U.S. Department of Transportation
Federal Highway Administration

CASE STUDY

Coordinating Operations and Safety Through Project Prioritization, Funding, and Design in Ohio

NOTICE

This document is disseminated under the sponsorship of the U.S. Department of Transportation (USDOT) in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in this document.

The U.S. Government does not endorse products, manufacturers, or outside entities. Trademarks, names, or logos 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.

NON-BINDING CONTENTS

Except for the statutes and regulations cited, the contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies. While this document contains nonbinding technical information, you must comply with the applicable statutes and regulations.

QUALITY ASSURANCE STATEMENT

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

Source of cover images: Getty Images.

Introduction

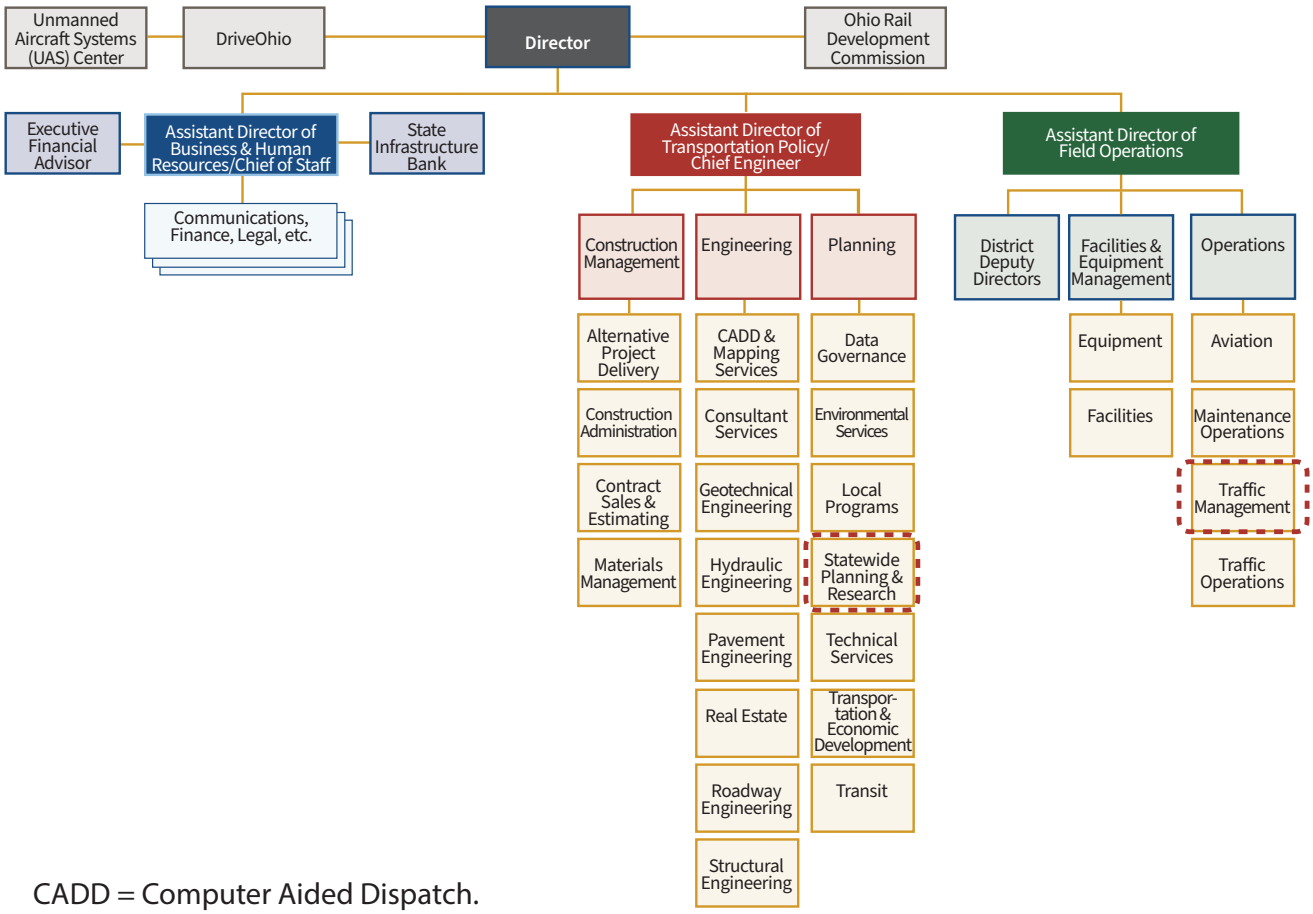
At the Ohio Department of Transportation (ODOT), agency leadership and staff recognize that close coordination and joint activities between the highway safety program and the transportation systems management and operations (TSMO) program can improve safety and mobility outcomes. ODOT has long jointly considered safety and congestion and has found that approximately 40 percent of the locations with the greatest safety issues also have significant congestion. This case study highlights safety and operations coordination at ODOT. Additionally, this case study highlights the Northeast Ohio Areawide Coordinating Agency (NOACA), the metropolitan planning organization (MPO) for the Greater Cleveland, OH, area. NOACA integrates safety and operations through a joint safety and operations council, an intelligent transportation systems (ITS) strategic plan, and a livable communities initiative.

ODOT: At a Glance

ODOT's statewide transportation system includes over 43,000 lane miles of roads across 44,825 square miles and $115 billion in infrastructure assets, with annual vehicle miles traveled statewide totaling 170 million (not including Ohio Turnpike facilities). For improved safety and operations across the system, ODOT's TSMO and safety units share and cross-reference each other's list of priority projects and areas so that their individual planning and prioritization is coordinated. Staff from ODOT districts, local agencies, and MPOs also participate in this process.

Connecting Operations and Safety Through Institutional Arrangements

ODOT has 13 divisions and 12 regional districts (figure 1). The TSMO program is located in the Traffic Management unit of the Operations Division, and the Highway Safety program is in the Statewide Planning and Research Division. Despite this organizational separation, the TSMO and Safety programs have worked closely since the inception of the TSMO program to coordinate prioritizing, funding, and implementing operations strategies for joint safety and mobility benefits. ODOT leadership has been credited with enabling this cooperation, which allows the programs to operate as a team to maximize the cost-effective use of transportation funds and staff time to meet the dual objectives of safety and mobility.



CADD = Computer Aided Dispatch.

Source: ODOT.

Figure 1. Graph. Ohio Department of Transportation organizational structure.

The Highway Safety program is a broad program with a $183 million annual budget that invests at least $1 million annually in data, analysis, and visualization to guide decisionmaking. Program staff manage approximately 500 safety projects and collaborate with other ODOT programs to ensure safety is considered throughout ODOT's functions.

The TSMO program began around 2017 as the result of a Second Strategic Highway Research Program grant, which funded a set of capability maturity modeling workshops and a multistate benchmarking tour that resulted in a TSMO plan, as well as the reorganization of the ODOT Division of Operations. Through that reorganization, the Traffic Management unit was developed to house the TSMO program. The TSMO program began with the financial support of the Highway Safety program and modeled its $5 million annual capital program and project prioritization process after the safety program. The TSMO program created a performance-based method to develop a prioritized list of roadway segments for operations investment that is like the method used to prioritize safety improvements. At the outset of the TSMO program, the Highway Safety program funded TSMO pilot projects that enabled the TSMO program to demonstrate its safety and mobility benefits for the public. The TSMO program measured the impact of the pilots and produced case studies to publicize the successes within ODOT and to other transportation stakeholders.[1] The Connecting Operations and Safety Through Project Funding and Design section describes the pilot projects.

1 Ohio DOT, Case Studies webpage. Available at: https://www.transportation.ohio.gov/programs/tsmo/case-studies/case-studies.

The Highway Safety and TSMO programs strategically exchange safety and operations perspectives and knowledge by ensuring TSMO and safety staff are represented on each other's committees and forums at the central office and district levels. For example, a Highway Safety program representative served on the ODOT TSMO Council, a group that was active during the development of the TSMO Plan and early years of the TSMO program. Similarly, many TSMO coordinators at the district level support the safety program. A TSMO coordinator is appointed from each district to serve as the TSMO leader for that district and act as a liaison to the central office. Some TSMO coordinators are also leaders of the District Safety Review Teams (DSRTs), which include representatives from MPOs and local governments. The DSRTs meet regularly and review all Highway Safety program investments, priorities, and projects within their respective districts. The teams do not take the exact same approach to linking operations and safety, however. For example, in one district, the DSRT meetings incorporate TSMO agenda items, whereas, in another district, traffic operations group meetings are separate, although four to five staff members typically attend both. The meetings are an important way for the district stakeholders to provide input on TSMO, safety investments, and ongoing projects.

Both the TSMO and safety programs also work with DriveOhio, an initiative within ODOT that collaborates with research institutions and private industry to bring together organizations involved in the design, development, testing, use, and regulation of automated vehicle, connected vehicle, electric vehicle, and advanced air mobility efforts.[2] The TSMO and safety programs view work on automation and connected vehicle technology as a significant opportunity to advance safe mobility.

Connecting Operations and Safety Through Data

The TSMO and Highway Safety programs collect data to track system performance and inform investment decisions that benefit operations and safety. The TSMO program brings together crash data, crowdsourced speed and incident data, and third-party probe speed data and analyzes them in real-time using third-party cloud-based software. This collection of data forms the TSMO data warehouse that powers most of the TSMO program's dashboards and Traffic Operations Assessment Systems Tool (TOAST) (see dashboard example in figure 2). The Connecting Operations and Safety Through Transportation Planning and Project Prioritization section discusses TOAST in greater detail. For example, ODOT uses system performance data to calculate TOAST's bottleneck impact factor (the duration of the bottleneck multiplied by its length in miles). Data is archived for 3 years in the TSMO warehouse.

2 To learn more about DriveOhio, go to: https://www.drive.ohio.gov/.

The Highway Safety program uses crash and roadway data as the two primary data sources for safety analyses related to engineering-based improvements. The Highway Safety program obtains crash reports submitted by enforcement agencies across the State to the Ohio Department of Public Safety. ODOT spatially locates the crash data using the Ohio Geographically Referenced Information Program[3] and stores the crash data in ODOT's crash data warehouse. The TSMO program, as well as various State and local agencies, query the data and use it for their own analyses. The Highway Safety program obtains roadway data (e.g., mileposts, traffic counts, functional class) for its safety analyses primarily from ODOT's Transportation Information Mapping System, a web-mapping application.[4]

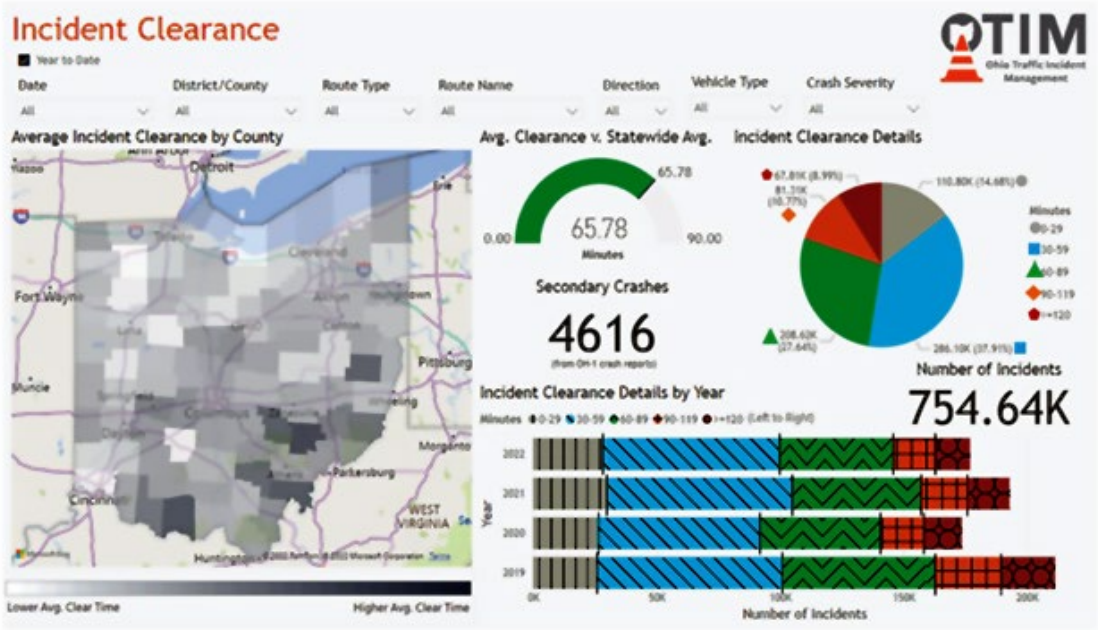
The Highway Safety program uses many different tools and applications to visualize and analyze its crash data for the purpose of tracking major crash types, creating priority lists for ODOT districts' annual safety work plans, evaluating project applications, conducting benefit-cost ratios for proposed projects, and several other activities. For example, ODOT uses a third-party safety analysis tool, structured query language (SQL) coding, and the crash data warehouse to create a ranked list of road segments and intersections that have fatal and injury crashes above anticipated levels. This approach is like the one the TSMO program uses to identify and prioritize areas with operational needs through TOAST. ODOT also uses commercial geographic information system (GIS) software to map the top 500 safety locations by urban, suburban, and rural attributes. These lists are used to prioritize areas for safety studies, rapid improvements, and longer term safety countermeasures. Priority lists for the districts are frequent agenda items at the DSRT meetings, which include safety and TSMO staff. The Highway Safety program also produces dashboards using commercial data visualization software to communicate information through interactive visualizations of crash data to internal and external transportation stakeholders.

A major area of coordination between the TSMO and safety programs is traffic incident management (TIM), including a TIM dashboard. ODOT leads a statewide TIM committee that enables safety, TSMO, and external public safety representatives to coordinate on continually improving TIM. This coordination is guided by the ongoing performance tracking of key TIM measures using a combination of operations and safety data. The TSMO program maintains an incident clearance dashboard on the ODOT website that tracks incident clearance performance measures in addition to primary incident and secondary crash statistics (figure 2).[5]

3 Ohio DOT, Ohio Geographically Referenced Information Program webpage. Available at: https://das.ohio.gov/technology-and-strategy/OGRIP.

4 Ohio DOT, Transportation Information Mapping System webpage. Available at: https://gis.dot.state.oh.us/tims.

5 Ohio DOT, Ohio TSMO Dashboards, webpage. Available at: https://www.transportation.ohio.gov/programs/tsmo/tsmo-dashboards/tsmo-dashboards-landing#page=1.



Source: ODOT, modified by FHWA.

Figure 2. Graph. Ohio Department of Transportation transportation systems management and operations dashboard.

Connecting Operations and Safety Through TSMO and Safety Plans

ODOT links safety and operations within its TSMO plan and Ohio's Strategic Highway Safety Plan (SHSP). Highway Safety program staff provided input to the development of the TSMO plan finalized in 2018. The TSMO plan acknowledges the safety linkage by stating that TSMO "deals directly with the root causes of congestion and unreliable travel," including incidents, and that TSMO has the potential to help system users travel more safely and efficiently.[6] Safety is also listed as the TSMO plan's first of seven strategic goals: 1) safety, 2) reliability, 3) efficiency, 4) access, 5) coordination, 6) integration, and 7) security.

Similarly, TSMO staff supported the 2020 update to Ohio's SHSP. SHSPs identify emphasis areas where the State will focus its efforts to improve safety. The individual who serves as the traffic management center and operations engineer from the TSMO program leads the implementation of the speed emphasis area of the Ohio SHSP, because several speed-setting activities and policies fall under the TSMO program area, and the engineer was a former staff member in the safety program. The SHSP includes a variety of operations related activities, including distributing real-time travel information to alert motorists of driving conditions through mobile or vehicle applications, continuing the statewide signal timing analysis program, and conducting automated and connected vehicle research and pilot projects with partners.[7]

6 Ohio DOT, Final TSMO Plan, December 2017. Available at: https://www.transportation.ohio.gov/programs/tsmo/final-plan.

7 Ohio DOT, Ohio Strategic Highway Safety Plan 2020. Available at: https://www.transportation.ohio.gov/working/publications/strategic-highway-safety-plan.

Connecting Operations and Safety Through Transportation Planning and Project Prioritization

Considerable coordination between TSMO and Highway Safety program staff also occurs when planning, prioritizing, and funding projects. The TSMO program's TOAST tool is an example of this coordination. TOAST is a spreadsheet-based tool that helps ODOT prioritize road segments for TSMO investments based on both operational and safety performance measures. TOAST was developed to enable data-driven decisions by identifying corridors that may benefit the most from operational improvements throughout the State. TOAST performance measures include travel time performance, bottlenecks, incident clearance, secondary crashes, traffic volume per lane, freight corridors, and TSMO safety. TOAST performance measure calculation results are reported in a ratings map published online and in TOAST reports.[8] The data and calculations are used to fund and quickly deploy capital improvements in priority segments.

The Highway Safety program develops a separate list to prioritize safety investments. The lists are vetted through the DSRTs and operations staff. The TSMO and safety programs coordinate to ensure at least one of the programs funds the top priorities.

Connecting Operations and Safety Through Project Funding and Design

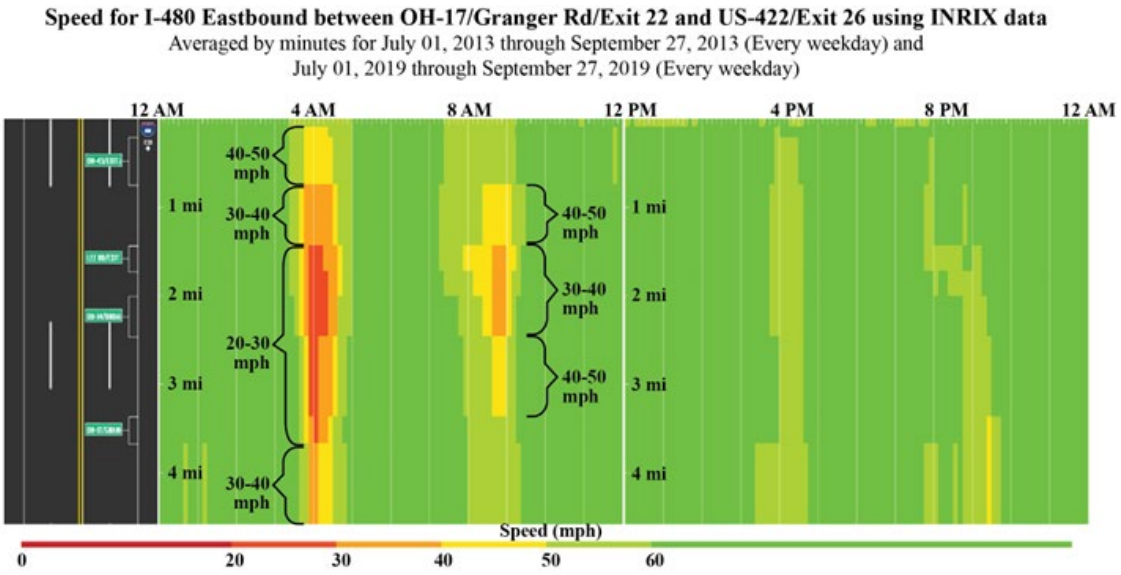
The Highway Safety program at ODOT played a critical role in launching the TSMO program. The Highway Safety program, within the Statewide Planning and Research Office, approved Highway Safety Improvement Program (HSIP) funding for three TSMO pilot projects. One project was to improve safety along a 12-mile section of I–90 near Lake Erie in Lake County, OH. This stretch of I–90 experiences frequent low visibility and white-out conditions because of lake effect snow, which was causing multivehicle crashes, closures, and long delays. The TSMO solution was to use cameras and weather-sensing stations to monitor weather and road conditions and deploy variable speed limits (VSLs) and dynamic message signs to communicate conditions to motorists. With deployment of the TSMO solution, crashes were reduced by 40 percent—from 138 snow event crashes during snow events in 2014–2016 to 83 in 2017–2019—after implementation. Additionally, no fatalities or major pileups occurred during the same study period, incident clearance times were reduced from 112 to 81 minutes, and secondary crashes were reduced by 25 percent. The project also significantly reduced travel delay costs from more than $2 million before the project to $364,281 after the project.[9]

Another safety-funded TSMO project was to reduce congestion and backups during peak travel times on I–480 and Warrensville Center Road in Cuyahoga County. The solution was to use a performance-based practical design (PBPD) approach for restriping to make better use of an auxiliary lane on I–480 with an on-ramp/off-ramp weaving section. The approach removed a bottleneck, improved reliability, and improved the public's travel experience within 2 years. PBPD is a relatively new area of integrating operations, safety, and engineering in Ohio. TSMO and safety staff support the design staff, who lead ODOT's PBPD initiatives. The I–480 project reduced implementation time by 4 or more years and reduced costs by $11 million over a traditional project to add additional lanes.[10] Traffic operations improved from a recurring standstill to a functional area, as shown in figure 3.

8 For more information on TOAST, see: https://www.transportation.ohio.gov/wps/portal/gov/odot/programs/tsmo/resources/toast.

9 Ohio DOT, TSMO Project Case Study: I–90 Lake County. Available at: https://www.transportation.ohio.gov/programs/tsmo/case-studies/tsmo-case-study-i-90.

10 For more information, see: https://www.transportation.ohio.gov/programs/tsmo/case-studies/tsmo-case-study-i-480.



Source: ODOT.

Figure 3. Map. Heat map illustrating a decrease in congestion on a segment of I–480 eastbound following a performance-based, practical design solution.

The third TSMO pilot project focused on improving travel times during peak periods from downtown Columbus to the east side of Columbus on I–670 by implementing part-time shoulder use during the evening peak period using overhead dynamic lane control signs. A postimplementation analysis revealed that average travel times were reduced, from a daily trip that varied between 10 and 20 minutes on average to one that was consistently 5–6 minutes. Additionally, more consistent speeds were achieved; while speeds before 2017 averaged less than 45 mph, average speeds post project are in the 55–65 mph range.[11]

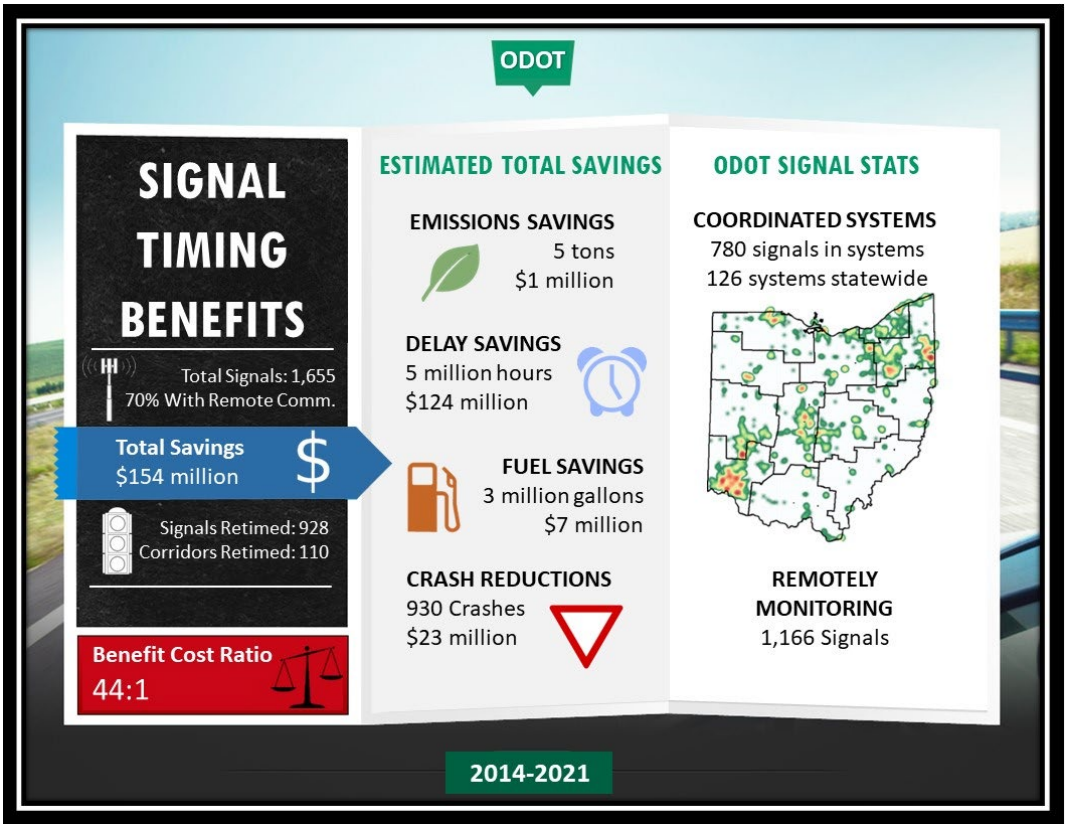
In addition to supporting the above TSMO projects, the Highway Safety program administers and funds the ongoing Statewide Signal Timing and Phasing Program at around $500,000 per year to improve traffic signal timing as requested by ODOT districts or local agencies. The Office of Traffic Operations is the lead within ODOT for prioritizing the corridors to study and in the technical reviews of studies, which are performed by ODOT consultants. ODOT provides consultant assistance to analyze and upgrade signal timing in corridors with significant numbers of crashes. Priority is given to locations with signal-timing-related crash patterns. With each retiming project, ODOT calculates the reduction in delay using either travel time runs or third party probe travel time data from before and after the project. ODOT also calculates the predicted crash reduction using the signal timing crash modification factor (CMF) and estimates fuel use and emissions savings based on travel time, speed data, and formulas from the Southeastern Transportation Research, Innovation, Development and Education Center.[12] ODOT monetizes the benefits to calculate a program-wide benefit-cost-ratio. Since 2014, ODOT has retimed 110 corridors, resulting in a benefit-cost ratio of 44:1.[13] The benefits include an estimated reduction in delay of

11 For more information, see: https://www.transportation.ohio.gov/programs/tsmo/case-studies/tsmo-case-study-i-670.

12 Southeastern Transportation Research, Innovation, Development and Education Center, Final Report *Signal Timing Optimization with Consideration of Environmental and Safety Impacts,* Part A, 2017. Available at: https://ntlrepository.blob.core.windows.net/lib/65000/65200/65203/Signal-Timing-Optimization-STRIDE-Part-A-2013-022_20180827.pdf.

13 Ohio DOT, Statewide Signal Timing & Phasing Program (SSTPP) website. Available at: https://www.transportation.ohio.gov/programs/traffic-operations/signals/sstpp.

5 million hours, 3 million gallons of fuel saved, 5 metric tons of emissions avoided (i.e., carbon monoxide, nitrous oxide, and volatile organic compounds), and 930 crashes prevented.[14] ODOT updates an infographic each year to reflect the data collected from the prior year. The infographic in figure 4 reflects data through 2021.



Source: ODOT.

Figure 4. Graphic. Infographic showing the cumulative benefits of the Ohio Department of Transportation's *Statewide Signal Timing and Phasing Program*.

Summary

The strong coordination and cooperation between ODOT's Highway Safety and TSMO programs are enabled by recognizing safety and operations are interdependent. Expertise shared across the program activities ensures operational impacts of safety projects are considered, as well as the safety impacts of TSMO projects. ODOT also maximizes its TSMO and safety dollars by investing in projects that improve both safety and mobility, such as traffic signal retiming, TIM, and VSLs. By using safety and operational performance data to inform where TSMO investments are made, ODOT derives dual benefits (i.e., safety and mobility) from its TSMO budget. The TSMO and safety program personnel look forward to joint improvements in safe mobility through their work with DriveOhio, the State's center for automated and connected technologies.

14 Ohio DOT, Statewide Signal Timing & Phasing Program (SSTPP) website. Available at: https://www.transportation.ohio.gov/programs/traffic-operations/signals/sstpp.

Northeast Ohio Areawide Coordinating Agency

NOACA is the MPO for the Greater Cleveland, OH, area (figure 5). NOACA coordinates regional transportation planning for a 2,000 square-mile area containing 5 counties, 61 cities, 45 villages, and 58 townships with a combined population of 2.1 million. Like at ODOT, safety and operations are closely integrated within the work program and activities of NOACA and are combined within NOACA's budget. The linkages between safety and operations are highlighted in four ways:

Source: NOACA.

Figure 5. Graphic. Logo for the Northeast Ohio Areawide Coordinating Agency.

1) Combining Operations and Safety Through the Safety and Operations Council

NOACA formed a Safety and Operations Council to improve both internal and external communication and provide recommendations in the areas of safety and operations. The council includes representatives from counties and cities in the NOACA region, ODOT, transit agencies, the Federal Highway Administration (FHWA), local law enforcement, and the community. The official role of the council is to provide recommendations about regional safety and operations programs to the NOACA Transportation Subcommittee. ODOT then brings relevant projects forward to the council for their input once the project has received funding, but NOACA representatives also participate in the ODOT DSRTs for ODOT District 3 and District 12 to discuss countermeasures for specific locations to get NOACA's input during the early stages of planning. NOACA staff use these DSRT meetings as a forum to gather input and engage in dialogue on potential projects. The council is invaluable in bringing to the surface cross-jurisdictional concerns and supporting development of effective solutions.

2) Connecting Operations and Safety Through the *Northeast Ohio ITS Strategic Plan*[15]

NOACA's 2019 update of the *Northeast Ohio ITS Strategic Plan* provides a significant integration point for operations and safety. In this plan, ITS is intended to improve mobility, safety, and security. Several of the ITS needs identified during the plan update illustrate the connection of safety and operations:

- Expanding traffic signal preemption for emergency vehicles
- Improving incident detection and incident-related communication for local agencies
- Disseminating real-time truck parking availability to help truck drivers plan for rest stops and reduce fatigue
- Implementing technologies to improve safety in larger work zones
- Collecting roadway surface conditions data (e.g., icing) from vehicle sensors
- Improving emergency notification/dispatch and response times
- Collecting real-time traffic data for routing emergency vehicles to incidents

15 For more information, see: https://noaca-its.aecomonline.net/NOACA_ITSStrategicPlan_2019-09.pdf.

The *Northeast Ohio ITS Strategic Plan* includes a detailed list of prioritized ITS projects that are recommended for funding and implementation. These prioritized ITS projects include the following safety-related projects that can also improve operations:

- Winter maintenance projects, such as installing snow and ice detection management and advanced snowplow systems to reduce crashes and mitigate delays
- Work zone ITS applications that help reduce crashes, such as alerts for drivers, queue detection, and VSL systems, which may also improve operations by advising motorists of slowdowns and enabling them to detour around the affected areas
- Intersection collision warning systems to reduce crashes and mitigate associated delays
- Traffic signal retiming for reducing rear-end crashes, as well as reducing signal-related congestion

3) Connecting Operations and Safety Through the Transportation for Livable Communities Initiative

NOACA funds a Transportation for Livable Communities Initiative (TLCI)[16] to connect neighborhoods and enhance active modes of transportation at a community level. Through this planning and implementation initiative, NOACA has funded 142 planning studies and 66 implementation projects, spending nearly $20 million on the two-pronged approach. The TLCI program focuses on making roads within communities work better for all modes, enhancing lives through connection, and increasing safety and positive public health impacts through Complete Streets[17] and context-sensitive solutions. Operations is an element of all projects (e.g., establishing intersection signal timing to ensure pedestrians have enough crossing time relative to vehicles and implementing Road Diets[18] to reduce speeds and increase multimodal throughput on a corridor).

16 For more information, see: https://www.noaca.org/community-assistance-center/funding-programs/transportation-for-livable-communities-initiative-tlci.

17 For more information, see: https://highways.dot.gov/complete-streets.

18 For more information, see: https://highways.dot.gov/safety/other/road-diets.

4) Connecting Operations and Safety Through a Proactive Community Safety Approach

NOACA recently incorporated a systemic safety management approach into its ongoing safety programs. This approach is based on the *Highway Safety Manual (HSM)* and uses crash prediction models based on roadway and traffic characteristics for estimating average crash frequency along arterials and major intersections. Produced by the American Association of State Highway and Transportation Officials, the HSM provides predictive methods for estimating the expected average crash frequency of a road network, facility, or individual site involving vehicles, motorcycles, bicycles, and pedestrians. NOACA anticipates combining high expected future crash locations and high crash history sites will result in safety improvement projects with higher efficacy. The predictive method will also be used in the absence of high-quality historical site-level crash data or where there is no history of reported crashes. NOACA produced a Community Safety Report for each jurisdiction in its region, which identifies and prioritizes arterials and major intersections based on predicted crash analysis.[19] Communities can use the information in these reports to consider the most appropriate of FHWA's Proven Safety Countermeasures to apply to make their facilities and operations safer.

19 NOACA, Community Safety Reports, webpage. Available at: https://www.noaca.org/community-assistance-center/planning-assistance/community-safety-reports.

U.S. Department of Transportation
Federal Highway Administration
1200 New Jersey Avenue, SE
Washington, DC 20590
https://ops.fhwa.dot.gov
March 2023

FHWA-HOP-22-083

U.S. Department of Transportation
Federal Highway Administration