MDOT Processes in Connected and Automated Vehicle Environment

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Table of Contents

List of Figures

List of Tables

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Executive Summary

The Michigan Department of Transportation (MDOT) is a national leader in researching, developing, and deploying intelligent transportation systems (ITS) solutions and advanced connected and automated vehicle (CAV) technologies. These technologies have been integrated into state-wide transportation systems to improve safety and fuel efficiency, and environmental benefits. In the meantime, preparing for transportation changes and providing effective solutions requires innovations, organizational change, and support from all stakeholders. The disruption can also challenge existing business processes of DOTs – especially the balance between compliance and innovation. Ultimately, the transformation will be necessary for DOTs to prepare for the potential impacts and maximize the benefits of CAV technologies for future transportation systems.

Specifically, the advancement of CAV technology will require transportation agencies to update their internal and external communication methods in order to be successful. Effective internal communications and disseminating CAV-related information to various parts of the department are important steps to enhance transparency and support overall mission and goals. Successful internal communications will also help with external communications. Engagement, research, integration, consistency, and training are effective approaches to support internal communications.

CAV programs are increasingly important for transportation agencies across the country. Similar to MDOT, many CAV programs are independent from conventional ITS programs. Close interactions with other departments, such as research, operation, data management, and planning activities, are often seen. Showcasing statewide CAV assets (e.g., CAV testing) is a main priority for many CAV programs. Information related to national CAV trends and local activities are available and disseminated online in order to educate the public and peers.

The successful MDOT CAV survey provides valuable information about staff knowledge of CAV technologies, state-wide CAV activities, importance to their work, current and desired internal communication methods, and expected benefits of CAV technologies to MDOT's programs and mission. The positive feedback reflects the growing importance and increasing impacts of CAV technologies to MDOT and Michigan in general. The respondents are willing to receive more information about CAV technologies and other related information to help them prepare for the changes, support communication, build trust, and perform their work. In terms of communication and collaboration across offices and bureaus, the CAV technologies pursued and deployed should be applicable across different modes, and include the needs of transit, pedestrians, freight, bicyclists, personal cars, and others. Similarly, the financial, funding, and potential economic development impacts of CAVs should also be considered throughout the process. Taking such an integrated and full system approach will help internal stakeholders and the public better understand how these emerging technologies could affect them personally, and what feedback they could provide to ensure their needs and concerns are met.

Chapter One: Introduction

The Michigan Department of Transportation (MDOT) is a national leader in researching, developing, and deploying intelligent transportation systems (ITS) solutions and advanced connected and automated vehicle (CAV) technologies. These technologies have been integrated into state-wide transportation systems to improve safety and fuel efficiency, and environmental benefits. That said, connected and automated vehicle deployments present specific challenges for state transportation agencies, including infrastructure improvement, impacts of new mobility services, and changes in the regulatory environment. Departments of transportation (DOTs) face the conundrum of operating and maintaining the transportation infrastructure for existing transportation needs while simultaneously preparing for future transportation systems.

Preparing for transportation changes and providing effective solutions requires innovations, organizational change, and support from all stakeholders. The disruption can also challenge existing business processes of DOTs – especially the balance between compliance and innovation. Ultimately, the transformation will be necessary for DOTs to prepare for impacts and maximize the benefits of CAV technologies to future transportation systems.

The purpose of this study is to evaluate MDOT's current CAV activities and information dissemination methods, recommend necessary steps for all levels of the department in relation to the new CAV environment, and maximize benefits from the department's CAV projects and overall CAV environment that would advance MDOT's goals. The research is based on a literature review and an MDOT staff survey. The topics of the remaining report include:

- Chapter Two summarizes the literature review; specifically on strategic internal communications for government in the context of technological innovation
- Chapter Three highlights major CAV activities in Michigan and connections to MDOT programs: Transportation Systems Management and Operations (TSMO) initiative, Intelligent Transportation Systems (ITS), and Connected and Automated Vehicle (CAV)
- Chapter Four investigates peer state DOT CAV activities and program foci
- Chapter Five summarizes findings from the MDOT Connected and Automated Vehicles Survey
- Chapter Six contains conclusions of the study as well as recommendations to enhance MDOT's CAV program and improve relations with other program areas.

Chapter Two: Literature Review: Strategic Internal Communications for Government

Consistent communication as well as actively engaging with employees can help a government agency build a solid foundation to support its ultimate mission of serving the public. Successful internal communications will help to build and maintain trust while supporting the goal of transparency and accountability with the public (American Council of Engineering Companies & Michigan Department of Transportation, 2013). Innovations, including applications in CAV technologies, will present new requirements to the transportation agency's internal and external communications. Below is a summary of best practices related to strategic internal communications for the government.

Guiding Principles

Communications and outreach both refer to efforts to engage with specific stakeholder groups around an agenda or mission ((NACG) & Granicus). In the context of organizational culture, informal and formal communications efforts can reduce conflict and confusion, build a sense of purposefulness and shared agenda, and create an improved organizational climate (Stein & Sloan, 2001). Successful communications usually follow these principles (Achieve, 2011):

- Internal communication that supports the overall strategic goals;
- Clarity and consistency for the public, partners, and stakeholders;
- Coordinated and consistent messaging and education;
- Employees as content makers;
- Transparency in communications, both internally and externally;
- Understanding between initiatives to foster trust; and
- Creative communication channels & activities.

DOT Innovation and Internal Communication

Transformative digital and transportation technologies, such as 5G network, Internet of Things (IoT), artificial intelligence (AI), and connected and automated vehicles (CAV), have huge potential to disrupt and change the way people travel and how transportation is managed. These technologies will provide unprecedented opportunities for transportation agencies to improve operations, deliver new services, and create new internal and external communication capabilities. Many state DOTs consider innovation, including advanced CAV technologies, as a way to support the agency's strategic plan and implement transformational changes. They believe these technologies could open up new strategies and abilities to respond to traditional transportation challenges in a new and possibly more effective way. Leadership, empowerment, communication, recognition, and measurement are essential to brace innovation (Caltrans Division of Research, Innovation, and System Information , 2015). To be effective, organizations are providing resources as well as access to information to support innovation (e.g., Washington State DOT, see Section 4.13) (Caltrans Division of Research, Innovation, and System Information , 2015). It's also important to find affordable and effective ways to keep employees informed and communicate stories about innovation across multiple channels (National Academies of Sciences, Engineering, and Medicine, 2018).

Research Activities and Communication

DOTs can see significant benefits from giving employees the opportunity to explore innovative ideas, such as participating in research programs (Caltrans Division of Research, Innovation, and System Information , 2015). To fully reflect the value of research activities, researchers and project managers

need to communicate to multiple stakeholders, including upper management (internal communication), policy-makers (internal and external communication), peers, and the general public (external communication). For example, stories in department newsletters, displays of key research projects or research findings, presentations at various types of internal and external gatherings, and social media messaging can effectively communicate the value that CAV technologies would provide. It is also recommended to work closely with the department's communication office (Bukowski, 2012).

External and Internal Communications

Internal and external communication are closely linked. While it is critical for DOTs to reach out to external key stakeholders to build support for their programs and services, they also need to communicate across agency units internally to ensure a cohesive delivery (LGBTI Equal Rights Association, n.d.). For example, one of the strategic goals identified in the Arkansas Department of Transportation Strategic Plan 2017-2022 is "to continually improve transportation services and solutions through employee engagement". Highlighting various Department functions through internal and external communications is one of the strategies to promote teamwork, accountability, and innovation throughout the Department (Arkansas Department of Transportation , 2017). When employees are informed and empowered, they can more effectively deliver the message for the department in other public settings (Iliff, 2016).

Internal communications are usually an important responsibility of the communications unit. The structures of communications units across DOTs are varied. A current practice scan revealed that the typical DOT outreach unit is called "Communications," and is a standalone division that reports to the head of the DOT, with an average of approximately 15 employees. However, there are many variations on this model (Short, 2011).

Integrated Communications

Related to an effective communication structure is the concept of "integrated communications," or the collaboration between divisions and agency units. The driving forces behind integrated communications are the requirements for transparency, rapid advancements in technologies, and the need for better coordination. Integrated communications allow an organization to coordinate information and feedback. It also helps ensure that employees are speaking with one voice to all of an organization's internal and external audiences. For example, Minnesota DOT (MnDOT) launched its "Speaking with One Voice" campaign with employees and all managers. PennDOT coordinates communications across agency units to promote agency activities and avoid redundancies. TxDOT's Communications Plan is a key component of the mandatory Integrated Management System (IMS) that aims at efficiency and consistency (Cintra, 2007).

Training and Workforce Development

Successful training could also help staff translate complex policy, management, and technical issues into easy-to-understand communications to the general public (WSP, 2017). For example, providing training opportunities has been identified as a priority for the Michigan Department of Transportation. The Workforce Development (WFD) Program consists of a Foundational Curriculum for new employees, a Supervisor/Manager Curriculum for new supervisors and managers, and a Continuing Education Guide. The program was designed to ensure all MDOT employees have the same baseline level of knowledge and training regarding important and select organizational topics, regardless of their specific work area (Michigan Department of Transportation, 2018).

Engagement Tools

Internal communications at a state DOT need to take the decentralized nature of the agency into account (Iliff, 2016). Organizations need to establish fast, interactive, and reliable channels to reach all employees. Often this takes the form of electronic communications. According to a recent study of state transportation agencies' communication plans, about 75 percent of research offices feel they communicate well internally. Email news updates, electronic newsletters, and websites are the most common types of communication methods. Respondents were also asked to select the one method they find most effective for internal communication. Of the 22 states that provided their most effective internal communication method, the most effective communication method was an electronic newsletter, followed by email news updates (Minnesota Department of Transportation, 2017).

State DOTs also reported a stronger investment in the use of social media to achieve overall agency communication goals - according to results from "State DOT Social Media Survey" conducted by American Association of State Highway and Transportation Officials (AASHTO). The most dominant social media platforms are Twitter (98 percent), Facebook (95 percent) and online video (95 percent). A few states utilized other platforms such as Waze, Snapchat, Storify, Instagram, Flickr and podcasts (Minnesota Department of Transportation, 2017).

Measuring Internal Communications

While measuring external communications is generally the priority for many organizations, measuring the success of internal communication and engagement is also important. Live metrics have been used to measure various topics directly and more precisely than ever before (Lockley, 2018). Table 1 shows some of the traditional quantitative and qualitative ways to track engagement, requests, and usage.

Table 1: Communication Measurement

Quantitative ways to track engagement	Qualitative ways to track engagement
Email tracking tool to see how many people have opened, clicked, or deleted emails	In-person group discussions
Polls to collect insights and ideas from employees	Discussion forums
Count the number of requests for information	Feedback from employees
Track social media statistics	Feedback from management
Internet use analytics	Surveys

Summary

This Chapter reviewed strategic internal communications for government, especially challenges and opportunities generated by innovations and new technology advancements within state departments of transportation. Connected and automated vehicle technologies are evolving quickly to create long term impacts on state and local transportation systems, mobility trends, and the state department of transportation's responsibilities. Successful internal communications and disseminating CAV related information to various parts of the department are important steps to enhance transparency and support overall mission and goals. Effective internal communications will also help with external

communications. Engagement, research, integration, consistency, and training are effective approaches to promote successful internal communications.

Chapter Three: MDOT CAV Activities

The Connected and Automated Vehicle (CAV) program is an important component of MDOT's Intelligent Transportation Systems (ITS) program, which is part of the broader Transportation Systems Management and Operations (TSMO) initiative. Ultimately, these programs and initiatives are all under MDOT's Strategic Plan as a whole. The relation of MDOT's CAV Program with the Department's other strategic areas is illustrated in Figure 1. As a result, it is critical to build alignment in the CAV Program's mission and vision that interrelates through ITS, TSMO, and MDOT Strategic Plans (MDOT, n.d.). The remainder of this Chapter will summarize these interrelations.

Figure 1: MDOT CAV Program Alignment

| MDOT Strategic Plan | Transportation Systems Management and Operations (TSMO) | Intelligent Transporation Systems (ITS) | Connected and Automated Vehicles (CAV) |
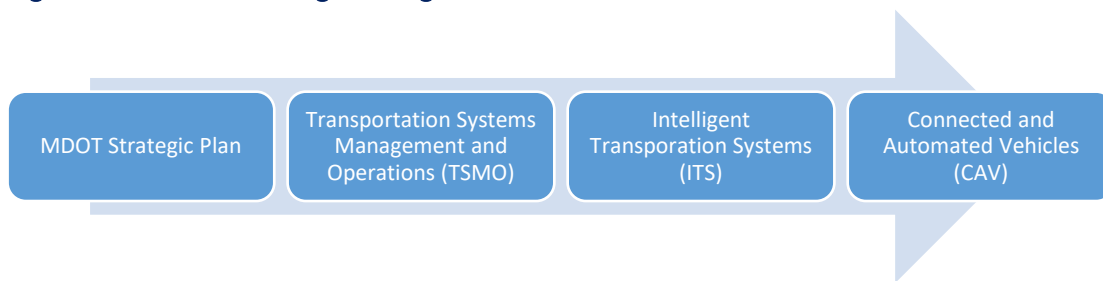
MDOT Strategic Plan and Areas of Focus

The most recent MDOT Strategic Plan (2017) identified seven strategic areas of focus for the Department, including leadership, safety, customer-centered, system focus, partners, innovative & efficient, and workforce. The strategies for the area of innovative & efficient are (Michigan Department of Transportation, 2017):

- Pursue innovations, transformational changes and organizational efficiencies that lead to investing more in the transportation system.
- Manage performance to provide value and better customer-centered results.

Both strategies are fundamental to TSMO, ITS, and CAV programs and will influence the directions of these programs as shown below.

MDOT Transportation Systems Management and Operations (TSMO)

MDOT launched a TSMO Implementation and Strategic Planning process in 2016. The mission is to "operate and manage an optimized, integrated multimodal transportation network by delivering high-quality services for safe and reliable mobility for all users" (Michigan Department of Transportation, 2019). There are ten MDOT business areas that fall under the "TSMO's umbrella," ranging from work zone management to transportation modal integration. Applications of advanced technologies, such as ITS and CAV, are also TSMO's strategic areas of focus (Michigan Department of Transportation, 2019).

MDOT Intelligent Transportation Systems (ITS) Program

The MDOT ITS Program is part of the Transportation Systems Management and Operations (TSMO) program. It closely interrelates with several other MDOT programs and business areas. The following seven focus areas are in alignment with TSMO strategies:

- Information technology processes
- TSMO business area integration
- ITS/signal program integration
- Emerging transportation technologies
- Partners and outreach
- Workforce development
- Performance-based priorities

MDOT's advanced traffic and data management systems (e.g., flex routes, data use analysis and processing) and connected and autonomous vehicle deployments are examples of effective use of emerging technologies. As new technologies continue to become available and play a bigger role in our transportation systems, there is a growing need to ensure these programs (e.g., asset management, advanced traffic management system or ATMS) are capable of integrating these technologies. Finally, MDOT ITS program enhances its effectiveness through interdepartmental collaboration and communication as well as the inclusion of stakeholders and other ITS-related organizations within the State.

MDOT CAV Program

The MDOT CAV Program Strategic Plan, developed in 2017, provides renewed support and direction for Michigan's robust CAV program. The strategic plan is built on the following foundational components: MDOT's CAV mission and vision, overarching goals of CAV program, and categories of CAV program strategies. Below are the highlights of the CAV Plan.

MDOT CAV Program Goals:

- Goal 1: Serve as a national model to catalyze CAV deployment.
- Goal 2: Establish foundational systems to support wide-scale CAV deployment.
- Goal 3: Make Michigan the go-to state for CAV research and development.
- Goal 4: Accelerate CAV benefits to users.
- Goal 5: Exploit mutual benefit opportunities between CAV technologies and other department business processes and objectives.
- Goal 6: Use Michigan experience to lead dialogue on national standards and best practices.

MDOT CAV Program Strategic Areas:

- Foundational actions to institutionalize CAV
- CV infrastructure development
- Application development and benefit acceleration
- Michigan industry and workforce development
- Partnering and promotion

The tactical actions recommended to supplement current initiatives and to address critical gaps:

- Develop partnering evaluation methodology and tracking system

- Update cross-department impact mapping of CAV technologies
- Support PlanetM communication strategies
- Incorporate CAV in planning and forecasting activities

Table 2 shows MDOT CAV program's mission and vision alignment with MDOT's Strategic Plan, TSMO Strategic Plan, and ITS Strategic Plan.

Table 2: Mission and Vision Statement Alignment

Plan	Mission Statement	Vision Statement
MDOT Strategic Plan (Michigan Department of Transportation, 2017)	Providing the highest quality integrated transportation services for economic benefit and improved quality of life.	MDOT will be recognized as a progressive and innovative agency, with an exceptional workforce that inspires public confidence.
TSMO Strategic Plan (Michigan Department of Transportation, 2019)	Operate and manage an optimized, integrated transportation network by delivering high-quality services for safe and reliable mobility for all users.	1) Integrate Operations as a core MDOT program united with the execution of MDOT's overall mission. 2) Inspire public confidence as a progressive and innovative national leader in the management and operations of our transportation system. 3) Collaborate across program areas, leveraging technology and resources to achieve the best possible results. 4) Maintain a sustainable and engaged operations workforce with exceptional knowledge, skills, and abilities.
ITS Program Strategic Plan (HNTB Corporation, 2018)	Provide high quality, adaptive, and integrated transportation technology solutions that improve safety and mobility for all users.	Integrate MDOT's ITS Program into all TSMO business areas and leverage both proven and emerging transportation technologies to sustainably enhance safety, mobility, economic benefit, and support improved quality of life.
CAV Program Strategic Plan (HNTB Corporation, 2018)	MDOT will work to ensure Michigan remains the national leader in the evolution of CAV technologies, to deliver enhanced transportation safety and reliability, providing economic benefit and improved quality of life.	MDOT's CAV Program will be recognized as a progressive and innovative leader, driving national efforts to explore and implement emerging mobility technologies.

Current MDOT CAV Projects

MDOT has various projects and initiatives aimed at meeting its CAV program's strategic goals. These include but are not limited to (HNTB Corporation, 2018):

- I-94 Road Weather Program

- M-53 SPaT/Transit Signal Priority Deployment
- I-275 Curve Speed Warning Deployment
- M-43 (Saginaw Highway) CV Deployment
- US-12 Test Bed Deployment
- Mound Road Signal Phase and Timing (SPaT) Deployment
- Auburn Hills Test Bed Deployment
- I-75 Test Bed Deployment
- Collision Avoidance and Mitigation System (CAMS)
- Weather-Responsive Traveler Information System (Wx-TINFO)
- Data Use, Analysis and Processing (DUAP) Program
- I-69 Truck Platooning Test Support
- USDOT Test Bed Infrastructure Transition
- Vehicle-Based Info Data Acquisition System (VIDAS) Program
- Southeast Michigan V2I Deployment Plan

MDOT is actively engaged with statewide, national, and international CAV activities and partnership, such as Planet M (Center for Automotive Research, n.d.), Smart Belt Coalition (Figure 2) (Cole & Shuey, 2017), and cross-border testing of autonomous vehicles with Canada (BodyShop Business, 2017). The most recent initiative is the NAIAS 2020 Michigan Mobility Challenge that aims at deploying cutting-edge technology to create mobility solutions during the North American International Auto Show (NAIAS) (Crain's Detroit Business, 2019). MDOT also supports research initiatives either through its own research program or through activities of FHWA, AASHTO, ITSA, TRB, and universities.

Figure 2: Smart Belt Coalition

ITS and CAV Information Dissemination

Online dissemination of ITS and CAV information is one of the most important tools to inform MDOT staff and the general public about ongoing efforts and activities. Below is a review summary of the information available and the way they were organized.

MDOT Intelligent Transportation Systems (ITS) Program

From MDOT's home website, ITS program is navigated through "Roads and Travel" → "ITS" (HNTB Corporation, 2018). The ITS homepage listed ITS definition, Contact Information, 2014 Road Weather Information System Evaluation, and MxVision WeatherSentry Online (broken links). The website also lists "Documents" and "Links and News" as shown below:

Documents:

- MDOT ITS Strategic Plan 2018 Appendix A - Existing MDOT ITS Program Functions
- Truck Parking Project Report
- The Connected Driver: Integrated Mobile Observations 2.0: 2014-2015
- Weather Responsive Traveler Information (Wx-TINFO) System Implementation Project
- Cost-Benefit of MDOT ITS (July 2015)
- Road Weather Information System (RWIS) Documents
- MDOT Triangle ATIS Final Con-Ops
- MDOT ITS Strategic Plan 2018

Links and News:

- Weather Responsive Traveler Information (Wx-TINFO) System Flyer
- The Intelligent Traveler, July 2013
- The Intelligent Traveler, October 2013
- The Intelligent Traveler, April 2013
- ITS Special Provisions
- 5.9GHz Roadside Unit-12IT800(B720) 01-17-2018
- Metro Detroit
- West Michigan
- Connected Vehicles
- ITS America

The ITS homepage dropdown menu contains additional two links. One is "ITS Project Resources," which provides "Staking Request Form (Form 5300)" and four "Regional ITS Architectures and Deployment Plans" (Michigan Department of Transportation , n.d.). Another link is "Transportation Operation Center" that provides (Michigan Department of Transportation , n.d.):

- Statewide Transportation Operations Center (STOC)
- Southeast Michigan Transportation Operations Center (SEMTOC)
- West Michigan Transportation Operations Center (WMTOC)

Connected Vehicles

MDOT Connected Vehicles Program resides on a separate webpage. The navigation path is "MDOT homepage" "Projects and Programs" "Highway Programs" "Connected Vehicles." The Connected Vehicles homepage is shown below:

Figure 3: MDOT Connected Vehicles Homepage

All the drop-down menus (Documents, Presentations, Newsletters, Testbeds, and CV Working Groups) contain plenty of ITS and CAV related materials (Michigan Department of Transportation , n.d.). Information under "Documents" and "CV Working Group" are up to 2018; while information under "Newsletter," "Presentations," and "Test Beds" are outdated (before 2009).

PlanetM

In addition, MDOT has partnered with Michigan Economic Development Corporation (MEDC) to showcase the CAV assets in the state of Michigan through the PlanetM initiative. PlanetM is a partnership of mobility organizations, communities, educational institutions, research and development, and government agencies that are working together to develop and deploy advanced mobility technologies. It is the gateway to mobility opportunities in Michigan and therefore another important avenue to receive CAV information. PlanetM's website lists information related to testing facilities for mobility technologies, the landing zone that provides a physical entry point for global mobility startups interested in doing business in Michigan, and other services and programs to connect with partners or apply for a PlanetM grant (PlanetM, n.d.).

Summary

ITS and CAV programs are important to MDOT's mission and overarching goals. This Chapter discussed the programs' relations with MDOT's overall strategies and TSMO's strategic areas and their alignments, major ITS and CAV activities and projects, and information dissemination methods through MDOT's and PlanetM's websites. One of the areas MDOT could improve is to redesign its ITS and CAV websites. The potential improvements include more user-friendly layouts, using fewer drop down links, and updating content and resources regularly in order to reflect statewide achievements in the evolving areas of ITS and CAV technology and applications. The next Chapter will review peer State DOT CAV programs and their best practices.

Chapter Four: Peer State DOTs CAV Programs

This Chapter summarizes several high profile CAV programs of State Departments of Transportation (DOT) across the country. The focus is on key CAV activities, their relations with other departmental function areas, and information dissemination methods.

Colorado Department of Transportation (CDOT)

CDOT's Connected and Autonomous Technology (CAT) program is part of the ITS Innovation initiative that aims at using 21st-century technology and ingenuity to solve infrastructure challenges. CAT program is focusing on partnership to help CDOT understand the benefits of CAV technologies, infrastructure needs, and responsibilities for deployment. The CAT program's website describes the relations of advanced mobility, open data, operational diversity, economic impacts, and Colorado's CAV regulatory and testing requirements (Colorado Department of Transportation , n.d.).

Delaware Department of Transportation (DELDOT)

Connected and Autonomous Vehicles Program is a new independent program within Delaware DOT. The program is overseen by the Advisory Council signed by Governor John Carney in September 2017. The Advisory Council is tasked with "developing recommendations for innovative tools and strategies that can be used to prepare Delaware's transportation network for connected and autonomous vehicles." The Advisory Council also makes recommendations on the following subject areas:

- Promoting economic development;
- Technology, security, and privacy;
- Transportation network infrastructure; and
- Impacts on public and highway safety

The Advisory Council held monthly meetings and the meeting materials are listed on Delaware DOT's website (Delaware Department of Transportation, n.d.).

Florida Department of Transportation (FDOT)

Florida adopted legislation allowing for automated vehicle testing on public roadways in 2012. FDOT manages two independent programs: Florida Connected Vehicle Initiative (FCV) and Florida Automated Vehicle Initiative (FAV). Both initiatives are aimed at "helping to educate the public by engaging stakeholders, creating awareness of the technologies, and developing research and pilot projects and how they support FDOT's vision statement." These technologies should be able to further FDOT's vision statement" (Florida Department of Transportation, n.d.).

FDOT's website is designed to provide information on the Florida-specific initiatives and the progression of CAV technologies nationwide. For example, the "Program Resources" and "News" links include the following information:

- Program Overview
- Research Projects
- Pilot Projects
- Working Groups
- 2017 FAV Summit
- Transportation System Management (TSM)
- SunTrax
- Recent Headlines
- Florida AV News
- Videos and Photos

- Federal Resources
- Legislation Resources
- FAV Newsroom

The website also includes an overview of FDOTs latest efforts, a calendar of events and an archive of relevant articles. The Florida connected vehicle project map lists statewide CAV planning, design/implementation, and operational projects (Florida Department of Transportation , n.d.).

Figure 4: Florida CAV Projects/Initiatives
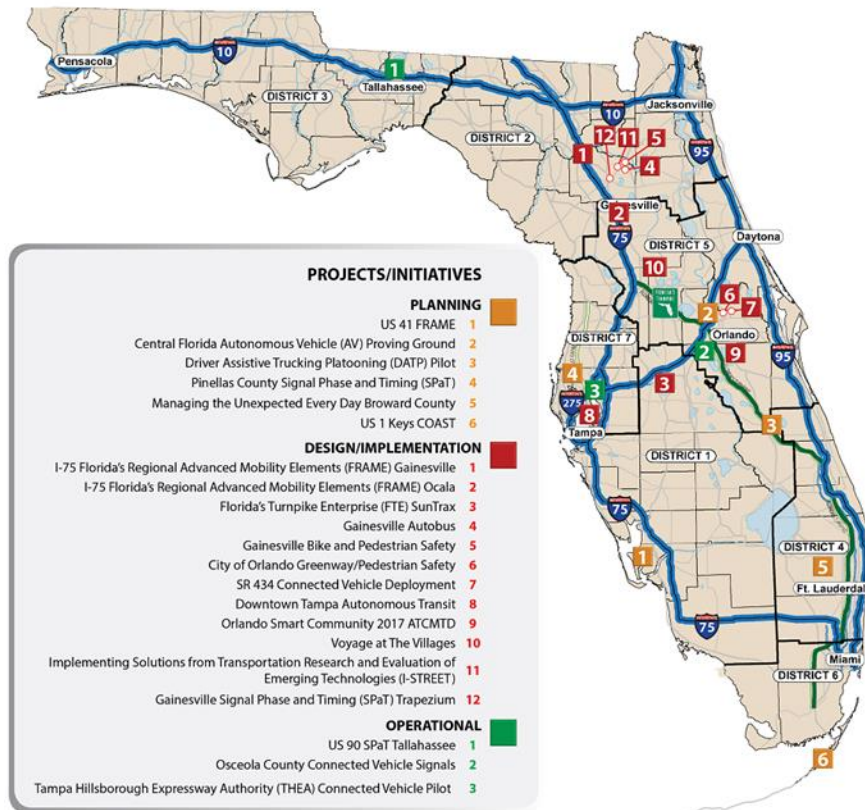
Maryland Department of Transportation (MDOT)

Maryland has a clear vision for CAV technologies, which is to "uphold and enhance a safe, efficient, and equitable transportation future by delivering collaborative and leading-edge CAV solutions" (Maryland Department of Transportation , n.d.). The business and economic benefits of CAV technology are also emphasized. Maryland embraces CAV technology and innovation through continuing collaboration on researching, testing, and implementation of CAVs. Other information available online includes:

- Fast Facts on CAV Technology
- Maryland Open for Business – CAV Technology
- Collaboration on CAV Research, Testing & Implementation in Maryland
- Maryland Locations to Enable Testing Sites (LETS) for CAV
- Maryland Connected and Automated Vehicles (CAV) Working Group
- Working Group Meeting Agenda and Presentations

- Other Resources

Figure 5: Maryland CAV Working Group
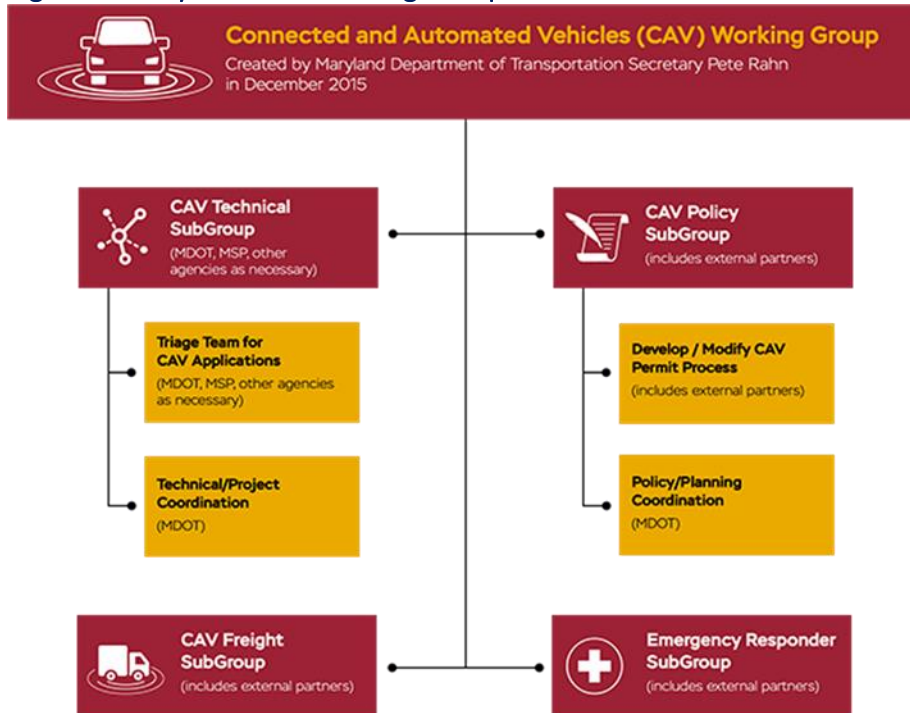
Like many other state DOTs in this Chapter, MDOT's CAV strategies include applying for Federal grant programs to support specific research and deployment projects, such as Automated Driving System (ADS) Demonstration Grants, Advanced Transportation and Congestion Management Technologies (ATCMTD) Program Grants, and Integrated Mobility Innovation (IMI) Demonstration Program Grants, as well as broader or more traditional Federal grant programs that can be used to support CAV projects. These grant applications often leverage local funding and partnerships, and require strong communication and coordination between different local agencies and private partners such as universities, consultants, and technology vendors.

Minnesota Department of Transportation (MnDOT)

MnDOT is a pioneer in ITS and CAV applications and research. The CAV program provides strategic support to prepare for next-generation state-wide transportation systems. The Governor's Advisory Council on Connected and Automated Vehicles was established in March 2018. The Council was supported by State Interagency Connected and Automated Vehicles Team (I-CAV Team) and was tasked with recommendations to Minnesota statutes, policies, and rules to the Governor and legislature. Additionally, the "MnDOT CAV-X Office" provides intradepartmental support and coordination (Figure 6). MnDOT's website has a CAV link that lists current and completed projects, research products, plans, partnerships, and resources. The navigation is straight forward and information can be easily found (Minnesota Department of Transportation, n.d.).
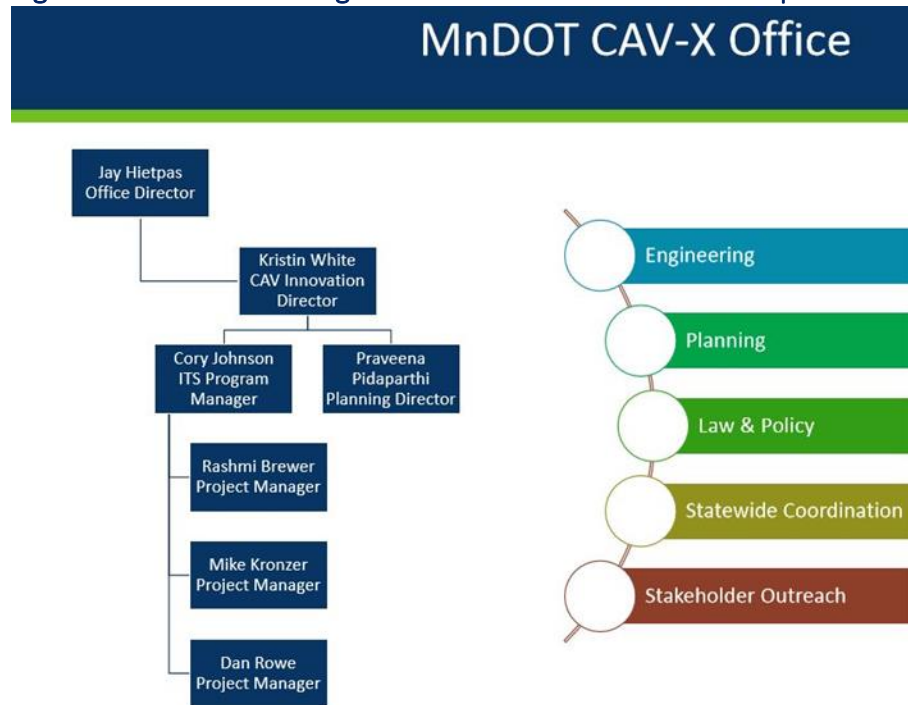
Nevada Department of Transportation (NDOT)

NDOT is leveraging emerging technologies to ensure the best investments are made for the mobility and safety of its residents – "keeping all of Nevada Safe and Connected". Nevada became the first state in the U.S. to establish regulations to encourage CAV technology development, making Nevada an early national leader in regulating, testing, and licensing connected and autonomous vehicles on public roads. Also, government entities within the state (governor, state, county, city) are working together to be a national leader in CAV technology testing, partnerships, collaboration, and innovation. Information about CAV knowledge, NDOT CAV projects and partners can be easily found on NDOT's website (Nevada Department of Transportation , n.d.).

Figure 7: Nevada DOT CAV Program Logo

North Carolina Department of Transportation (NCDOT)

NCDOT's "Automated Vehicles Roadmap for North Carolina" is aimed at:

- Assessing the Department's and the State's current AV conditions (testing and operations) and providing recommendations for changes.
- Benchmarking against industry and current federal, state, local, and international initiatives.
- Providing near-term actions for NCDOT and key State agencies.

The program is overseen by "Fully Autonomous Vehicle (FAV) Committee" consisted of state and local community representatives. CAV related activities and resources are available on NCDOT's website (North Carolina Department of Transportation, n.d.).

Ohio Department of Transportation (ODOT)

CAV activities in Ohio are mostly under the "DriveOhio" initiative created in 2018. DriveOhio is supported by ODOT, and aims to organize and accelerate the connected and automated vehicle and smart mobility projects in Ohio. As the point of contact for all statewide CAV initiatives and advancements, DriveOhio "fosters cooperation and collaboration, offers faster access to resources, improves efficiencies and communications, and helps developing future transportation technologies" (DriveOhio, n.d.).

After the Governor signed an Executive Order in 2018 legalizing the use of AVs on roadways in Ohio under certain restrictions, DriveOhio partnered with the state's capital of Columbus (also the winner of the 2016 Federal Smart City Challenge) to deploy an automated shuttle service that is currently operational and open to the public. This has allowed both the DriveOhio workforce and the local public to learn about the opportunities and limitations of CAV technology, and to better understand where else it might make sense to deploy similar technology statewide (Smart Columbus, 2019).

Oregon Department of Transportation (ODOT)

The ODOT's Office of Innovation is known for collaborations and transportation innovations. Automated vehicle and connected vehicle are two separate programs but they are all within the Office of Innovation. Other innovative programs include:

- Alternative Vehicle and Fuel Technologies Toolkit
- Electric Vehicles and Infrastructure Program
- OReGO: Oregon's Road Usage Charge Program
- Transportation Research Program
- EcoDrive

Michigan Department of Transportation Connected Vehicles Program is cross-referenced on ODOT's website (Oregon Department of Transportation, n.d.).

Pennsylvania Department of Transportation (PennDOT)

Pennsylvania has been at the forefront of CAV technology innovations thanks to world-renowned research universities such as Carnegie Mellon University and the University of Pennsylvania. PennDOT's Automated Vehicles program is under the "Research and Testing" group. On its website, the AV program includes information about AV Testing (testing guidance and developer resources, etc.), AV Task Force, AV Summit, CAV Initiatives, Authorized Testers, and Frequently Asked Questions (Pennsylvania Department of Transportation , n.d.). The AV Task Force is made up of a diverse and comprehensive set of stakeholders, including manufacturers, technology companies, representatives from federal, state

and local government, law enforcement, higher education, motorists and trucking groups, and academic research institutions (Pennsylvania Department of Transportation , n.d.).

Figure 8: Pennsylvania AV Summit

Rhode Island Department of Transportation (RIDOT)

RIDOT launched the Rhode Island Transportation Innovation Partnership (TRIP) in 2017. TRIP is a multi-agency effort and includes a proposal for autonomous vehicle transit pilot program called "The Little Roady Pilot Project," which began operations in 2019 (Figure 9).

TRIP also engages the state-wide stakeholders to explore various CAV applications and to address transportation challenges. The research component of the TRIP is aimed at studying autonomous mobility solutions, ridership, workforce impacts, environmental impacts, and technology adoption, among others (Rhode Island Department of Transportation, n.d.).

Figure 9: Rhode Island AV Pilot Program
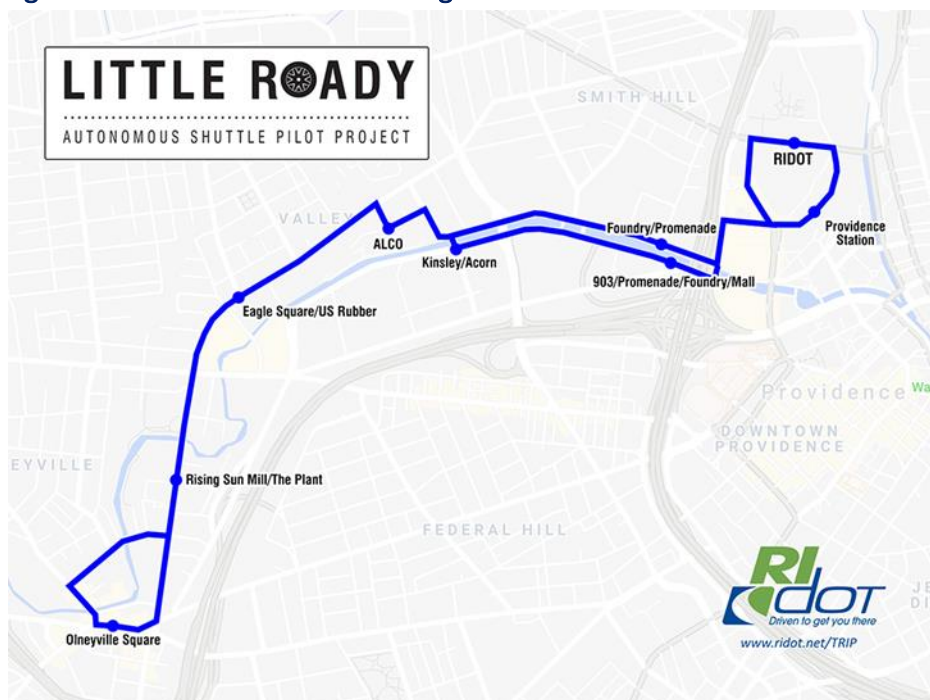
Virginia Department of Transportation (VDOT)

The VDOT CAV program helps guide the department in the deployment of related technologies. The program supports several strategic goals of VDOT, including:

- Improving safety
- Increasing mobility and system reliability
- Reducing infrastructure investments through CAV enabled efficiencies, and
- Enhancing traveler information

VDOT's website lists program focus areas, CAV program plan, and available CAV resources (including testing facilities) (Virginia Department of Transportation, n.d.). One noteworthy aspect of VDOT's CAV program is that it leverages key resources unique to Virginia, including world-class research and testing capabilities, an "open-for-business" regulatory environment for innovative transportation solutions, and robust cloud-based data services. For example, to facilitate CAV deployment, VDOT partnered with the Virginia Tech Transportation Institute (VTTI) to create the Virginia Connected Corridors (VCC). The VCC is an open environment that enables the development and assessment of early-stage CAV applications. Developers may create applications that can run directly on the VCC cloud computing platform, which can also integrate with VDOT data-sharing systems such as traffic, incident, weather, and dynamic message sign data (Figure 10) (Virginia Tech Transportation institute , n.d.).

Figure 10: Virginia's CAV Test Bed Facilities and Data Portal
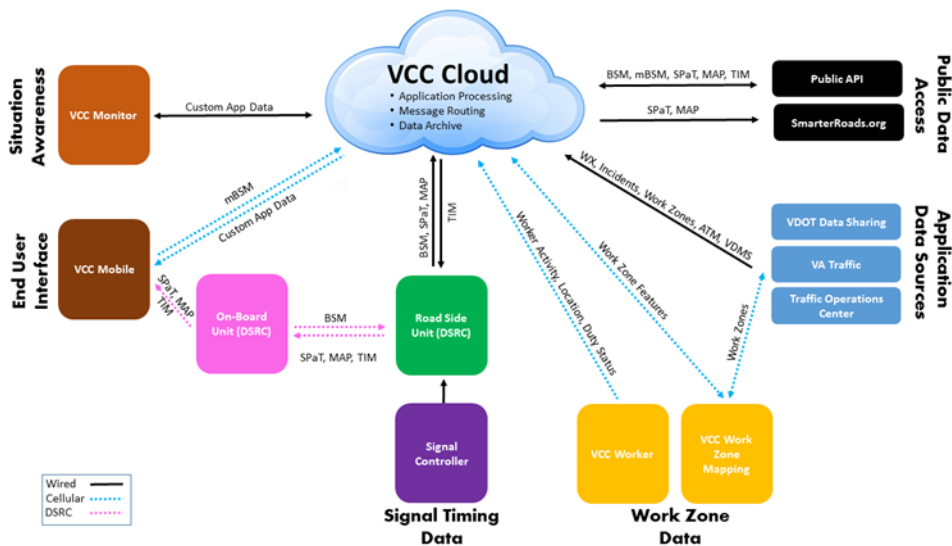
Washington State Department of Transportation (WSDOT)

WSDOT's Cooperative Automated Transportation (CAT) program, including autonomous and connected vehicles, works with and supports both state and national CAT technology efforts. The program focuses on CAT capabilities that can advance the state's multimodal transportation system. Key areas include:

- Developing a policy framework covering both community and regional transportation system needs

- Developing multimodal CAT goals to help determine investment priorities
- Creating opportunities for partnerships
- Promoting safe testing and operation of autonomous vehicles (including ongoing pilot programs)
- Pursuing sustainable funding to support the agency's CAT efforts

WSDOT's CAT Policy Framework is used in a variety of ways to guide decision making, policy development, and CAT investment priorities (Washington State Department of Transportation, n.d.).

Summary

CAV programs are becoming increasingly important for transportation agencies, including State DOTs across the country. This Chapter reviewed the organizational and functional characteristics of State DOTs' CAV programs. Similar to MDOT, many CAV programs are independent from conventional ITS programs. Several DOTs even have two independent AV and CV programs. Closely interacting with other departmental programs are often seen, such as research, operation, data management, and planning activities. Showcasing state wide CAV assets (e.g., CAV testing) is always one of the priorities for many CAV programs. Information related to national CAV trends and local activities are timely available and disseminated online in order to educate the public and peers. Finally, many DOT's CAV programs are results of Governor's initiatives and therefore they could receive stronger inter-departmental support within the state, but they are susceptible to changes in leadership priorities.

Chapter Five: MDOT CAV Survey

In order to assess existing CAV processes within MDOT, a survey was conducted in May 2019. The survey was developed with input from the MDOT Project Manager and administered online via Survey Monkey by CAR. An invitation to participate in the survey was sent by MDOT on May 16, 2019. Follow-up emails were sent one week after. The survey was closed on May 31, 2019. A total of 64 responses were received. Below is the summary of survey findings. The survey questionnaire is included in Appendix A.

Part A: CAV Technologies

How familiar are you with CAV technologies?

Most respondents are familiar with CAV technologies (73% are somewhat familiar and 7.9% are very familiar).

Figure 1: How Familiar Are You with CAV Technologies?
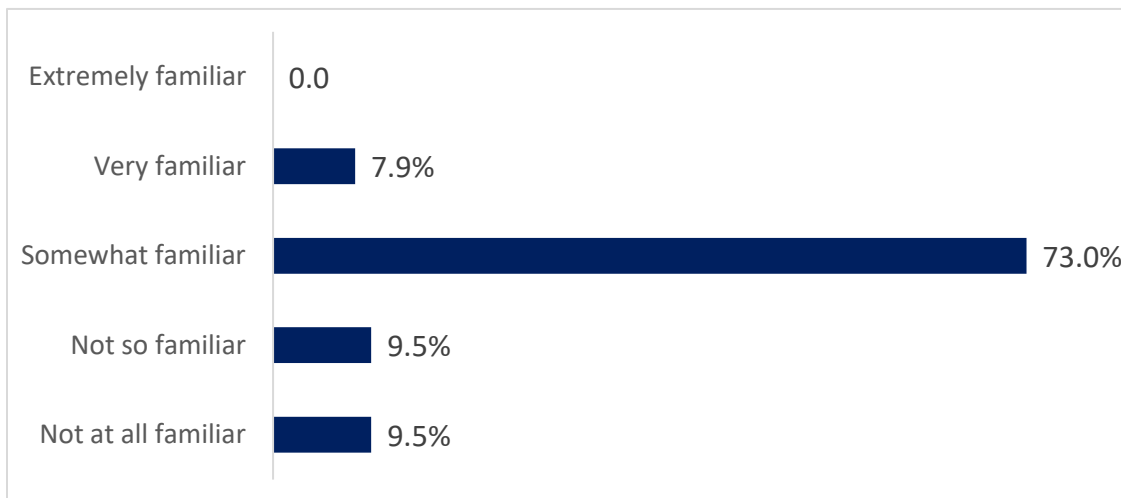
Please check if you are familiar with following CAV activities.

Almost all respondents are familiar with MDOT's MiDrive program, followed by MCity, American Center for Mobility, and MDOT's road weather information system. Surprisingly, only two respondents are familiar with MDOT's CAV Working Group quarterly meetings, which has been in existence for more than a decade and involved a wide range of participants from the industry, public sector, academia, and other organizations. Respondents also indicated their interests to learn more about CAV testbeds and advanced rail technologies.

Figure 2: Familiarity with CAV Activities
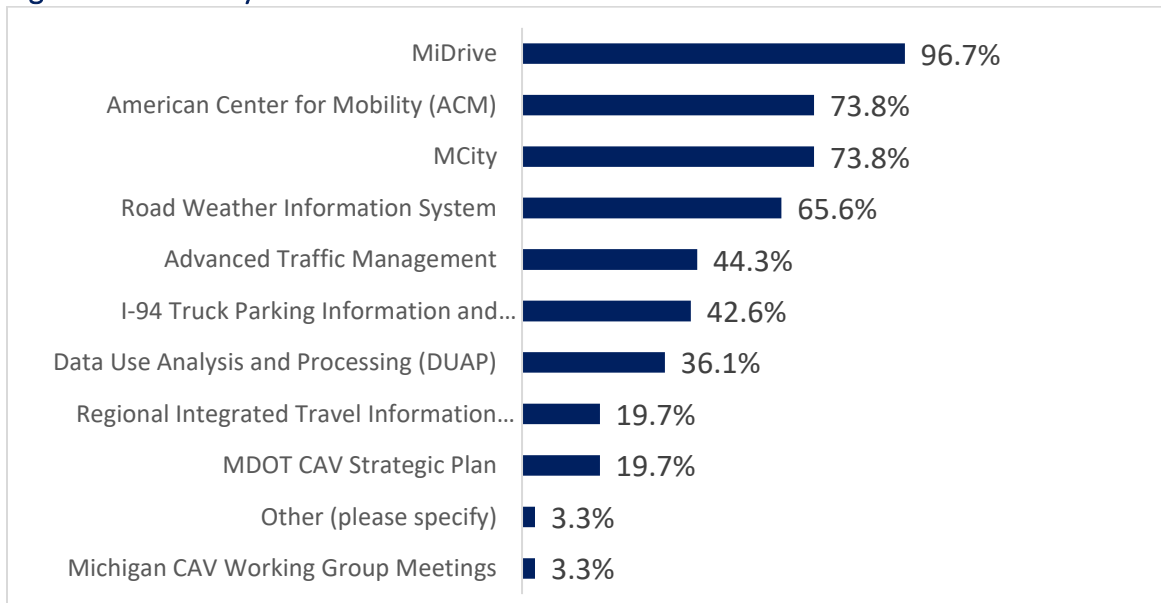
Activity	Percentage
MiDrive	96.7%
American Center for Mobility (ACM)	73.8%
MCity	73.8%
Road Weather Information System	65.6%
Advanced Traffic Management	44.3%
I-94 Truck Parking Information and…	42.6%
Data Use Analysis and Processing (DUAP)	36.1%
Regional Integrated Travel Information…	19.7%
MDOT CAV Strategic Plan	19.7%
Other (please specify)	3.3%
Michigan CAV Working Group Meetings	3.3%

For your job at MDOT, how important is it for you to stay updated on the development and adoption of CAV technologies?
With regard to the importance of CAV technologies to their work, 72.3% respondents indicated that it's important (6.3% extremely important, 25% very important, and 41% somewhat important).

Figure 3: Importance to Stay Updated on CAV Technology?

Not at all important	4.7%
Not so important	23.4%
Somewhat important	40.6%
Very important	25.0%
Extremely important	6.3%
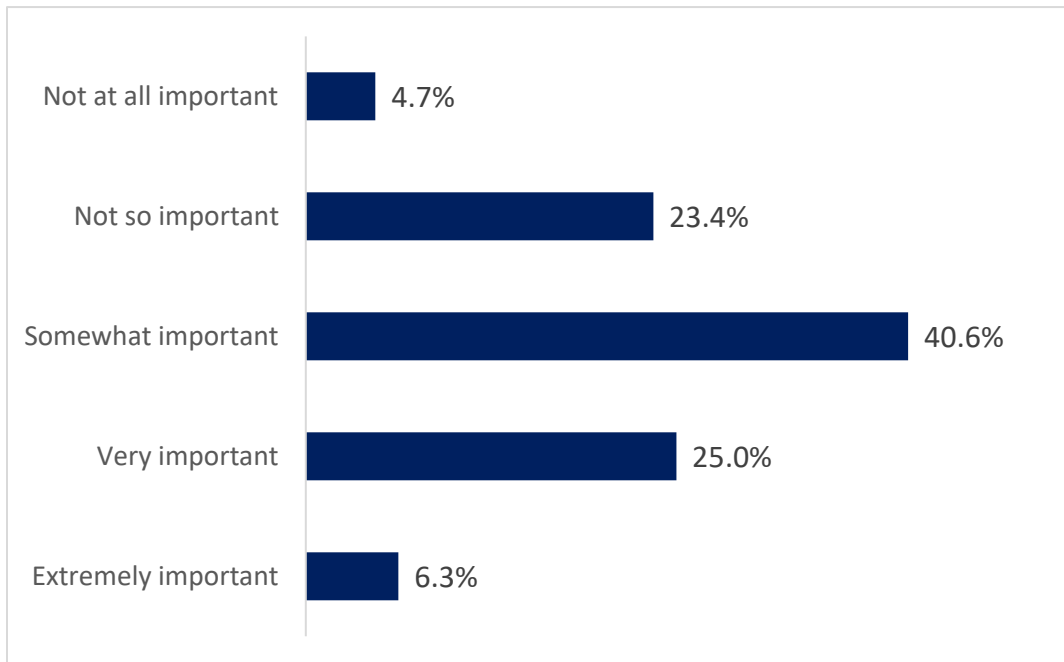
How useful would the following information be to your job at MDOT?

According to the survey, the order of CAV information usefulness is: MDOT connected vehicle projects, MDOT automated vehicle projects, CAV projects in other states, USDOT CAV projects, and international CAV projects.

Figure 4: Usefulness of CAV Information

	Not useful	Somewhat useful	Very useful
International CAV projects	45.9%	41.0%	13.1%
USDOT CAV projects	31.2%	57.4%	11.5%
CAV projects in other states	32.3%	54.8%	12.9%
MDOT connected vehicle projects	11.1%	55.6%	33.3%
MDOT Automated vehicle projects	14.3%	57.1%	28.6%
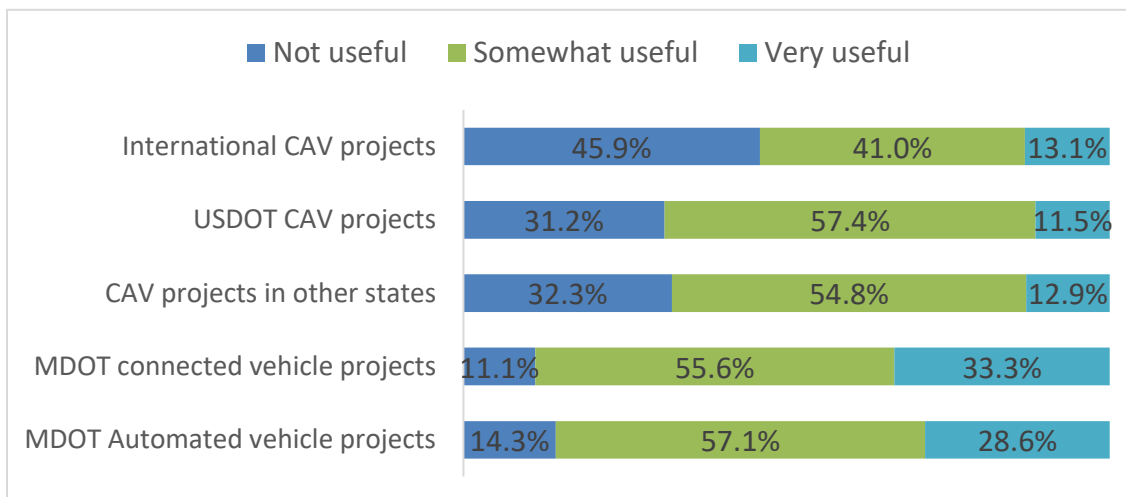
What aspects of CAV technology are most important to you?

The order of importance of CAV technologies is: impact on infrastructure, safety implications, mobility impacts, new data sources, and trends in CAV. Other aspects mentioned by the respondents include: pedestrian and bicyclist safety and impacts, passenger transportation, contribution to road funding sources, and an overall view for personal knowledge.

Figure 5: What Aspects of CAV Technology Are Most Important to You?

Impact on infrastructure — 38.7%
Safety implications — 25.8%
Other (please specify) — 12.9%
Mobility impacts — 12.9%
New data sources — 8.1%
Trends in CAV — 1.6%
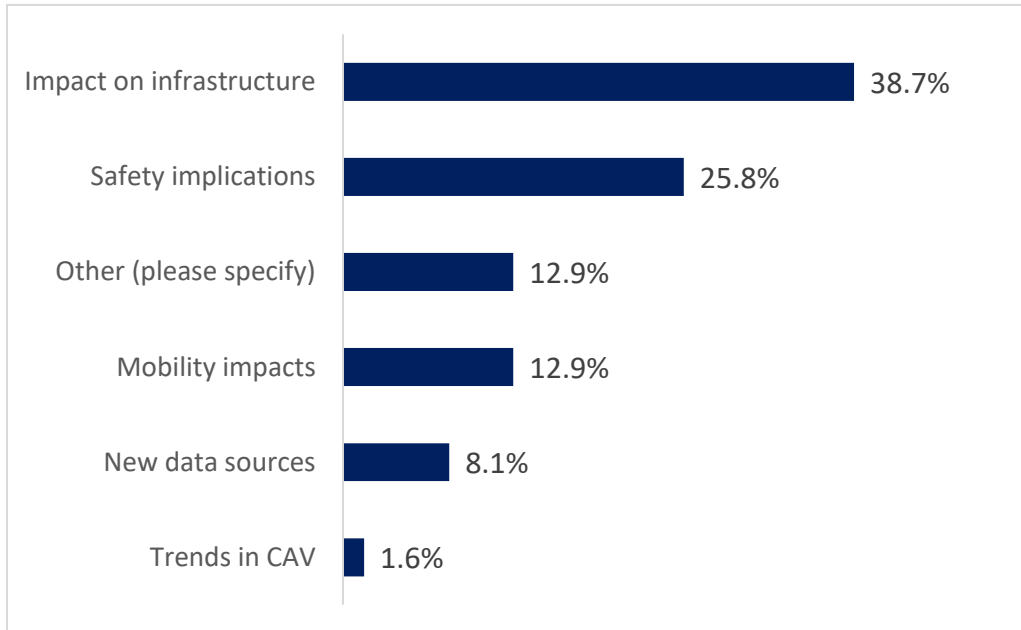
How does information on CAV help you better perform your responsibilities?
Information about CAV will provide decision support (25.9%), develop new planning tools (24%), provide new data sources (24%), support external communications (12%), and support internal communications (3.5%). Others include: no impacts, direct impacts on guidance & technical guidance to SRTS action plan customers and grant applicants, and better understanding of MDOT's finance.

Figure 6: CAV Technology to Support Your Work
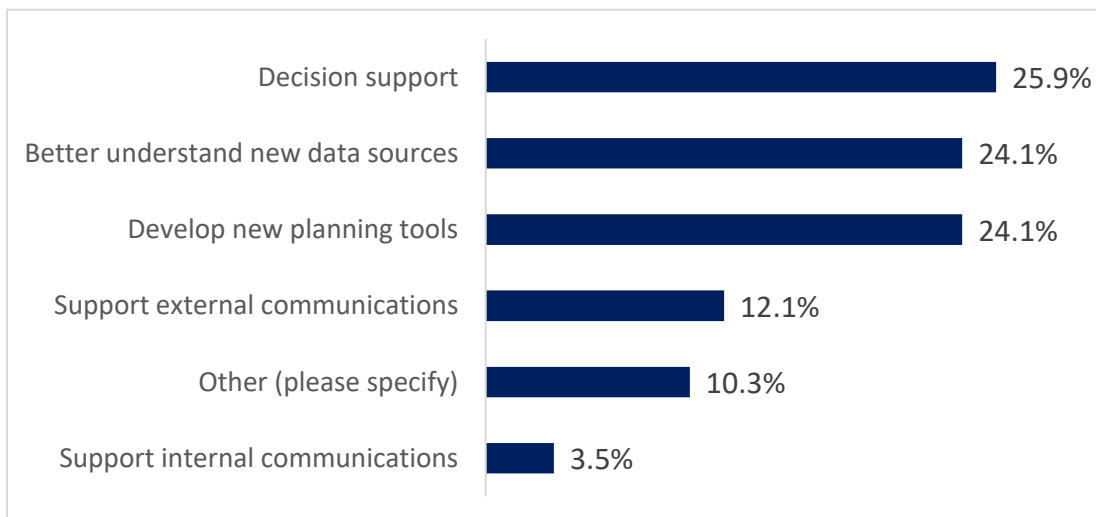
Decision support — 25.9%
Better understand new data sources — 24.1%
Develop new planning tools — 24.1%
Support external communications — 12.1%
Other (please specify) — 10.3%
Support internal communications — 3.5%

How often do you receive information about CAV technologies from MDOT sources?
MDOT newsletters/publications are the most popular method getting information about CAV technologies, followed by MDOT social media, and MODT research reports. MDOT training workshops and webinars are less popular, with more than half respondents saying that they never received information through these two methods.

Figure 7: How Often Do You Receive Information About CAV Technologies?
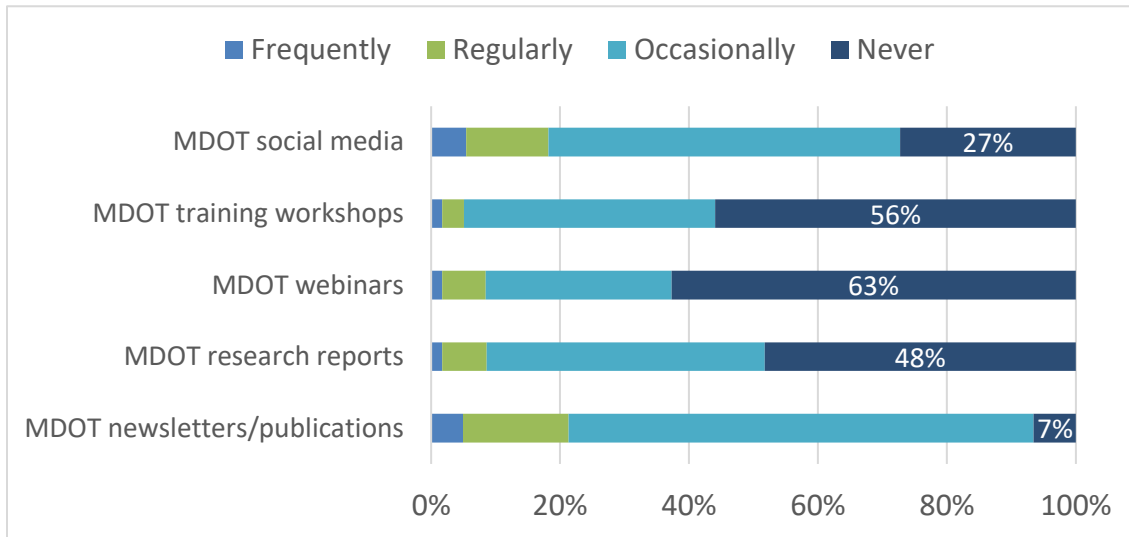
How often would you like to receive information about CAV technologies from MDOT sources?
In terms of the desired frequency to receive information, 97% respondents would like to receive CAV information via newsletters/publications on a frequent, regular or occasional basis. 88% would like to receive research reports, 84% for workshops, 82% for webinars, and 80% for social media. Comparing to the results of Q7, which reflects the actual situation of receiving CAV information, the desire to receive more CAV information is obvious for all type of sources.
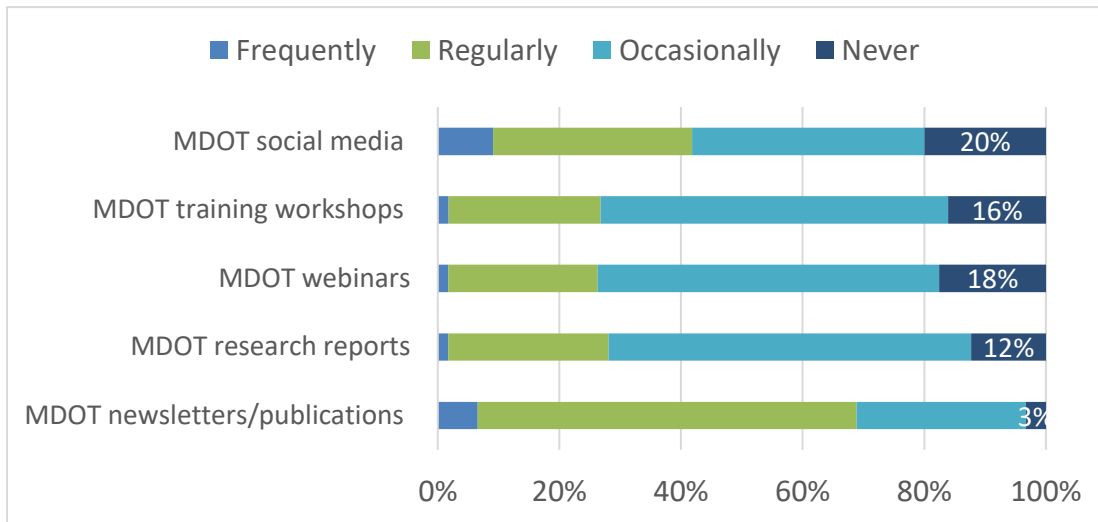
How could MDOT best help you stayed informed about CAV technologies?

In terms of communication methods, below are the suggestions from the respondents. The numbers in the parenthesis are the times mentioned in their responses:

- Newsletters/publications (11)
- Emails like Monday memos with links to articles or updates (10)
- Updates at various meetings/conferences (e.g., TSMO meetings) to keep staff informed and up-to-date (4)
- Webinars (2)
- Face-to-face meeting (1)

How will the deployment of CAV technologies benefit MDOT's mission?

The benefits of CAV technologies to MDOT's mission include:

- Keep Michigan forefront and help MDOT to be the leader in the industry.
- Create an integrated transportation system.
- Improve mobility, safety, travel reliability, and accessibility for Michigan citizens.
- More efficient flow of traffic and consumer goods.
- Help the efficient operation of transportation networks.
- Add capacity.
- Provide the highest quality transportation services.
- Provide opportunities for mobility to seniors and other disadvantaged groups.
- Enhance opportunities for economic growth, safety and overall customer experience.
- Link digital infrastructure to physical infrastructure, and
- Better data to support MDOT's programs and investment decision making.

How can CAV and intelligent transportation systems (ITS) benefit MDOT's transportation management systems and operations (TSMO)?
The benefits of CAV technologies to TSMO Program include:

- Reduce accidents and improve safety for roadway users.
- Provide operational efficiency and reliability.
- Improve mobility for people and goods.
- Better coordination of multi-modal mobility.
- Streamline infrastructure maintenance and eliminate redundancies.
- More and better data to support decision making, such as transportation planning, project development, asset management, traffic operations, and congestion management.
- Deliver cost effective tools to support MDOT's programs, and
- Better support for a successful TSMO program.

How will the deployment of CAV technologies impact your job?
New CAV technologies will impact the overall business and all kinds of jobs at MDOT:

- New features needed for next generation transportation infrastructure, especially geometry and traffic control devices.
- Reducing the amount of new infrastructure needed.
- Impacts on roadway use and design (e.g., shoulder widths reduced or lanes removed in some areas).
- The deployment of CAV technologies would change the approach of my position and job efficiency.
- Impacts on public transit and new partners for public transportation.
- Support our mission at the Office of Passenger Transportation.
- Know what needs to be incorporated at the scoping level of road projects.
- Essential knowledge to support internal and external communications.
- Understand the impacts of CAV on MDOT's overall business.
- Understand the impacts of CAV on safety and their implications to safety planning and investment.
- Understand the impacts of CAV on DOT's revenues.
- Contribute to funding the transportation system.
- Integration of transportation modes, program development, and investment planning.
- Will have to develop methods for modeling and forecasting CAVs at the urban levels.
- How the processes and standards need to consider the changing technologies and how are costs considered.
- How to apply new data sources to support decision making and do our business better.
- New grant opportunities to support CAV activities in Michigan.
- Active planning strategies to adopt CAV applications (e.g., Safe Routes to School practices).
- Increased new data sources could improve decision making, reduce the need to collect data manually, potentially improve safety & reduce labor costs (of collecting data onsite).

- Impacts on travel behavior and traffic trends and consequently the performance implications of roadway pavement designs, and
- More accurate data to support pavement designs.

Part B. Your Profile

Your Bureau/Office

52 respondents provided their working units within MDOT. 30.8% of them are employed by Transportation Planning, followed by Regional Offices (21.2%), Field Services (19.2), Development (9.6%), Passenger Transportation (7.7%), Economic Development (5.8%), Finance and Administration (3.9%), and Rail (1.9%).

Figure 9: Respondents' Bureau/Office

Bureau/Office	Percentage
Transportation Planning	30.8%
Regional Offices	21.2%
Field Services	19.2%
Development	9.6%
Passenger Transportation	7.7%
Economic Development	5.8%
Finance and Administration	3.9%
Rail	1.9%
Human Resources	0.0%
Government Affairs	0.0%
Communications	0.0%
Bridges and Structures	0.0%
Business Development	0.0%
Operations Administrative Services	0.0%
International Bridge Administration	0.0%
Aeronautics	0.0%

Your position type

Among 46 respondents who provided their position types, majority have management responsibilities (administrator 28%, supervisor 26%, project manager 4.4%). The rest are planners, engineers, technician, and analysts.

Figure 10: Respondents' Position Type

Position	Percentage
Administrator	28.3%
Supervisor	26.1%
Transportation Planner	19.6%
Transportation Engineer	13.0%
Technician	4.4%
Project Manager	4.4%
Appraiser	2.2%
Policy Analyst	2.2%
Mechanic	0.0%
Vehicle Safety Inspector	0.0%
Maintenance	0.0%

Please summarize your main responsibilities, projects, and tasks.

Survey respondents cover a wide range of responsibilities at MDOT, including: design, engineering support, transportation planning and project development, operations, program management, customer services, outreach and communications, grant and contract management, budget and funding, and administrative support.

The programs and projects the survey respondents are involved in include: ITS, traffic & safety, TSC operations, capital and finance, passenger transportation, rail, freight, transportat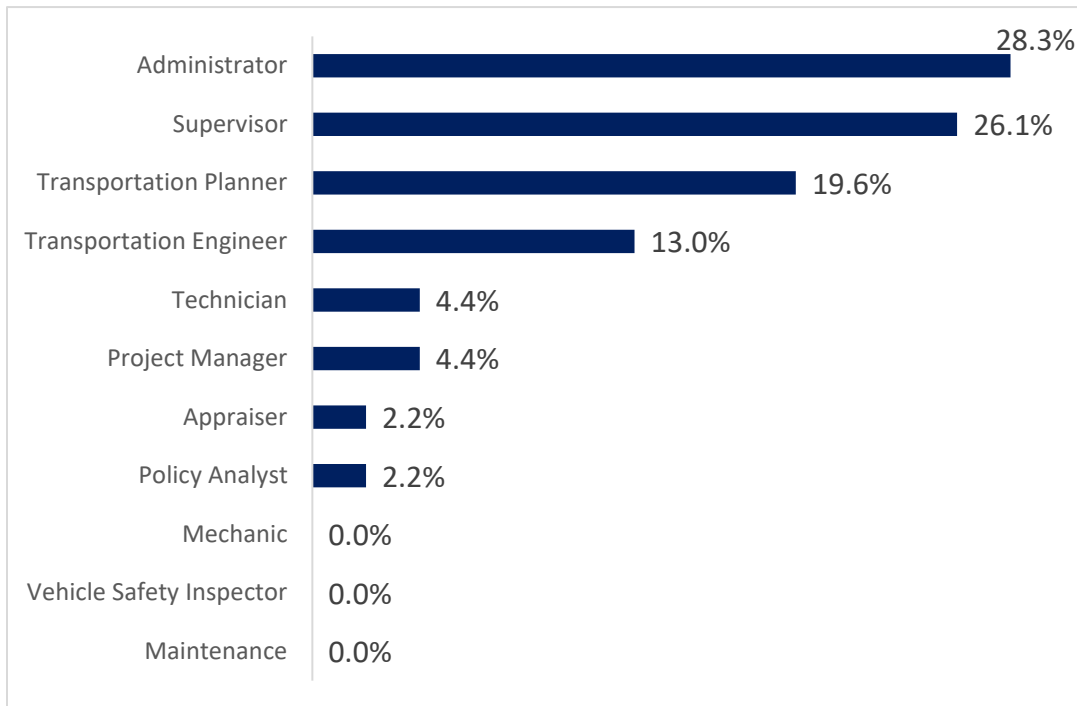ion services, travel demand modeling, congestion mitigation and air quality improvement (CMAQ), TSMO, long-range transportation plan, revenue forecasting, asset management (pavement and bridge projects), transportation data analysis and management, non-motorized transportation, construction and materials, and field services.

May the research group contact you for more information? If yes, please provide your name and preferred email address or phone number.

14 respondents provided their emails or phone numbers. No follow-ups were made as their answers were clear to the researchers.

If you have any suggestions for MDOT's intelligent transportation systems (ITS) and connected and automated vehicles (CAV) program managers, please offer them here.

Survey respondents provided many valuable suggestions for MDOT's ITS and CAV programs. They include:

- Establish a realistic timeline for when infrastructure enhancements would (if ever) need to be incorporated to support CAV.
- Disseminate information on a regular basis about CAV technology adoption and potential impact on MDOT Planning for the future.
- Continue to update CAV trends and support how they would affect MDOT's Enterprise Information Management (EIM) and DTMB partners.
- More investments in MDOT IT programs.
- Continue to fund the expansion of ITS statewide to better plan and serve the taxpayer of Michigan and make CAV a reality for future generations.
- More investment in connected vehicle technology (e.g., vehicle to signals and speed control devices) to help traffic flow, improve safety, and reduce maintenance costs.
- To include both MDOT and outside non-motorized experts in system design and testing
- Applications of CAV technologies should consider the impacts of weather conditions and pavement deteriorations
- It's great that MDOT is supportive of CAV/ITS related projects, but MDOT should also consider the risks and costs of early adoptions since the rate of change of CAV/ITS technologies is so fast.
- Continue to perform cost benefit analysis of ITS/CAV investments and better support decision-making.

Summary

The successful MDOT CAV survey provides valuable information about staff knowledge of CAV technologies, state-wide CAV activities, importance to their work, current and desired internal communication methods, and expected benefits of CAV technologies to MDOT's programs and mission. The positive feedback reflects the growing importance and increasing impacts of CAV technologies to MDOT in particular and the State in general. The respondents are willing to receive more information about CAV technologies and other related information to help them prepare for the changes, support communications, and perform their work.

Chapter Six: Conclusions and Recommendations

This study involved the CAR/WSP research team leveraging a literature review (including on peer State DOTs CAV program focuses) and an MDOT staff survey in order to evaluate CAV initiatives, information dissemination methods, and communication gaps. Key findings include:

- The advancement of CAV technology will require transportation agencies to update their internal and external communication methods in order to be successful. Internal and external communication are inherently connected and improvements to inter-departmental communication are also extremely beneficial for external communications as informed and empowered employees can relay departmental messages to the public in a myriad of settings. State DOTs also need to recognize the decentralized nature of their agencies and develop fast, reliable, and interactive communication methods to inform all employees in a time-efficient manner. Meeting this challenge will include leveraging and expanding existing communications tools, such as department-wide email newsletters and instructional meetings (i.e., webinars) to further include CAV technology, and may also involve integrating new tools such as social media and others that may become available in the future. Most MDOT employees surveyed indicated a desire to stay updated on CAV technologies, and while this may be higher in the group that completed the survey than others, it is only likely to increase as CAV technologies become more relevant to different business needs.
- DOT research opportunities for employees will help foster effective internal and external communication and increase the DOT's public presence. This includes national conference attendance as well as support of initiatives within the state. Partnerships with universities may also be an opportunity, as many local institutions are increasing their expertise in and focus on CAV.
- Integrated Communications is an effective structure that requires collaboration between division and agency units in order to accommodate rapid advancements in technology and improve an organization's internal coordination. Additionally, integrated communications ensure that an organization presents itself as one front with a consistent message. Strong internal communications are essential to supporting an integrated communications approach to external stakeholders.
- The organizational and functional characteristics of CAV programs vary among State DOTs. Similar to MDOT, many CAV programs are now independent of traditional ITS programs. Several DOTs even have two independent AV and CV programs. Closely interacting with other departmental programs, such as research, operation, data management, and planning activities, is often a solid approach.
- Showcasing and leveraging state-wide CAV assets (e.g., CAV testing) are considered top priorities for many CAV programs. On peer state DOT websites, information related to local CAV activities or national trends is available promptly and generally kept up-to-date. Many CAV pilots and tests have already been conducted in the State of Michigan, and information on these projects has been disseminated, though additional outreach would certainly be beneficial to generate additional awareness and knowledge, while preparing for more sophisticated deployments.
- Many DOT CAV programs are part of the Governor's initiatives and therefore could receive stronger inter-departmental support within the state. Other non-transportation departments

that will be directly impacted by CAV early on include (but are not limited to): Insurance & Financial Services, Licensing & Regulatory Affairs, State (i.e. driver licensing), Technology, Management, & Budget, Talent & Economic Development, and Treasury.

- Many State DOTs also collaborate with local city and county governments, particularly as they move from planning for to deployment of CAV technologies. Programs like the Michigan Mobility Challenge can provide a method to create and leverage such relationships, and to ensure that local governments and residents across the state have the opportunity to develop their understanding of new technologies through first-hand experience.

- ITS and CAV programs are important to MDOT's mission and overarching goals. Major ITS and CAV activities and projects have been disseminated online via MDOT's website, benefiting both internal communication and external outreach to the public. Because online dissemination of ITS and CAV information is one of the main avenues of informing MDOT staff and the public, a CAV and ITS website rework should be considered. Improvements could include a cleaner, easy to navigate UI, using fewer drop down links, and a space for more frequent updates to inform visitors on Michigan's achievements and work relating to ITS and CAV technology.

- The MDOT staff survey was paramount in determining current methods of information dissemination used for CAV news and MDOT activities within MDOT, and ways in which the process would be most effectively altered for the MDOT staff. The survey also provided valuable information about staff's knowledge of CAV technologies, importance to their work, current and desired internal communication methods, and expected benefits of CAV technologies to MDOT's programs and mission. The positive feedback reflects the growing importance and increasing impacts of CAV technologies to MDOT in particular and the State in general. The respondents are willing to receive more information about CAV technologies and other related information to help them prepare for the changes, support communications, and perform their work. Additional key findings include:
  - o Internal outreach on existing projects could be improved: almost 20% of survey respondents were "Not so familiar" or "Not at all familiar" with CAV technologies and only 4 (MiDrive, ACM, MCity, and RWIS) MDOT CAV activities have over 45% familiarity among respondents.
  - o There is interest in becoming more informed on CAV: almost 90% of respondents said that information about MDOT connected and automated vehicle projects would be "somewhat useful' or 'very useful' to their job.
  - o Overall, respondents are eager to get more frequent information about CAV technologies from MDOT sources: responses to the questions "How often do you receive information about CAV technologies" and "How often would you like to receive information about CAV technologies" showed that many respondents want more frequent information than they currently receive.
  - o This survey highlights the importance of CAV and ITS information to MDOT employees across many different offices and the positive feedback that improved internal communication would have, if implemented appropriately.

- In terms of communication and collaboration across offices and bureaus, it will be important that the CAV technologies pursued and deployed are applicable across different modes, and include the needs of transit, pedestrians, freight, bicyclists, personal cars, and others. Similarly, the financial, funding, and potential economic development impacts of CAVs should also be

considered throughout the process. Taking such an integrated and full system approach will help internal stakeholders and the public better understand how these emerging technologies could affect them personally, and what feedback they could provide to ensure their needs and concerns are met.

Communication is often the foundation required to build trust: in this case, trust in the abilities of a new technology, trust that the department understands its limitations and people's concerns, and trust that its deployment and integration will ultimately be beneficial to the State of Michigan. MDOT can continue to build this trust by continuing and strengthening its internal and external communications to prepare for a changing future.

Appendix A: MDOT CAV Survey Questionnaire

Connected and automated vehicle (CAV) technologies have the potential to improve the safety and efficiency of transportation systems and increase users' mobility and accessibility. Connected vehicle technologies enable the exchange of digital information between a vehicle and its surroundings. Automated vehicle technologies influence the lateral or longitudinal operation (or both) of a vehicle. MDOT strives to disseminate information on CAVs across the Department to maximize technological benefits to the department and to support the strategic decisions of MDOT and better provide services to Michigan transportation users. To assist information dissemination, MDOT is conducting a Department-wide survey to assess and improve internal communications of CAV activities. Please complete this 10-minute survey about your interests and needs for these technologies and how they are related to your work at MDOT. Your input is highly appreciated!

Part A: CAV Technologies

Q1. How familiar are you with CAV technologies?

- Not at all familiar
- Not so familiar
- Somewhat familiar
- Very familiar
- Extremely familiar

Q2. Please check if you are familiar with following CAV activities:

- MCity
- American Center for Mobility (ACM)
- Michigan CAV working group meetings
- MDOT CAV Strategic Plan
- MiDrive
- I-94 Truck Parking Information and Management System
- Advanced Traffic Management
- Regional Integrated Travel Information System
- Road Weather Information System
- Data Use Analysis and Processing (DUAP)
- Other [please describe]

Q3. For your job at MDOT, how important is it for you to stay updated on the development and adoption of CAV technologies?

- Extremely important
- Very important
- Somewhat important
- Not so important
- Not at all important

How useful would the following information be to your job at MDOT?

MDOT automated vehicle technologies	Not useful	Somewhat useful	Very useful
MDOT connected vehicle technologies	Not useful	Somewhat useful	Very useful
CAV projects in other states	Not useful	Somewhat useful	Very useful
USDOT CAV projects	Not useful	Somewhat useful	Very useful
International CAV projects	Not useful	Somewhat useful	Very useful

Q4. What aspects of CAV technology are most important to you?

- Trends in CAV
- Mobility impacts
- Safety implications
- New data sources
- Impact on infrastructure
- Other [please specify]

Q5. How does information on CAV help you better perform your responsibilities?

- Decision support
- Support internal communications
- Support external communications
- Develop new planning tools
- Better understand new data sources
- Other [please specify]

Q6. How often do you receive information about CAV technologies from MDOT sources?

MDOT newsletters/ publications	Frequently	Regularly	Occasionally	Never
MDOT research reports	Frequently	Regularly	Occasionally	Never
MDOT webinars	Frequently	Regularly	Occasionally	Never
MDOT training workshops	Frequently	Regularly	Occasionally	Never
MDOT social media	Frequently	Regularly	Occasionally	Never
Other (please specify)	Frequently	Regularly	Occasionally	Never

Q7. How often would you like to receive information about CAV technologies from MDOT sources?

MDOT newsletters/ publications	Frequently	Regularly	Occasionally	Never
MDOT research reports	Frequently	Regularly	Occasionally	Never
MDOT webinars	Frequently	Regularly	Occasionally	Never
MDOT training workshops	Frequently	Regularly	Occasionally	Never
MDOT social media	Frequently	Regularly	Occasionally	Never
Other (please specify)	Frequently	Regularly	Occasionally	Never

Q8. How could MDOT best help you stayed informed about CAV technologies?

[text box]

Q9. How will the deployment of CAV technologies benefit MDOT's mission?

[text box]

Q10. How can CAV and intelligent transportation systems (ITS) benefit MDOT's transportation management systems and operations (TSM&O)?

[text box]

Q11. How will the deployment of CAV technologies impact your job?

[text box]

Part B. Your Profile

Q12. Your Bureau/Office
[drop down menu]
- Finance & Administration
- Transportation Planning
- Passenger Transportation
- Rail
- Aeronautics
- International Bridge Administration
- Development
- Field Services
- Operations Administrative Services
- Business Development
- Bridges and Structures
- Communications
- Governmental Affairs
- Economic Development

- Human Resources
- Regional Offices
- Other [please specify]

Q13. Your position type
[drop down menu]
- Administrator
- Supervisor
- Project manager
- Transportation engineer
- Transportation planner
- Transportation technician
- Transportation maintenance worker
- Policy analyst
- Vehicle safety inspector
- Mechanic
- Appraiser
- Other [please specify]

Q14. Please summarize your main responsibilities, projects, and tasks.
[text box]

Q15. May the research group contact you for more information? If yes, please provide your name and preferred email address or phone number.
[text box]

Q16. If you have any suggestions for MDOT's intelligent transportation systems (ITS) and connected and automated vehicles (CAV) program managers, please offer them here.
[text box]

Appendix B: National Resources for Connected and Automated Vehicles

There are great CAV resources available for transportation agencies, including the following from federal agencies or national associations:

- USDOT Automated Vehicles Policy and Activities
- USDOT Connected Vehicle Pilot Deployment Program
- FHWA National Dialogue on Highway Automation
- NHTSA Automated Vehicles for Safety
- NHTSA Vehicle-to-Vehicle Communications
- NHTSA Vehicle Cybersecurity
- AASHTO Connected and Automated Vehicles Portal
- The National Cooperative Highway Research Program (NCHRP 20-102): Impacts of Connected Vehicles and Automated Vehicles on State and Local Transportation Agencies
- The American Association of Motor Vehicle Administrators (AAMVA) Autonomous Vehicle Information Library
- National Conference of State Legislatures (NCSL): Autonomous Vehicles Enacted Legislation
- USDOT ITS JPO: Connected Vehicle Overview and Pilots
- ITSA Autonomous Vehicle Resources
- National Operations Center for Excellence (NOCoE): Vehicle to Infrastructure Deployment Coalition
- The Institute of Transportation Engineers (ITE) Connected/Automated Vehicle Resources

APPENDIX C: Acronyms and Abbreviations

AAMVA American Association of Motor Vehicle Administrators

AASHTO American Association of State Highway and Transportation Officials

AI Artificial Intelligence

ATIS Advance Traveler Information System

ATMS Advanced Traffic Management System

AV Automated Vehicle

CAMS Collision Avoidance and Mitigation System

CAT Connected and Autonomous Technology

CAT Cooperative Automated Transportation

CAV Connected and Automated Vehicles

CMAQ Congestion Mitigation and Air Quality Improvement

CoDOT Colorado Department of Transportation

CV Connected Vehicle

DelDOT Delaware Department of Transportation

DOT Department of Transportation

DTMB Department of Technology, Management, and Budget

DUAP Data Use Analysis and Processing

EIM Enterprise Information Management

FAV Florida Automated Vehicle Initiative

FAV Fully Autonomous Vehicles

FCV Florida Connected Vehicle Initiative

FDOT Florida Department of Transportation

FHWA Federal Highway Administration

IMS Integrated Management System

IoT Internet of Things

IT Information Technology

ITE Institute of Transportation Engineers

ITS Intelligent Transportation Systems

ITSA Intelligent Transportation Society of America

LETS Locations to Enable Testing Sites

MDOT Maryland Department of Transportation

MDOT Michigan Department of Transportation

MEDC Michigan Economic Development Corporation

MnDOT Minnesota Department of Transportation

NAIAS North American International Auto Show

NCDOT North Carolina Department of Transportation

NCHRP National Cooperative Highway Research Program

NCSL National Conference of State Legislature

NDOT Nevada Department of Transportation

NHTSA National Highway Traffic Safety Administration

NOCoE National Operations Center for Excellence

ODOT Ohio Department of Transportation

ODOT Oregon Department of Transportation

PennDOT Pennsylvania Department of Transportation

RiDOT Rhode Island Department of Transportation

RWIS Road Weather Information System

SEMTOC Southeast Michigan Transportation Operations Center

SPaT Signal Phasing and Timing

SRTS Safe Routes to School

STOC Statewide Transportation Operations Center

TRB Transportation Research Board

TRIP Transportation Innovation Partnership

TSC Transportation Service Center

TSM Transportation System Management

TSMO Transportation Systems Management and Operations

TxDOT Texas Department of Transportation

UI User Interface

USDOT United States Department of Transportation

V2I Vehicle to Infrastructure

VCC Virginia Connected Corridors

VDOT Virginia Department of Transportation

VIDAS Vehicle-based Info Data Acquisition System

VTTI Virginia Tech Transportation Institute

WFD Workforce Development

WMTOC West Michigan Transportation Operations Center

WSDOT Washington State Department of Transportation

Wx-TINFO Weather-Responsive Traveler Information System

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