



U.S. Department of Transportation
Federal Highway Administration

CASE STUDY

A light blue silhouette map of the state of Florida is positioned behind the 'CASE STUDY' text.

Connecting Transportation Operations and Safety in Florida



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Introduction

The Florida Department of Transportation (FDOT) is committed to providing a safe transportation system that ensures the mobility of people and goods. Florida has a unique transportation context for addressing safety and mobility. The State's population increased by more than 32 percent from 2000 to 2019 and saw a significant growth in visitors or tourists unfamiliar with the transportation system during that same period.¹ The population of adults over 65 is expected to grow by 61 percent by 2045, leading to an increase in specialized mobility needs.²

FDOT views safety and mobility as two sides of the same coin rather than two independent programs. The agency demonstrates strong coordination between safety and operations in several areas, including data, analysis, and highway needs and priorities. FDOT evaluates its transportation system to identify actions that can both enhance safety and improve mobility, such as diverting traffic during a crash or moving traffic more efficiently through intersections while protecting vulnerable users. Through joining transportation systems management and operations (TSMO) and safety, FDOT's Traffic Engineering and Operations Office has new ways to identify problematic locations. Once highway problem locations are identified, FDOT draws upon a holistic suite of strategies to address safety and operational issues, including coordinating with the MetroPlan Orlando, Central Florida's metropolitan planning organization, which incorporates a TSMO advisory committee and has a strong focus on improving safety while improving mobility for pedestrians and other vulnerable users.

FDOT: At a Glance

FDOT serves a population of 21.5 million residents and 122 million visitors each year. The State covers 53,625 square miles with 12,136 centerline miles of State highways supporting 312.8 million vehicle miles traveled daily. Within FDOT, the operations office uses safety data to detect hotspots and implement countermeasures, and the safety office uses TSMO data to assist law enforcement with safety efforts.

Sources: VISIT FLORIDA®. 2022. "Research FAQ" (web page). <https://www.visitflorida.org/resources/research/research-faq/>, last accessed December 1, 2022.

FDOT. n.d. "Florida Transportation Fast Facts" (web page). https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/fastfacts.pdf?sfvrsn=29ef5de8_8, last accessed December 1, 2022.

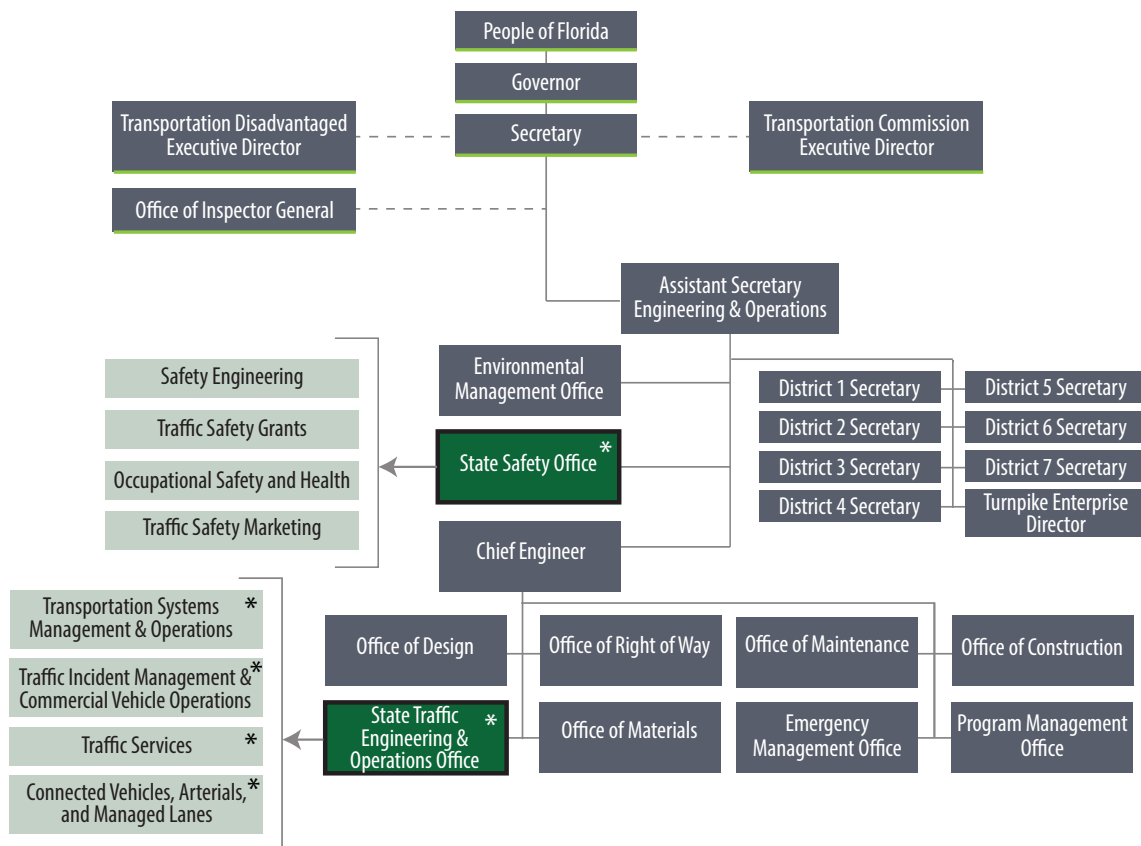
1 FDOT. March 2021. *Florida Strategic Highway Safety Plan*. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/safety/shsp-2021/shsp_mar21.pdf?sfvrsn=5452dad_0, last accessed December 1, 2022.

2 Ibid.

Connecting Operations and Safety Through Institutional Arrangements

FDOT is organized into a central office, seven districts, and a turnpike enterprise. The Engineering and Operations Division at FDOT’s central office manages the central office operations and safety functions. Within that division are the State Safety Office, which directs safety for FDOT, and the Traffic Engineering and Operations Office, which houses the TSMO program and safety functions related to operations and traditional traffic engineering at the central office level. Central office staff work with representatives from the districts to implement the safety and TSMO programs.

The Traffic Engineering and Operations Office’s mission is to “improve safety and mobility through the efficient application of traffic engineering principles and practices.”³ The State traffic operations engineer leads the office, and it contains five units: TSMO; Traffic Incident Management and Commercial Vehicle Operations; Traffic Services; Connected Vehicles (CVs), Arterials, and Managed Lanes; and the Transportation Engineering Research Laboratory (figure 1). Much of the traditional traffic engineering work, including safety studies, occurs in the Traffic Services unit. For each FDOT district, the district safety engineer, TSMO engineer, and traffic services engineer report to the State traffic operations engineer.



Source: Adapted from FDOT.

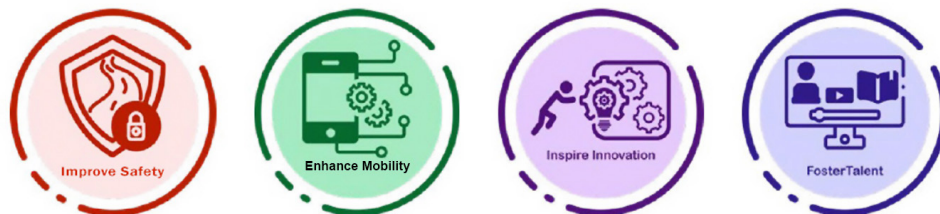
Figure 1. Graph. Portions of the Florida Department of Transportation organizational chart with the State Safety Office, the State Traffic Engineering and Operations Office, and its four units highlighted.

3 FDOT. 2022. “Traffic Engineering and Operations Office” (web page). Available at: <https://www.fdot.gov/traffic/default.shtm>, last accessed December 12, 2022.

The State Safety Office's mission is to "continually improve the safety of Florida's traveling public and FDOT employees."⁴ The Office consists of four core functions: safety engineering, traffic safety grants, FDOT occupational safety and health, and traffic safety marketing. The State Safety Office leads the development of the Florida Strategic Highway Safety Plan (SHSP), FDOT's National Highway Traffic Safety Administration Highway Safety Grant Programs for education and enforcement, and FDOT's Federal Highway Administration (FHWA) Highway Safety Improvement Program. The chief safety officer leads the State Safety Office at FDOT headquarters. The State Safety Office coordinates with all FDOT technical disciplines, the safety offices in each district, and partners to serve as a force multiplier to achieve Florida's target of zero fatalities and serious injuries.

Safety and operations disciplines also collaborate through multidisciplinary committees and forums to enable joint work on projects of interest to safety and operations stakeholders. Representatives from the State Safety Office are part of the statewide TSMO leadership team and TSMO task team, which meet regularly. The TSMO task team includes office managers from the design, maintenance, construction, planning, project development and engineering, and information technology divisions. FDOT's State Safety Office holds quarterly meetings, which include central and district office personnel and their TSMO counterparts.

Under FDOT's Vital Few⁵ initiative, staff from the operations and safety disciplines crossed over to support both safety and mobility initiatives. FDOT leadership elevated improvements in safety and mobility through the Vital Few, which represented four key, agency-wide priorities: improve safety, enhance mobility, inspire innovation, and foster talent (figure 2). The results from the Vital Few initiative have been integrated into daily practice and FDOT's core mission and values.



Source: FDOT.⁶

Figure 2. Image. Improve Safety, Enhance Mobility, Inspire Innovation, and Foster Talent are the core elements used by the Florida Department of Transportation to implement its organizational mission.

Connecting Operations and Safety Through Data

FDOT uses a data-driven approach to enhance safety and mobility. FDOT relies on combining safety and operations data and sharing data between the State Safety Office and the Traffic Engineering and Operations Office. For example, the State Safety Office supplies the Traffic Engineering and Operations Office with crash data for crash analysis and remediation, including work zone crashes, secondary crashes, wrong-way driving crashes, and lane departure crashes. The TSMO unit has used crash data to address wrong-way driving for more than 5 years. By

4 FDOT. 2022. "State Safety Office" (web page). Available at: <https://www.fdot.gov/Safety>.

5 FDOT. 2022. "Office of Inspector General" (web page). Available at: <https://www.fdot.gov/ig/default.shtm>.

6 FDOT. FDOT's Annual Report from FY 2020–2021. Available at: <https://www.fdot.gov/agencyresources/aboutfdot.shtm>, last accessed August 15, 2022.

working to reduce crashes, the TSMO unit is also improving travel time reliability and reducing delay for the movement of people and goods. The Traffic Engineering and Operations Office also uses data from the State Safety Office and district safety engineers as part of its intersection control evaluations to categorize and identify locations where engineering countermeasures can be implemented to improve safety and operations.

Although the State Safety Office is more often a supplier of data than a receiver, it does use operations data to assist law enforcement in safety efforts. The Traffic Engineering and Operations Office and the State Safety Office are working on creating a repository to integrate their shared data.

Additional FDOT safety and operations initiatives that focus on data include:

Quantifying the Benefits of TSMO Strategies—FDOT sponsored research by Florida International University and the University of North Florida to quantify the mobility and safety benefits of the following TSMO strategies: ramp metering systems, dynamic message signs, Road Ranger Service Patrols, express lanes, transit signal priority, and adaptive signal control technology.⁷ The researchers evaluated operational performance using mobility performance measures, such as travel time, travel time reliability, average speed adjustment, and incident clearance duration. The authors also evaluated safety benefits using measures, such as crash occurrence risk, secondary crash occurrence risk, and crash frequency. The study results were incorporated into a spreadsheet application, referred to as the TSMO Strategies Assessment Tool.

The researchers used several data sources⁸ to quantify safety and mobility benefits:

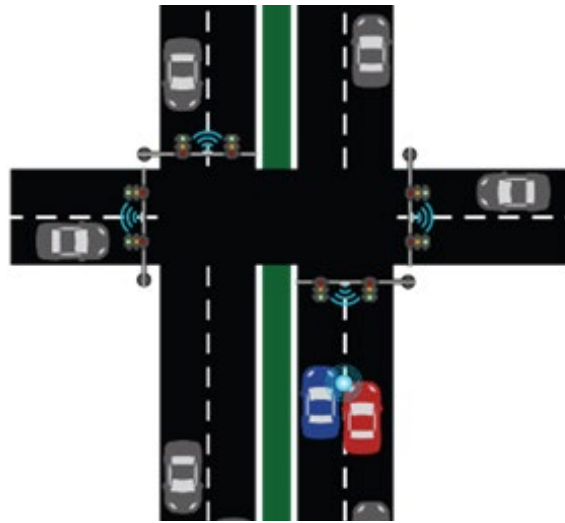
- Regional Integrated Transportation Information System (RITIS)—An automated data sharing, dissemination, and archiving system that includes real-time data feeds and data analysis tools, such as a probe, detector, and transit data analytics
- SunGuide®—An advanced traffic management system used to process and archive incident data on Florida’s transportation system
- BlueToad™—A database that contains real-time traffic data that are collected using Bluetooth signal receivers
- SignalFour Analytics—An interactive web-based geospatial analytical tool for the State of Florida that provides crash data with numerous crash attributes
- Roadway Characteristics Inventory—An inventory that contains data describing the features and characteristics of Florida’s roadway network

7 Alluri, P., T. Sando, C. Kadeha, H. Haule, J. Salum, M. S. Ali, J. Kodi, and A. Kitali. 2020. *Developing Florida-specific Mobility Enhancement Factors (MEFs) and Crash Modification Factors (CMFs) for TSM&O Strategies*. Tallahassee, FL: Florida Department of Transportation.

8 The United States Government does not endorse products or manufacturers. Trademarks or manufacturers’ names appear in this report only because they are considered essential to the objective of the document. They are included for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one product or entity.

TSMO managers at FDOT used this research on the mobility and safety benefits of TSMO strategies to make the case to FDOT leadership for using operations data and deploying TSMO strategies to improve safety and mobility.⁹

Near Miss Identification Safety Systems (N-MISS)—FDOT is implementing N-MISS, a project that uses both traditional and emerging technology and real-time data to detect and analyze near-miss traffic incidents at intersections (figure 3).¹⁰ FDOT uses video data to analyze vehicle and bicycle/pedestrian trajectories to locate safety issues. FDOT will use this information to recommend safety countermeasures to proactively avoid crashes that result in congestion and delay, thus providing a parallel operational benefit. The project covers 26 intersections on State roads in the City of Lakeland, Seminole County, and the City of West Palm Beach. This project helps establish the need for real-time data instead of historic data for mobility and safety improvements.



Source: FDOT.

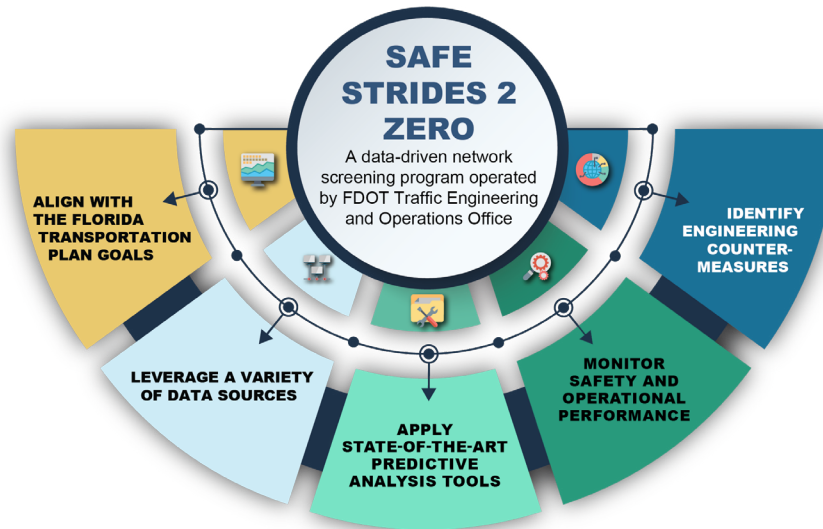
Figure 3. Diagram. Near-Miss Identification Safety System intersection diagram.

SAFE STRIDES 2 Zero—The Traffic Engineering and Operations Office leads the System Analysis and Forecast Evaluation State Traffic Roadway and Intersection Data Evaluation System (SAFE STRIDES) 2 Zero program. SAFE STRIDES 2 Zero is a data-driven network screening program to monitor safety and operational performance and identify appropriate countermeasures to improve both safety and operational performance (figure 4). The program focuses on signalized intersections on State highway systems, but FDOT anticipates expanding the program to include both unsignalized intersections and roadway segments. The program looks at historic hotspots and risk factors that may lead to future crashes to proactively address safety problems.¹¹ SAFE STRIDES 2 Zero provides stakeholders with data on candidate roadway segments and intersections for safety improvements. All seven district engineers use the SAFE STRIDES 2 Zero study reports for engineering studies and to support their safety improvement program.

⁹ FDOT. "Using Operations Data to Support Mainstreaming TSMO." Webinar from Federal Highway Administration Office of Operations, Washington, DC, May 11, 2022.

¹⁰ FDOT. n.d. "SAFE STRIDES Near Miss Identification Safety Systems (N-MISS)" (web page). <https://www.fdot.gov/traffic/teo-divisions.shtm/cav-ml-stamp/cv/maplocations/n-miss>, last accessed December 1, 2022.

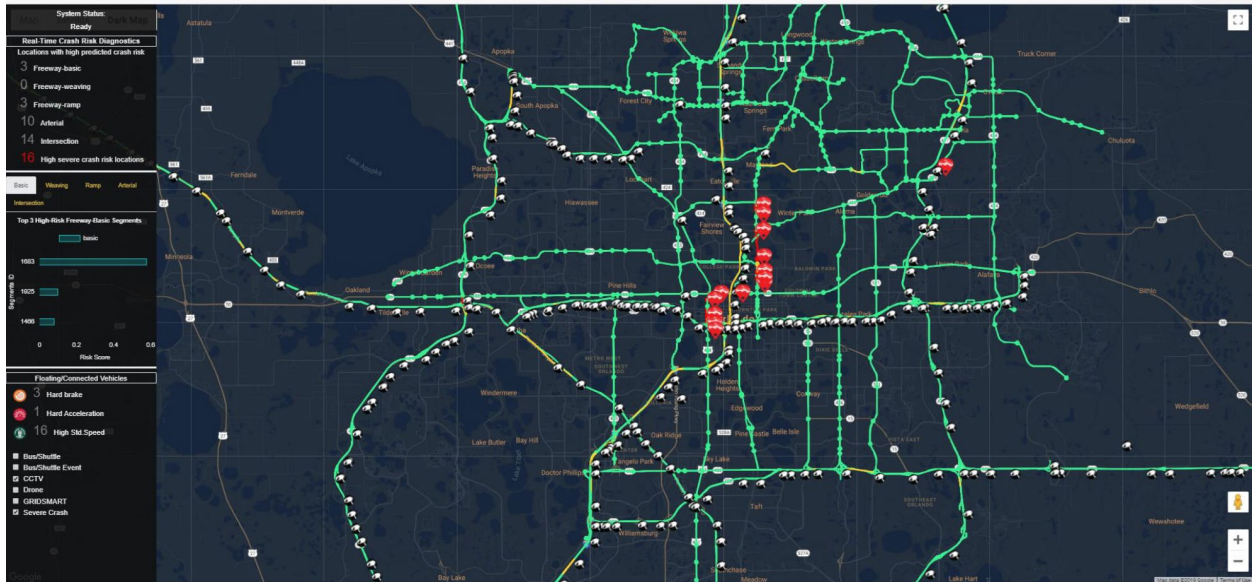
¹¹ SAFE STRIDES 2 Zero" (web page). <https://www.fdot.gov/traffic/trafficservices/safestrides2zero/overview>, last accessed December 1, 2022.



Source: FDOT.

Figure 4. Graphic. SAFE STRIDES 2 Zero.

Real-Time Crash Risk Visualization Tool for Traffic Safety Management—Developed by the University of Central Florida (UCF), the Real-Time Crash Risk Visualization Tool for Traffic Safety Management aims to help prevent crashes before they occur. The tool uses traffic and weather sensors and crowdsourced data and applies advanced analytics to provide real-time crash risk visualizations. The tool's functionality allows operators and decisionmakers to identify proactive traffic management strategies and intervene in real-time to reduce or prevent potential crashes. The tool uses machine learning methods and peer-reviewed literature to produce crash risk estimates, including the severity of crashes, based on real-time conditions. The Real-Time Crash Risk Visualization Tool combines real-time data typically gathered from operations infrastructure to assess crash risk and identify operational, engineering, and behavior modification strategies to reduce crash risks. The tool may recommend operations strategies, including speed management and signal optimization. FDOT's District 5 Traffic Management Center is experimenting with the Real-Time Crash Risk Visualization Tool to reduce its incident response time. Figure 5 is a screenshot of the Real-Time Crash Risk Visualization Tool's user interface. The interface shows the locations that are of high-risk for crashes based on different facility types. It also maps hard braking, hard acceleration, and high-speed data from floating CV. In this map, there are 16 locations that are rated as having a high severe crash risk.



Source: Mohamed Abdel-Aty.¹²

Figure 5. Image. Sample user interface for the Real-Time Crash Risk Visualization Tool.

Connecting Operations and Safety Through Operations Strategies

With support from the State Safety Office's data, TSMO and safety program staff work together to address work zone crashes and deploy advanced technologies to improve safety and mobility.

Work Zones

FDOT's SHSP¹³ identifies work zones as an evolving emphasis area, a safety area that represents a potentially high-risk or high-impact challenge or opportunity in reaching Florida's goal of zero fatalities. The plan notes that work zone fatalities represent approximately 2 percent of all fatalities statewide and that work zone crashes create significant disruptions to State roadway operation. The plan recommends many operations strategies to address this issue, including smart work zone implementation. Smart work zones apply sensor, computer, and communication technology to provide traveler information and traffic control in and around a work zone. Smart work zones rely on real-time traffic condition analysis to help traffic managers select the traffic control strategies that will optimize throughput and safety. FDOT's 2017 *TSM&O Strategic Plan*¹⁴ identifies work zone traffic management as an important tool in the TSMO strategy toolbox to improve safety and mobility.

12 Abdel-Aty, M. 2020. "Real-Time Crash Risk Visualization Tool for Traffic Safety Management." Orlando, Florida: University of Central Florida. <https://metroplanorlando.org/wp-content/uploads/Dr.-Aty-UCFSST-presentation.pdf>, last accessed December 12, 2022.

13 FDOT. 2021. *Florida Strategic Highway Safety Plan*. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/safety/shsp-2021/shsp_mar21.pdf?sfvrsn=5452dad_0, last accessed on December 1, 2022.

14 FDOT. 2017. *TSM&O Transportation Systems Management & Operations*. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/content/traffic/doc_library/pdf/2017-tsm-and-o-strat-plan-aug-24-2017-final.pdf?sfvrsn=d38c3054_0, last accessed December 1, 2022.

Using crash data to identify locations for treatment, FDOT has applied smart work zones on the State Road (SR) 869/SW 10th Street connector in Broward County. This project will enable staff to monitor safety and mobility during construction and deploy TSMO and CV equipment (e.g., CV roadside units, fiber communications network and power, and a CV central control system) around the project to manage regional arterials. Smart work zone applications will include “work zone ahead” alerts; traffic queue warning; and advisories about travel times, alternate routes, and speed limits. (See [Smart Work Zone \(SR-869\)](#).)

Advanced Transportation Technology Integration

The FDOT Advanced Transportation Technology Integration (ATTAIN)¹⁵ Central Florida program is deploying smart transportation technologies on public roads in Central Florida to improve reliability, reduce congestion, and increase mobility and safety.¹⁶ Funded through an Advanced Transportation and Congestion Management Technologies Deployment grant from the FHWA and local matching funds, and in partnership with FDOT District 5, MetroPlan Orlando, UCF, and local agencies, ATTAIN Central Florida provides interrelated programs where safety and operations connect. One such program is PedSafe, a collision avoidance system that uses CV technologies to reduce vehicle collisions with pedestrians and bicycles in crosswalks at high-crash locations. PedSafe will be implemented on the UCF campus and connect the traffic signal and pedestrian detection systems to provide information on signal changes and reduce vehicle/pedestrian conflicts. This implementation will ultimately improve operations, as well, by encouraging a modal shift from single-occupancy vehicles to walking and biking and reduce delays resulting from incidents.

15 For clarification, FDOT’s ATTAIN program is different from the FHWA Advanced Transportation Technology and Innovation (ATTAIN) program.

16 FDOT. 1996–2016. “District 5 Smart Roads: CV & AV Program/ATTAIN Central Florida” (web page). <https://cflsmartroads.com/projects/ATTAIN-CFL.html>, last, accessed December 1, 2022.

Connecting Operations and Safety Through TSMO and Safety Plans

Safety and operations are also connected within the FDOT TSMO and safety plans.

2017 TSM&O Strategic Plan

Safety is integral to the mission and vision in the *2017 TSM&O Strategic Plan*. The performance areas of focus are mobility, safety, and system uptime. Crash rates and crash severity are two safety performance metrics in the plan. One goal in the plan is to reduce secondary crash rates.

The plan includes several TSMO strategies widely used in Florida that have proven safety and mobility benefits. These strategies include:

- Traffic incident management practices to clear roadway lane blockage
- Freeway management systems with dynamic message signs to alert motorists of blocked lanes and congestion
- Optimally timed and coordinated traffic signal systems
- Ramp metering
- Connected and automated vehicle (CAV) technologies

2021–2025 SHSP

In Florida’s 2021–2025 SHSP, FDOT states that transportation safety will be moving from a stand-alone program to “addressing safety through all parts of the transportation system – from planning to design to operations to emergency response.” This more integrated philosophy will continue to build cooperation between the safety and operations disciplines. Key strategies in the SHSP include operations activities, such as incident clearance, TSMO technologies, and data-driven traffic operations decisions.¹⁷

2017 TSM&O STRATEGIC PLAN MISSION:

“Identify, prioritize, develop, implement, operate, maintain, and update TSMO program strategies and measure their effectiveness for improved safety and mobility.”

2017 TSM&O STRATEGIC PLAN VISION:

“Increase the delivery rate of fatality-free and congestion-free transportation systems supporting the FDOT vision and Florida Transportation Plan goals.”

Source: FDOT. 2017. *2017 TSM&O Strategic Plan*. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/content/traffic/doc_library/pdf/2017-tsm-and-o-strat-plan-aug-24-2017-final.pdf?sfvrsn=d38c3054_0, last accessed December 12, 2022.

¹⁷ FDOT. March 1996-2021. “Florida Strategic Highway Safety Plan.” (web page). https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/safety/shsp-2021/shsp_mar21.pdf?sfvrsn=5452dad_0, last accessed December 1, 2022.

CAV Business Plan

Florida's *CAV Business Plan* combines safety and operations and describes the State's CAV vision, goals, objectives, focus areas, action items, and project evaluation and selection criteria. The *CAV Business Plan* includes both safety and mobility objectives.¹⁸ The safety objective is to improve safety for all transportation modes and road users and aligns with FDOT's other plans, including the SHSP. The mobility objective is to leverage CAV technologies to improve traffic operations and increase vehicle, person, and multimodal throughput. The State's increasing focus on readying its infrastructure for CAVs and pilot projects supports the use of advanced analytics and detection technologies that are expected to enhance both operations and safety on Florida's roadways. Advanced analytics and detection technologies include increased TMC network connectivity, upgraded traffic signal controllers, smart work zones, and pedestrian safety applications.

METROPLAN ORLANDO

MetroPlan Orlando is the metropolitan planning organization for Central Florida that sets State and Federal funding priorities for the region. MetroPlan Orlando leads transportation planning in Orange, Osceola, and Seminole counties through close coordination with elected officials, industry experts, and the community.

While there is no dedicated safety staff at MetroPlan Orlando, safety is embedded in its TSMO program. The TSMO program has a foundation in safety, with traffic incident management as the springboard. MetroPlan Orlando supports signal timing efforts to promote pedestrian and bicyclist safety while balancing mobility and traffic flow. MetroPlan Orlando's congestion management process emphasizes safety, with crashes a top cause of congestion. The 2045 Metropolitan Transportation Plan is guided by five goals:

- Safety and Security
- Reliability and Performance
- Access and Connectivity
- Health and Environment
- Investment and Economy

The first goal aims to protect lives and provide safe ways to travel. The second goal focuses on innovation and technology to make trips more reliable and predictable. These goals guide performance targets to identify needs, select projects, and monitor results.

¹⁸ FDOT. 2019. *Florida's Connected and Automated Vehicles (CAV) Business Plan*. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/traffic/doc_library/pdf/fdot-cav-business-plan-2019.pdf?sfvrsn=45b478ff_0, last accessed December 1, 2022.

Connecting Operations and Safety Through Project Funding and Development

FDOT funds and develops a range of operations and safety projects, including roundabouts, diverging diamonds, wrong-way driver detection, and lane departure crashes. Once a project is identified, multidisciplinary teams at FDOT develop the project scope. FDOT's processes ensure broad agency input, including from design, safety, operations, and maintenance staff. After it is scoped, the project moves through plan development and each office within FDOT provides a key review of the plan from its perspective. FDOT's collaborative internal review and comment system allows for transparency among the reviewers. The internal review and comment system also helps ensure TSMO project development considers safety and operational impacts. FDOT has recently updated its *Project Development and Environment Manual*¹⁹ to include language on TSMO strategies, noting that TSMO strategies are one of many alternatives to consider.

At the district level, FDOT often tries to capture safety initiatives within TSMO projects because the increased flexibility provided with TSMO funding enables safety elements often to be implemented more quickly than seeking safety funding. For example, in District 2, the TSMO program is funding and installing passive pedestrian systems to improve safety at pedestrian crossings at several locations: adjacent to the University of Florida in Gainesville, a hiking trail in South Gainesville, and near a synagogue in Jacksonville. The district TSMO program is also working with FDOT safety staff on funding enhanced wrong-way driving system deployments, advanced raised pavement markers, and analytics based on light detection and ranging (LiDAR) and closed-circuit television (CCTV) detection to validate improvements targeted to vulnerable road users.

Summary

One benefit of integrating and coordinating safety and operations data and strategies at FDOT has been the improved capability to allocate funding more strategically to projects and locations. Coordinating safety and operations supports FDOT's mission of providing the safest transportation system and balancing the needs of the community. The TSMO team is safety focused and serves as an extension of the staff in the State Safety Office. With the State's strong focus on cooperating to share data, create dashboards and visualization tools, and collaborate on plans and strategies, FDOT is increasingly able to address the State's safety and operational goals.

¹⁹ FDOT. 2019. *Project Development and Environmental Manual*. <https://www.fdot.gov/environment/pubs/pdeman/pdeman-current>, last accessed December 1, 2022.

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