NOCOE SMART WORK ZONES

PEER EXCHANGE PROCEEDING REPORT

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On March 27th - 28th, 2019, the National Operations Center of Excellence (NOCoE) hosted the Smart Work Zone (SWZ) peer exchange in Baltimore, Maryland. The purpose of the peer exchange was to facilitate the knowledge transfer between operations practitioners of transportation public agencies and other stakeholder groups.

The overall theme for this event was Transportation Systems Management and Operations (TSMO) strategies can support more efficient work zone operations. The peer exchange covered the following topics with several presentations in each topic area (See Agenda):

- **Topic 1:** Traveler Information in Work Zones (Presentations: Nevada DOT, Minnesota DOT, and Michigan DOT)
- **Topic 2:** Lane Closure Management (Presentations: Virginia DOT, Delaware DOT, Nevada DOT, and Tennessee DOT)
- **Topic 3:** Technology in Work Zones (Presentations: InTrans, FHWA, MDTA, and ADOT/MCDOT)

The rest of this report includes a section on each of the topic areas above. Each section includes a high level summary of the topics followed by a detailed summary of discussion highlights. The last section of the report includes the summary of the breakout group discussion on day 2 of the peer exchange.

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TOPIC 1: WORK ZONE TRAVELER INFORMATION

The first topic of discussion in the peer exchange was work zone traveler information. The smart work zone strategies provide a strong set of tools to agencies to ensure that accurate, timely, and reliable information is communicated to the road users. Any road work zone, construction, and maintenance information provided to the travelers will help them make more informed decisions on their travel choices. This information is also disseminated to Traffic Management Centers (TMCs) and third-party applications to help them offer more accurate navigation to the road users. During the group discussions, the importance of several aspects of the traveler information in work zones was highlighted including the following:

- Correct placement of smart work zone devices
- User experience in designing 511 websites
- Streamlining of DOT's internal processes

The three sub-topics above are described in detail in the section below in **Discussion Highlights for Topic 1.** The highlights include some of the lessons learned and successes of Nevada DOT, Michigan DOT, and Minnesota DOT in work zone traveler information issues.

Discussion Highlights for Topic 1

Nevada DOT- Lessons Learned Using Smart Work Zones for Automated Real Time Traveler Information

The first discussion highlight was on Nevada DOT's lessons learned using smart work zones for automated real time traveler information. Nevada DOT is currently using the smart work zone technology in two projects: I-15 Starr Interchange construction (Funded through Federal Highway Administration (FHWA) State Transportation Innovation Council) and SR 160 construction. For both projects, queue warning and dynamic travel time system devices such as iCone Traffic Beacons for speed monitoring, portable rumble strips, and Changeable Message Signs (CMS) are used along the route. There are multiple considerations for the agency when deploying SWZ Technology:

- First, the agency needs to ensure that the contractor is monitoring the devices throughout any period of deployment (weekly report to DOT).
- Second, the agency needs to require the contractor to maintain an adequate inventory of parts to support the maintenance and repair of the devices.
- Finally, proper language needs to be used in the contract for the specifications of the SWZ implementations (See Slides for Nevada's example language for the contract).

Another lesson learned for Nevada DOT was the importance of the correct placement of smart work zone devices. The devices have sensitive systems, often in need of checking and repositioning (especially if in an area prone to wind, rain, and snow). The inclement weather in Nevada affects solar panel and battery re-charging and the solar panel needs a sturdier set-up, especially if an area is prone to wind. Also, if a vehicle is parked near a sensor or if there is queuing in front of a barrel, the devices will have erroneous readings.

Michigan DOT Lessons Learned on Redeveloping 511 Website

The second discussion highlight was on lessons learned from Michigan DOT (MDOT) on redeveloping their 511 website. MDOT redeveloped its 511 website in June 2018, moving from the in house development to external private development, in an effort to upgrade the website and improve user experience for road commuters. The issue that faced MDOT was that ever since the website was first created, too many data elements were added to the website which made it hard for the travelers to easily find the information needed. To address this issue, MDOT slimmed down the website and used a simplistic approach for easier user navigation. The simplistic approach also helped avoid website crashing when there is too much demand.

To implement the changes, the data entry form was redesigned in partnership with MDOT's communication office. The data fields were divided into the following two categories: 1- Public facing data for traveling public; 2-Engineering data for internal coordination. As part of this process, MDOT also standardized each district's work zone data elements across the state. Additionally, a new feature was added to the website to show available truck parking to meet the MDOT's MAP 21 Grant requirements. The website update also helped MDOT to organize and integrate the 511 entry data in a way that can be used for CAV research and implementation. The update also helped MDOT to integrate work zone data sets to be able to incorporate them to the FHWA Work Zone Data Exchange template.

Minnesota DOT: Lessons Learned on Streamlining Internal Processes

The third discussion highlight was on lessons learned from Minnesota DOT's streamlining of its internal processes for implementing smart work zones. For Minnesota DOT, there were several takeaways from the smart work zone implementation. First, there is a learning curve for the agency on deciding the application of smart work zones in select projects for it to be most effective. Second, the smart work zones utilize a new and different type of technology so the equipment installation and maintenance process is likely new to the prime contractor, subcontractors, and construction crews. As a result, more lead time is necessary prior to deployment deploying smart work zone technology so that the project team can learn about the devices and ensure that they meet the agency requirements. Because of this learning curve, it is recommended to start deploying the smart technology as a pilot on simpler projects before deploying it on extended complicated projects. Finally, it is important that all equipment be installed well in advance of the beginning of the construction work since the installation and testing takes considerable time.

TOPIC 2: LANE CLOSURE MANAGEMENT

The second topic of discussion in the peer exchange was Lane Closure Management. Effective lane closure policies, practices, and processes help agencies to have work zones with the least impact on operations and the travelling public. Several considerations need to be addressed when discussing the lane closure management practices:

- Smart work zone equipment: ownership, maintenance, system integration, safety, and physical security considerations
- Internal and external coordination of road closures
- Contractor compliance for work zone plans and agency policies
- Variable Speed Limits in work zones

The four sub-topics above are discussed in detail in the next section, **Discussion Highlights for Topic 2.** The highlights include some of the lessons learned and successes of Virginia DOT, Delaware DOT, Utah DOT, and Tennessee DOT.

Discussion Highlights for Topic 2

The Ownership, Maintenance, System Integration, Safety, and Physical Security Considerations for Smart Work Zone Equipment

Equipment plays a primary role in executing a successful smart work zone. One of the decisions that agencies need to make is determining who is responsible for maintaining and mobilizing the equipment (DOT vs contractor). Also, after the work zone project is finished, the agency may consider purchasing the equipment from the vendor. One of the risks of completely outsourcing the equipment handling is that if the vendor goes bankrupt, the DOT can no longer utilize the equipment.

The other consideration with outsourcing smart work zone equipment is ensuring that the linkage is created between the new Smart Work Zone technology and the DOT's current resources. For example, Delaware DOT uses WTMC (DelDOT's traffic advisory radio station), Facebook, Twitter, DelDOT App, and permanent message boards for communications and is looking into connecting the SWZ equipment to those resources. Available IP address numbers is another concern for DelDOT because they are running out of cellular provided IPs that allow communication between the signals and Dynamic Message Signs.

There are additional considerations for the maintenance of smart work zone equipment. When designing projects that are heavily dependent on ITS maintenance, the staff and resource limitations of the maintenance division needs to be taken into consideration. The physical security of the SWZ equipment is also another concern because batteries or other parts of the devices may be. Additionally, if not properly placed, the equipment could become a roadside hazard.

Internal and External Coordination of Road Closures

The second discussion was about the internal and external coordination of road closures. A lane closure management system can support effective coordination, tracking, and communication of the lane closures. Virginia DOT uses the Lane Closure Advisory Management System (LCAMS) to proactively

manage and communicate lane closures across the state. The LCMAS information is used for public awareness through the VA Traffic tool and the 511 system.

One of the most important features of the LCAMS is its ability to help avoid conflicts when scheduling road work. If two requests for construction conflict, the system notifies the two users that there is a conflict and asks them to change dates/time. Preference is given to high priority work (i.e., design-build, major structure repair, etc.) by the system.

Minnesota DOT uses similar processes to coordinate road closure among divisions and districts. Construction maps are created regularly to display road work. These maps are also used to ensure the alternative routes are clear to accommodate detour traffic. Another aspect of coordination for the road closures is deciding who is responsible for giving permits for lane closures. For smaller scale projects, if the permit request is processed at the district level, the paperwork and processing time would be reduced considerably.

Compliance of Work Zone Agency Policies

The third topic of discussion was on the contractor compliance of work zone agency policies. DOTs usually have policies in place to limit the allowable hours of work on the road. These limitations are set using traffic analysis to find the least impactful allowable hours to avoid unnecessary congestion in major routes and urban areas. The consideration for road closures in rural areas is that detour routes are very limited and the detours add considerable time to the travel time.

Additionally, it is essential for DOTs to ensure that the contractors are not only complying with these allowable hours of work but also are properly following the Maintenance of Traffic (MOT) plans in the field. It can be challenging for DOTs to do field visits for checking contractor compliance (especially in remote rural areas). One potential solution is to use TMC cameras to remotely perform a remote quality check on the field. TMC cameras can also be used to confirm if a work zone is active or not. The other potential solution is to use law enforcement officers to ensure the workers are not doing road work outside the allowable hours. Additionally, the DOT can penalize a contractor who violates the rules the next time a request a permit for road work. The issue of compliance with the agency policies remains an important concern for DOTs to ensure the mobility and safety of the traveling public and construction workers.

Variable Speed Limits in Work Zones

The fourth topic of discussion was on the Variable Speed Limits in work zones. Utah DOT uses Variable Speed Limit (VSL) in some of its work zones. A Portable VSL (PVSL) is used in construction zones for speed management. The PVSL unit monitors the real time traffic speeds and averages into 1-minute bins. The system will round down the average speed to the next 5 mph increment and then subtract an additional 5 mph, setting the speed limit up to 10 mph less than the average speed. Application is limited to rural two lane high speed facilities (60+ mph) and only placed in the active work zones where workers are on the road (Source: UDOT 2017 innovation and efficiencies report). Tennessee DOT will also use variable speed limits for this year's interstate night resurfacing projects. The speed limits will be lowered only when the work zone is active. The variable speed limit signs are wirelessly controlled and weekly logs are generated to ensure proper usage.

TOPIC 3: TECHNOLOGY IN WORK ZONES

The third topic of discussion in the peer exchange was Technology in Work Zones. Emerging technologies help agencies have more dynamic management of traffic in work zones. The following aspects of work zone technology applications were discussed:

- Connected Work Zone systems
- Harmonized work zone data specification (Work Zone Data Initiative (WZDI))
- Active Traffic Management System in work zones (Maryland I-895 bridge project)

The three sub-topics above are described in detail in the following section, **Discussion Highlights for Topic 3.** The highlights include some of the lessons learned and successes of Arizona DOT and Maricopa County DOT, Iowa DOT, and Maryland Transportation Authority in addition to the description of FHWA work zone data initiative.

Discussion Highlights for Topic 3

Smart Connected Work Zones

The first discussed aspect of technology in work zones was the topic of Connected Work Zone Systems. The Maricopa County Department of Transportation (MCDOT), as part of AZTech and the Federal Highway Administration's (FHWA's) Every Day Counts initiative, developed a system for deployment of Smarter Work Zone technology at work zone sites. The smart work zone system is designed to be implemented during the construction of MCDOT's MC-85 project. The system will use the Connected Vehicle Work Zone (CVWZ) technology to provide dynamic, real time, and continuous work-zone related in-vehicle information. For more background information on the Arizona Connected Vehicle Work Zone see here. With the diverse group of project stakeholders involved in the MCDOT's CVWZ project, coordination is key. Prior to the deployment and during the deployment, MCDOT holds weekly coordination meetings to coordinate the MCDOT MC-85 SWZ technical details. The project requires engaging a diverse group of stakeholders including MCDOT Resident Engineer, MCDOT Construction Manager, MCDOT TMC, MCDOT PIO, ADOT, University of Arizona, Prime Contractor, RoadSafe (SWZ Field Locations), and Ver-Mac (SWZ Software).

MCDOT faced several challenges during the design and implementation of the CVWZ system. First, considerable effort went into the coordination with multiple groups and divisions within the Department including the construction work zone division which is separate from the TSMO division. Second, the project team needs to be aware of the considerable time goes into getting software and cloud approval through IT services. Also, prior knowledge of the FCC licensing process is helpful (Height limitations was an issue for this project). Finally, the project team needs to be aware of the DSRC range limit at the design stage. To cover cars moving at higher speeds, the antennas need to be placed diligently to ensure full coverage. See linked flyers and presentations to learn more about the project (Flyer 1, Flyer 2, and slides).

FHWA Work Zone Data Initiative

The second topic of discussion was on the Federal Highway Administration's Work Zone Data (WZDx) Initiative. FHWA launched the Work Zone Data Initiative with the goal of creating a consistent language for communicating information on work zone activity across jurisdictional and organizational boundaries. The initiative includes the creation of a state of the practice review, data framework, dictionary, system pilot, implementation guide, and WZDx . The WZDx was launched in March 2018 to jumpstart the voluntary adoption of a basic work zone data specification through collaboration with data producers and users. (More information on WZDx can be found here.)

Iowa DOT is one of the pilot agencies who agreed to be part of the WZDx. The Initiative enables infrastructure owners and operators to make harmonized work zone data available for third party use. Iowa DOT agreed to use the suggested template to report work zone activity. As part of this effort, existing 511 data were mapped to the WZDx enumerations. One of the challenges that Iowa DOT faced was reorganizing location information from visual demonstration to the beginning and end latitude and longitude values. The other challenge was that Iowa DOT has a different classification of the work zone events, counting 1 event per closure, whereas the WZDx template treats each lane closure independently by date, location, and direction. Another challenge was the data quality, where vague terminology was used to describe the work zone (e.g., intermittent lane closure) or where inaccuracies were found showing work zone status as inactive/active incorrectly.

To improve data quality, Iowa DOT uses the Connected Devices such as iCone Traffic Beacons to make the lane closure status more accurate. The challenge with the connected devices is that they will collect some information but not enough to give a full picture of the work zone. The connected devices usually collect and share information such as ID#, Location (Latitude, Longitude), and ON/OFF, which can be used to mark the work zone begin and end location, begin and end time, and the specific lane that is closed. Information such as Duration (recurring, short-term, etc), Traffic Restrictions, and Associated Project is not currently collected through these devices. This missing information cannot be complemented with crowdsourcing applications.

The data quality is an important aspect of work zone data. With limited resources and time, it can be challenging to expect the construction workers to fill out multiple forms in the field. To achieve higher quality work zone data, it is important to make the process online, automated, and integrated through the available technologies. To make the work zone data management process more integrated, Iowa DOT uses a combination of planned (work zone data) and actual (field data) to create accurate 511 work zone data feed. The integration process will verify lane closure (length as well as begin/end time). Also, an alert will be created if a planned closure has not been activated when expected or if a closure is extending past anticipated closure times or extents.

Active Traffic Management System in Work Zones

The third topic of discussion was about the Maryland Transportation Authority's (MDTA) successful use of Active Traffic Management System at I-895 Bridge Project. The MDTA's I-895 Bridge Project includes replacing the Holabird Avenue exit ramp and rehabilitating the Harbor Tunnel. Throughout the project, MDTA will update motorists on changing traffic patterns via traffic advisories and social media. The MDTA

will deploy an Active Traffic Management System for this project including Portable Changeable Message Signs (PCMSs) and portable traffic sensors with communications capabilities for queue warning and real time traveler information. The status of PCMS and sensors can be viewed through a web-based system management interface (jam logic). Automated user notifications are sent to the system administrator and TMC through email or text. MDTA also has system override capability to avoid conflicting messages on PCMSs.

For the MDTA's I-895 bridge project, the smart work zone ITS device installation and maintenance is contracted out to a vendor. One of the benefits of outsourcing this task is that the installation, testing, and operations of devices are completed at a much faster speed. For temporary and shorter-term projects with a tight schedule, it is better to use a vendor; however, for longer time projects, it is better if it is done in house. When using a contractor, it is important to give the contractor more lead time to make sure they have enough time to set up all the devices, verify the operability of devices, and the quality of the collected data. During this test phase, the agency needs to make sure the collected data can be used in a meaningful way. Additionally, to ensure operational status at all times, MDTA has defined vendor penalties if the system becomes non-operational to ensure timely response for troubleshooting any issues.

For the I-895 project, the data is collected in the field through the sensors and is automatically processed to create speed thresholds, volumes, and lane occupancy information. For some segments of the project, a combination of third-party app data and portable sensor data is used for the most accurate and cost-effective travel time estimation. Historic travel data is also used for advising travelers to take alternative routes when the travel time for the route is more than three times the free flow.

BREAKOUT GROUP DISCUSSION (DAY 2)

On the second day of the peer exchange, the participants were divided into four breakout groups to further discuss the other aspects of the work zones not covered in day 1. The breakout group discussions were conducted in two parts. In part 1, the group discussed work zone-related gaps and issues listed in Table 1:

Table 1 Work Zone Gaps/Issues by Capability Maturity Model Categories

Business Processes	• Limited hours/calendar days of work for construction (based on weather and special events) • Different schedules for project cycles and maintenance cycle (potential solution: having aligned schedules for potential efficiencies) • Inadequate processes in place to support the use of local funding for smart work zone • Holding contractor/vendor accountable (visiting project regularly is not always feasible) (Also Collaboration)
Collaboration	• The big difference between the MOT plan and the real-world implementation of the plans (changing the phasing of the plans leads to inefficiencies) • Enforcement of work zone safety laws (especially distracted drivers), lack of sufficient policies beyond reducing speed limits to support the safety of work zones, making sure that a designated location is included in MOT plans for the law enforcement officers • Politics in urban areas and finding a balance in customer service (over communication when handling complaints and citizen requests can be unproductive) • Communication with partners and stakeholders throughout the work zone planning and implementation processes especially for smaller projects (early inclusion versus being an afterthought)
Culture	• Resistance in the adoption of new technologies from local and regional public agencies • Lack of public trust in lower work zone speed limits due to inaccurate information on the status of work zones (active/inactive) (Also automated speed enforcement citations go to the owner of the car and not necessarily the driver) • Cultural silos between the divisions of the DOT (construction vs TSMO)

	• The slow rate of adoption of new technologies or unconventional solutions (e.g. portable concrete barriers, dynamic signs showing workers are present) (Also Business Processes)
Organization/Workforce	• Staff retention difficulties including high turnover in highway patrol/tow industry/flaggers (also insufficient training for some of the field workers)
Performance Measurement	• Lack of qualitative data and performance measure tracking especially in smaller projects • Lack of high quality/timely data to make the business case for funding the smart work zones
Systems & Technology	• Lack of studies to help agencies decide on who owns smart zone equipment (state or vendors)

Table 2 displays the stakeholders that were identified in discussions:

Table 2 Work Zone Stakeholder Groups

Public Agencies/Officials	• DOT Divisions: planning, structures(bridges), special events, permits, communication, 511/Transportation Management Centers, weather, maintenance, district offices, and Traffic Incident Management • Other jurisdictions (public sector): MPOs, cities, rural counties, local agencies, tribal agencies, and federal partners • Freight liaison: airport, railroad, transit (bus and metro) • First responders: difficulty accessing incidents, work zone injuries, and access to hospitals • Public Relations: public involvement/media relations, social media followers • Enforcement community • Decision Makers: lobbyists, elected officials, advocacy/community groups • Other stakeholders: military, secret service, trash management, postal service, festivals, and ticket sales • Utility companies: the importance of having an agreement in advance through pre-contract meetings • National Park Service, Department of Natural Resources, fish and wildlife, parks, and historical landmarks

Road Users	• Farmers (agricultural considerations and harvest schedule) • Landowners and businesses: better communication with affected owners • Schools: school zone detours, school bus, unusual school schedules (daily/seasonally) • Disabled: ADA access (e.g. blind, deaf, wheelchair, etc.) • Pedestrian and bicyclists

Overall, the peer exchange provided a forum for TSMO practitioners to learn from their peers and discuss issues and opportunities on a variety of smart work zones topics. For more information visit NOCoE Knowledge Center: https://transportationops.org/knowledge-center

SUPPORTING DOCUMENTS & RESOURCES

1. Agenda and Participants List
2. Download link for the all peer exchange slides
3. FHWA Work Zone Management Flyer
4. MC-85 SWZ Lane Closure Management Flyer - MCDOT&ADOT
5. MC-85 SWZ Traveler Information Flyer - MCDOT&ADOT
6. MCDOT Smart Work Zone Technical Feasibility Concept Document
7. NDOT Active Traffic Management System ConOps Document
8. Minnesota Intelligent Smart Work Zone Toolbox
9. MnDOT IWZ Scoping Needs Decision Tree & Cost Estimates
10. UDOT Portable Variable Speed Limit in Work Zones
11. Guidelines for Work Zone "Variable" Speed Limits For NC Highway
12. TxDOT End of Queue Warning
13. MD Transportation Authority - Traffic Management System Specification for I-895 Smart Work Zone