SHRP2 Reliability
Lead Implementer Roundtable

Summary Report from January 2016 Workshop

September 2016

SHRP2SOLUTIONS

U.S. Department of Transportation
Federal Highway Administration

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Introduction

In January 2016, the Federal Highway Administration (FHWA) Office of Operations convened 10 lead implementers of Reliability products from the second Strategic Highway Research Program (SHRP2) for a discussion on their deployment experiences and ideas. Participants represented State departments of transportation (DOT), metropolitan planning organizations (MPOs), and associated Federal and professional group stakeholders. The purpose of this event was to:

- Share experiences and lessons learned in the implementation of SHRP2 Reliability products,
- Identify opportunities for SHRP2 product enhancement and expanded product delivery,
- Understand how to better engage States that have not yet used SHRP2 products, and
- Explore opportunities for additional national level support for SHRP2 product implementation.

This report captures key activities and lessons learned as of January 2016.

Key Findings

Each participant described how SHRP2 Reliability products have been used in their respective States and regions to help them advance transportation systems management and operations (TSMO). The discussion demonstrated the benefits of the SHRP2 Reliability products and associated Implementation Assistance Program (IAP) funding for transportation agencies seeking to improve the implementation and integration of TSMO. Common themes from the discussion highlighted how the products have contributed to the following outcomes at transportation agencies throughout the country:

- **Served as "tipping point" for advancing TSMO in transportation agencies:** While many agencies had been working to advance TSMO, the SHRP2 products helped bring energy, attention, funding and new tools/capabilities to catalyze efforts to advance TSMO practices and create buy-in across the agency.

- **Institutionalized TSMO in transportation agencies:** SHRP2 Reliability products helped agencies to establish and develop TSMO programs and offices/divisions and strengthen staff capabilities to implement those programs.

- **Supported integration of operations and planning:** In several states, SHRP2 tools and technical assistance enabled the integration of TSMO concepts into transportation planning and the project selection processes.

- **Strengthened partnerships with local, State, and Federal stakeholders:** Through the use of SHRP2 products State DOTs identified critical stakeholders and strengthened partnerships to improve the efficiency and effectiveness of TSMO activities.

- **Supported use of TSMO tools, data and performance measures:** SHRP2 Reliability products were used by transportation agencies to develop operations performance measures and performance-based decision-making practices that better consider the benefits of operations strategies.

- **Sparked development of TSMO program plans:** The use of SHRP2 products led to program planning efforts and the development of plans to support systemic efforts to formalize, integrate, and evaluate TSMO programs.

- **Raised awareness of the benefits of TSMO among agency staff and leadership:** Many States that used SHRP2 Reliability products saw that they increased the visibility of TSMO practices,

leading to greater awareness and improved communication among staff as well as a more supportive culture for TSMO.

- **Strengthened TSMO peer networks:** SHRP2 provided a forum for States and MPOs to share their experiences related to TSMO and SHRP2 products to advance the state of the practice. This is being leveraged and further developed by the National Operations Center of Excellence.

These themes are described in further detail in the section titled Successes and Lessons Learned.

Overview of SHRP2 and SHRP2 Reliability Products

SHRP2 conducted more than 100 research projects designed to address critical State and local challenges in the areas of capacity, safety, renewal, and reliability. Research products developed in the Reliability focus area are aimed to improve congestion and travel reliability on the nation's roadways by supporting the advancement of TSMO by helping agencies:

- Assess and improve their business processes and organizational capabilities,
- Gather and analyze data to make better decisions in real-time and for planning,
- Implement TSMO strategies more effectively, and
- Increase their TSMO knowledge.

A summary of the SHRP2 products discussed at the Roundtable is provided in Table 1.

Table 1. SHRP2 Reliability Products Discussed

Product	Description
Organizing for Reliability Bundle (L01/L06/L31/L34)	A set of tools that helps agencies assess their TSMO programs and implement changes to technical and business processes in order to enhance the ability to manage unexpected congestion.
Reliability Data and Analysis Tools (L02/L05/L07/L08/C11)	A suite of tools to help transportation planners and engineers improve monitoring and analysis of data to achieve more consistent, predictable highway travel.
National Traffic Incident Management Responder Training Program (L12/L32)	Brings police, firefighters, DOT, towing, medical personnel, and other incident responders together to engage in interactive, hands-on incident resolution exercises.
Regional Operations Forum (L36)	An in-person regional training workshop curriculum that allows managers and program leaders at public agencies to build expertise in TSMO.
Guidelines for Incorporating Reliability Performance Measures into Travel Models (L04)	Application guidelines for incorporating reliability into micro- and/or meso-simulation models that identify key steps for integrating demand and network models.
Communicating Traveler Information and Estimating Its Value to Travelers (L14)	A lexicon that describes how transportation agencies can best communicate information about travel time reliability to motorists so they can make informed decisions and better plan to arrive at their destination on time.
Framework for Improving Travel-Time Reliability (L17)	The National Operations Center of Excellence (NOCoE) and a corresponding website that actively supports the TSMO community.

All States, the District of Columbia, and Puerto Rico are implementing at least one SHRP2 Reliability product, and some States are implementing more than 10 products. SHRP2 products have been offered through the IAP, which provides funding to State DOTs, MPOs, and other interested organizations to implement SHRP2 solutions. Funding was offered to three types of recipients: Proof of Concept Pilots, Lead Adopters, and User Incentives. The SHRP2 Reliability Lead Implementer Workshop covered experiences from State DOTs and MPOs already implementing multiple Reliability products.

Roundtable Session Process

FHWA led a facilitated discussion that focused on six key questions:

- What products did your agency select and why?
- How were they perceived to be relevant to advancing Transportation Systems Management and Operations (TSMO) and the development of your TSMO program?
- What were your experiences in applying the selected products? What might have made them easier to adopt and apply? What lessons did you learn in applying the tools –both about your agency and program, and about the value of the tools?
- What is the current status of your adoption of the products into common practice and policy? What are the limitations or challenges in their sustained utilization?
- What needs and opportunities exist for improving national level support for SHRP2 product implementation?
- What lessons can be learned more generally about how to successfully disseminate and implement TSMO research products?

Each State and MPO shared its response to these questions, with some discussion after each State or MPO's update. At the end of the Roundtable, the group discussed key lessons learned and opportunities for additional Federal support for TSMO. This report summarizes the result of the Roundtable.

Participants included staff from Arizona DOT (ADOT); Maricopa County, AZ; Colorado DOT (CDOT); Florida DOT (FDOT); Maryland State Highway Administration (MDSHA); Minnesota DOT (MNDOT); Oregon DOT (ODOT); Tennessee DOT (TDOT); Utah DOT (UDOT); Virginia DOT (VDOT); and Washington State DOT (WSDOT). Partners from American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB) participated in the session as well. The National Operations Center of Excellence (NOCoE) also participated to glean information for sharing with its broad network of TSMO professionals and to identify possible needs for future services. A full list of attendees is available in Appendix A.

Lead Implementer Practices

This section summarizes key SHRP2 Reliability activities of the States represented at the Roundtable discussion. Each location did not necessarily discuss all the SHRP2 Reliability products they are implementing.

Arizona

Products Used: L01/L06/L31/L34, L12/L32, L17, L36

ADOT used the Capability Maturity Model (CMM) assessment tool (L01/06) to develop organizational strategies for their new TSMO division, which is very large and operates as an umbrella for other divisions. ADOT uses the Transportation Incident Management (TIM) responder training (L12/L32)

extensively to support their TIM efforts, and recently hosted a TIM peer exchange working with the NOCoE (L17).

ADOT sent several staff members to a Regional Operations Forum (L36) with other southwest States, which helped ADOT build relationships with other agencies and allowed staff to gain a better understanding of TSMO. ADOT noted that the Forum exposed a larger number of their staff to TSMO and increased the momentum for TSMO in their organization. These activities have helped to firmly establish TSMO at ADOT and strengthen leadership support.

Maricopa County, Arizona
Products Used: L01/L06/L31/L34, L04, L12/L32, L36

Maricopa County recently underwent a reorganization which involved integrating the planning, project management and traffic management functions into a single division. The guide, Integrating Business Processes to Improve Reliability (L01), and the associated e-Tool (L34), helped the agency analyze their business processes at the local level and identify influences. This enabled them to better build TSMO concepts into the organization at an early stage of the reorganization. The product also helped them build relationships and partnerships between the groups and incorporate TSMO into planning.

Maricopa County also used implementation assistance made available under the IAP for L01/06 to conduct a CMM assessment in 2015 with each of the local agencies. The CMM assessment was a follow on from an earlier review completed in 2009. As a result of the 2015 assessment, the County is now focusing on addressing key challenges and gaps, which include: staffing local agencies, communicating with the public, adopting new technologies (e.g., connected vehicle), and enhancing multimodal planning. Maricopa County has deployed the L12/L32 TIM training extensively, and they are working on building in a local component to the training to address non-freeway situations. Maricopa County is also pilot testing the L04 pre- and post-processing tools for incorporating reliability into simulation models.

Colorado
Products Used: L01/L06/L31/L34, L12/32, L17, L36

CDOT served as a pilot site for testing the CMM assessment tool (L01/06) in 2010, and subsequently conducted an operations self-assessment in 2013 to improve travel-time reliability in the State. The results of this assessment assisted with a reorganization of the Department that merged traffic, safety, and operations responsibilities into a single division. Then, under its SHRP2 IAP award, the Agency used L06 to conduct a statewide CMM workshop in 2014. Shortly before that, CDOT participated in an L36 ROF with neighboring States. This was followed by three L34 program area-specific CMMs on work zones, road weather, and TIM; the development of a TSMO program plan; and training through an in-house Operations Forum (a weeklong Colorado version of the L36 ROF with approximately 40 stakeholders). CDOT found the ROFs fueled interest among attendees for more in-depth training on specific topics.

The L12/32 TIM Training Program has been adopted into CDOT policy and incorporated into the CDOT University. More than 150 trainers have been trained to date, and it has helped local agencies take ownership of TIM.

CDOT noted several benefits that SHRP2 Reliability products have had on advancing TSMO in the State. The Agency found that the products were very relevant to their efforts and provided an objective and

systematic approach to what are often territorial and sensitive subjects. This helped CDOT ensure that the reorganization was systematic and it allowed the agency to work through solutions objectively. The SHRP2 products also helped CDOT get over their tipping point to undergo a major culture shift, moving from a point where TSMO is emphasized to one where it is institutionalized.

Florida
Products Used: L01/L06/L31/L34, L02/05/07/08/C11, L12/L32, L36, R11

The FDOT TSMO group used L01/L06 to assist in the process of assessing its needs, leading to the hiring of a new TSMO manager and traffic operations manager. FDOT is using its IAP pilot testing of the reliability data and analysis tools (L02/05/07/08/C11) to incorporate operations and travel time reliability into their planning process, including their planning documents and tools (e.g., Highway Capacity Manual analysis) and MPO modeling processes and planning documents. To assist in this effort, FDOT holds joint meetings between planning and TSMO staff every three months. FDOT would like to have additional analytical capabilities/tools that fall between long range planning tools and the Highway Capacity analysis to further integrate operations considerations into the project development process.

FDOT indicated that a major benefit of the SHRP2 Reliability products has been the building of relationships with external partners and staff in other disciplines, such as planning. This has improved the understanding of the benefits of operations improvements among planners. FDOT has also built relationships with county and MPO staff through this effort and believes the tools could be useful to these groups.

Maryland
Products Used: L01/L06/L31/L34, L02/L05/L07/L08/C11, L12/L32, L17, R11

MDSHA used L01/L06 to determine how planning and operations staff can better work together to advance their system to a higher level of maturity and improve travel time reliability. The agency used the CMM self-assessment to support the development of strategic and implementation plans that identify ways to better integrate operations into planning. The strategic plan establishes a vision, program goals, strategies, action items, time frames, and lead offices for implementation for the MDHSA TSMO program. The CMM assessment helped managers recognize that there is a need for better programmatic planning and integration between offices to improve the effectiveness of TSMO activities.

MDSHA has begun investigating how they can use the benefit-cost analysis tools during the planning process to justify freeway management projects. They are using L07/C11 to understand how to quantify the economic benefits of improved reliability. MDSHA has sought to integrate TSMO concepts into planning through: qualitative data management strategies for planning projects; increasing their understanding of the tradeoffs between planning and operations projects; and, improvements in the implementation of practical design standards. MDSHA's goal is to integrate TSMO, asset management, and performance management in the same organization. MDSHA hopes the use of L06 and the reliability data and analysis tools can support their integrated corridor management (ICM) concept of operations effort, performance management, and better integration across offices.

MDSHA has also made progress in implementing TIM responder training (L12/L32). The agency hired a full-time program manager dedicated to providing TIM training in State. As of January 2016, they had trained approximately 8,000 responders.

Minnesota

Products Used: L02/L05/L07/L08/C11, L12/L32, L36

MnDOT piloted the SHRP2 analytical tools (L02/05/07/08/C11) during an earlier project and is using SHRP2 implementation assistance to integrate the tools into their business processes. Officials at MnDOT are reviewing their Congestion Management Safety Plan, which is targeted to implement lower cost solutions, to identify how to incorporate reliability to improve decision-making. MnDOT has used the tools in corridor studies and plans to continue applying them in studies and network planning throughout the State. MnDOT plans to mainstream the tools and is assessing how to do so. There has been widespread support for incorporating reliability performance measures into planning. MnDOT has developed a new reliability tool to identify and prioritize potential operational improvements and has used it on a wide range of projects. Using the SHRP2 analytical tools has raised awareness of TMC staff to how much data is available and the need to use it better from planning through day-to-day operations.

Oregon

Products Used: L01/L06/L31/L34, L04, L12/L32, L17, L36

ODOT implemented L01/L06 to foster a better understanding of operational processes and to improve travel time reliability among State agencies. Oregon held a statewide CMM workshop, which allowed stakeholders to participate in a holistic discussion about the best ways to organize to implement TSMO strategies. As a result of the CMM workshop, ODOT is developing a statewide joint strategic plan with law enforcement, an effort that has been facilitated by the partnering relationships they developed through the L12/32 TIM responder training. Oregon put significant emphasis on implementing the classroom version of the L12/L32 training and found it to be a very useful product that has been well-received across the State. They found it beneficial that the training was a national product with national backing.

ODOT participated in a Regional Operations Forum (L36) with other northwest States and hosted a follow-up workshop on performance management in collaboration with the NOCoE (L17) in November 2015. The workshops brought together similar attendees and have led to further discussions and peer exchange among attendees. ODOT and its MPO in the Portland area are participating in a pilot test of the L04 simulation pre- and post-processing tools for analyzing reliability.

Tennessee

Products Used: L01/L06/L31/L34, L02/05/07/08/C11, L12/32, L36, R11

TDOT established a Traffic Operations Division in 2013. L01/06 CMM implementation assistance helped to support and reinforce this reorganization. SHRP2 funding allowed TDOT to accelerate the institutionalization of operational business processes and communicate TSMO strategies and priorities throughout the agency. They did this by integrating concepts described in L01/06 into a new TDOT TSMO Program Plan. Use of L01/06 CMM, combined with the L36 Regional Operations Forum (ROF), helped to educate TDOT employees and partners about TSMO. TDOT plans to conduct the CMM assessment every three years. TDOT is also considering organizing ROFs that will include the CMM as a component.

TDOT adopted widespread TIM Training and integrated the training into the law enforcement training academy. An important outcome of TDOT's use of SHRP2 products is that they have helped TDOT develop stronger partnerships with the Tennessee Department of Safety. Working with the Department of Safety, TDOT has implemented the TIM responder training (L12/L32) and established a traffic control fusion center co-located with State Patrol.

In conducting their CMM assessment, TDOT identified the need for system performance measures and the associated data collection and analysis functions. TDOT is using implementation assistance for the reliability data and analysis tools (L02/05/07/08/C11) to develop a system performance plan. TDOT is also testing the R11 work zone project coordination tool to build on its work zone analysis capabilities and tools.

Utah
Products Used: L01/L06/L31/L34, L12/L32, L17, L36

UDOT had encouragement from top leadership to look for ways the SHRP2 products could help them get better outcomes and build a stronger TSMO culture. UDOT used L01/L06 implementation assistance to conduct an assessment of their current culture and develop a set of short- and long-term priority actions based on the findings. As a result of this effort, the agency has implemented reliability performance measures, reorganized the incident management program, and identified a need to increase operations discipline representation at the regional level. UDOT also identified the need to build relationships with agencies they do not work with regularly (e.g., USFS, NPS).

UDOT used L12/L32 implementation assistance to improve crash clearance performance. The assistance helped them to build a stronger relationship with fire fighters, hold over 30 training sessions, train over 700 responders, and make plans to integrate TIM training into the State Fire Academy training. UDOT sent four staff to an L36 regional operations forum. The forum helped staff build connections with others in the State and in neighboring States, and build energy around new initiatives, such as creating performance measures. UDOT found that the SHRP2 Reliability products helped build strong connections with staff in other disciplines and agencies and provided opportunities to share experiences and lessons learned with these staff. UDOT found L17/NOCoE was a good way to engage staff that do not have the opportunity to participate in-person.

Virginia
Products Used: L01/L06/L31/L34, L12/L32, L17

VDOT has used the SHRP2 Reliability products to assess their current operations program and identify areas for improvement. VDOT has set up operations-related performance measures (e.g., vehicle hour delays) using a scorecard approach. VDOT is also in the process of integrating travel time reliability into planning and project prioritization. The VDOT Operations Division used the CMM self-assessment (L01/L06) to review specific areas to better understand where to make organizational changes. VDOT also developed a very active TIM Training Program using L12/L32 implementation support. VDOT preferred the in-person version of the training and noted challenges with how to get a large agency trained while keeping the training multi-disciplinary.

Washington

Products Used: L01/L06/L31/L34, L02/05/07/08/C11, L12/L32, L17, L36

WSDOT used L01/L06 to help implement changes in their Operations Division. The Agency had been changing their project delivery process and the way they plan for operations, and TSMO has been at the core of that shift. WSDOT utilized the CMM to help them examine their business processes from planning through operations and identify changes. WSDOT implemented the reliability data and analysis tools (L02/05/07/08/C11) to improve their ability to measure reliability on a corridor basis. They are using SHRP2 funding to migrate their previous performance measurement system, TRAC, into DRIVENET, which allows staff to look at rural and suburban reliability measures that were not previously visible. The SHRP2 Reliability products have helped make TSMO a more readily apparent activity for WSDOT and have elevated the perceived importance of operations among other groups in the agency.

Benefits and Lessons Learned

This section describes key successes and lessons learned from implementation of the Reliability products covered in this session. The major benefits of the SHRP2 products are listed and described in more detail below.

- Served as "tipping point" for advancing TSMO in transportation agencies,
- Institutionalized TSMO in transportation agencies,
- Supported integration of operations and planning,
- Strengthened partnerships with local, State, and Federal stakeholders,
- Supported use of TSMO tools, data and performance measures,
- Sparked development of TSMO program plans,
- Raised awareness of the benefits of TSMO among agency staff and leadership, and
- Strengthened TSMO peer networks.

Served as a "tipping point" for advancing TSMO

The SHRP2 Reliability products helped bring energy, attention, funding and new tools/capabilities to precipitate a significantly higher level of awareness, capacity and support for TSMO processes in lead implementer States. States mentioned that the products were relevant and beneficial to their efforts to make it over their tipping point to getting TSMO institutionalized. CDOT, for example, used L01/06 to conduct a CMM assessment and initiate a major agency reorganization which shifted traffic, safety and operations responsibilities into a single division. TDOT used L01/L06 Implementation assistance to ensure the success of their newly established Operations Division. WSDOT used L01/L06 to incorporate TSMO into a shift in project delivery methods that was already underway at the agency. In MnDOT, use of the Reliability Data and Analysis Tools (L02/05/07/08/C11) was a turning point for TMC staff to realize the amount of data they have and engage in efforts to identify how they could use it better.

Institutionalized TSMO in transportation agencies

Participants indicated that a major benefit of implementing the SHRP2 Reliability products was that they helped raise awareness of TSMO and institutionalize TSMO within their agency's culture and structure. Some agencies underwent organizational change to better support TSMO and others bolstered TSMO in their staff training programs.

The Organizing for Reliability Tools (L01/L06/L31/L34) were especially effective in helping agencies incorporate TSMO into their organizational structure. In some cases, SHRP2 assistance helped initiate this process and in other cases it supported changes that were already underway. The extent of organizational change varied greatly by agency, but in each case it further formalized TSMO within the agency's structure. TDOT used L01/06 to accelerate the institutionalization of operations-related business processes, which was an effort already in the works. FDOT and MDSHA both used SHRP2 funding to identify the need for and hire staff responsible for managing TSMO operations.

Several agencies used SHRP2 Reliability products to bolster TSMO training for staff and institutionalize this training into their agency's processes. After hosting a Regional Operations Forum (L36), CDOT identified a need for more in-depth TSMO training and is now working to get TSMO reflected in its CDOT University. Other agencies integrated the TIM training (L12/L32) into existing training programs. UDOT, for example, integrated the TIM training (L12/L32) into their State's Fire Academy. This has helped the agency take ownership of TIM and ensured that TIM will continue to be taught in the future.

Supported integration of operations into planning

Several agencies utilized SHRP2 tools and assistance to integrate operations into planning. FDOT, for example, used Reliability Data and Analysis Tools (L02/05/07/08/C11) to incorporate reliability into their Highway Capacity Manual analysis, State and MPO planning documents, and MPO modeling processes. FDOT holds regular joint meetings between TSMO and planning staff to assist with this effort. The close collaboration developed through this effort has helped ensure that planners understand the cost effectiveness of operations improvements on improving travel time reliability. VDOT also integrated travel time reliability into their planning and project selection process. All projects eligible for funding in the State are scored for prioritization in the six-year improvement plan, and reliability measures are now considered as factors in that scoring process.

Strengthened partnerships with local, State and Federal stakeholders

Agencies indicated that the SHRP2 Reliability products helped them identify the need for and build stronger partnerships with local, State and Federal stakeholders. UDOT identified the need to build relationships with Federal agencies, such as the U.S. Forest Service and the National Park Service, which they do not work with on a regular basis. The agency's intention was to establish relationships with these groups so they can work together more easily when needed. FDOT built relationships with county and MPO staff through SHRP2 efforts. TDOT developed stronger partnerships with the Tennessee Department of Safety and State Patrol through implementation of the TIM Training Program (L12/L32). They also used SHRP2 C15 funding to enhance coordination between the State's Operations Office and Planning Office in order to better integrate freight into planning. Maricopa County was able to use the L01/06 tools to work with local agencies to identify their TSMO challenges and prospective solutions.

Supported use of TSMO tools, data, and performance measures

Agencies shared examples of how SHRP2 supported their development of more formalized and effective TSMO programs through helping agencies develop operations-related performance measures and operations plans.

Several agencies used the Reliability Data and Analysis Tools (L02/05/07/08/C11) to develop reliability performance measures for their programs. WSDOT is also using the tools to improve their ability to measure reliability on a corridor basis. They used the funding to migrate their previous performance

measurement system, TRAC, into DRIVENET, which allows staff to look at rural and suburban reliability measures that were not previously visible. WSDOT noted that their operations process is becoming more performance-based. MnDOT used SHRP2 assistance to support implementation of their Congestion Management Safety Plan as well as improve their corridor studies. MnDOT plans to continue applying the tools in corridor studies and network planning throughout the State and intends to mainstream them.

Sparked development of TSMO program plans

Several agencies used L01/L06 and L36 to support the development of TSMO strategic plans and program plans. MDSHA is using SHRP2 assistance to support an update to their TSMO Strategic and Implementation Plan, which outlines several activities that will improve their operations program. CDOT used L01/06 to conduct a CMM assessment workshop for statewide TSMO and subsequently developed a program plan. TDOT used support for L01/06 to develop a TSMO Program Plan and identify system performance measures and the associated data collection and analysis functions. TDOT is also implementing a parallel effort to the TSMO Program Plan that includes the system safety performance. From this effort, they have developed corridor operations plans for several critical, strategic operations corridors. This has helped them get out of a pattern of reactive operations and shift toward more proactive, strategic operations.

Raised awareness of the benefits of TSMO among agency staff and leadership

Several agencies indicated that the SHRP2 Reliability products helped increase the awareness of TSMO among staff of all disciplines and levels and elevated the perceived importance of TSMO among these staff. In many cases, the organizational changes, institution of TSMO programs, TSMO training, and connections made with other disciplines helped agencies make their shift to TSMO more visible.

CDOT, for example, used SHRP2 products to undergo a major culture shift, moving from a point where TSMO is emphasized to one where it is institutionalized. The creation of programs funded by SHRP2 activities – such as the Corridor Operations and Bottleneck Reduction Program, TSMO evaluation program, and TIM training program – fueled this culture shift. UDOT also built a stronger operations culture by implementing TSMO programs. The agency used L01/06 to conduct a capability maturity assessment of their previous culture and then identified and implemented a set of short- and long-term priority actions, such as a formal TSMO plan.

Communicating the benefits of TSMO throughout the agency and earning leadership support were also important factors for creating an operations culture. SHRP2 helped agencies do both of these. At ADOT, staff are starting to understand TSMO better and the organizational commitment to TSMO has increased. ADOT suggested that these helped increase the priority of TSMO in the agency. The Arizona Governor and other State leadership have expressed strong support for TSMO which also aided this culture shift. MnDOT found that the Reliability Data and Analysis Tools (L02/05/07/08/C11) provided a common language for communicating the benefits of operational systems, which improved the ability of operations staff to communicate the benefits of TSMO throughout the agency.

Strengthened TSMO peer networks

SHRP2 provided a forum for states and MPOs to connect and share experiences related to TSMO, and participants emphasized the value of this during the Roundtable session. SHRP2 facilitated these connections both formally and informally: in some cases, the SHRP2 network itself provided a structured

way for agencies to contact each other and share lessons learned related to TSMO and, in other cases, the products themselves brought TSMO partners together and allowed staff to build connections. Participants also noted the growing role and value of the NOCoE in helping to support these efforts and further provide opportunities for peer networking.

ADOT, for example, used other states' CMM assessment experiences and lessons learned when implementing L01/06 to help develop their TSMO division. ADOT also connected with partners through their L12/32 TIM efforts by inviting six neighboring states (UT, CO, NV, CA, TX, and TN) to attend their latest TIM summit. ADOT indicated that learning from other States was the most useful component in developing their agency's operations activities.

The Regional Operations Forum (L36) provided an excellent venue for networking and building peer relationships, and several participants mentioned that this venue for networking was highly valuable. TDOT, UDOT and ADOT all indicated that their staff developed strong partnerships with others in their respective states and regions from attending this forum. At UDOT, the connections formed helped the agency respond when a section of I-15 in Nevada closed following a flash flood.

Participants also indicated that the Lead Implementer Roundtable itself was extremely useful and they would appreciate more such forums to connect with other States either in-person or via teleconference. Participants found value in being able to access resources that other States are producing (e.g., fact sheets, marketing materials, guidance) with implementation assistance funds.

Suggestions for FHWA Implementation Support

There is a clear opportunity for FHWA to continue supporting agencies in moving toward institutionalizing TSMO. Participants identified opportunities for FHWA to continue to support State and MPO TSMO programs. Key suggestions included:

- **Facilitate the sharing of TSMO best practices:** FHWA should provide an ongoing forum for sharing best practices. Regular meetings or webinars with lead adopter States focused on certain products could help to promote peer-learning. In-person workshops or peer exchanges among States and MPOs on the implementation of Reliability products are also an effective venue. Consider having some activities/forum focused on individual projects, and on sharing more (e.g., case studies) about how the different ways agencies are organized and how that can affect TSMO programs and efforts. FHWA should continue to support discussions about SHRP2 product use, best practices and lessons learned, such as this Roundtable. NOCoE is also a key conduit for sharing TSMO best practices. Continued collaboration with the NOCoE and leveraging of efforts is important.

- **Raise awareness of SHRP2 implementation and encouragement deployment:** To raise awareness and promote further deployment, FHWA should develop materials sharing progress, lessons-learned, case studies and best practices concerning the implementation of SHRP2 products. For example, a map describing which States are implementing which SHRP2 products could be a useful reference and spur action (like the TIM training map). Leading States and MPOs should share their success with putting the SHRP2 research into action to encourage other agencies to put the SHRP2 products and other TSMO-related research into practice. There was specific mention of the need to increase awareness of the L34 e-tool.

- **Demonstrate leadership commitment to SHRP2:** To improve awareness and support among transportation agency leaders, FHWA should encourage visits from the leadership of FHWA, AASHTO, and TRB to the States and MPOs adopting SHRP2 products.

- **Provide additional funding to support TSMO activities.** The deployment funding provided by SHRP2 helped agencies advance TSMO efforts and introduce new concepts, processes, analytical methods, and strategies. To further momentum for TSMO activities FHWA should consider providing similar funding for future TSMO efforts, as well help agencies better understand how to use flexibilities within existing funding sources.

Conclusion

SHRP2 Reliability products are helping to advance TSMO in State and MPO agencies and to develop effective TSMO programs. The backing of AASHTO and FHWA has helped agencies gain support for deployment within State DOTs and among their partners. As a result, these tools have provided an objective and systematic approach to successfully integrate TSMO practices into the business processes of transportation agencies. Used in tandem, these products have helped transportation agencies understand and address their organizational needs to improve the reliability highway operations. Future Federal support could continue to advance the institutionalization and recognition of TSMO as an established discipline across the country.

Appendix A – Participants

State/Organization	Participants
Arizona	Brent Cain (ADOT)
	Faisal Saleem (Maricopa County)
Connecticut	Ryan Rice (CDOT)
Florida	Doug McLeod (FDOT)
Maryland	Tom Jacobs (University of Maryland)
	Subrat Mahapatra (MDSHA)
Minnesota	Paul Morris (SRF Consulting for MnDOT)
	Todd Polum (SRF Consulting for MnDOT)
Ohio	Galen McGill (ODOT)
Utah	Carlos Braceras (UDOT)
	Rob Clayton (UDOT)
Tennessee	Brad Freeze (TDOT)
Virginia	Dean Gustafson (VDOT)
Washington State	John Milton (WSDOT)
NOCoE	Tom Kern
AASHTO	Strat Cavros
	Gummada Murthy
	Patrick Zelinksi
FHWA	Bob Arnold
	John Corbin
	Doug Laird
	Jeff Lindley
	Tracy Scriba
TRB	Dave Plazak
USDOT Volpe Center	Aaron Jette
	Emily Futcher