENT Recommendation Title	Description	Steps and Outcomes	Context for Recommendation	Recommended Champion	Recommended Stakeholder Involvement in Implementation	Quantity	Cost Per Unit	Total Capital Cost	Total O&M Cost	Contracting Mechanism
EXPANSION OF ADOT TECHNOLOGY DEPLOYMENT										
Install Speed Feedback Signs	Install speed feedback signs on I-40 through Kingman.	**Steps:** Define the scope of the project with District. Write request for proposals for advertising design through ECS. Manage consultant throughout the project design to achieve goals. Coordinate with IDO to advertise construction through C&S and manage installation. **Outcomes:** Infrastructure.	District has identified this location as an issue with speed management due to the mix of local and interstate travel.	TSMO Operational Traffic & Safety Group Manager	ADOT Districts to assist in scoping. ADOT IDO will manage construction.	1	$1.5M	$1.5M	$50K	Out-source – ECS (design) C&S (construction)
Install Speed Feedback Signs	Install speed feedback signs on I-17 approaching Flagstaff.	**Steps:** Define the scope of the project with District. Write request for proposals for advertising design through ECS. Manage consultant throughout the project design to achieve goals. Coordinate with IDO to advertise construction through C&S and manage installation. **Outcomes:** Infrastructure.	District has identified this location as an issue with speed management due to the termination of the interstate into the "main street".	TSMO Operational Traffic & Safety Group Manager	ADOT Districts to assist in scoping. ADOT IDO will manage construction.	1	$2M	$2M	$50K	Out-source – ECS (design) C&S (construction)
DEMONSTRATED TECHNOLOGIES FOR ADOT DEPLOYMENT										
Address Signalized Intersection Safety Performance	Deploy ATSPM for intersection operations/queuing for connection to safety measures.	**Steps:** Define the scope of the project and ATSPM needs. Write request for proposals for advertising design through TSMO On-call. Manage consultant throughout the project effort to achieve goals. Coordinate within TSMO to manage installation and monitoring. **Outcomes:** Performance measures/statistics.	Safety concerns are typically reactive (post incident). ATSPM provides opportunity to be proactive at signalized intersections.	TSMO Operational Traffic & Safety Group Manager	None	1	$1M	$1M	$100K	Out-source - ADOT TSMO On-call

INFRASTRUCTURE DEPLOYMENT Recommendation Title	Description	Steps and Outcomes	Context for Recommendation	Recommended Champion	Recommended Stakeholder Involvement in Implementation	Quantity	Cost Per Unit	Total Capital Cost	Total O&M Cost	Contracting Mechanism
EMERGING TECHNOLOGY FOR ADOT PILOTING										
Continue to Test Technologies for Safety Benefit	Continue to pilot new/emerging technology to gain knowledge of benefits and maintenance costs. Coordinate within existing Anthem Test Bed or other projects in MAG region based on available partnerships.	**Steps:** Identify emerging technology that may be applicable. Work with MAG, MCDOT, others on available funding, partnerships, or shared testing. Identify pilot location and oversight. Install, test, and evaluate. **Outcomes:** Infrastructure.	New technologies may be beneficial in improving operations, safety, and/or reducing staff workload. Piloting small deployments gives an opportunity to evaluate.	TSMO Systems Technology Group Manager	All TSMO Group Managers					In-house
Connected Vehicle Data Use Evaluation Pilot	Investigate use of connected vehicle data to support active transportation demand management with new forms of data.	**Steps:** Identify types of data that might replace or enhance traditional real-time traffic data and determine if connected vehicle data could effectively deliver that information. **Outcomes**: Understanding of usefulness of new data sources for transportation management.	Traditional traffic data sensors can be expensive to install and may be prone to maintenance problems. Replacing or enhancing traditional data collection can reduce overall costs and could supply enhanced data to allow for more effective ATDM.	TSMO Systems Technology Group Manager	MAG	1	$300K	$300K	-	MAG Emerging Technology Program/In-house

Performance Measures

The ADOT TSMO Plan defines performance measures using three categories, safety, mobility, and infrastructure/system health. The following performance measures were developed to track the progress of the above recommendations associated with the Safety Applications System Layer Plan.

Performance Measurement Topic	Performance Measure	Measure Applicability
Speed compliance	Reduce speed variation	Number, frequency, and locations of rear end crashes
Safety for non-motorized users	Improved safety at intersections	Left turn and angle crashes including number of pedestrian and bicycle crashes using smart technology at signals
Safety improvements	Increased programming of safety improvements	Average benefit-cost analysis for HSIP awarded projects and before and after crash performance