Innovation to Implementation

Collaborative Forums to Boost Research-Based Solutions to Transformational Technology and Innovation

Research Final Report from Vanderbilt University, the University of Memphis, and Tennessee State University | Janey Camp, Stephanie Ivey, Catherine Armwood-Gordon, Jake Milligan, Katherine Turner, Miguel Moravec, Craig Philip, Marty Lipinski, Shahram Pezeshk, Salwa Badr | July 1, 2022

DISCLAIMER

This research was funded through the State Planning and Research (SPR) Program by the Tennessee Department of Transportation and the Federal Highway Administration under ***RES #2019-20: Collaborative Forums to Boost Research-Based Solutions to Transformational Technology and Innovation.***

This document is disseminated under the sponsorship of the Tennessee Department of Transportation and the United States Department of Transportation in the interest of information exchange. The State of Tennessee and the United States Government assume no liability of its contents or use thereof.

The contents of this report reflect the views of the author(s) who are solely responsible for the facts and accuracy of the material presented. The contents do not necessarily reflect the official views of the Tennessee Department of Transportation or the United States Department of Transportation.

Technical Report Documentation Page

1. Report No. RES2019-20	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle *Innovation to Implementation: Collaborative Forums to Boost Research-Based Solutions to Transformational Technology and Innovation*		5. Report Date July 2022
		6. Performing Organization Code
7. Author(s) Janey Camp, Stephanie Ivey, Catherine Armwood-Gordon, Jake Milligan, Katherine Turner, Miguel Moravec, Marty Lipinski, Shahram Pezeshk, Salwa Badr, Craig Philip		8. Performing Organization Report No.
9. Performing Organization Name and Address Vanderbilt University 2301 Vanderbilt Place Nashville, TN 37213		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. Grant RES2019-20
12. Sponsoring Agency Name and Address Tennessee Department of Transportation 505 Deaderick Street, Suite 900 Nashville, TN 37243		13. Type of Report and Period Covered Final Report May 2019 – August 2021
		14. Sponsoring Agency Code
15. Supplementary Notes Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.		

16. Abstract

Technology is changing rapidly in this world, especially with regards to transportation. Recent advancements have potential to significantly change transportation system design, operations, and management in Tennessee and beyond. Additionally, innovation and "out of the box" thinking is contributing to improved workflows and more efficient processes. The overall objective of this project was to assist and guide TDOT's Research Office in identifying and evaluating potential opportunities to improve the research program with a focus on both embracing innovation and effectively facilitating the implementation of research. The project team performed a literature review and surveys of researchers from across Tennessee and state DOT staff from across the nation to provide a foundation for an Innovation to Implementation Forum and a Peer Exchange, both of which were hosted by the research team. Best practices and key takeaways were integrated into information shared at the events and utilized to develop a framework and recommendations for TDOT and other agencies to utilize for future research program improvements.

17. Key Words **INNOVATION; IMPLEMENTATION; PEER EXCHANGE; BEST PRACTICES**		18. Distribution Statement No restriction. This document is available to the public from the sponsoring agency at the website http://www.tn.gov/.	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 134	22. Price

Acknowledgements

Information derived from surveys of Tennessee researchers, state Department of Transportation staff, and the literature review were utilized to inform both the development of the Innovation to Implementation Forum and the Peer Exchange. Institutional Review Board (IRB) approval was obtained at each member institution of the research team for all surveys. Special thanks go to all who participated in the surveys, the Forum, and the Peer Exchange to make this project possible.

A portion of the study data was collected and managed using REDCap electronic data capture tools hosted at Vanderbilt University.[1],[2] REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.

Executive Summary

The Tennessee Department of Transportation (TDOT) recognized the need to be at the forefront of utilizing technology and innovation for more efficient and effective transportation systems to meet the needs of the state. To address this need, a team of researchers representing multiple universities researched the current states of practice across Tennessee and beyond to identify best practices for both managing research programs and implementing research into practice.

The research approach included a literature review that included state Departments of Transportation (DOTs) Peer Exchange reports, online surveys of state DOT staff and researchers, a one-day forum where stakeholders learned more about TDOT's research program and best practices, and a 1.5-day Peer Exchange where several state DOTs were brought together to share information about how research programs address implementation. Approximately 90 individuals representing TDOT, the Federal Highway Administration, other state DOTs and institutions of higher education from across the state participated in the virtual one-day Innovation to Implementation Forum event. The Peer Exchange included representatives from nine state DOTs sharing information about their research programs in an effort to identify activities and processes that are most effective. The team also created a framework that included both a ranking of state DOT research programs based upon developed criteria and a database of expertise across the state of Tennessee to identify opportunities for additional research areas and additional academic partners.

The information gathered was synthesized into key findings and recommendations as described below.

Key Findings

The key findings that emerged from the literature review, surveys, and events (Innovation to Implementation Forum and Peer Exchange) are the following:

- TDOT is operating sufficiently in comparison to its peers in terms of research program management and administration; but there are opportunities for improvement.
  - o From the surveys of researchers and state DOT staff, the analysis of other state DOT websites as part of the framework, it is apparent that TDOT is performing similarly with many other state DOTs and well regarded by the research community.
  - o Key opportunities for improvement include improving transparency and communication, utilizing technical experts and others to help provide oversight/management of projects, and have clearly defined expectations for the research process, timelines, and deliverables.
- Successful research and implementation requires planning, communication, and ultimately financial resources.
- Successful research requires making available formal, consistent guidelines for all involved to follow (state DOT staff and project managers as well as researchers).

- Implementation should be considered from the beginning – even before funding a research project to ensure the project has real benefit to the state DOT as well as those performing the research.
- Improving a research program is a proactive process that requires gathering feedback from stakeholders (internal and external), can be iterative in nature, and requires a willingness to learn from others.
    - The surveys conducted (with the researchers and Tennessee DOT staff) provided a litmus test of how TDOT's research program is received and viewed by stakeholders.
    - The Forum allowed for sharing of both research that TDOT can leverage as well as showcased best practices.
    - At the Peer Exchange, many good ideas were shared as well as discussion about the benefits and processes of facilitating them.

Key Recommendations

Arising out of the many different activities of this report, the key recommendations for improved implementation of innovative research can be summarized as the following:

- Improve transparency throughout the process
    - Transparency is critical to success and building a relationship between researchers and the state DOT. There should be clear information available to all (researchers and state DOT staff) made available about when research can be proposed, the process (including review), awards, and expectations for reporting and deliverables. Many researchers and state DOT staff identified transparency and related issues as challenges to research success.
- Communication is critical
    - Internally to the state DOT, research staff, project managers (current or potential), and technical experts (if not the project manager) need to be engaged throughout the process of solicitation, review/evaluation, the project's undertaking, and even potentially through implementation. Research staff cannot be expected to know or understand the technical aspects of a project, nor can they truly facilitate implementation, yet, they provide the connection for finding researchers to help address the needs of others at the state DOT. Similarly, while projects may be funded using State Planning and Research funds, other fundings sources may be required for implementation. It is imperative that all state DOT staff involved in the project (administratively or technically) be on the same page to guide the researchers and lead to its success.
    - Researchers need to understand both the needs and expectations of the state DOT staff early on and if those change over the course of a project. Often, research is primarily about advancing the science and the needs of the state DOT, while similar in context may differ in terms of expected deliverables and implementation. Additionally, an understanding of the research process involved, which may include students engaged in the project and academic semester timelines and demands may need to be communicated to ensure expectations for deliverables are consistent.

- o Suggested activities for improved implementation include hosting a regular event such as the Innovation to Implementation Forum to bring researchers and state DOT staff together to share information about ongoing and innovative research, changes to the research program, and opportunities for collaboration. In the TDOT Forum, the poster session allowed state DOT staff to meet and learn about expertise across the state and the keynotes provided valuable information about TDOT's research program as well as identified best practices to consider.
- Implementation should be integrated throughout the process
  - o Throughout both the research, the Forum, and the Peer Exchange, this recommendation was repeated. Implementation must be considered as the research is being performed and not exist simply as an afterthought at the end of the project. This applies to both the research community and the state DOT. Researchers want to see their research utilized to benefit the customer and/or the community; however, lack of funding and consideration of "how" the findings would be implemented prevent this from happening. The state DOT does not want to expend funds for research that is not going to be utilized. Both the research community and the state DOT can benefit from considering implementation early and throughout the project.
- Continue proactively seeking out feedback from peers and researchers
  - o Information was shared at the Forum about the TDOT research program and improvements that are underway. Yet, there is opportunity to further improve the program by utilizing the information shared from the best practices findings from surveys and literature review as well as the Peer Exchange for further advancement. This is an evolving and iterative process where the stakeholders all have potential to benefit from improvements to aspects such as increased transparency and communication as well as integration of implementation considerations throughout the entire project lifecycle.

Table of Contents

List of Tables

List of Figures

Chapter 1 Introduction

Technology is changing rapidly in this world, especially with regards to transportation. The recent advancements associated with connected and autonomous vehicles, the Internet of Things, positive train control, unmanned aerial vehicles, and others have potential to significantly change transportation system design, operations, and management in Tennessee and beyond. Additionally, innovation and "out of the box" thinking is contributing to improved workflows and more efficient processes.

The Tennessee Department of Transportation (TDOT) recognizes the need to be at the forefront of utilizing technology and innovation to do more with less as budgets become tighter while embracing new approaches for transportation planning and infrastructure management. However, research historically supported by TDOT has only had limited opportunities for innovation. The collaborative team from Vanderbilt University (VU), the University of Memphis (UofM), and Tennessee State University (TSU) was retained by TDOT to help the organization prepare for the future through this project. Together, the universities researched the current states of practice across Tennessee and beyond where new, innovative approaches are being used to address transportation planning, design and operations activities; identified best practices for both managing research programs by other state Departments of Transportation (DOTs) and for integrating innovation into the research program/processes through online surveys, a review of state DOT websites, and a peer exchange; and facilitated sharing of information through a virtual forum.

The following chapters of this report present the research findings from the literature review and surveys, an overview of the "Innovation to Implementation Forum," a recap of the peer exchange and accompanying expertise from attending peer states, and key takeaways that can be utilized by TDOT and other state Departments of Transportation (DOTs) moving forward to improve implementation of innovative research.

Chapter 2 Literature Review of Best Practices for Research Implementation

2.1 Literature Review approach/methodology

As part of the planning process for the Innovation to Implementation Forum and Peer Exchange, a literature review was conducted to determine the state of practice for peer exchanges and to identify examples of successful research implementation efforts. Sixteen (16) recent peer exchange reports from various states were reviewed. All of the reports reviewed focused on AASHTO Peer Exchange Reports Topic 6: "Implementation, Deployment of Results, Technology Transfer" (Page n.d.), as this topic best reflected TDOT's vision for the Peer Exchange. Reports from the following states' peer exchanges were reviewed:

- Alabama, Arkansas, and Kentucky (2019)
- Wisconsin (2018)
- South Carolina (2018)
- Illinois (2017)
- Montana (2017)
- Ohio (2017)
- Utah (2016)
- Ohio (2015)

- Mississippi (2015)
- Georgia (2015)
- Idaho, Nevada, South Dakota, and Wyoming (2015)
- Oregon (2014)
- South Carolina (2014)
- Virginia and West Virginia (2014)
- Minnesota (2014)
- New Mexico (2013)

These peer exchange reports were searched for case studies of successful research implementation projects and effective research implementation initiatives/programs at the DOT level. Some states combined peer exchanges with neighboring states or states with similar research initiatives. As an example, in 2015, Idaho, Nevada, South Dakota, and Wyoming DOTs conducted a combined webinar-based peer exchange to save time and travel expenses. This format was viewed overall as a success, but presented challenges in that it lacked informal time, required more preparation and rehearsal time than in-person exchanges, and lacked the wide participation that an in-person exchange allows (Texas A&M Transportation Institute 2015).

Representatives from the host state usually included DOT research staff only. Most peer exchanges had 15 to 20 total participants, but the number of participants varied from 9 to 32. Peer exchanges typically divided their participants into a "panel," a "peer exchange team," and "other participants." Representatives from peer states were chosen based on proximity to the host state and/or reputation in the host state's focus area for the peer exchange. Universities and private research agencies were sometimes present, especially if the DOT brought them for assistance. For example, the University of Kentucky Transportation Center performs all research for the Kentucky DOT (ARDOT System Information and Research Division - Research Section 2019).

The general format for the peer exchange is for each agency to present its state of practice for research/implementation, followed by open discussions among all team members. Often, agencies give different presentations for predetermined focus areas (e.g., solicitation of research ideas, partnership with universities, performance measures, etc.). Peer exchanges often

concluded with a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis of the host state's research program. The report was usually written either during the peer exchange or shortly following the event.

Additionally, national reports on DOT research programs and specific research projects were reviewed to determine the state of practice and case studies of successful research implementation. These included both individual state and collaborative implementation efforts.

2.2 Case Studies

The following sections highlight states with exemplary research practices and projects that have led to successful implementation.

Virginia: A National Leader in Implementation
In July 2017, the Transportation Research Board (TRB) published an issue of its *TR News* magazine that focused on technology transfer successes. In this issue, the Virginia Transportation Research Council (VTRC) was highlighted for its leadership in implementation of research results (McGhee, Wright and White 2017). VTRC began as a partnership between the University of Virginia and the Virginia Department of Transportation (VDOT) and now serves as the research arm of VDOT.

What makes VTRC stand out as an implementation leader is the creation of a new position known as the "implementation coordinator" (McGhee, Wright and White 2017). This person serves as the implementation project manager and the liaison between researchers and field personnel. The implementation coordinator is an active member of the project team during the research phase from kickoff to closeout. This ensures implementation always remains feasible throughout the research project and that the implementation coordinator has a thorough understanding of the research conducted.

VDOT often deploys small pilot projects as the first phase of implementation, allowing problems to be resolved on a small scale before statewide implementation (McGhee, Wright and White 2017). This was the case for implementing an innovative hi-polymer asphalt—first on one street in a subdivision in Northern Virginia, now widely used across the state.

VTRC has identified three keys to successful implementation of research results. They are:

1. "Employ a coordinator with a broad knowledge of department operations and with network connections to potential change agents throughout the organization."
2. "Begin research with implementation in mind, ensuring that research projects add value to the department and that implementation is considered in all stages of the project."
3. "Recognize that implementation is a learning process." (McGhee, Wright and White 2017)

Nebraska's 5 Levels of Research Readiness
The Nebraska Department of Transportation (NDOT) categorizes research projects by a "Research Readiness Level" (RRL) (NDOT n.d.). These define the immediate next steps for a project to advance it towards widespread implementation. NDOT's five RRLs are:

1. Basic Research
2. Applied Research/Proof of Concept/Laboratory Level

3. Development Field Standard Practice Level
4. Implementation with Follow-Up
5. Standard Practice/Fully Understood

NDOT's website lists research projects in each of the five RLLs. This categorization process has enabled NDOT to strategically invest in projects with near-term readiness for implementation as well as to develop realistic goals and expectations for projects that are at lower levels of readiness.

State Transportation Innovation Councils

A State Transportation Innovation Council (STIC) is "a group of public and private transportation stakeholders that evaluates innovations and spearheads deployment statewide" (Harman 2017). STICs are comprised of federal, state, and local agency representatives, as well as university faculty and industry professionals. These collaborative groups implement innovations selected by the Federal Highway Administration's (FHWA's) Every Day Counts program, which selects about 12 new technologies that have been proven effective to be deployed nationwide. FHWA provides various resources to STICs to assist in incorporating this Every Day Counts innovations. The STIC projects provide excellent case studies for implementation best practice and lessons learned.

In 2016, FHWA began presenting the STIC Excellence Award to states that demonstrated exemplary performance in fostering cultures of innovation. The 2019 winners were (1) New Jersey for its innovations in unmanned aerial systems and collaboration with crowdsourcing apps, (2) Pennsylvania for its business practices, and (3) Washington for its research involving hydraulics and wildlife (Federal Highway Administration 2019). Past winners include Colorado, Delaware, Texas, Wisconsin, Kentucky, Massachusetts, and Vermont.

There are other states with notable STIC programs. New York is known to combine several innovations into one project. For example, the Tappan Zee Bridge replacement incorporated 7 Every Day Counts innovations and 3 Strategic Highway Research Program 2 products (Harman 2017). Florida and Michigan are known for e-construction innovations, using mobile devices in lieu of paper to save time and money (Harman 2017). Idaho has used FHWA STIC incentive funds to develop design standards for geosynthetic-reinforced, soil-integrated bridge system construction (Harman 2017).

Case Study: Eight-State Truck Parking Project

In 2018, DOTs from Indiana, Iowa, Kentucky, Michigan, Minnesota, Ohio, Wisconsin, and Kansas (lead) collaborated to implement a Regional Truck Parking Information Management System (TPIMS) (Moore, et al. 2018). The white paper summarized four key lessons learned in the implementation process. They were:

1. Focus on Outcomes—each DOT should focus discussions around "end-user benefits rather than agency custom" (Moore, et al. 2018).
2. Link Goals and Performance—decisions on which technologies to include should be made based on predetermined goals to keep the project focused.
3. Communicate Early and Often—keep all team members informed on major decisions and have monthly project team meetings.
4. Define Roles Clearly—make sure all team members know their roles to avoid confusion.

Case Study: Indiana's DamageWise Program

In 2009, Indiana DOT recognized the need for a better way to pay for damaged roadway infrastructure, such as signs, guardrails, and bridges. The agency partnered with Purdue University to examine the existing process for replacing damaged infrastructure. The research team proposed a new way to pay for the damage by billing the parties responsible for it, a system known as DamageWise (Brassard, Horton and Bullock 2019). To implement this strategy, Indiana DOT formed a DamageWise team, started a training and outreach program for law enforcement officers, developed software for tracking damage and recovering costs, coordinated with Indiana State Police (ISP) to make sure the new software would integrate with ISP's State Crash Report System, and assigned district DOT employees to oversee implementation in their respective districts (Brassard, Horton and Bullock 2019). The new system yielded a benefit-cost ratio of 6.4 in Fiscal Year 2018, and funds obtained through DamageWise now provides for 81% of all roadway damage repair costs.

These examples showcase successful approaches to implementation which involved partnerships with universities and/or other state DOTs. Implementation has been shown in many of these examples to be financially beneficial and improve efficiencies in processes.

Key takeaways form these states and case studies are:

- A designated position, such as an Implementation Coordinator, increases likelihood of translation of research to practice
- Be flexible and expect to iterate on implementation strategies
- Identify projects with the most potential for implementation through a Research Readiness Level assessment
- Research projects should start from the outset with implementation in mind
- Clearly define roles and expectations between research team and DOT staff
- Communication is key - early and often!

2.3 Literature Review Findings

The following best practices for state DOT research programs were identified:

- Utilize focus groups and expert panels to vet and refine research problem statements.
- Align research categories and project topics with the organization's strategic plan to create the most valuable research program for the DOT.
- Prioritize research with near-term outcomes.
- Create set-aside, flexible funds to allow quick movement on urgent, high-priority research needs.
- Create a transparent and accountable selection process (for both internal and external stakeholders).
- Develop a comprehensive communication plan that emphasizes the value of research projects (with specific outcomes) for the DOT, and "tells the story" of the project.
- Consider requiring multiple deliverables targeted to different stakeholders.
- Develop a tracking system that documents projects from start to finish and identifies both outputs and outcomes.
- Leverage completed research for professional development opportunities.

Regarding implementation, the following best practices were identified:

- Develop a robust agency-wide research implementation plan that integrates research strategy, a communication plan, and tracking.
- Planning for implementation must begin with project conceptualization and be included at all stages.
- Form technical advisory committees for high risk/reward projects. Consider steering committees for all projects (that include the implementer).
- Require project-level implementation plans upon research completion (including connections to additional resources, funding, etc.).
- Partner with industry to review implementation plans, specifications, and schedules to ensure they are viable.
- Recognize that implementation requires as much (or more!) resources than the research itself and plan accordingly.
- Create a follow-up process after research ends to hold staff accountable for implementation, such as implementation reviews/assessments.
- Consider an implementation manager within the research office.
- Develop an implementation tracking database - and make this accessible to broad range of stakeholders.

Chapter 3 State DOT Survey

3.1 Background

To better understand how state DOTs are approaching innovation, managing research programs and projects, and working toward implementation, online surveys were disseminated via email to state DOT personnel across the US. Participants were identified using online searches as being leaders among research offices at his/her respective DOT and/or from the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee (RAC) list (AASHTO, n.d.). The survey instrument is provided in Appendix A. The surveys resulted in 84 respondents. Twenty-six of the respondents identified as being from TDOT and 26 of the respondents were from other state DOTs. The remaining respondents did not provide information about their DOT affiliation. The responses were analyzed together collectively and then the responses indicating that they were TDOT personnel were analyzed to provide information about TDOT's research process.

A more detailed analysis of the State DOT Survey results is included in Appendix B, but key findings are presented below. The analysis provided below focuses solely on responses from TDOT personnel, which were predominantly comprised of individuals in the research office or division leaders. In the Appendix, answers from members of other DOTs were compared with those from TDOT personnel to assess specific strengths and growth points for TDOT.

3.2 Approach

The online survey instrument was developed by the research team and administered using both Qualtrics and Vanderbilt's RedCAP survey platforms. Internal Review Board (IRB) approval was obtained at all of the research team institutions prior to survey distribution. RedCAP was the original platform set up, but because it was blocked by firewalls for many state DOT personnel (including those at TDOT), a duplicate survey was created within hours and a new link to the Qualtrics survey was distributed.

Respondents were asked to respond to a series of questions about research procedures at their state DOT. Including yes/no questions, check-all-that-apply, and multiple-choice. Questions were analyzed by looking at the percentage of times each answer choice was picked. Fill in the blank questions were analyzed by coding text responses into specific categories. Some of the analysis includes sample quotes from respondents to provide greater insight into feedback.

Unless otherwise noted, responses were analyzed based on completed answers only. Certain questions received fewer responses than others. This can happen when individuals participating are interrupted or quit the survey for any number of reasons. Questions asking for elaboration based on choosing 'other' for multiple choice style questions were more frequently left blank than other types of questions.

3.3 General Survey Results

Results from the survey analysis were grouped into five distinct themes:

- Pre-Project and Proposal Review Process
- Communication During Project

- Implementation
- Collaboration with Colleges and Universities
- Future Research Opportunities

Pre-Project and Proposal Review Process

Evaluation of Proposals

Survey respondents were asked to describe the process for evaluating proposals in their own words. TDOT respondents heavily mentioned scoring in their answer choices, with 71% of TDOT respondents mentioning scoring themes. Zero of the TDOT respondents indicated evaluating implementation possibilities.

Respondents were asked if the proposal evaluation and review process is transparent. Figure 3-1 and Figure 3-2 show how TDOT respondents answered proposal review questions. Thirty-nine percent of TDOT respondents indicated the process is not transparent, and 61% indicated the process is transparent. Eighty-three percent of TDOT respondents said the proposal review and ranking is the same across departments/divisions. Survey respondents were also asked how funding is distributed within and/or across different disciplines. Sixty percent of TDOT respondents indicated that they do not know how funding is distributed. It should be noted that this might also be the case for other types of funding and may not be specific to the Research Office.
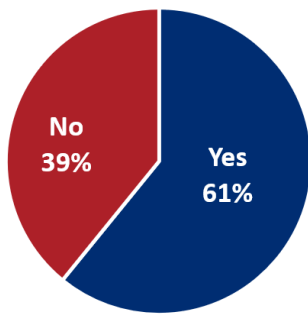
Figure 3-1 Is the proposal evaluation and review process transparent?
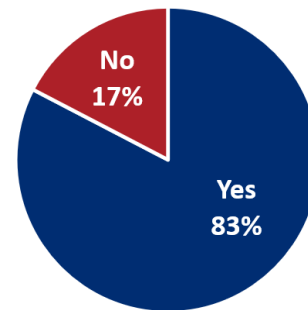
Figure 3-2 Is the proposal review and ranking the same across departments?

Primary Findings
- Lack of transparency in the proposal evaluation and review process
- Lack of knowledge on the distribution of funding across different disciplines

Communication During Project

Oversight Committee, Panel, or Person

Respondents were asked if there is a need for an oversight committee or panel for each funded project. This question was posed as a fill-in-the-blank style question and respondents were also asked to explain what their assigned duties or roles would be in the oversight of the project. Responses to this question are shown below in Figure 3-3. Fifty percent of TDOT respondents indicated they do not think there is a need for an oversight committee or panel, 35% indicated they do think there is a need for an oversight committee or panel, and 15% indicated that there may be a need for an oversight committee or panel.

Respondents were asked if there is a need to have one DOT research staff member serve as the liaison/project manager to work directly with Principal Investigators (PIs) to make sure all their questions are answered, deadlines are met, and regular touchpoints are set up. Responses to this question are shown below in Figure 3-4. Fifty-seven percent of TDOT respondents said there is a need for this role, 24% said there is not, and 19% said maybe or in some cases.

Respondents were also asked if they felt they were on the same page as researchers during the project. Responses to this question are shown in Figure 3-4. Twenty-six percent of respondents said no and 74% said yes.
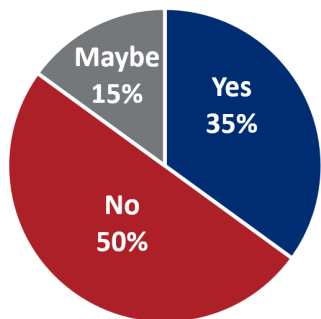
Figure 3-3 Is there a need to have an oversight committee/panel for each funded project?
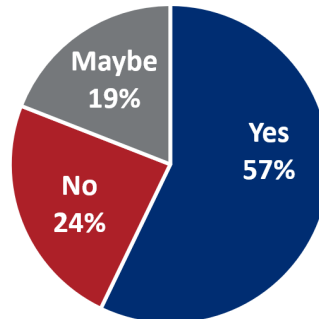
Figure 3-4 Do you feel there is a need to have one DOT research staff member serve as the liaison/project manager to work directly with PIs?

Respondents from other DOTs indicated roles and duties of oversight committees and mentioned the following tasks:

Advising the project

- Eliminating any barriers
- Redirecting research if necessary
- Identifying implementation opportunities

Respondents mentioned the following reasons to have someone from DOT research staff as a liaison or project manager for each project:

- Protecting project scope and schedule
- Helping technical leads answer non-technical questions about the project
- Addressing administrative/contractual requirements

Survey respondents were also provided a fill-in-the-blank question asking who oversees/manages the research project from the state DOT side and who reviews the progress reports and/or the final report. Responses to the question about who should manage the project were varied with some suggesting having someone with technical expertise involved in project oversight, others specifically mentioned the research office or long-range planning division with no mention of including someone with specific technical expertise. Responses about who reviews the reports indicated that someone from both the relevant department and members of the research office review the progress reports and final reports.

- The majority of respondents indicated that there is not a need for an oversight committee, but there exists a need for a role, such as a research project manager to help with administrative/contractual requirements, protect scope and schedule, and answer non-technical questions about the project

Implementation

Survey respondents were asked if there are procedures in place for state DOT or the researchers to implement or further publish results of the project after the final report has been submitted. Fifty-eight percent of TDOT respondents said no, and 42% of respondents said yes.

Respondents were also asked what is done with final reports after they have been accepted. Nineteen percent of TDOT respondents said results were implemented, 38% said they do not know what happens to reports, and 43% said results were internally distributed or published. Answer category percentages do not add up to 100% because some fill-in-the-blank answers were coded into multiple categories.

Respondents were also asked how they learn about the latest state-of-the-art in their field or area of expertise. Figure 3-8 shows how respondents answered this question, respondents were able to select all that apply. Ninety-one percent of TDOT respondents indicated they learn about the latest in their field by participating in discipline-specific conferences/workshops.
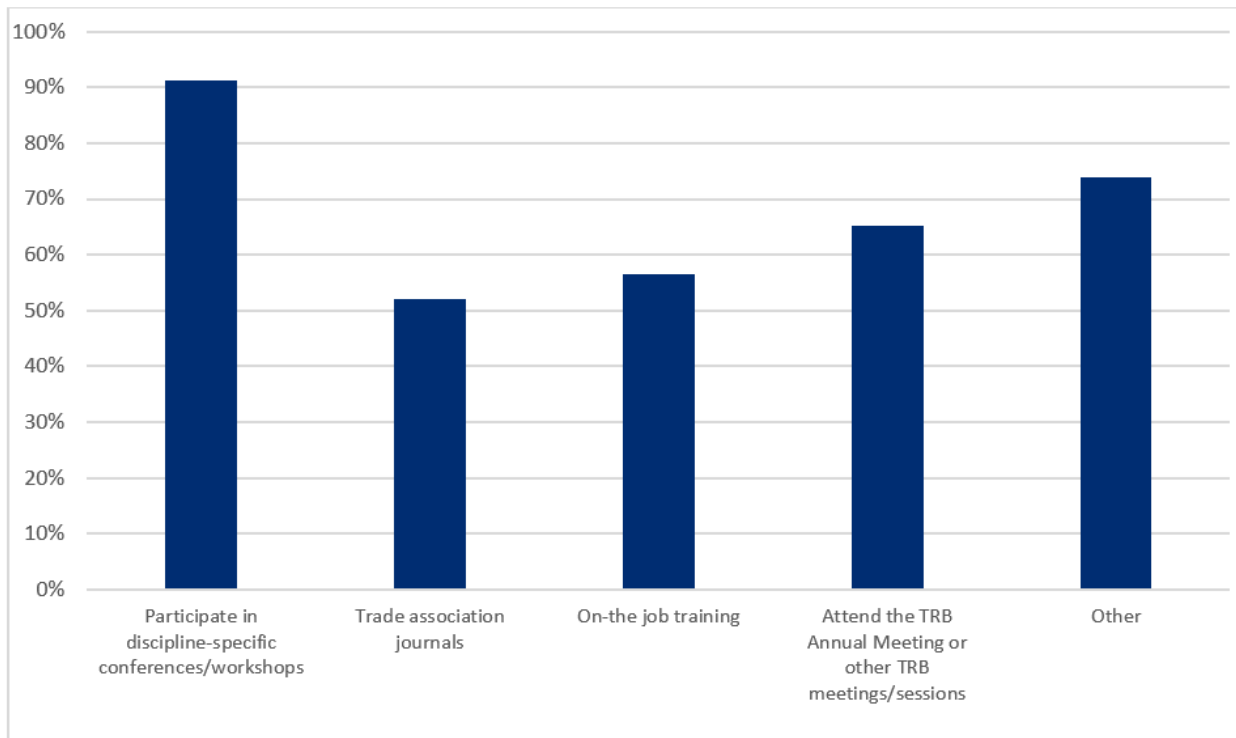
Figure 3-5 How do you learn about the latest state-of-the-art in your field or area of expertise?

The most common responses about the other ways respondents learned about the latest state-of-the-art in their field or area of expertise explained themes of networking, conferences, or communicating with peers directly.

Linkage Between Research Results and Implementation

Respondents were asked whether researchers understand the linkage between research results and implementation. As shown in Figure 3-6, DOT respondents generally agree that yes, researchers understand the linkage between research results and implementation.

Respondents were also asked if there are procedures in place for state DOT or the researchers to implement or further publish results of the project after the final report has been submitted and approved. Figure 3-7 shows responses to this question showing from left to right total responses, TDOT responses, and other DOT responses. Seventy-five percent (75%) of respondents from other DOTs agreed that there are procedures in place for further implementation, and forty-two percent (42%) of TDOT respondents agreed.
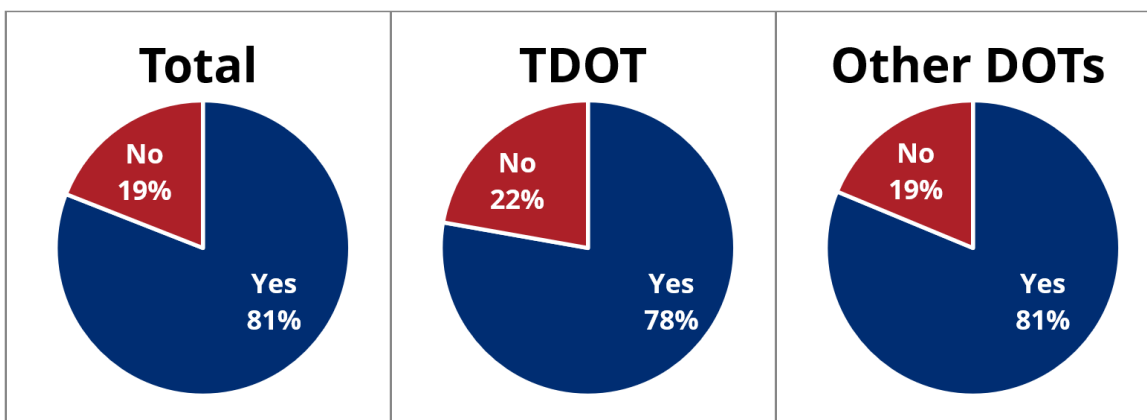
Figure 3-6 Did the researchers understand the linkage between research results and implementation?
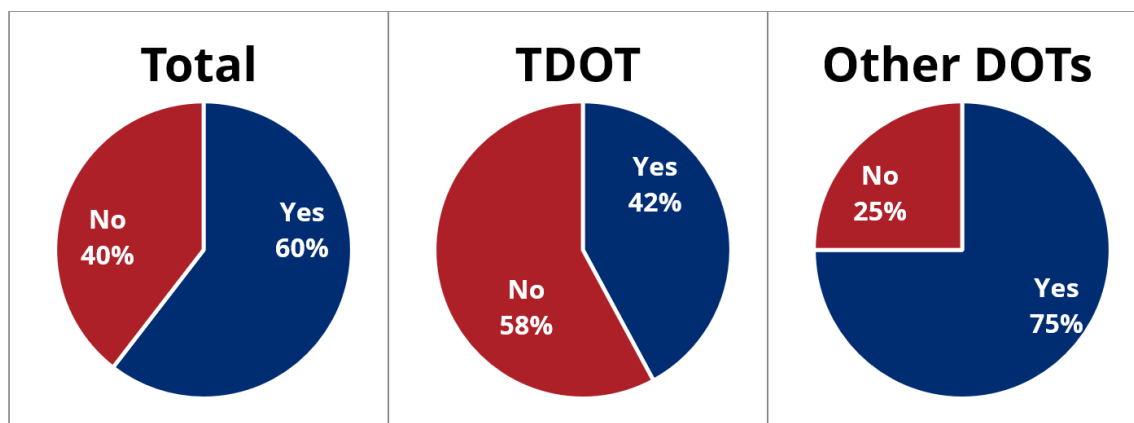
Figure 3-7 Are there procedures in place for state DOT or the researchers to implement or further publish results of the project after the final report has been submitted and approved?

Respondents were also asked what is done with final reports after they have been accepted. The fill-in-the-blank answers were broken into the categories shown in Figure B-10. Respondents from other DOTs more frequently specifically mentioned submitting the reports to national databases.

Primary Findings
- Approximately half of the respondents indicated there is not a manner for producing results following the publishing process.
- Almost all respondents indicated that they learn about new and innovative procedures at conferences or workshops.

Collaboration with Colleges and Universities

Survey respondents were asked to rate their personal interest level in partnering with universities from 0-100. Sixty-five percent of TDOT respondents ranked their interest level as greater than 75.

Respondents were also asked via a fill-in-the-blank question whether they have experienced or are aware of barriers to successful research collaboration with universities. Forty-eight percent of TDOT respondents indicated that they were aware of barriers to successful research collaborations with universities. Figure 3-8 shows how TDOT respondents answered the question, and common barriers respondents mentioned in their answers. Timeline, budget, and differing priorities were the most commonly mentioned barriers to successful research collaboration.
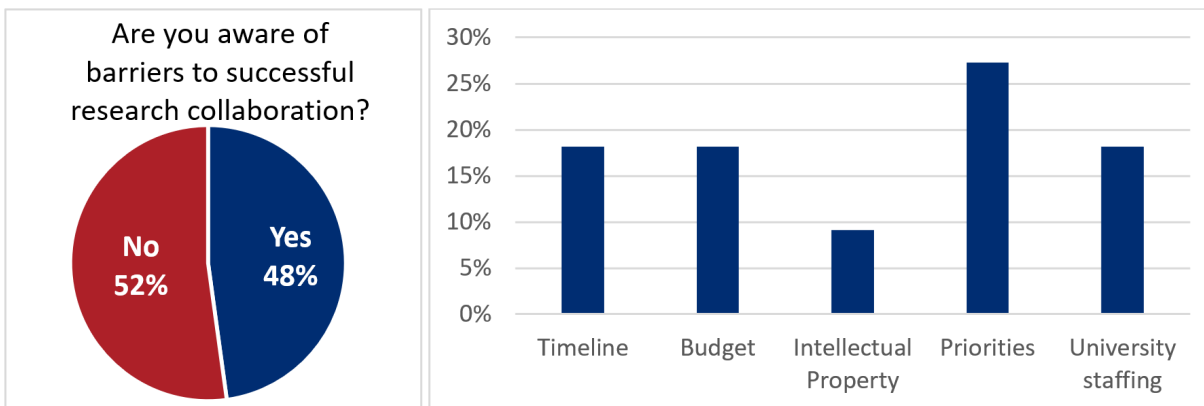
Figure 3-8 TDOT Awareness of Barriers to Successful Research Collaboration and Barriers

Survey respondents were asked if they have any recommendations on how TDOT or other State DOTs could increase and/or improve collaborations with universities.

Answer Themes:

1. Develop relationships between DOT employees and university faculty
2. Conduct meetings to brainstorm research ideas
3. Match project funding decisions with university calendars
4. Simplify the process
5. Create a standard written process for how research is conducted and increase consistency year-to-year

Future Research Opportunities

Survey respondents were asked which innovation areas should be prioritized moving forward. Respondents could check multiple boxes of which areas to prioritize. Among TDOT respondents, the top five innovation areas to prioritize were connected/autonomous vehicles, structural monitoring of bridges, improved pavement designs, LIDAR, and innovative research in pavement evaluation.

3.4 Key Takeaways

After survey responses were analyzed, several best practices emerged for successful research and implementation as summarized below.

- Prioritize communication at every step of the project
- Increase transparency about the research process
- Implement formal, consistent guidelines for all involved to follow (state DOT staff and project managers as well as researchers)
- Assess implementation from the outset

Chapter 4 Researcher Survey

4.1 Background

In planning for the event, a survey of research professors in Tennessee was conducted to gauge researcher perceptions of TDOT's research program. The survey addressed the topics of proposal evaluation and selection, communication during the research process, and implementation of research results. Researchers were given the opportunity to provide suggestions for improving TDOT's research program.

4.2 Approach

The survey provided to respondents is attached in Appendix C. The survey of state DOTs was designed alongside the survey of Tennessee researchers to allow comparison between the two. Several questions were nearly identical to allow the research team to compare researcher sentiments with TDOT research staff perceptions of the state's research program. A detailed report of the survey findings can be found in Appendix D.

Survey responses were anonymous. The only identifiable information collected was the name of the university that employs each respondent. This information was only used to ensure a representative sample across Tennessee was obtained and was not used in analysis except when searching for predictors of future interest in TDOT's research program.

Because the survey instrument included many free response questions, much of the collected data was textual. Due to the rather small sample size (38), no advanced natural language processing was performed. Rather, free response data were anonymized and read in their entirety to search for common themes. All free response questions were analyzed independent of all other survey questions. That is, there was no cross check to ascertain if specific respondents were overwhelmingly negative or positive. Numerical or categorical response data were analyzed using basic descriptive statistics and visualizations.

4.3 Results

The survey drew a representative sample of Tennessee researchers with 38 respondents representing 8 universities across Tennessee and 30 areas of expertise. Appendix D provides additional results from the researcher survey.

The researchers were asked to indicate the extent of their involvement in TDOT's research program. Of the 38 respondents, 24 had submitted research ideas, 18 had had research proposals rejected, 22 have conducted research for TDOT in the past, and 1 was unaware of research opportunities. Participants were also asked if they had performed research for other state DOTs (Table 4-1). Most survey respondents (20) have only worked with TDOT.

TABLE **4-1:** INVOLVEMENT WITH OTHER STATE **DOTS**

Have you worked with other state DOTs?	
Two	6
Three	3
Four	1
Blank	8
Just TDOT	20

Research Proposal and Award Process

Survey respondents were asked to select from a list one way they found out about research opportunities with TDOT. Table 4-2 summarizes the results from this question.

TABLE **4-2** NOTIFICATION OF RESEARCH OPPORTUNITIES

How did you find out about the research opportunity?	Total
Email from state DOT	20
State DOT website	1
Colleague or friend at your university or another university	6
Other	1

The results show that email is by far the most effective way to notify researchers of opportunities, and the TDOT website is the least effective.

The respondents were asked to provide recommendations for improving the proposal submission and review process. The most common recommendation was to have increased feedback and communication. Twelve respondents mentioned this. Other recommendations included:

- Shorter timeline for proposal process (3)
- Transparency in the evaluation process (2)
- Blind evaluation process (3)
- Increased communication between RFP and submission (2)
- Consistent annual timeline (4)
- Addition of target funding amounts (1)

There were competing ideas about who should submit research ideas and who should be awarded projects using those research ideas. One respondent said the one who submits an idea should automatically be awarded the project if TDOT chooses to go forward; another said this already happens and is a problem.

Communication During Project

Participants were asked a series of questions regarding communication with TDOT during the research project. Responses in this section were generally positive. When asked, 17 respondents said they felt like they were on the same page as the PM, and 17 said they have received adequate feedback and direction during the project.

When asked if there were any hindrances to conducting research, respondents mentioned funding/contract delays research (5), vague report requirements (1), poor communication (2), and issues with FHWA involvement (1). One respondent also mentioned that there is no benefit to the TDOT employee on the project.

Deliverables usually included reports to state DOT/FHWA and/or conference presentations. Most (17) projects include multiple deliverables, and 12 survey participants reported projects involving all three.

TABLE 4-3 TYPES OF DELIVERABLES FROM RESEARCH PROJECTS

Outcomes/Deliverables	Total
Report(s) to state DOT/FHWA	18
Peer reviewed journal article(s)	13
Conference presentation(s)	17
Other	3

Implementation

The next section of the survey focuses on implementation of research results. Overall, research projects conducted by the survey respondents have not been implemented to the knowledge of the respondents. Table 4-4 shows the responses to the question "Do you know if any of your findings/results have been implemented by the state DOT sponsor or others into day-to-day practices?"

TABLE 4-4 IMPLEMENTATION OF RESEARCH RESULTS

Is your research being implemented?	
Blank	21
No	7
Unsure	6
Yes	4
Total	**38**

There were separate questions on the survey asking if the TDOT project manager (PM) understood the link between research and implementation and if there was an implementation plan in place for the research. There is evidently a breakdown somewhere in the implementation process. Seventeen respondents said that the state PM at least sometimes understands the link between research results and implementation, yet only 9 said there was an implementation plan in place. Moreover, of the 9 who said there was an implementation plan in place, only 2 have seen successful implementation. This is summarized in Figure 4-1 and detailed in Table 4-5.

THE IMPLEMENTATION PROCESS
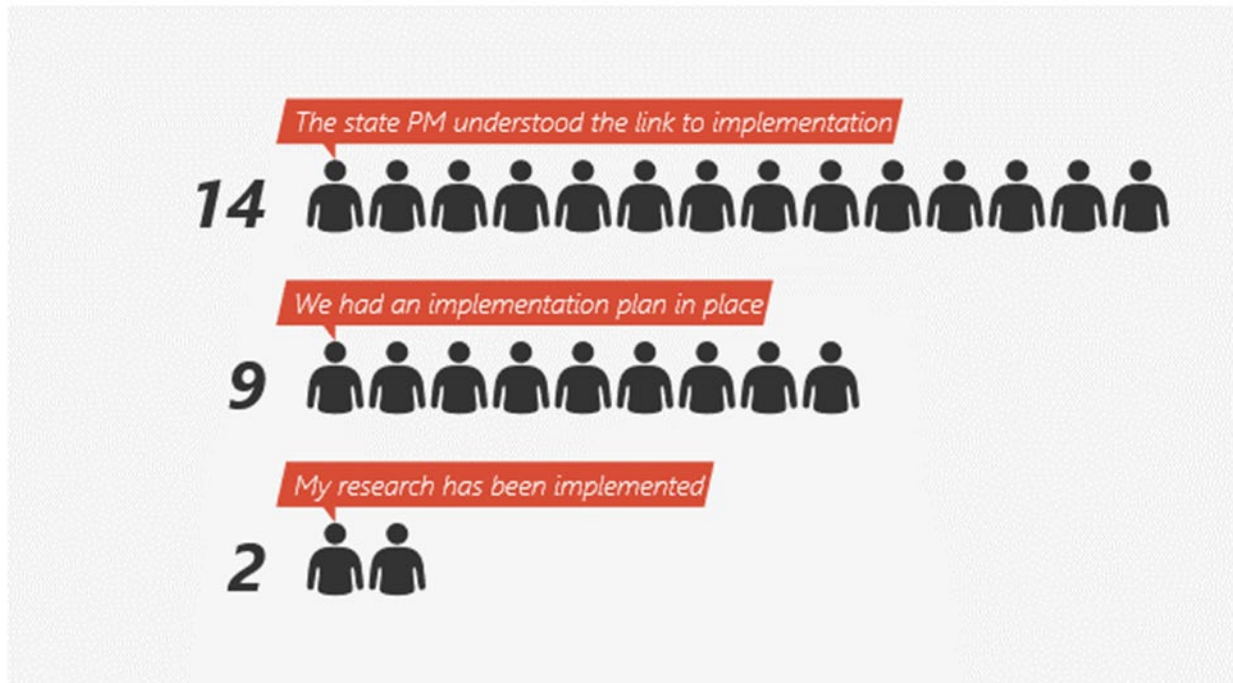
Figure 4-1 Breakdown in the Research Implementation Process

The survey also asked the researchers to select from a list which TDOT division(s) they thought could benefit from research (with considerations for implementation). Respondents noted that the following TDOT divisions could benefit from research:

TABLE 4-5 TDOT DIVISIONS THAT COULD BENEFIT FROM RESEARCH

Division	Count
Planning	17
Materials, pavement, etc.	15
Environmental	15
Traffic Operations	14
Maintenance	14
Safety	12
Structures	12
Construction	11
Information Technology	11
Geotech	9
Hydraulics and Hydrology	7
Human Resources	7
Aeronautics	5
Other	4

Other divisions mentioned were geospatial mapping, economics, and public involvement and/or civic engagement.

Survey participants were asked to provide other potential innovation areas aside from the ones provided above. The following were mentioned (each only once):

- Making urban areas less auto-centric, support emerging technology
- Fiber reinforced composites in structures, etc.
- Natural hazards
- Artificial intelligence (AI) image processing
- Controlled low-strength materials (CLSMs)
- Connected and autonomous vehicles (CAVs)
- American with Disabilities Act (ADA)

When asked how to improve collaborations, responses included the following:

- Schedule consistency and improvement (5)
- Incentives, especially for regional universities (2)
- Allow/designate new professors to work on collaborative projects (1)
- Include DOT staff on the research team (3)
- Collaborate during the idea phase (2)
- Favor collaborative proposals (3)
- Understand and trust university research faculty (3)
- Increase funding (2)

When asked how to improve implementation, responses included the following:

- Make it a specific deliverable (3)
- Dedicate post-research funding for training, etc. (3)
- Internal review process for implementation results (1)
- Favor proposals with explicit implementation components (1)
- Inform researchers of real-world problems (1)
- Get buy-in from TDOT leadership, employees, and local contractors (3)
- Communicate expectations with the PI (1)

4.4 Key Findings and Recommendations

The following themes emerged from the survey results. According to Tennessee researchers:

1. The current process of evaluating and selecting research proposals is not transparent enough, mostly due to a lack of feedback and communication.
2. Once awarded the project, communication with TDOT staff is good throughout the project's life.
3. Research results are typically not being implemented, even if implementation was kept in view throughout the project.
4. A consistent annual timeline for research proposals would be helpful as researchers lean heavily on graduate students who are constrained to academic calendars.

Based on the survey results, the research team recommends the following for TDOT's research program:

1. Increase transparency throughout the process
2. Focus on implementation at every step of a project
3. Ensure consistent execution of research processes
4. Become familiar with research expertise in the state, and create a process to update this information
5. Implement oversight committees and panels with clearly defined roles and responsibilities

Chapter 5 Framework

5.1 Overview

To develop a framework for research program management and considerations of capabilities that could be leveraged from across the state of Tennessee, two distinct activities were undertaken. The first was to develop a set of criteria and evaluate state DOTs from across the US to learn what aspects of research programs existed that may lead to successful research and implementation. The second was to identify and compile a listing of researchers from across the state with their expertise. This was to be developed into a resource for TDOT to utilize in consideration of areas for research that may not yet be utilized and also to ensure that opportunities for research contributions to TDOT could be communicated and potentially realized. In the sections that follow, the analysis of state DOT research programs is described along with the findings as well as the approach to compile an up-to-date, inclusive representation of researcher expertise from across Tennessee.

5.2 State DOTs Research Program Analysis

A key consideration of the project in addition to the survey work was to independently assess the research and implementation processes of State DOTs as a resource for TDOT. This was done using only what is visible or accessible from state DOTs website(s) because that is what is typically available to researchers and the public as the outward facing showcase of the research program. Practices at specific DOTs may be practiced differently in-person. There are limitations to this approach given that all state DOTs do not conduct research in-house. Various DOTs employ other methods, such as an external institution.

The team reviewed resources easily accessible by each state DOT and created a list of common and beneficial components from the websites that provided relevant information pertaining to the DOTs' research and implementation process. The evaluation resulted in 11 individual categories which are provided in Table 5-1 and a description of each category is provided in the section that follows. The project team used a binary code system where 1 point was given if the DOT had the category accessible on the website and 0 was given if it did not have the category accessible. Using this system, the team developed four tiers of rank where each state would be categorized against the others. The tiers consisted of Tier 1: 9-11 pts; Tier 2: 6-8 pts; Tier 3: 3-5 pts; Tier 4: 0-2 pts. All 50 states were evaluated using this binary system and placed in a tier based upon the points achieved.

TABLE 5-1 CATEGORIES USED TO EVALUATE STATE DOT RESEARCH PROCESS TRANSPARENCY

Categories
1. State Research Center
2. State Transportation Conference, Summit and/or Forum
3. Research Manual
4. Current Research List
5. Research Needs or Specific RFP's
6. Proposal and Documentation Forms and Information
7. Access to Past Research, Publications and Research Reports
8. Clear Display of Grant Funding and/or Pooled Funding Information
9. Implementation Information/ Implementation Efforts
10. Cooperative Research, Peer Exchange
11. Physical DOT Library

Description of Categories

This section describes each of the 11 categories identified in more detail. It is valuable to note that the final data from this review was acquired in Fall of 2020. Some DOTs may have added or implemented programs/policies after the review was conducted, in which case the data presented here will not reflect those changes. For some categories, a state DOT was given credit if it mentioned or provided contact information for an individual being responsible for the area at the DOT, even if the DOT did not provide more content towards the category. As an example, some DOTs did not specify projects that have been implemented or implementation practices, but they did have a section dedicated to the area and specified who to contact to obtain more information.

State Research Center
A State Research Center is a listed research center that oversees the DOTs research program. This center's responsibilities include but are not limited to contacting universities and other research providers, conducting research in areas of transportation, and coordinating funding for state and/or national research.

State Transportation Conference, Summit and/or Forum
State Transportation Conference, Summit and/or Forum refers to a conference organized by the DOT, universities, or other transit associations which explore the latest transportation innovations, research, peer exchanges and networking opportunities. This category is satisfied only if it is an individual state effort, not a group conference such as the Tri-State Conference.

Research Manual
This category is defined based on the accessibility to the research manual designed by the state DOT. While this may seem common, not all DOTs have a research manual publicly available.

Research List
In this category, DOTs that provide the lists of current research that has been awarded by the state, is given a point.

Research Needs or Specific RFPs

This category refers to DOTs that provide a list of what research areas are essential to the DOT currently. Some states provide "Request for proposals (RFPs)," this is considered a method that can be used to express the DOT's research needs, which is why it is counted under this category.

Proposal and Documentation Forms and Information

In this category, the access to research proposal forms, guides, and/or documentation procedures is reviewed. The visibility of these documents can be resourceful to researchers in preparation of proposals, during research projects, and after the completion of projects.

Access to Past Research, Publications and Research Reports

This category looks to see if DOTs provided access to past research and reports. It also includes states that provide access to publications that resulted from the research conducted by the researchers.

Clear Display of Grant Funding and/or Pooled Funding Information

If a state DOTs website provided evidence and information of grant funding resources or pooled funding information, the state was awarded a point. The website may or may not include the process for these funding sources but at least the necessary documents or components are provided.

Implementation Information/ Implementation Efforts

The DOTs website was reviewed to see if any information pertaining to the states implementation practices or efforts was accessible. Some states provided implementation reports of research products that have been implemented across the state and the results of the implementation or they provide an implementation plan. The DOTs that provide contact information for the person over implementation are included in this category.

Cooperative Research/ Peer exchange

Information on the collaboration efforts of the DOT and/or its peer exchange efforts is considered in this category.

Physical DOT Library

Access to information on the State DOT Library, which provides access to publicly funded transportation research results is under this category. Different from category 7 because this category considers if the DOT has a physical address of the library where documentation is stored.

Results of the Review

Using the categories provided above and assessing all 50 states, the team found the conclusions provided in this section.

Evaluation of the Categories per State DOTs

Table 5-2 provides the summary of the results for the review in terms of the number of states were provided points for each category. These results are summarized below.

TABLE 5-2 SUMMARY OF RESULTS FROM STATE DOT REVIEW

Categories	Number of State DOTs in Category
State Research Center	17
State Transportation Conference, Summit and/or Forum	42
Research Manual	33
Current Research List	45
Research Needs or Specific RFP's	8
Proposal and Documentation Forms and Information	34
Access to Past Research, Publications and Research Reports	49
Clear Display of Grant Funding and/or Pooled Funding Information	29
Implementation Information/ Implementation Efforts	21
Cooperative Research, Peer Exchange	27
Physical DOT Library	37

- Over 80% of the States have:
  - State Transportation Conference, Summit, or Forum
  - Current Research List
  - Access to Past Research Publications and Research Reports
- Over 50% of the States have:
  - Physical DOT Library
  - Proposal and Documentation Forms and Information
  - Research Manual
  - Grant, Funding and/or Pooled Funding Information
  - Cooperative Research and/or Peer Exchange
- Less than 50% of the States have:
  - Implementation Information/Implementation Efforts
  - State Research Center
  - Research Needs or Specific RFPs

Evaluation of State DOTs per Tiers
The review resulted with 20% (10) of the states being in Tier 1, 60% (30) of states being in Tier 2, 18% (9) of states in Tier 3, and 2% (1) of state being in Tier 4. Figure 5-1 provides a depiction of the information provided and Figure 5-2 provides a visual of the Tier 1 states and the regional location. Each tier represents the following point ranges:

- Tier 1: 9-11 points
- Tier 2: 6-8 points
- Tier 3: 3-5 points
- Tier 4: 0-2 points
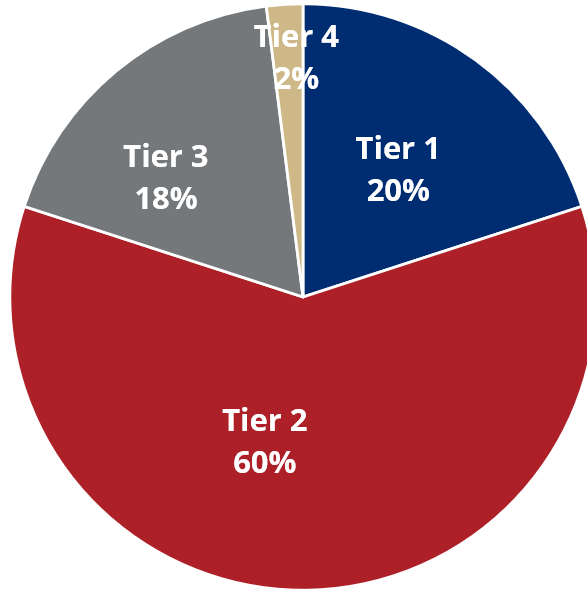
Figure 5-1 Evaluation of State DOTs per Tiers
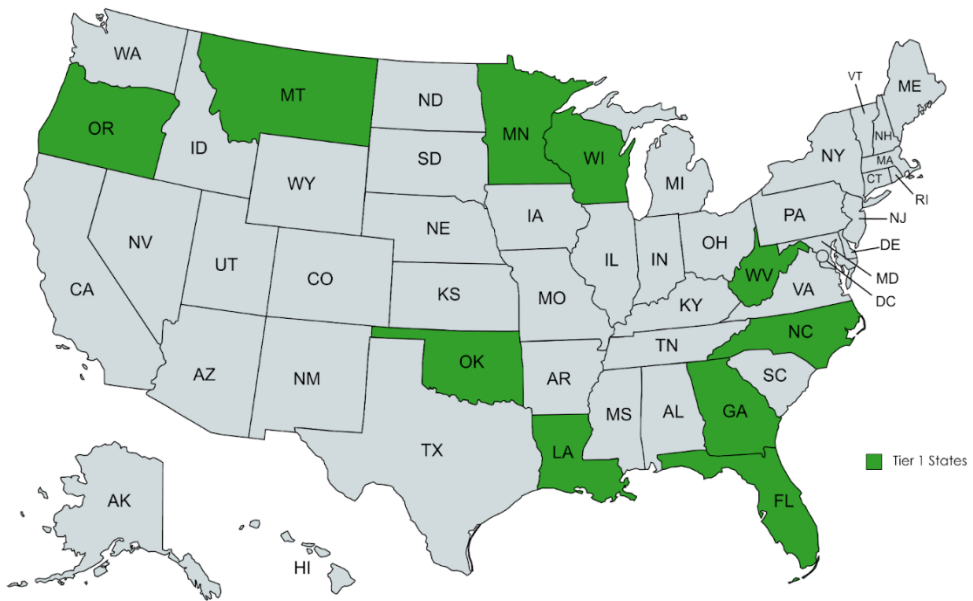
Figure 5-2 Tier 1 State DOTs

- 100% of Tier-1 States have:
    - A State Transportation Conference, Research Summit or Forums
    - Proposal and Documentation Forms and Information
    - Access to Past Research, Publications, and Research Reports
    - Implementation Information/Implementation Efforts
    - Cooperative Research, Peer Exchange
    - Physical DOT Library
- 80% of Tier-1 States have:
    - A Research Manual
    - Current Research List
    - Clear Display of Grant Funding and/or Pooled Funding Information
- 50% Have State Research Centers
- 30% Specify Research Needs or Specific RFPs were posted when this evaluation was completed

5.3 TN Researcher Capabilities and Expertise

As part of the considerations for the framework and recommendations for TDOT, the research team sought to create somewhat of a database of research expertise from across the state. This had two purposes: (1) provide a current resource for TDOT staff for research-related announcements and (2) explore areas for research where Tennessee has expertise that may not be tapped into by TDOT to date.

To accomplish this, the research team obtained a listing from TDOT of prior PIs or co-PIs that had proposed projects through the Long Range Planning Research Office whether those proposals were successful or not. The research team worked to identify current email addresses and university affiliation for all on that list. Some individuals had moved out of the state, passed away, or were not at universities (e.g., non-profits, private industry, municipalities, etc.). Those were removed from the list. Secondly, the research team identified key research area themes from prior TDOT Research Needs Statements, TRB Committees and Annual Meeting Topics, and other transportation-centered solicitations for research through various programs/announcements such as those from the National Cooperative Highway Research Program (NCHRP). Using this information, the team developed themes or topic areas to use as part of the database.

The research team then perused websites for institutions of higher education from across the state (public and private) to validate faculty information from the list that TDOT provided and also identify other faculty members in similar departments that may have expertise or interest in transportation-related research. TDOT staff emphasized that they were also interested in opportunities for research beyond "typical" transportation activities, so the search was expanded to related areas such as leadership, planning, environmental science, etc.

The information was cataloged in a Google Spreadsheet with all faculty/researchers from each institution grouped together with their names and emails provided in the first two columns. Subsequent columns contained the various research/topic areas.   In total, there were 33 topics

identified including public health, earthquakes, human factors, safety and knowledge management to name a few. A column for other was used for additional research that did not fall into one of the categories. For each faculty member, an "X" was placed in the column for the topic area if they had a publication, presentation, or listed it as one of their areas of expertise on his/her university/college website.

The link to the spreadsheet was shared at the Innovation Forum to allow faculty to self-edit and validate the information compiled by the research team. The most recent version of the spreadsheet can be obtained by contacting the TDOT Research Office.

Chapter 6 Innovation to Implementation Forum

6.1 Introduction

A key aspect of the project was to facilitate and host an Innovation to Implementation Forum to showcase findings from the research (i.e., literature review, surveys, framework, etc.), share information about the research program more broadly with researchers, other state DOTs, and TDOT staff that may or may not have been involved in research projects previously. The research team and TDOT worked closely together to plan the forum. The event was originally planned to be held in-person, but due to COVID restrictions, a virtual event was held instead. This may have been more effective in allowing more participation for those who may have had difficulty traveling to the event due to budget constraints and/or schedules.

The Innovation to Implementation Forum was hosted virtually on March 31st, 2021 using the Zoom platform. A virtual conference space was created to facilitate the event, which included keynote sessions, a poster session, and virtual exhibit hall. The website was to remain active with videos of keynotes added following the event for non-participants' viewing and review by participants for one year. The forum website can be viewed at https://tdotforum2021.com/. A screenshot of the virtual conference space is provided in Figure 6-1. Based upon attendance in the Zoom session for keynotes, 90 individuals participated in the event. Seventy-nine participants completed the online sign-in sheet, but undercounting is expected in a virtual sign-in because host members often do not complete these forms and others forget to.

Keynotes were provided by TDOT's Executive Leadership and Research Office and FHWA staff as well as the research team. In the afternoon, a panel discussion was held with multiple pairs of researcher and research sponsor from the state DOT to discuss best practices and lessons learned from their experiences. The full agenda for the one-day event is provided in Appendix E. At the conclusion of the Forum, a follow-up survey was emailed to participants. The survey tool is attached in Appendix F.

Figure 6-1 Screenshot of Virtual Event Platform

6.2 Innovation to Implementation Forum

The Innovation to Implementation Forum was comprised of five main sessions: A Virtual Poster Session/Exhibitor Showcase, Welcoming Remarks and Tennessee's State of Research, Best Practices for Innovation to Implementation, Research Framework and Database Presentation, and the panel session titled Putting Innovation into Practice (see Appendix E for the agenda).

Figure 6-2 shows attendees' reasons for attending the Innovation to Implementation Forum, ordered by which options were most frequently picked as "very important." The options in order of ranking by respondents were (1) learn more about implementing research; (2) learn more about TDOT's research program; (3) learn about research happening across TN; (4) discover new products, services or technology; (5) gain more subject matter expertise; (6) participate in networking; (7) share my product, services, or research with others.
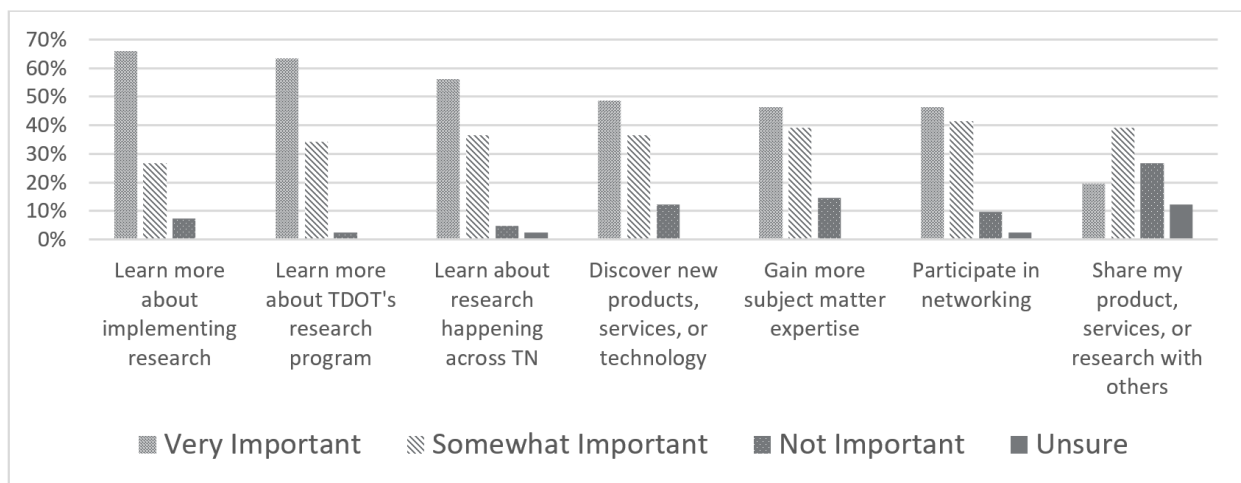
Figure 6-2 Importance of Different Innovation Forum Opportunities

Virtual poster/exhibitor showcase

The virtual poster session/exhibitor showcase was divided into a series of two virtual rooms. In the poster room, research teams from universities across the state of TN presented 28 different topics. In the exhibition hall, nine exhibitors also met with forum attendees to discuss their services. Using Zoom breakout rooms, the hour-long showcase promoted the exchange of ideas and fostered important and intimate discussion to kick off the day's activities.

Exhibitors:

- Geokon
- Via Transportation Inc.
- Roadroid AB
- Greater Nashville Regional Council
- THRIVE Regional Partnership
- Measurement Solutions Inc.
- New Global Systems
- Bentley Systems
- AECOM

Presenting Universities

- East Tennessee State University
- Tennessee Technological University
- Tennessee State University
- University of Memphis
- University of Tennessee – Knoxville
- Vanderbilt University

In the follow-up survey, forty-seven percent (47%) of survey respondents who attended the poster/exhibitor session ranked it as their top session. Table 6-1 shows how many posters or exhibitor booths respondents visited.

TABLE 6-1 NUMBER OF POSTER AND EXHIBITOR BOOTHS VISITED

Number of Booths	1 to 5	6 to 10	11+
Number of Respondents	14	7	7

Seven of the nine survey respondents who indicated they were poster presenters or exhibitors said their booth had one to three visitors. Survey responses about the poster session indicated the benefit and enjoyment of the poster session, as well as opportunities for improving future poster sessions and exhibitor booths. Seventy-seven percent (77%) of respondents were satisfied with the amount of time allocated for the poster/exhibitor session. In the free response portion of the survey, respondents indicated a desire for more time allocated to the poster session, organization of posters into disciplines/topic areas, and more structure. Due to receiving many of the posters with insufficient time to do so, the posters would have been grouped into topical areas for easier exploration by participants. A listing of the posters with author information, etc. was made available to participants as an index to the virtual poster room.

Welcoming Remarks and Tennessee's State of Research

TDOT Commissioner Clay Bright provided welcoming remarks and an introductory overview about the purpose and goals of the forum. Melanie Murphy of the TDOT Research Office provided an update on TDOT's current state of research and an overview of the State's Research Program. Melanie outlined the research project selection process, from identifying research needs through the Call for Research Needs Statements and soliciting proposals from researchers through the Call for Proposals. A timeline for the FY 2022 Call for Projects was provided, along with preliminary outcomes of the Research Strategic Plan being developed for the Research Program. Pam Kordenbrock, FHWA's Tennessee Division Administrator, also shared remarks about the role of the federal DOT in this process. The trio fielded questions from the audience.

The welcome session was highly ranked in the follow-up survey. Thirty-seven percent (37%) of welcome session attendees ranked it as the most beneficial session. Ninety-one percent (91%) of attendees were satisfied with the "Welcoming Remarks and State of Research for TN" session.

Best Practices for Innovation to Implementation

Dr. Stephanie Ivey (UofM) presented on best practices for innovation and implementation based on a review of the literature, recommendations from other peer exchanges, and survey perspectives from other state DOTs. Dr. Ivey shared lessons learned from case studies of DOTs

in Nebraska, Virginia, and Indiana, before discussing the results of a new state DOT survey data on the subject. Dr. Ivey concluded with recommendations on best practices for proposing, communicating, and implementing research. These findings included:

Proposal Best Practices

- Assess implementation from the outset
- Assess need or benefit of the project during the proposal review process
- Use panels or committees to review proposals and manage projects
- Emphasize transparency in the proposal review process
- Consistency and clearly-defined guidelines for proposal evaluation

Communication Best Practices

- Have one specific research staff member working directly with PIs and technical leads to facilitate projects
- Streamline communication between technical members, Principal Investigators, and research staff
- Oversight committees can advise the project, redirect if necessary, and facilitate and oversee implementation opportunities
- Communication of project outcomes is critical

Implementation Best Practices

- Consider and discuss implementation at every stage of the project
- Create a steering/implementation committee that oversees each project and redirects as needed
- Include an implementation plan as a final deliverable or part of the final report
- Recognize the costs of implementation (and the benefits)
- Formal tracking is essential

The best practices session was ranked highly in the follow-up survey. Forty-seven percent (47%) of attendees ranked it as the second most beneficial session of the forum. There were no criticisms provided about the best practices session.

Research Framework and Database Presentation

Dr. Catherine Armwood-Gordon (TSU) presented on developing a research framework for TDOT to assist and provide guidance on management of sponsored research projects and opportunities for improvements to the current process(es) with a focus on implementation. Dr. Armwood Gordon's team evaluated and sorted other state DOTs into tiers based on the ease of access to critical research program information on each state program website. Dr. Armwood-Gordon then reviewed survey data that specifically addressed how Tennessee researchers thought TDOT could improve its research process. Recommendations from both efforts included:

- Have a State Transportation Conference, Research Summit, or Forums annually or bi-annually
- Develop implementation plans and make visible implementation efforts
- Engage in Cooperative Research and/or Peer Exchanges consistently and make it visible
- Consider publicly providing a Research Manual

Building on Dr. Ivey's recommendations for best practices, Dr. Armwood-Gordon also shared other recommendations for TDOT to improve transparency, collaboration, and implementation while addressing Tennessee research area gaps and promising innovation areas to prioritize. These areas included:

- Connected/autonomous vehicles
- Structural monitoring of bridges
- Improved pavement designs
- Innovative research in pavement evaluation
- LIDAR
- Materials testing
- Data science
- Sensor technology
- Artificial intelligence in pavement assessment and evaluation
- Structural health monitoring

According to the post-forum survey, 89% of attendees were satisfied with the framework and database session.

Putting Innovation into Practice – Prior and Ongoing Research Partnerships between state DOTs and Research Institutions/Successful Innovative Projects

This panel discussion included DOT staff members and research partners on prior and ongoing research partnerships that led to improved transportation system design, operations, safety, or management, including discussions on lessons learned and best practices utilized. Projects discussed included Michigan DOT: Bridge Street Bridge Project, which was the first carbon fiber reinforced bridge, and also a project from TDOT: ITS Software Implementation Project, among others.

Moderator:

- Dr. David Lee, TDOT

Panelists:

- Michael Townley, Michigan DOT
- Said El Said, TDOT
- Dr. Abhishek Dubey, Vanderbilt University
- Daniel Pallme, TDOT
- Dr. Mihalis Golias, UofM
- Anne Freeman, Washington DOT
- Mustafa Mohamedali, Washington DOT
- Dr. Nabil Grace, Lawrence Technical University

Key takeaways from the session included the following:

- Researchers should be agile to state DOT needs, as outlined in annual 'State of Transportation' reports
- Research projects need to be practical to meet identified knowledge gaps
- Trust between state TDOT and academics can lead to improved flexibility

- The team (researchers and state DOT staff) should have implementation in mind from the onset, and track deliverables throughout project
- For data science and software products that are harder to deploy immediately, researchers should demonstrate the tech with small scale pilots to prove real world applicability as part of the implementation plan

Furthermore, seventy-six percent (76%) of attendees were satisfied with the panel session. In the response feedback survey, a couple of respondents provided recommendations for improvement of the panel session. One respondent said they, "would have liked to have heard more from the panelists about their successes."

Additional Feedback from Post-Forum Survey

Survey respondents rated the research team's organization and facilitation of the event out of 10. The average score given was an 8.6. Respondents were also asked how likely they would be to recommend a similar event to a friend or colleague. Sixty-six percent (66%) of respondents chose the option, "extremely likely," and twenty-nine percent (29%) of respondents chose the option, "somewhat likely." All except one respondent indicated that the forum either met or exceeded their expectations.

In the free response/additional commentary section of the survey, one respondent suggested rotating the event geographically between Tennessee regions. Another suggested including a presentation about TDOT research needs. A few respondents indicated wanting more researchers to present their work. Based on the overall responses to the survey, an innovation forum in the future could benefit from having a longer, more structured poster session. Survey responses indicate attendees would be interested in learning more about research from the TDOT side and the researcher side and that there is interest in attending more events like this in the future. Seventy-three percent (73%) of survey respondents indicated they would be interested in seeing a similar event annually and twenty-five percent (25%) indicated they would be interested in seeing a similar event bi-annually.

Innovation Forum Key Takeaways

- Communication is key - early in the process and frequently throughout project (including considerations for implementation)
- Clearly define research needs in advance
- Involve subject matter experts in the project beyond the research team
    - Including organizations like Non-profit organizations (NPOs)
    - Within and across state lines

Chapter 7 Peer Exchange

Another aspect of the research was to facilitate a Peer Exchange for TDOT with a focus on implementation of research. In partnership with TDOT staff and FHWA partners, the research team identified key topics for the sessions, key participants to invite from other state DOTs (informed through TDOT staff AASHTO RAC participation, the tier analysis, and proximity to Tennessee). The agenda for the 1.5-day event, held virtually over April 5th, 2021 and April 6th, 2021, is provided in Appendix G.

The first day of the peer exchange included the sessions: Facilitating Innovation and Collaboration, SPR Program Administration – Facilitating Research and SPR Program Management, and Best Practices and Lessons Learned. The second day of the peer exchange included a session on Performance Metrics, Deliverables, and Actual Implementation, as well as a SWOT Analysis. The peer exchange was focused on improving research methods toward improving management of the TDOT research program and implementation of research across the state. This event was held after the Innovation Forum with the intent that most all participants at the Peer Exchange would participate in the Forum and use the information gained from that as foundational knowledge for the Peer Exchange activities.

The peer exchange attendees utilized Google's Jamboard, a digital whiteboard, throughout the sessions to share answers and ideas; the Jamboards are included in Appendix H. Throughout the Peer Exchange, many participants shared links to resources and information in the Zoom chat. These have been captured and provided for reference in Appendix I. Following the peer exchange, participants were sent a feedback survey. The survey tool is attached in Appendix J.

7.1 Peer Exchange Participants

The peer exchange brought together representatives from TDOT, nine peer state DOTs, and FHWA. The following individuals participated throughout the 1.5-day event. A screen shot of the zoom meeting session with participants is provided in Figure 7-1.

Tennessee DOT
- Matt Meservy, Director of Long Range Planning Division
- David Lee, Assistant Director of the Long-Range Planning Division
- Lia Price, Planning Manager Program & Administration
- Melanie Murphy, Research Office Supervisor
- Allison Gwinup, Research Office Senior Planner
- Tyler Thompson, Research Office Planning Specialist
- Beth Jirik, Program Administrator

Invited Participants and Guests
- Brian Worrel, Research Program Manager, Iowa DOT
- Clark Graves, University of Kentucky, Kentucky Transportation Center
- Curtis T. Bradley, Research Implementation Manager, North Carolina DOT
- Jarrod Stanley, Research and Implementation Manager, Kentucky Transportation Cabinet
- Sharon Distance-Hawkins, Senior Project Manager, Maryland DOT

- Stacy Wyman, Tech Transfer Manager and Implementation Manager, Washington State DOT
- Sunil Thapa, Research Implementation Manager, Georgia DOT
- Susan Sillick, Research Programs Manager, Montana DOT
- Tawney Brennfleck, Research Implementation Engineer, CalTrans
- Teresa Stephens, Research Engineer, Oklahoma DOT
- Tricia Sergeson, Transportation Pooled Fund Program Manager, FHWA Turner-Fairbank Highway Research Center
- Sean Santalla, Transportation Planning Specialist, FHWA TN Division

Research Project Team & Peer Exchange Facilitators
- Janey Camp, Vanderbilt University
- Craig Philip, Vanderbilt University
- Miguel Moravec, Vanderbilt University, student
- Katherine Turner, Vanderbilt University, consultant
- Catherine Armwood Gordon, Tennessee State University
- Jake Milligan, University of Memphis, student
- Martin Lipinski, University of Memphis
- Shahram Pezeshk, University of Memphis
- Stephanie Ivey, University of Memphis
- Salwa Badr, Tennessee State University, student

Figure 7-1 Peer Exchange participants as screen shot from zoom meeting

7.2 Format and Methods

The peer exchange was hosted entirely virtually using the Zoom meeting platform. The virtual nature of the exchange allowed for greater participation and was chosen to alleviate concerns about the COVID-19 pandemic. Using a virtual platform for the peer exchange allowed participants to use Google Jamboards, the chat box in Zoom, and slightly modified traditional peer exchange information sharing methods such as facilitated discussions.

The peer exchange was hosted over two days and included the following five sessions:

- Facilitating Innovation and Collaboration
- SPR Program Administration
- SPR Program Management
- Performance Metrics, Deliverables, and Actual Implementation
- SWOT Analysis and Recommendations for TDOT

Each session started with a primer on the topic provided by the facilitators and had guided discussions in conjunction with the Jamboard virtual whiteboard platform. Participants were also able to share links and pdfs in real time during the discussions.

7.3 Facilitating Innovation and Collaboration

The topic of the first session on day 1 of the peer exchange was facilitating innovation and collaboration. In this session, the aim was the acquire information about key components for good research projects and recognizing projects with high probability of implementation. Ensuring the right stakeholders – internally and externally – are involved, aligning projects to strategic goals, and mechanisms for funding were also discussed in this session.

Prior to the facilitated discussion, a presentation was given about the findings of the research conducted prior to the peer exchange. The presentation included information about the following:

- Case studies in successful implementation
- The researcher expertise database created for TDOT
- Innovation areas to prioritize

Discussion questions:

- What makes for a good research project?
- TDOT now has a database of expertise for researchers across the state. Are other states using similar databases/systems? How can this information be leveraged to strengthen a DOT's research program?
- Are there certain characteristics of a project or types of projects that more easily translate to implementation (topic areas, stage, etc.)?
- How should research needs statements be assessed to determine timeframe for implementation?
- Who participates regularly in sponsoring/championing research internally and are there state DOT divisions/leaders that could/should be sponsoring research given today's emerging technologies and opportunities?

- Should collaborative (multi-institution and/or multidisciplinary) efforts be prioritized for funding? Do such efforts lead to more robust project outcomes and likelihood for successful implementation?
- Non-solicited research and/or Rapid Response research - who is facilitating this and how is it working?

Takeaways and Findings for TDOT

Many of the findings and takeaways for FHWA and other state DOTs are useful for TDOT as well. However, the following recommendations are specific to TDOT and represent tailored implementation opportunities for research process improvement.

- Use the researcher expertise database created as part of this project to ensure there is adequate understanding of state expertise
- Implement the Quick Response Program as a mechanism for non-solicited research
- Align research objectives with the innovation areas identified by the survey and the peer exchange respondents
- Assess and prioritize implementation strategy and deliverables from the beginning of a project

Takeaways and Findings for FHWA and Other State DOTs

Research Expertise Database and Research Process
In Iowa, there is an online system where people can create a profile and put voluntary information about research. At MassDOT, a database was created with researchers highlighted monthly. Caltrans has a research database they have had for 12 years. They use it as a project management tool for research projects.

Examples of collaborative initiatives

- UMass Research Affiliates Website: https://www.umasstransportationcenter.org/umtc/Research.asp
- Voluntary expertise databases, listservs
- Highlight Local Researcher on Monthly Basis to State DOT
- New Professors visit state DOT staff
- Webinars

Innovation Areas to Prioritize
The full list of Jamboard responses about innovation areas to prioritize is provided in Appendix H. The following themes were pulled out from the responses:

- Resiliency
- Innovative materials
- Structural health monitoring
- Safety
- Cybersecurity and IT

Mechanisms for non-solicited research
- Examples from North Carolina, Kentucky, and Iowa state DOTs detail small amounts of money set aside to for quick response projects
- Montana: Quick response MPART small projects- master agreement for 7 years

- NCDOT: Technical assistance program at NC state university – can work with any professor or researcher at any school

What makes for a good research project?

Four key themes emerged and are summarized below as the main takeaways from that discussion:

- Implementation strategy and deliverables in mind from start
- Strong, demonstrated need for research that matches agency needs
- Thoughtful planning, communication, and assignment of responsibility
- Has a project champion

7.4 SPR Program Administration – Facilitating Research

The second peer exchange session focused on SPR program administration. As with the first session, participants were first given a presentation before they participated in a moderated discussion.

Shahram Pezeshk and Jake Milligan presented slides with topics including Research Perspectives – Proposals, Researcher Perspectives – Transparency, Research Suggestions – Proposal Phase, Idea Submission – Should it Guarantee Proposal Selection, External Review Committees, and Oversight Committees.

Representatives from various states discussed who can submit proposals, whether or not proposals are anonymous, if proposals become property of state DOT, and how to share proposals among various universities. NCDOT requires research staff to champion a proposal before its allowed to be submitted. Other states also require a "cabinet champion," like Kentucky. Iowa has rolling applications vs annual applications. States discussed transparently grading the proposals with mechanisms such as standard rubric and PI risk assessment. States also discussed appropriating funds fairly.

There are different levels of transparency in the research process among state DOTs. The surveys done prior to the peer exchange by the research team indicated that researchers appreciate transparency throughout the research process.

Takeaways and Findings for TDOT

Generally, during this session of the peer exchange, the representatives from other DOTs discussed methods the prioritized transparency and information access for researchers during the process. Specific methods for implementing peer exchange takeaways are listed below.

- Outline the proposal evaluation process on the website
- Notify proposal submitters about which proposal was selected
- Ensure there is a research champion for each project
- Create and advertise transparent, easy to find resources about the proposal evaluation process, research timeline, and research development process
- Consider providing a letter of acceptance or non-acceptance to researchers after the proposal process

Takeaways and Findings for FHWA and Other State DOTs

Proposal Phase

Guidelines for Proposals

- Maryland: https://www.roads.maryland.gov/OPR_Research/Guidelines-for-Proposals.pdf
- Iowa: https://iowadot.gov/research/Process/Proposal-Deliverable-Guidelines
- Montana: https://www.mdt.mt.gov/other/webdata/external/research/docs/proposal.pdf

Who can submit proposals?

- Montana – can give work to any public entity with no restrictions
- Iowa – allows proposals from any research agency (in state, out of state, international)
- Oklahoma – allows out of state research opportunities
- NCDOT – anyone can submit a request for proposal; external submitters need to have a NCDOT sponsor

Idea Submission, Proposal Selection, and Transparency

There are competing ideas about whether idea submissions should guarantee proposal selection. Several states have language indicating that once ideas are submitted, they become the property of the DOT. The participants from Iowa and Tennessee specifically mentioned their research idea submission forms including statements about releasing ideas to the DOT. Some states generally try to have the idea writers write proposals, along with caveats about ensuring someone has a research sponsor/champion. For example, in North Carolina, if a research idea is authored by a researcher and selected for funding, the idea is considered proprietary, and the author of the idea is the only one able to submit a proposal. North Carolina also provides a letter of acceptance or non-acceptance after each proposal process.

Research Champion

Having a member of TDOT championing and pushing a project forward is a vital component to success. Some states require a research champion from the initial idea submission stage. The participants from Montana and Georgia said all ideas need to have found a champion and in North Carolina all external ideas need to have an NCDOT sponsor.

Research Timeline

State DOTs adhere to many types of timelines. They participants of this peer exchange mentioned following the federal fiscal year, following the state fiscal year, aligning with the academic calendars, and aligning with the DOT project calendars. Iowa DOT generates a progress bar for each project currently underway.

Additional Research Facilitation Resources

During the Peer Exchange, participants shared resources they have about various aspects of research facilitation.

- Montana Report Writing Requirements:
  https://www.mdt.mt.gov/other/webdata/external/research/docs/report_guidelines.pdf
- Montana Research Project Solicitation:
  https://www.mdt.mt.gov/research/unique/solicit.aspx
- Maryland Research Projects Page:
  https://www.roads.maryland.gov/mdotsha/pages/oprreports.aspx?pageid=367&SA=Program%20Information

- Iowa Research Development Process:
  https://iowadot.gov/research/Process/Development-Process
- Iowa Roles and Responsibilities:
  https://iowadot.gov/research/Research-Process/Roles-and-Responsibilities
- Georgia Project Development Process:
  http://gti.gatech.edu/content/working-gdot-project-development-process
- Georgia Working with GDOT:
  https://www.gti.gatech.edu/content/working-gdot

7.5 SPR Program Management – Best Practices and Lessons Learned

Dr. Catherine Armwood-Gordon facilitated a discussion based on questions such as:

- What is the process for evaluating the researcher at the end of the project?
- How does your state DOT disseminate research findings after the report has been finalized?
- Are the researchers supported to travel to conferences for dissemination of research findings?

Takeaways and Findings for TDOT
Evaluating Researcher and Research Staff

- Implement blind or anonymous feedback for PIs provided by those who worked with them at TDOT
- Implement an assessment process for the researchers to provide feedback to the TDOT Research Office and use those evaluations to improve future projects
- Expand the methods used to disseminate research findings – example methods include webinars, presentations, and email distribution
- Podcast could be a unique method to explore disseminating research findings

Takeaways and Findings for FHWA and Other State DOTs
Evaluating Researcher and Research Staff
Some states formally evaluate PIs after projects conclude. In some cases, this is anonymized, and the results are used only by the research office to encourage comprehensive responses.

- Montana researcher survey:
  https://forms.office.com/Pages/ResponsePage.aspx?id=mEypBw_zu0q9ftY_hyDcAi8rFliA4QpOtiB_JW4GcaVUOE5JTUlMMFVCQzJNSlpQR01HRVMzMUxHTS4u
- North Carolina Research Customer Service Survey:
  https://forms.office.com/Pages/ResponsePage.aspx?id=3IF2etC5mkSFw-zCbNftGSrXIbnOZiVOgNHyVVi0V2NUNlFaOUg2SDRVNjM0S1k5WVVaQzFlWVlTWC4u&wdLOR=c5BFBE175-7488-4076-8521-9D47CA28B978
- North Carolina Researcher Survey:
  https://forms.office.com/Pages/ResponsePage.aspx?id=3IF2etC5mkSFw-zCbNftGSrXIbnOZiVOgNHyVVi0V2NUMVJVSTM4VVkxNEtLUzhGQUlYRVo4S0o4RC4u&wdLOR=cF587236D-3C46-4841-906D-C02BAA8B8221

Disseminating research findings

The Jamboard where peer exchange participants provided information about research dissemination is provided in Appendix H.

- Research expo
- Research newsletters
- Research publications email distribution list
- Posting on website
- Summary documents – both academic and from DOT perspective
- Webinars
- Seminars and or project finding presentations
- Disseminate through RAC listserv

Some states provide funding for researchers to go communicate their findings of the research projects, but generally that is stated in the proposal and communicated beforehand.

Implementation

Again, the states reported a wide variety of approaches to implementation. Some had dedicated staff and funding set aside for implementation, others did not. Some formally consider implement-ability as part of selection criteria for proposals. Some implementation funding is separate and competitive, while some states include it automatically when funding the original research proposal.

North Carolina has a Research Follow-Up Quantifiable Results Survey they use to assess quantifiable metrics of implemented research projects. Montana DOT has an implementation report that they receive from the researcher with recommendations of what can be implemented, and the DOT uses that report to create an implementation plan.

7.6 Performance Metrics, Deliverables, and Actual Implementation

Participants defined how "success" differs between research projects. While success in research means delivering sharable answers to certain objectives, implementation success instead focuses on changing a process or model of business model. Attendees outlined the roles and responsibilities of researchers and state DOT staff for implementation considering timelines, funding, and tracking in the process. Participants discussed what needs to be tracked and how to efficiently use metrics to do so. Regular meetings and reports supplement metrics are points to that track project performance and deliverables. Finally, attendees also considered how DOTs could better leverage completed research projects with wide communication platforms.

Discussion Questions:

- What are the roles and responsibilities regarding implementation?
- How is success defined for a research project and an implementation project?
- What needs to be tracked and how is this done? What are the metrics used?
- In what ways can state DOTs leverage completed research projects?

Takeaways and Findings for TDOT
- The research office serves as an important facilitator and driver of communication between the state DOT liaison/champion/project manager and the researcher

- Focusing on implementation at every stage of the research process with input from the researcher and subject matter expert pushes implementation
- Ensure there are adequate and appropriate methods to distribute completed research projects

Takeaways and Findings for FHWA and Other State DOTs

Roles and Responsibilities for Implementation

Researcher

- Make implementation recommendations
- Providing the response to the problem statement
- Coordinate with the DOT subject matter expert to prepare what the agency needs

State DOT Liaison, champion, project manager or sponsor

- Subject matter experts are responsible for implementing the research recommendations
- Project Champions ensure development of the implementation plan
- Review and guide the context (results) for the deliverables from the researcher
- Ensuring project alignment with goals

Collaboration between researcher and state DOT rep

- Communication!
- Research office establishes implementation process and provides support for implementation

Implementation Plan

Some states have a version of an implementation plan that is created at some point during the research process to guide implementation. North Carolina does this in an iterative process where the researcher and subject matter expert work together to create an implementation plan that is guided by both DOT needs and project constraints. For this process it was emphasized that constant and ongoing communication is crucial. They review this plan at the kickoff, in the middle, and at the end of the project, and sometimes have a follow-up meeting as well. Georgia DOT's research office prepares an implementation plan in coordination with the subject matter expert.

How is success defined for a research project and an implementation project?

The following responses are from the Jamboard used during the peer exchange. The Jamboard with all of the responses is provided in Appendix H. Participants also noted that success doesn't always mean implementation – sometimes research results point towards not implementing something or pursuing a project.

Research Project

- Research objectives were met
- Implementable deliverables
- Publishable research
- Easily shareable findings
- Results integrated into DOT processes

Implementation

- A change in process or business model
- Impacted decision making at the DOT in some capacity
- Results used in timely and satisfactory manner

Project Tracking

Some examples of how DOTs track completion are provided below:

- Track percent complete
- Track implementation and measures of success
- Track what impacts/changes were recorded (policy, procedure, specifications, work methods, etc.) and types of benefits (time, money, improved safety)
- Track on-time completion
- North Carolina is currently working on tracking students that work on their projects to understand who stays in the transportation workforce

Communicating Research Results

The peer exchange participants also discussed how DOTs can leverage completed research projects. In the peer exchange session on the first day, participants discussed how results can be communicated more internally, and this discussion was posed to assess communication and distribution of results more widely.

- Posted results on a Facebook page
- Forum/expo
- TRB e-newsletter
- Poster board outside auditorium
- Listserv to share final research products

7.7 SWOT Analysis and Recommendations for TDOT

Participants completed a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis to characterize TDOT's research program.

Strengths
- Strong university partners
- RAC community/peer exchanges
- Flexibility of the research program

Opportunities
- Improve tech transfer
- Possibility of more Federal funding with increased focus on infrastructure
- Generate more buy in from leadership on innovation/implementation importance

Weaknesses
- Too few staff and resources to champion research in agency
- Obstacles to getting new researchers involved

Threats
- Over-relying on Federal funding when state resources are limited
- Lack of interest from senior management
- Loss of institutional knowledge from turnovers

Takeaways and Findings for TDOT

Based on this characterization, participants made the following recommendations to TDOT:

- Further develop the implementation plan with subject matter experts and researchers
- Consider how consultants could expand program capabilities
- Iteratively apply and improve on lessons from other state research offices
- Continue proactively seeking out feedback from peers and researchers
- Increase research office staff

7.8 Feedback from Post-Peer-Exchange Survey

A feedback survey was sent to participants of the peer exchange.

Survey respondents were asked how likely the would be to recommend a similar event to a friend or colleague. Eight (8) respondents chose the option, "extremely likely," and one (1) respondent chose the option, "somewhat likely." Respondents were also asked to what extent the Peer Exchange met their expectations. The answer options and responses were as follows:

- Exceeded expectations (5)
- Met expectations (4)
- Did not meet expectations (0)

Respondents were asked to rate the research team's organization and facilitation of the event out of ten. The average score given was 9.4.

Figure 7-2 shows how satisfied attendees were with each session. All respondents chose either extremely satisfied or somewhat satisfied. Respondents were asked if they learned anything new about SPR program management (in general) from the Peer Exchange. The answer choices and number of respondents who picked each answer were as follows:

- Yes (6)
- Maybe (2)
- No (1)
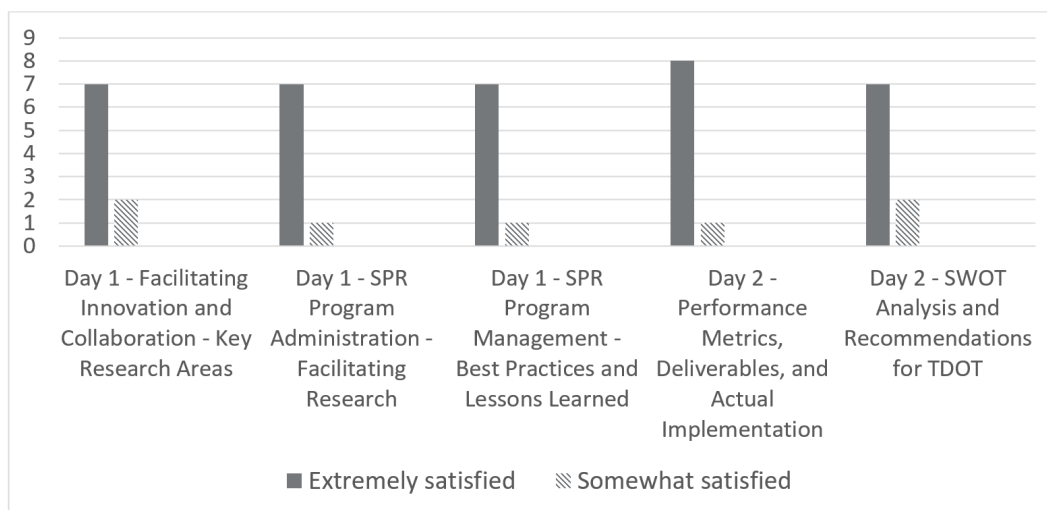
Figure 7-2 Satisfaction with Peer Exchange Sessions

Survey respondents were asked what types of future collaborative events related to research program management/administration they would like to see in the future. Respondents indicated interest in all of the following:

- A regular/annual forum similar to what was hosted by TDOT and the research team
- Peer Exchange focused on Tech Transfer
- Presentations of Best Practices
- Panel Showcasing best practices (research and state DOT perspectives)
- Networking Event

Respondents were asked, "What would you like to see included in future events like this (if TDOT or other state DOTs were to host them)?" Three answers mentioned more conversations about implementation. One respondent asked for more time for extended conversation. One respondent mentioned wanting an easier format for participants to share documents. Another participant indicated interest in participating in a webinar hosted by NCDOT on performance metrics research. The last question asked for any additional comments, and three respondents used this space to congratulate the team on the peer exchange. Throughout the survey, feedback and ratings heavily trended towards the positive side, and the attendees who filled out the survey indicated enjoyment and benefit from their attendance.

7.9 Peer Exchange Key Takeaways

- Create a state database of researchers by expertise
- Consider new ways to accept research proposals equitably
- Develop more transparent means for the researcher evaluation processes
- Increase regular opportunities for collaboration between university and DOT researchers
- Communication is critical in all phases of the research process, plan to communicate
- Recognize the variety in how the states handle the research process and learn from what works
- Start the research process with implementation in mind from the get go
- Track implementation as carefully as research progress is tracked
- Dedicate staff for implementation at the state DOT level
- Retain institutional knowledge and know your state's subject matter experts
- Champion research and implementation successes with regular communication platforms

Chapter 8 Conclusions and Key Takeaways

A multifaceted approach was taken to identify opportunities and best practices for implementing innovative research at the state DOT level. TDOT secured a team of researchers from Vanderbilt University, the University of Memphis and Tennessee State University to review and evaluate the current states of practice across Tennessee and beyond to identify best practices for both managing research programs and implementing research into practice.

The research approach included a literature review that included state DOT Peer Exchange reports, online surveys of state DOT staff and researchers, a one-day virtual forum where stakeholders learned more about TDOT's research program and best practices, and a 1.5-day Peer Exchange where several state DOTs were brought together to share information about how research programs address implementation. The Forum included representatives from TDOT, FHWA, other state DOTs and institutions of higher education from across the state who were brought together to learn about ongoing research, TDOT's research program and identified best practices by the research team. The Peer Exchange included representatives from nine state DOTs sharing information about their research programs in an effort to identify activities and processes that are most effective. In addition to these activities, the research team also created a framework for TDOT that included both a ranking of state DOT research programs based upon developed criteria and a database of expertise across the state of Tennessee to identify opportunities for additional research areas and additional academic partners.

The information gathered was synthesized into key findings and recommendations as described below.

Key Findings

The key findings that emerged from the literature review, surveys, and events (Innovation to Implementation Forum and Peer Exchange) are the following:

- A successful research program requires transparency and communication and clearly defined expectations for the research process, timelines, and deliverables (for all involved – researchers, state DOT staff, and any others involved).
- Successful research and implementation requires proactive planning, adequate consideration, and ultimately financial resources.
- All involved (state DOT staff and project managers as well as researchers can benefit from formal, consistent guidelines to follow.
- Implementation should be considered from the beginning – even before funding a research project to ensure the project has real benefit to the state DOT as well as those performing the research.
- Improvements to a research program is a proactive process that requires gathering feedback from stakeholders (internal and external), can be iterative in nature, and requires a willingness to learn from others,

References

AASHTO. No date. Research Advisory Committee Membership. Accessed December 1, 2020. https://research.transportation.org/rac-membership/

Alvarez-Castro, Aquilino, and Javier Bonilla-Díaz. 2017. "Technology Transfer at a European Construction Company: Case Study of ACCIONA Construction, Spain." *TR News*, July: 52-57. https://trid.trb.org/view/1482933.

ARDOT System Information and Research Division - Research Section. 2019. *Alabama Department of Transportation, Arkansas Department of Transportation, & Kentucky Transportation Cabinet Research Peer Exchange Report.* Peer Exchange Report, Little Rock: Arkansas Department of Transportation.

Brassard, Daniel L, Deborah Horton, and Darcy M Bullock. 2019. "Research Pays Off: DamageWise Program Implementation Pays Off for Indiana." *TR News*, 44-46.

Cambridge Systematics. 2013. *Peer Exchange: Journery from Adequate to Vital: The Pathway to Excellence.* Peer Exchange Report, Albuquerque: NMDOT Research Bureau.

Federal Highway Administration. 2019. *STIC Excellence Award.* October 10. Accessed January 14, 2020. https://www.fhwa.dot.gov/innovation/stic/excellence_award.cfm.

Harman, Thomas. 2017. "State Transportation Innovation Councils: Partnering for Continuous Innovation." *TR News*, July: 22-27. https://trid.trb.org/view/1482924.

McGhee, Cathy, Kevin Wright, and Jimmy White. 2017. "Research Results Go Statewide: Virginia Transportation Research Council's Implementation Program." *TR News*, July: 15-19. https://trid.trb.org/view/1482921.

Moore, Davonna, Gretchen Ivy, Brian Comer, Michael DeMent, Matthew Junak, and Charles Miller. 2018. *Creating a roadmap for successfully planning, implementing and administering complex multi-jurisdictional transportation technology projects.* White Paper, Topeka: Kansas Department of Transportation.

NDOT. n.d. *RLL.* Accessed February 22, 2021. https://dot.nebraska.gov/business-center/research/research-readiness-level-rrl/.

Page, Glenn. n.d. *Peer Exchange Reports Topics.* Accessed January 10, 2020. https://research.transportation.org/peer-exchange-reports-topics/.

Texas A&M Transportation Institute. 2015. *Four-State Virtual Research Peer Exchange.* Peer Exchange Report, Boise, Carson City, Pierre, Cheyenne: ITD, NDOT, SDDOT, WYDOT.

Appendix A. DOT Survey Instrument

Note: The recruitment email is provided before the survey instrument.

Email invite to state DOT Employees

Hello.

TDOT has retained researchers at Vanderbilt University, the University of Memphis, and Tennessee State University to conduct a study entitled 'Innovation to Implementation' with the intent of improving TDOT's ability to better put innovative research supported by the State Planning and Research (SPR) program into practice. The researchers are interested in obtaining your perspective via an online survey regarding the processes and activities involved in SPR Program-funded research projects to help in identifying best practices, opportunities, and challenges for TDOT. We are specifically focused on policies and activities associated with generating ideas and research needs statements, the selection and award process, program management, communication, research project oversight and management, handling of reporting and deliverables, and ultimately potential implementation of the research results.

You have been identified by the research team as an individual that may be able to provide valuable input as we gather information from stakeholders.

You may access the survey via the link below. All responses will be anonymous. The researchers have selected the appropriate settings to anonymize responses so that your IP address will not be collected. We will not collect your name or any other data that can be used to link your responses to you using the survey instrument. We encourage you to participate and to provide candid feedback.

Survey link: http://owen.az1.qualtrics.com/jfe/form/SV_0BoEHDYjIodFG97

If you have any questions regarding this survey or how the data will be collected or reported, please contact the project PI, Dr. Janey Camp at janey.camp@vanderbilt.edu.

Thanks,

Janey Camp (on behalf of the research team)

Janey Smith Camp, PhD, PE, GISP, CFM
Research Associate Professor, Department of Civil and Environmental Engineering
Associate Director, Vanderbilt Engineering Center for Transportation and Operational Resiliency (VECTOR)
Vanderbilt University

Default Question Block

The Tennessee DOT in partnership with a research team of Vanderbilt University, the University of Memphis and Tennessee State University is planning an Innovation to Implementation Forum which includes an Innovation Fair and Peer Exchange focused on best practices for putting state DOT-funded research into practice.

This survey is one of the efforts being used to identify best practices and challenges for putting research into practice and further understanding how state DOTs manage research projects. The information you provide will help us in better understanding these things.

1   What Division/Department do you affiliate yourself with?

2   How long have you worked for your state DOT?

3   In general terms, what would you say your role/position is?

Are you involved with management of the State Planning and Research (SPR) Program?

To what extent have you participated in the state DOT research program in the past? (mark all that are applicable)

☐ Submitted research needs statement(s) (RNS) or request(s) for research
☐ Reviewed RNS proposals
☐ Served as DOT partner/project manager on current/prior research project
☐ Was not aware of the opportunity to host/participate in research partnerships with state colleges and universities

How do individuals in your organization learn about opportunities to submit research project ideas or research needs statements?

☐ Personal conversation with members of the research office
☐ Email distribution inviting individuals to participate
☐ Other

What is the "other" way that you learned about opportunities to submit research project ideas or research needs statements?

[   ]

Have you been personally involved in preparing a research needs statement to go to the universities?

○ Yes
○ No

Is there a prioritization that you're aware of for research topics that are selected fro RNSs? If so, please explain your understanding of this.

[   ]

Were you involved in evaluating proposals related to a research need you submitted or one of more other research needs statements?

○ Yes
○ No

Please describe the process for evaluating proposals in your own words.

[   ]

Do you feel that the review and evaluation process for proposals is transparent?

○ Yes
○ No

Is the proposal review and ranking the same across departments/divisions? For example, does the Structures group use the same rubrics as the Geotechnical group? Note: We are only interested in proposals for research, not construction or engineering proposals.

○ Yes
○ No

Do any external reviewers participate in the evaluation of research proposals?

○ Yes
○ No

Do you think it would be beneficial to have external reviewers involved in reviewing research proposals? Why or why not?

[   ]

Based upon your experience and understanding how is research funding distributed within and/or across different disciplines?

[   ]

Is there a need to have an oversight committee/panel for each funded research project? If so, what will be their assigned duties or role in the oversight of the project?

[   ]

How many research projects have you been the project manager for or been involved with as the state DOT point-of-contact?

○ 1
○ 2-5
○ 6-10
○ More than 10

Do you feel you were "on the same page" with the researchers during the project?

○ Yes
○ No

Did the researcher(s) understand the linkage between research results and implementation?

○ Yes
○ No

Based upon your knowledge and understanding, who oversees/manages the research project from the state DOT side?

50

[   ]

Who reviews the progress reports and/or the final report (if they differ)?

[   ]

Do you feel there is a need to have one DOT research staff member serve as the
liaison/project manager to work directly with PIs to make sure all their questions are
answered, deadlines are met, and set up regular touch-points, etc.?

[   ]

Are you aware of guidelines for researchers to use in writing quarterly and final reports?

○ Yes
○ No

Based upon your experience, what is done with a final report after it has been accepted?

[   ]

Are there procedures in place for state DOT or the researchers to implement or further
publish results of the project after the final report has been submitted and approved?

○ Yes
○ No

Do you utilize state-of-the-practice research/innovative approaches in your
workflows/activities?

○ Yes
○ No
○ Sometimes
○ Never
○ Unsure

How do you learn about the latest state-of-the-art in your field or area of expertise?

☐ Participate in discipline-specific conferences/workshops
☐ Trade association journals
☐ On-the job training
☐ Attend the Transportation Research Board Annual Meeting or other TRB meetings/sessions
☐ Other

What is the "other" way you learned about the latest state-of-the-art in your field or area of expertise?

[   ]

From the list of innovation areas, which should be prioritized?

☐ Drones (structural elevation)
☐ Drones (flood hazard)
☐ Drones (seismic hazard)
☐ Ground penetrating radar (GPR)
☐ LIDAR
☐ Connected/autonomous vehicles
☐ Improved pavement designs
☐ Materials testing
☐ Sensor technology
☐ Artificial intelligence in pavement assessment and evaluation
☐ Structural monitoring of bridges
☐ Structural health monitoring
☐ Seismic hazard
☐ Innovative research in pavement evaluation
☐ Data science
☐ Getotechnical testing
☐ Other

What "other" innovation area(s) do you think should be prioritized?

[   ]

What is your personal interest in partnering with universities?

| No interest | | | | | | | | | | Extremely Interested |
| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |

My interest level:

To what extent are you aware of research capabilities in colleges and universities across the state and beyond?

☐ I'm not familiar with research happening across the state
☐ I'm familiar with research conducted at my alma mater
☐ I've worked with researchers before at one institution
☐ I've worked with multiple researchers at one institution
☐ I've worked with multiple researchers across multiple institutions

Have you experienced or are you aware of barriers to successful research collaboration with universities? If yes, please explain.

Do you have recommendations on how TDOT or other state DOTs could increase and/or improve collaborations with universities?

Is there anything else you'd like to share at this time?

Thank you for your time and input!

If you would be interested in further sharing your experiences and/or participating in a forum focused on these topics, please click on the link below and it will open another window with an online form to provide your name and contact information. Someone from the research team may reach out to you.

Note: This information will not be linked to your survey answers.

Please don't forget to click "submit" before leaving the survey.

https://forms.gle/9XMaDMYvS33dgTxN8

Powered by Qualtrics

Appendix B. Additional State DOT Survey Results

Introduction

A 36-question survey was sent out to members of TDOT and research personnel at other state DOTs. The survey assessed DOT research processes from project proposal to implementation.

Survey Respondents

Some of the survey respondents identified their state DOT in answers and could be categorized as either TDOT or other DOT. Not all respondents could be classified by DOT and state specific information is only provided for TDOT.

- 84 Total Respondents*
- 26 TDOT Respondents
- 26 Respondents from Other DOTs

Table B-1 shows general roles/positions of survey participants and Figure B-1 shows the respondents' extent of involvement in various stages of the research selection process.

TABLE B-1 ROLE OR POSITION AT DOT

	Total	TDOT	Other DOTs
Director	22	11	4
Research Manager	25	0	14
Manager Other	23	11	3
Research Analyst or Engineer	11	2	4
Engineer	3	2	1

Figure B-2 shows respondents' involvement in the research project management activities. Seventeen percent of TDOT respondents had submitted research needs statements (RNS) or request for research. Thirty-five percent of respondents from other DOTs had submitted research needs statements (RNS) or request for research. Ninety-six percent of TDOT respondents and respondents from other DOTs had reviewed RNS proposals. Eight percent of TDOT respondents had served as TDOT partner/project manager on current/prior research project. Thirteen percent of respondents from other DOTs had served as TDOT partner/project manager on current/prior research project.

Figure B - 1 Research Project Involvement
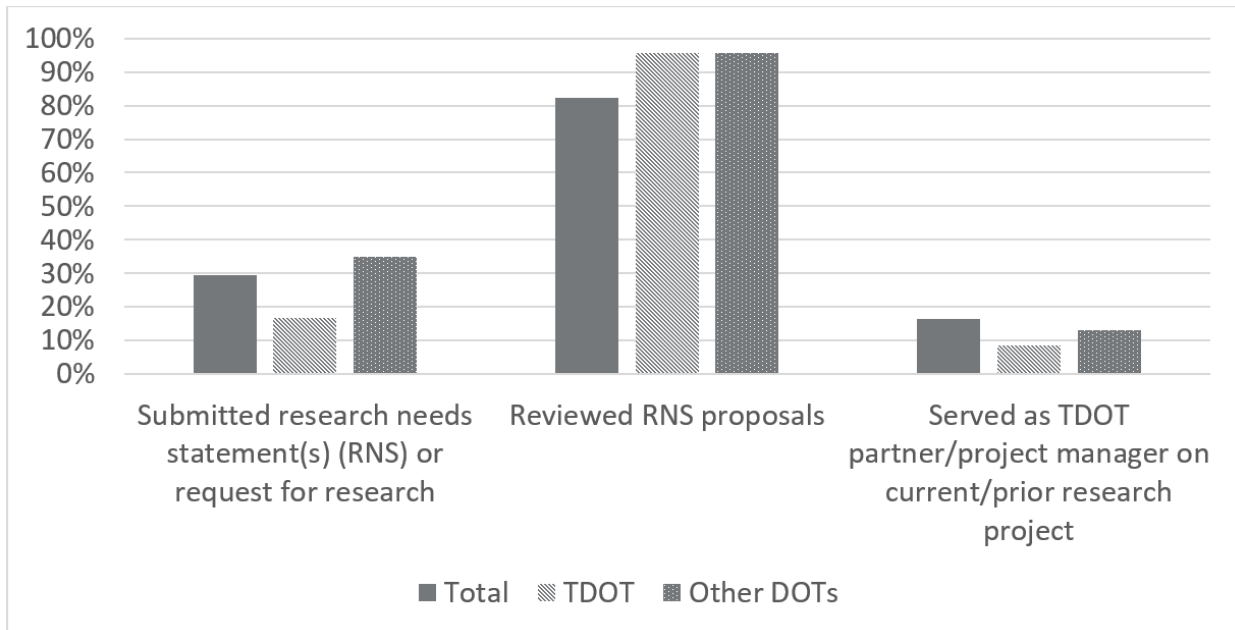
Figure B - 2 Level of Involvement in Research Process

Table B-2 shows how long survey respondents have worked at their respective state DOTs and Table B-3 shows how many projects respondents have served as project manager or state point-of-contact.

TABLE B - 2 LENGTH OF TIME AT STATE DOT

	COUNT	PERCENT
1-5 YEARS	15	18%
6-10 YEARS	12	14%
11-20 YEARS	28	33%
21+ YEARS	29	35%

TABLE B - 3 NUMBER OF PROJECTS AS PM OR STATE POINT-OF-CONTACT

	COUNT	PERCENT
1	8	10%
2-5	13	15%
6-10	3	4%
>10	20	24%
BLANK	40	48%

Figure B-3 shows which states are represented by survey respondents. The figure depicts a map of the United States with the following states shown in blue (representing survey respondent states):

- Arizona
- Oregon
- California
- Montana
- Wyoming
- Colorado
- New Mexico

- Texas
- Minnesota
- Iowa
- Missouri
- Tennessee
- Mississippi
- Florida

- North Carolina
- Maryland
- South Carolina
- Florida
- Maine
- Washington
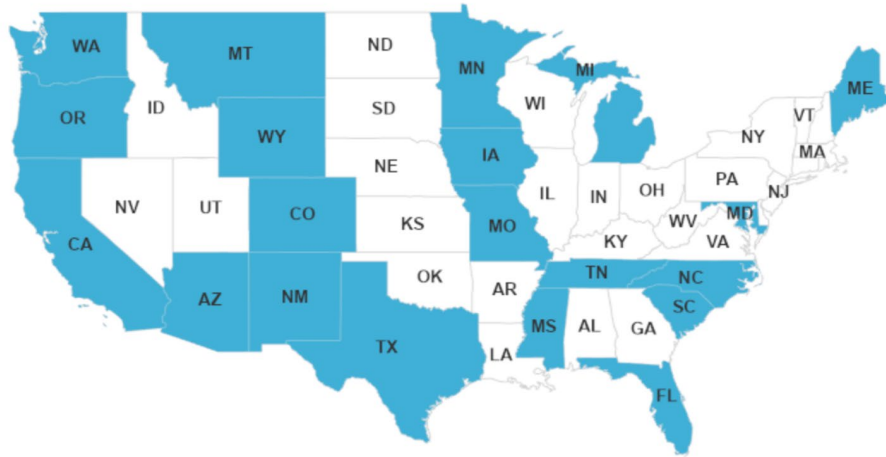
Figure B - 3 States Represented by Survey Respondents

Pre-Project and Proposal Review

Survey Findings

Learning about Opportunities to Submit Project Ideas

Respondents were asked how they learned about opportunities to submit project ideas or RNSs. As shown in Figure B-4, email is the most common method DOT personnel learn about opportunities to submit project ideas.
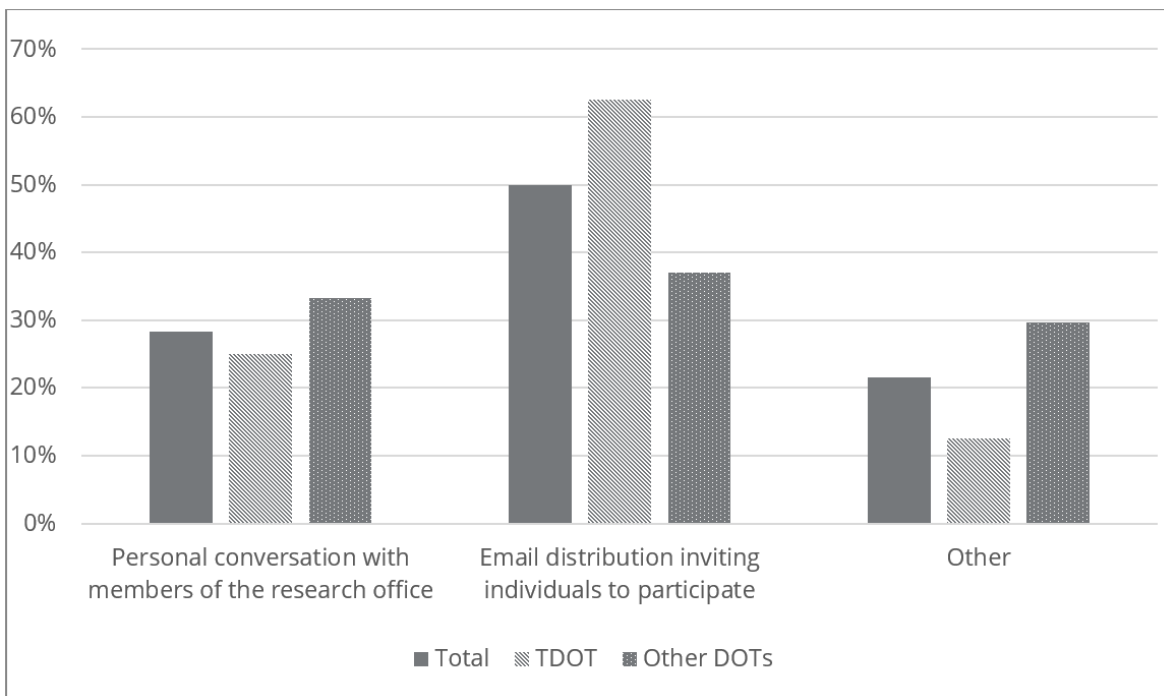
FIGURE B - 4 HOW INDIVIDUALS LEARN ABOUT OPPORTUNITIES TO SUBMIT PROJECT IDEAS

Evaluation of Proposals

Survey respondents were asked to describe the process for evaluating proposals in their own words. Answers were analyzed and categorized as shown below in Table B-4.

Table B-5 shows percentages of each answer type from total respondents, TDOT respondents, and respondents from other DOTS. TDOT respondents heavily mentioned scoring in their answer choices, with 71% of TDOT respondents mentioning scoring themes. Zero of the TDOT respondents indicated evaluating implementation possibilities, while 17% of respondents from other DOTs mentioned this category.

Respondents from other DOTs more frequently mentioned formal panels or committees when describing the evaluation process. Key evaluation metrics mentioned by respondents from other DOTs are listed below:

- Implementation of the results
- Need or benefit of the project
- Panel/committee
- Funding/cost

TABLE B - 4 KEYWORDS USED FOR ANSWER CATEGORIZATION

Scoring	Collaboration	Cost	Formal Process	Merit	Implementation or Strategic Goal
Scoring	Team	cost	manual	Idea	strategic goal
Rating	Committee	value	direction	Content	Implementation
Rank	meet	Price	instruction	Issue	Implement
Score	meeting		Process	Merit	
Point	Group		written		
Rate					

TABLE B - 5 PROPOSAL EVALUATION CONSIDERATIONS PRESENTED AS PERCENTAGES (TOTAL, TDOT, AND OTHER DOTS)

Key Themes	Total	TDOT	Other DOTs
Scoring	45%	71%	26%
Collaboration	27%	29%	35%
Cost	12%	0%	22%
Formal Process	13%	14%	9%
Merit	12%	5%	26%
Implementation or goal	12%	0%	17%

Respondents were also asked about the transparency of the research proposal evaluation and review process. Responses to the question, "Is the proposal evaluation and review process transparent?" are shown below in Figure B-5.
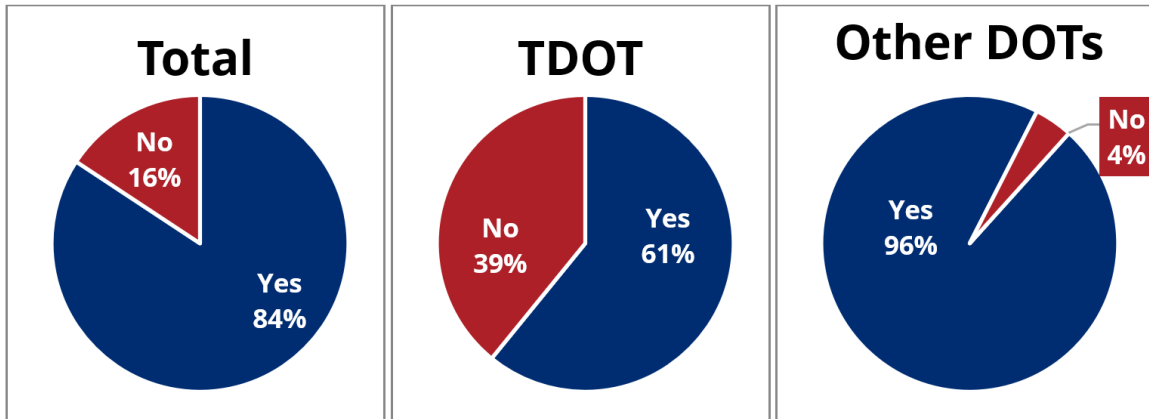
Figure B - 5 Transparency of the Proposal Evaluation and Review Process

Primary Recommendations
- Increase transparency in the proposal evaluation and review process
- Assess implementation during the proposal evaluation process
- Utilize specific committees or panels to collaboratively assess research ideas

Communication and Oversight During the Project

Survey Findings

Oversight Committee, Panel, or Person

Respondents were asked if there is a need for an oversight committee or panel for each funded project. This question was posed as a fill-in-the-blank style question and respondents were also asked to explain what their assigned duties or roles would be in the oversight of the project. Figure 0-6 displays how total survey respondents, TDOT respondents, and respondents from other DOTs responded to this question.
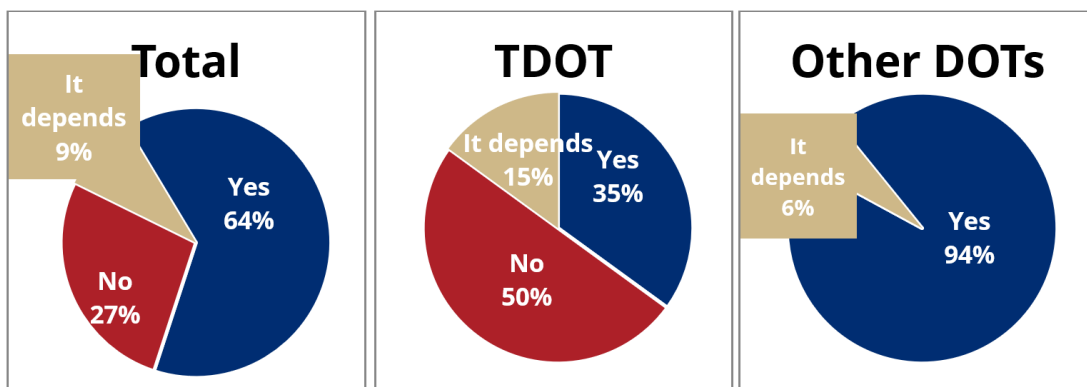
Figure B - 6 Is there a need to have an oversight committee/panel for each funded project? If so, what will be their assigned duties or role in the oversight of the project?

Assigned Duties or Roles:

- Advise the project
- Eliminate any barriers
- Redirect research if necessary
- Identify implementation opportunities

Sample of Quotes Indicating Utility or Role of Oversight Panel

- "Yes this is important. The panel provides guidance and checkpoints to the researcher, builds in accountability, increases implementation potential, provides critical review of deliverables."
- "In [state] each funded project has a Technical Advisory Committee. This TAC helps finalize project scope, reviews proposed methods against the project objectives, reviews analysis and final reports with an emphasis on post-project tech transfer and implementation."
- "Yes, the panel provides data, access, direction, and guides project to make sure outcomes are implementable. Review of deliverables is a final role of the panel."

Respondents were asked if there is a need to have one DOT research staff member serve as the liaison/project manager to work directly with PIs to make sure all their questions are answered, deadlines are met, and regular touchpoints are set up. Figure B-7 shows how total respondents, TDOT respondents, and respondents from other DOTs answered this question.
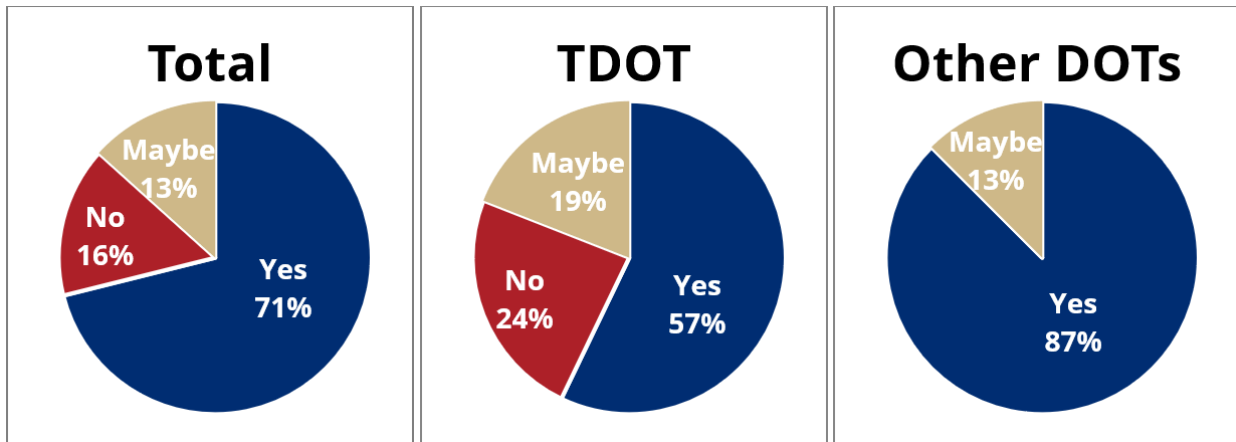
Figure B - 7 Do you feel there is a need to have one DOT research staff member serve as the liaison/project manager to work directly with PIs to make sure all their questions are answered, deadlines are met, and set up regular touchpoints, etc.?

Reasons to have DOT Research Staff as Liaison/PM

- Protects project scope and schedule
- Helps technical leads answer non-technical questions about the project
- Addresses administrative/contractual requirements

Respondents were asked who oversees/manages the research project from the state DOT side. This question was posed as a fill-in-the-blank style question.

- "The "project manager" is a subject matter expert assigned by the functional area (which has developed and requested the research), who works with the Research Center, which provides program administrative, performance, and quality oversight."
- "Research Project Manager along with the Project Monitoring Committee"
- "A [state] DOT research coordinator oversees each research project, The Research Manager may direct the projects as need, and individual TAC members may advise, however the research coordinator is the primary point of contact between the DOT and the contractor."
- "Project managers that have technical expertise oversee the project with administrative help from a Research Manager."

Primary Recommendations

- Assign a Research Project Manager – one of the research office staff, for each project, to help with administrative/contractual requirements, protect scope and schedule, and answer non-technical questions about the project
- Make sure DOT staff are aware of guidelines for researchers to use for quarterly and final reports
- Oversight or implementation panels can guide implementation throughout the research project lifecycle

Implementation

Survey Findings

Linkage Between Research Results and Implementation
Respondents were asked whether researchers understand the linkage between research results and implementation. As shown in Figure B-8, DOT respondents generally agree that yes, researchers understand the linkage between research results and implementation.

Respondents were also asked if there are procedures in place for state DOT or the researchers to implement or further publish results of the project after the final report has been submitted and approved. Figure 0-9 shows responses to this question showing from left to right total responses, TDOT responses, and other DOT responses. Seventy-five percent (75%) of respondents from other DOTs agreed that there are procedures in place for further implementation, and forty-two percent (42%) of TDOT respondents agreed.
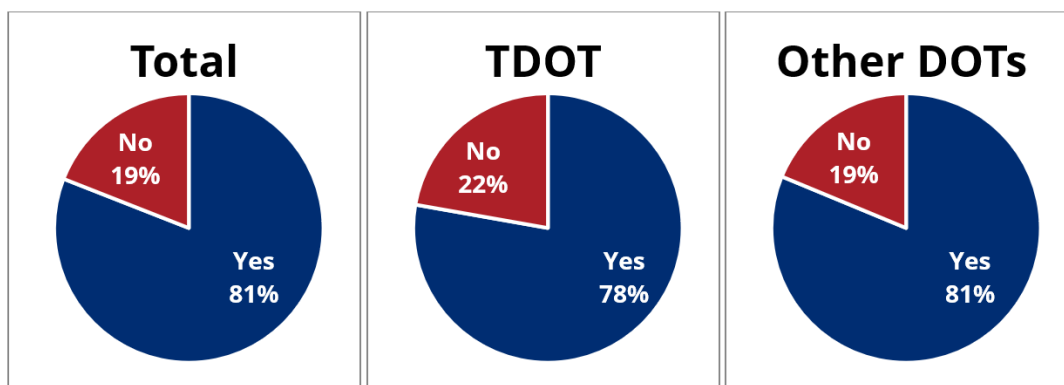
Figure B - 8 Did the researchers understand the linkage between research results and implementation?
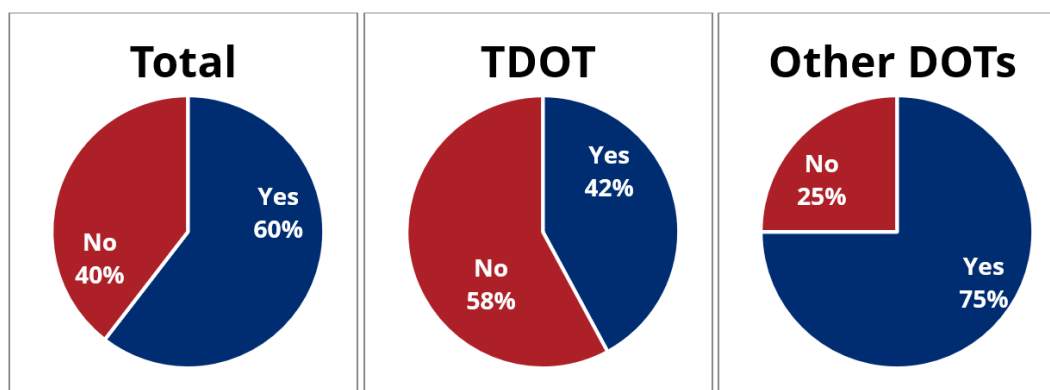
Figure B - 9 Are there procedures in place for state DOT or the researchers to implement or further publish results of the project after the final report has been submitted and approved?

Respondents were also asked what is done with final reports after they have been accepted. The fill-in-the-blank answers were broken into the categories shown in Figure B-10. Respondents from other DOTs more frequently specifically mentioned submitting the reports to national databases.

Sample of Quotes Indicating Ways other DOTs Prioritize Implementation Post Final Report:
- "Published to [state] DOT website, national transportation Library, and indexed with the TRID database. Project champions (with research staff support) work on implementing report recommendations."
- "It is distributed to the national transportation library, mass email distribution, TRB News, and social media. A copy is placed in the library. The PM uses the report to implement results."
- "Implementation Manager follows up with the Champion on Implementation"
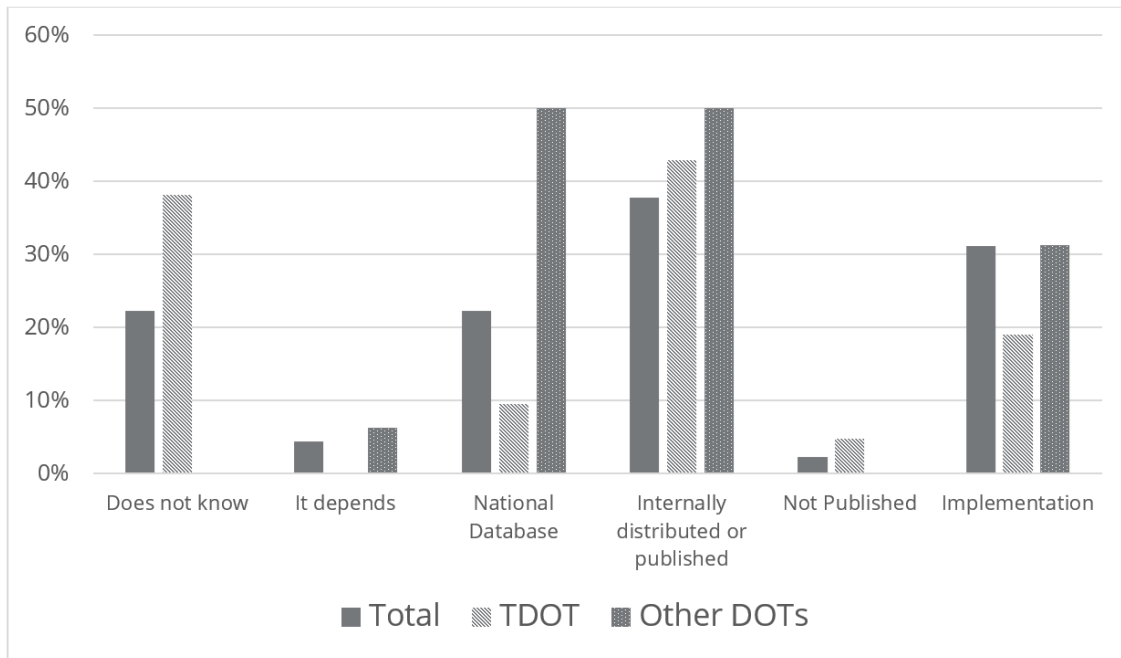
Figure B - 10 Based upon your experience, what is done with a final report after it has been accepted?

Respondents were also asked how they learn about the latest state-of-the-art in their field or area of expertise. Figure B-11 shows how respondents answered this check multiple boxes style question. The following options were provided:

- Participate in discipline-specific conferences/workshops
- Trade association journals
- On-the-job training
- Attend the TRB Annual Meeting or TRB meetings/sessions
- Other

All of the options were chosen with relatively high frequency. Respondents could answer a fill-in-the-blank style question about the other way they learn about the latest in their field. These answers were also categorized with the most frequent answer type being networking, conferences, or communicating with peers. This aligns with the high hit rates of the conference style answer choices shown in Figure B-11.
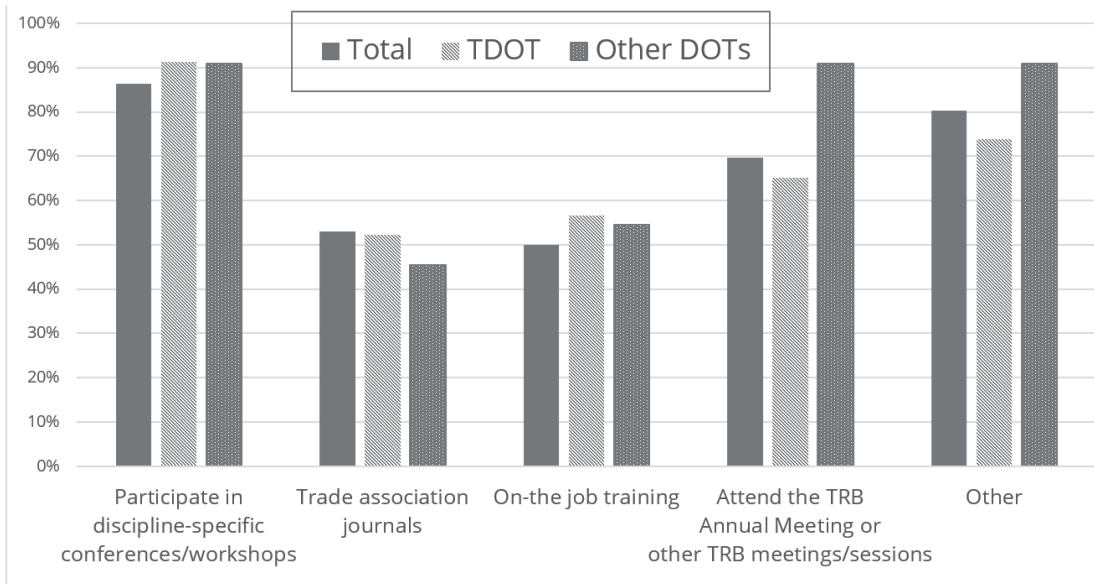
Figure B - 11 How do you learn about the latest state-of-the-art in your field or area of expertise?

Primary Recommendations

- Prioritize implementation from onset of project
- Consider instituting implementation committees or officers to guide the project and prioritize implementation
- Ask for an implementation section of final reports
- Consider implementation as the final step of the project, rather than a separate portion

Future Research Opportunities

Survey Findings

Respondents were asked to check boxes of which innovation areas should be prioritized. Table B-6 shows which five innovation areas were chosen most frequently by survey respondents.

TABLE B-6 WHICH INNOVATION AREAS SHOULD BE PRIORITIZED? – TOP FIVE AREAS

	Total	TDOT	Other DOTs
Connected/autonomous vehicles	54%	45%	61%
Structural monitoring of bridges	51%	41%	56%
Improved pavement designs	46%	41%	50%
Innovative research in pavement evaluation	42%	32%	56%
LIDAR	39%	41%	44%

Survey respondents were asked which of the following state DOT divisions they felt could benefit from research. This question was only asked on the Redcap survey, not the Qualtrix survey, so there are less responses to this question. Responses to this question are not broken into total, TDOT, and other DOTs. Table B-6 shows counts and percentages to this answer.

	Count	Percent
Safety	30	94%
Hydraulics and Hydrology	29	91%
Pavement, etc.	29	91%
Planning	28	88%
Structures	28	88%
Traffic Operations	28	88%
Construction	27	84%
Aeronautics	17	53%
Total Answered	32	

Summary Future Needs

Need for research was indicated across-the-board. In fill-in-the-blank style questions about which areas of innovation to focus on respondents provided a variety of answers. There is interest in innovation across multiple areas and divisions of TDOT.

Additional Opinions and Recommendations from Survey Respondents

Survey Findings

Awareness of Research Capabilities in Colleges and Universities

Survey respondents were asked about their personal interest level in partnering with universities. Most respondents answered favorably. Table B-7 shows how respondents answered this question. Less than eight percent (8%) of respondents answered below 50 as their personal interest level in partnering with universities. Over sixty-five percent (65%) of respondents indicated their personal interest level in partnering with universities as being above 75.

TABLE B - 7 WHAT IS YOUR PERSONAL INTEREST LEVEL IN PARTNERING WITH UNIVERSITIES?

	Total	TDOT	Other DOTs
0 - 25	5%	4%	5%
25 - 49	3%	4%	0%
50 - 74	22%	26%	14%
75 - 100	70%	65%	81%

Respondents were also asked about their awareness of research capabilities across the state and beyond. Figure B-12 shows how aware respondents are of research capabilities. The question was posed as a check multiple boxes style question. By a large margin, the option, "worked with multiple researchers across multiple institutions," was the most frequently picked answer choice, indicating a large degree of research awareness.
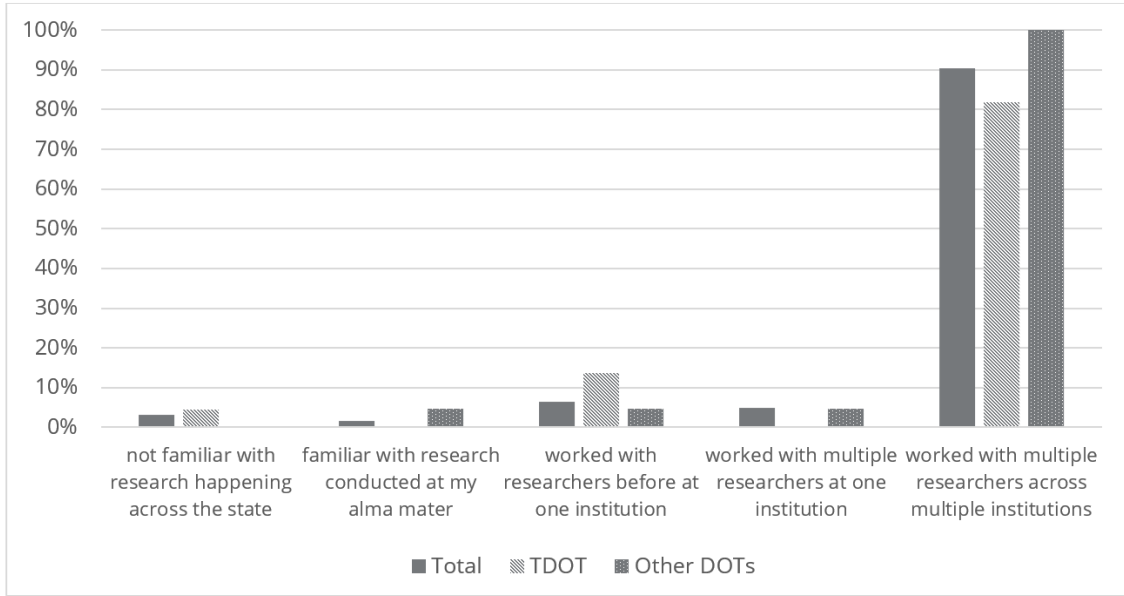
Figure B - 12 To what Extent are you aware of Research Capabilities in Colleges and Universities across the State and Beyond?

Barriers to Successful Research Collaboration with Universities

Respondents were asked, in the form of a fill-in-the-blank question, whether they have experienced or are aware of barriers to successful research collaboration with universities. Figure B-13 shows respondent answers separated into either yes or no. TDOT had 48% of respondents indicate yes, or some version thereof, while 86% respondents from other DOTs indicated the experience of barriers. Part of this discrepancy can be attributed to the different demographics of TDOT respondents versus respondents from other DOTs. Other DOT respondents were from research offices at their DOTS, while at TDOT, the survey was taken by members of multiple divisions and included respondents who had not been involved with research projects.
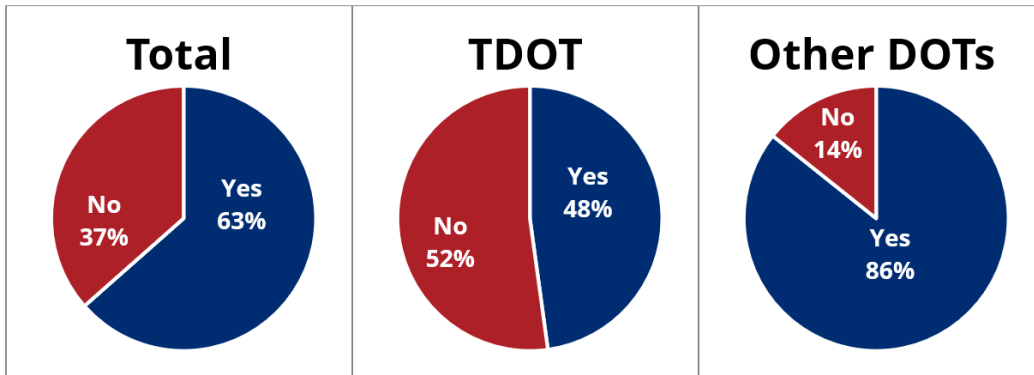
Figure B - 13 Have you experienced or are you aware of barriers to successful research collaboration with universities?

Responses indicating yes, the respondents had experienced or were aware of barriers to successful research collaboration with universities were coded into the following categories shown in Figure B-14. Timeline was the issue most frequently mentioned. Twenty-eight percent of respondents mentioned timeline. Practicality was mentioned by 20% of respondents who

answered affirmatively about experiencing barriers. Eighteen percent of respondents mentioned budget. Ten percent of respondents mentioned intellectual property. Ten percent of respondents mentioned differing priorities. Eight percent of respondents mentioned university staffing.
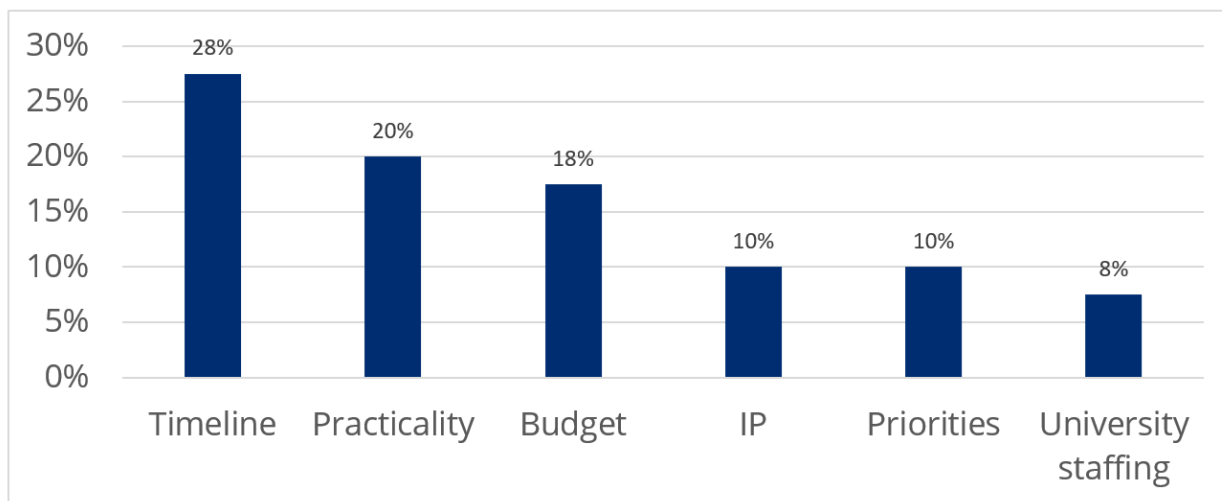
Figure B - 14 Percentage of total answers listing certain barriers to successful collaboration

Improving Collaborations with Universities
Survey respondents were asked if they have any recommendations on how TDOT or other State DOTS could increase and/or improve collaborations with universities.

Answer Themes:

1. Develop relationships between DOT employees and university faculty
2. Conduct meetings to brainstorm research ideas
3. Match project funding decisions with university calendars
4. Simplify the process
5. Create a standard written process for how research is conducted and increase consistency year-to-year

Sample of Quotes about Improving Collaborations with Universities:
- "In [state] we have helped the DOT find value in the fact that when we partner with our universities on projects we are exposing students to transportation engineering and it can encourage them to move in that direction with their career."
- "Visit the universities and talk to researchers to see what they are doing and what they are capable of."
- "Regular meetings with University partners to build relationships and review expectations. Meet and greets with departments to know and understand expertise and capabilities."
- "Dramatically shorten the length of reports. Include executive summaries and high-level infographics. Include ready-made summary slide decks."
- "Regular and on-going communication. A strong relationship where the needs of both the DOT (practical, applied research) and university (publishing, providing opportunities for students) are understood and appreciated is critical."

The final question of the survey asked respondents, "Is there anything else you'd like to share at this time." Particularly informative responses are provided below.

- **"Innovative ideas can come from every level within an organization**. DOTs need find a way to encourage and tap into this latent pool solutions to everyday problems as well as more complex issues that plague the transportation industry."
- "Providing better instruction on invoice and progress report submissions to universities and agency project lead would be helpful. Having a point of contact within research office would also be helpful."
- "DOT/university partnerships take time to cultivate. **Open, honest communication is important**. When we work together collaboratively, the transportation research community can accomplish a lot."
- "Work with AASHTO RAC. Contact your peer states. Other DOTs will share our materials and practices."

Conclusions

Key Findings

- Formal committees and panels are used at many DOTs during proposal evaluation, project oversight, and implementation
- Providing clear, consistent guidelines for every step of the research process aids implementation efforts and streamlines the research process

Key Recommendations

- Communication is key at every step of the project
- Enhance understanding, transparency, and consistency of TDOT research projects
- Provide consistent, clear guidelines about project management and assigned roles
- Consider utilizing an implementation committee to push for and monitor implementation at every stage of the project
- Have both technical leadership and research office leadership guiding the project, with clear and defined roles for members of the project team
- Increase transparency in the proposal review process

Appendix C. Researcher Survey Instrument

Note: The email text that was sent to participants is provided before the survey instrument.

Email invite to Tennessee researchers

Hello.

TDOT has retained researchers at Vanderbilt University, the University of Memphis, and Tennessee State University to conduct a study entitled 'Innovation to Implementation' with the intent of improving TDOT's ability to better put innovative research supported by the State Planning and Research (SPR) program into practice. The researchers are interested in obtaining your perspective via an online survey regarding the processes and activities involved in SPR Program-funded research projects to help in identifying best practices, opportunities, and challenges for TDOT. We are specifically focused on policies and activities associated with generating ideas and research needs statements, the selection and award process, program management, communication, research project oversight and management, handling of reporting and deliverables, and ultimately potential implementation of the research results.

You have been identified by the research team as an individual that may be able to provide valuable input as we gather information from stakeholders.

You may access the survey via the link below. All responses will be anonymous. The researchers have selected the appropriate settings to anonymize responses so that your IP address will not be collected. We will not collect your name or any other data that can be used to link your responses to you. We encourage you to participate and to provide candid feedback.

Survey link: https://redcap.vanderbilt.edu/surveys/?s=3P9TD8TWEH

If you have any questions regarding this survey or how the data will be collected or reported, please contact the project PI, Dr. Janey Camp at janey.camp@vanderbilt.edu.

Thanks,

Janey Camp

Innovation to Implementation

You have been invited to provide your perspectives on the processes and activities related to the state DOT's State Planning and Research (SPR) program.

This survey is part of a study entitled "Innovation to Implementation" which is intended to improve TDOT's ability to better put research into practice.

Thank you for your time and effort to provide input to assist with this project.

What university do you affiliate with?

_____

What do you consider your area(s) of expertise to be?
 (mark all that are applicable)

- ☐ Administration
- ☐ Aviation
- ☐ Bridges and Other Structures
- ☐ Construction
- ☐ Cyber-physical Systems
- ☐ Data/Information and IT
- ☐ Design
- ☐ Earthquake/Seismic Design
- ☐ Economics/Finance
- ☐ Education and Training
- ☐ Energy
- ☐ Environment/Sustainability
- ☐ Freight Transportation
- ☐ Hydraulics and Hydrology
- ☐ Human Factor/Behavior
- ☐ Law/Policy
- ☐ Maintenance and Preservation
- ☐ Marine Transportation
- ☐ Materials
- ☐ Operations and Traffic Management
- ☐ Pavements
- ☐ Pedestrians and Bicyclists
- ☐ Pipelines
- ☐ Planning and Forecasting
- ☐ Public Transportation
- ☐ Public Health
- ☐ Rail
- ☐ Resilience and Sustainability
- ☐ Safety
- ☐ Security and Emergencies
- ☐ Society
- ☐ Terminals and Facilities
- ☐ Other
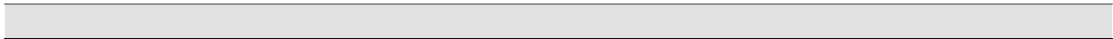
To what extent have you participated in state DOT sponsored research program(s) previously? (mark all that are applicable)	☐ Submitted research ideas ☐ Submitted one or more research proposals, but was not selected to do research ☐ Conducted or participated in research for the state DOT ☐ Was not aware of opportunity to participate in research partnership with the state DOT
How did you find out about the research opportunity/solicitation?	○ Email from state DOT ○ State DOT website ○ Colleague or friend at your university or another university ○ Other
Did you have interactions/communications with state DOT staff prior to submitting a proposal to address any questions you may have had about the research (on any proposal)?	_____
Do you feel there is adequate transparency in the process for evaluating research proposals? If not, why so?	_____
What recommendations would you make for improving the process of proposal submission and/or review?	_____

Do you feel you were "on the same page" with the state DOT project manager/staff member(s) during the project? If not, can you explain?	_____
Did the state DOT project manager/staff member(s) understand the linkage between research results and implementation?	_____
Did you receive adequate feedback/direction during the project from the state DOT project manager/staff member?	_____
Were there any factors that hindered the conduct of your research with the state DOT? If so, what were they?	_____
What were the outcomes/deliverables that came from your study/studies?	☐ Report(s) to state DOT/FHWA ☐ Peer reviewed journal article(s) ☐ Conference presentation(s) ☐ Other
Was there an implementation plan for any of your projects? Yes/No - please provide example if possible.	_____
Do you feel like your research became just another report on a shelf or do you think the state DOT(s) are using the results of your findings to improve operations/maintenance activities, technology, design, etc.?	_____
Do you know if any of your findings/results have been implemented by the state DOT sponsor or others into day-to-day practices? If so, please explain.	_____
Have you worked with more than one state DOT on research? If so, how many different state DOTs?	_____
What is your level of interest level in conducting research sponsored by the state DOT in the future?	Not Interested Extremely Interested ▭▭▭▭▭▭▭▭▭▭▭▭▭▭▭▭▭▭ *(Place a mark on the scale above)*

Which of the following state DOT divisions do you feel could benefit from research?

- ☐ Construction
- ☐ Hydraulics and Hydrology
- ☐ Safety
- ☐ Planning
- ☐ Structures
- ☐ Materials, pavement, etc.
- ☐ Traffic Operations
- ☐ Aeronautics
- ☐ Maintenance
- ☐ Geotech
- ☐ Environmental
- ☐ Human Resources
- ☐ Information Technology
- ☐ Other

Which "Other" state DOT divisions do you feel could benefit from research:

_____

From this list of innovation areas, which should be prioritized based on potential for translation of research to DOT practice? Place a number next to each priority. (1 = high and 5 = low priority)

	1	2	3	4	5	unsure
Administration	○	○	○	○	○	○
Aviation	○	○	○	○	○	○
Bridges and Other Structures	○	○	○	○	○	○
Construction	○	○	○	○	○	○
Cyber-physical Systems	○	○	○	○	○	○
Data/Information and IT	○	○	○	○	○	○
Design	○	○	○	○	○	○
Earthquake/Seismic Design	○	○	○	○	○	○
Economics/Finance	○	○	○	○	○	○
Education and Training	○	○	○	○	○	○
Energy	○	○	○	○	○	○
Environmental Sustainability	○	○	○	○	○	○
Freight Transportation	○	○	○	○	○	○
Hydraulics and Hydrology	○	○	○	○	○	○
Human Factor/Behavior	○	○	○	○	○	○
Law/Policy	○	○	○	○	○	○
Maintenance and Preservation	○	○	○	○	○	○
Marine Transportation	○	○	○	○	○	○
Materials	○	○	○	○	○	○
Operations and Traffic Management	○	○	○	○	○	○
Pavements	○	○	○	○	○	○
Pedestrians and Bicyclists	○	○	○	○	○	○
Pipelines	○	○	○	○	○	○
Planning and Forecasting	○	○	○	○	○	○
Public Transportation	○	○	○	○	○	○
Public Health	○	○	○	○	○	○
Rail	○	○	○	○	○	○
Resilience and Sustainability	○	○	○	○	○	○
Safety	○	○	○	○	○	○
Security and Emergencies	○	○	○	○	○	○
Society	○	○	○	○	○	○
Terminals and Facilities	○	○	○	○	○	○

Are there any specific activities or focus areas (beyond those listed previously) that you feel could benefit from research based upon your experience? If so, please explain.

_____

Have you experienced or are you aware of barriers to successful research collaboration with universities by state DOTs? If yes, please explain.

_____

Do you have suggestions on how state DOTs could increase and/or improve collaborations with universities?

_____

Do you have recommendations for improving implementation of research into practice by state DOTs?

_____

Is there anything else you'd like to share at this time?

_____

Thank you for your time and input!
If you would be interested in further sharing your experiences and/or participating in a forum/Peer Exchange focused on these topics, please click on the link below and it will open another window with an online form to provide your name and contact information. Someone from the research team may reach out to you.
Note: This information will not be linked to your survey answers.
Please don't forget to click "submit" before leaving the survey.

https://docs.google.com/forms/d/e/1FAIpQLScQJAy0j_Y7T8qmkL7z3pf2eR3aGMDSrTINuxl5ZPyF2_A9NA/viewform

Appendix D. Additional Researcher Survey Results

Characterization of Survey Participants

Survey participants were asked to indicate their university affiliation. A total of 38 researchers from 8 universities responded to the survey. The universities represented were:

- East Tennessee State University (1)
- Middle Tennessee State University (1)
- Tennessee State University (5)
- Tennessee Tech University (4)
- University of Memphis (5)
- University of Tennessee at Chattanooga (1)
- University of Tennessee at Knoxville (11)
- Vanderbilt University (6)
- [Blank (4)]

The researchers were then asked to select their area(s) of expertise from a list. The following areas were represented from the respondents:

- Administration (5)
- Aviation (2)
- Bridges and Other Structures (7)
- Construction (3)
- Cyber-physical systems (4)
- Data/Information and IT (8)
- Design (3)
- Earthquake/Seismic Design (2)
- Economics/Finance (3)
- Education and Training (10)
- Energy (2)
- Environment/Sustainability (8)
- Freight Transportation (5)
- Human Factor/Behavior (1)
- Hydraulics and Hydrology (3)
- Maintenance and Preservation (2)
- Marine Transportation (3)
- Materials (8)
- Operations and Traffic Management (7)
- Other (5)
- Pavements (4)
- Pedestrians and Bicyclists (3)
- Pipelines (1)
- Planning and Forecasting (3)
- Public Health (2)
- Public Transportation (6)
- Rail (2)
- Resilience and Sustainability (6)
- Safety (4)
- Security and Emergencies (2)
- Society (1)

The only unrepresented research areas in the survey were "Law/Policy" and "Terminals and Facilities". Table D-1 shows the number of faculty members from each university who indicated expertise in each of the listed research areas.

Number of Respondents									
	University								
Area of Expertise	ETSU	MTSU	TSU	TTU	UM	UTC	UTK	VU	Total
Administration			1		1		2	1	5
Aviation								1	1
Bridges and Other Structures		1		1	2		3		7
Construction	1	1		1					3
Cyber-physical systems							1	3	4
Data/Information and IT	1					1	3	3	8
Design					1		2		3
Earthquake/Seismic Design							2		2
Economics/Finance					2			1	3
Education and Training	1	1	2	2			3	1	10
Energy							1	1	2
Environment/Sustainability			1		1		4	2	8
Freight Transportation			1				1	3	5
Hydraulics and Hydrology					1		2		3
Human Factor/Behavior								1	1
Law/Policy									0
Maintenance and Preservation					1		1		2
Marine Transportation								3	3
Materials		1	1	3	1		2		8
Pedestrians and Bicyclists			2				1		3
Pavements	1	1		2					4
Operations and Traffic Mgmt			2	1			2	2	7
Pipelines								1	1
Planning and Forecasting					1		1	1	3
Public Transportation	1		2		1		1	1	6
Public Health					1	1			2
Rail								2	2
Resilience and Sustainability	1			1			1	3	6
Safety			1				1	2	4
Security and Emergencies								2	2
Society			1						1
Terminals and Facilities									0
Other			2	1	1		1		5
Areas represented	6	5	11	8	12	2	20	19	31

Communication Prior to Project

Participants were asked whether they had interactions/communications with TDOT staff prior to submitting proposals. There were 18 "yes", 5 "no", and 2 "sometimes" responses to this question. One respondent reported receiving inconsistent information from different groups within TDOT. Another respondent reported reaching out with questions to multiple people at TDOT but never receiving a response.

The next question asked "Do you feel there is adequate transparency in the process for evaluating research proposals? If not, why so?" The responses to this question were overwhelmingly negative, with 15 no's and only 6 "yes" responses. This was generally the case regardless of the respondent's involvement with TDOT research, as shown in Figure D-1.
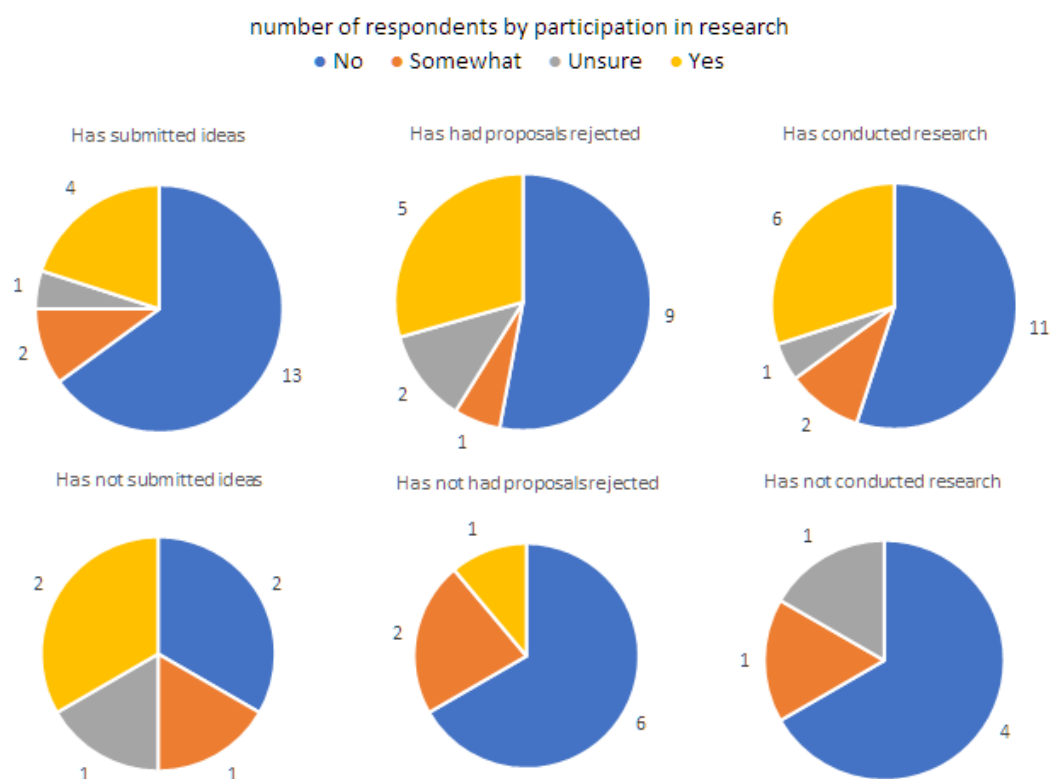
Figure D-1. Research Participation effect on Perception of Transparency in Proposal Evaluation

The reasons that respondents say they feel that TDOT is not transparent in its proposal evaluation process are summarized below:

- Favoritism toward experienced PI's, major universities (2)
- Lack of internal communication at TDOT (1)
- Feedback only by request and largely vague (8)
- Little to no communication after submission (2)
- No announcement of winning proposal (2)

Implementation

<p align="center">**TABLE D-2. DETAIL OF IMPLEMENTATION BREAKDOWN**</p>

Of those who said the state PM understood the link to implementation, was there an implementation plan for your project(s)?		Of those who had an implementation plan for any project, is your research being implemented?		Of those who said the state PM understood the link to implementation, is your research being implemented?	
Blank	3	Blank	2	Blank	2
No	4	No	3	No	6
Sometimes	1	Unsure	3	Unsure	6
Yes	9	Yes	2	Yes	3
Total	17	Total	10	Total	17

Researcher Opinions and Suggestions

When asked to rate their interest in performing TDOT-sponsored research in the future on a scale of 0 to 100, the responses were generally positive. Responses were broken down by potential influencing factors: previous participation in TDOT research, communication before proposal submission, perception of transparency in proposal selection process, feedback and communication during the project, deliverables required, presence of implementation of results, work performed for multiple DOTs, and university affiliation (Table D-3).

TABLE D-3. FACTORS INFLUENCING INTEREST IN FUTURE RESEARCH

Factor		Interest Level Average	Count	Std. Dev.
Participation	Not selected	91.0	18	13.20
	Selected	89.6	22	15.83
	Unaware	100.0	1	--
Communication before Proposal submission	Good	90.7	18	14.24
	Poor	98.5	2	2.12
	Sometimes	91.5	2	12.02
	None	86.8	4	13.25
Adequate Transparency in Selection Process	Yes	94.0	6	7.13
	No	90.3	15	12.21
	Somewhat	96.7	3	4.93
	Unsure	75.0	2	35.36
Adequate feedback/communication	Blank	81.5	13	22.09
	No	83.0	1	--
	Sometimes	100.0	1	--
	Yes	91.1	17	14.56
Deliverables	Reports	90.1	18	14.06
	Journal Articles	87.5	13	17.88
	Presentations	89.6	17	14.31
	Other	100.0	3	0.00
Implementation	Yes	99.0	4	1.41
	No	89.0	7	13.56
	Unsure	85.5	6	18.97
Involvement with Multiple DOTs	Just TDOT	87.5	19	18.79
	Multiple DOTs	90.5	10	15.80
University	ETSU	100.0	1	--
	MTSU	100.0	1	--
	TSU	86.6	5	21.56
	TTU	97.0	4	4.24
	UM	95.3	4	7.09
	UTC	73.0	1	--
	UTK	80.0	9	21.99
	VU	91.0	6	14.67
	(blank)	50.0	1	--
Total		87.2	32	18.07

Notably, respondents who have seen their research implemented are much more interested in performing future research than those who have not. Those who are unsure if their research is being implemented are even less interested.

Participants were also asked to rate the priority of the following areas based on potential for translation of research to DOT practice. This was on a scale of 1 to 5, with 1 being highest priority. The results are shown below (Table D-4).

TABLE D-4. PRIORITIZING INNOVATION AREAS

Rank	Innovation Area	Average	Count	No. "unsure"	No. blank
1	Pavements	2.375	24	3	11
2	Marine Transportation	2.444	18	7	13
3	Data/Information and IT	2.500	24	3	11
4	Materials	2.500	22	5	11
5	Education and Training	2.565	23	2	13
6	Operations and Traffic Management	2.577	26	2	10
7	Bridges and Other Structures	2.583	24	4	10
8	Construction	2.625	24	3	11
9	Pipelines	2.647	17	7	14
10	Freight Transportation	2.667	24	3	11
11	Resilience and Sustainability	2.680	25	1	12
12	Safety	2.692	26	1	11
13	Pedestrians and Bicyclists	2.696	23	3	12
14	Environment/Sustainability	2.750	24	2	12
15	Design	2.800	25	1	12
16	Cyber-physical systems	2.810	21	3	14
17	Public Health	2.810	21	4	13
18	Public Transportation	2.857	21	3	14
19	Security and Emergencies	2.864	22	2	14
20	Aviation	2.889	18	9	11
21	Earthquake/Seismic Design	2.905	21	4	13
22	Hydraulics and Hydrology	2.905	21	5	12
23	Maintenance and Preservation	2.913	23	3	12
24	Economics/Finance	2.950	20	4	14
25	Energy	2.952	21	4	13
26	Planning and Forecasting	2.955	22	3	13
27	Society	3.048	21	3	14
28	Human Factor/Behavior	3.050	20	4	14
29	Terminals and Facilities	3.050	20	4	14
30	Rail	3.095	21	4	13
31	Law/Policy	3.105	19	5	14
32	Administration	3.733	15	12	11

The responses from these two questions were checked for bias to see if respondents disproportionately favored their own area of expertise. No obvious bias was found.

Participants were also asked if they have experienced or were aware of barriers to successful collaboration. Responses were:

- Schedule inconsistency (3)
- Vague proposal selection process (1)
- Funding and budgeting issues (3)
- Topics already covered by existing literature (1)
- TDOT preference for bigger universities (1)
- TDOT tendency to fund less-qualified universities (1)
- Limited DOT involvement in research process (3)
- Too prescriptive with research needs (1)
- TDOT hiring consultants for things universities could do (1)
- Limited internal communication within TDOT (1)

Appendix E. Innovation Forum Agenda

Innovation to Implementation Forum
(VIRTUAL EVENT)
March 31, 2021
Agenda

8:30 – 10:00 a.m. **Virtual Poster Session/Exhibitor Showcase**

10:00 -11:00 a.m. **Welcoming Remarks and Tennessee's State of Research (, FHWA and/or research team members)**

Welcome remarks and introductory overview about the purpose and goals of the forum. Provide an overview of TDOT's current state of research and SPR Program
- o *Clay Bright, TDOT Commissioner; Preston Elliot, Deputy Commissioner*
- o *Pam Kordenbrock, FHWA – TN Division Administrator*
- o *Research Team*

11:00 – 11:30 a.m. **Research Framework/Database Presentation – Capabilities across TN**

The research team will present the research clearinghouse and framework for participants, explains methodology and how it can be used/utilized by both researchers and TDOT staff.

11:30 – 12:00 p.m. **Best Practices for Innovation to Implementation**

Research team members will provide overview of best practices from literature review, information from surveys, and opportunities identified from the research.

12:00 – 1:00 p.m. *LUNCH BREAK*

1:00 – 2:00 p.m. **Putting Innovation into Practice – Prior and Ongoing Research Partnerships between state DOTs and Research Institutions/Successful Innovative Projects**

Panel and presentations of (3) state DOT staff members and (3) research partners on prior and ongoing research partnerships where innovation has led to improved transportation system design, operations, safety, or management including discussions on lessons learned and best practices utilized.

TDOT Innovation to Implementation Forum - Feedback

Block: General Overview (27 Questions)

Start of Block: General Overview

Q1
Please indicate the type of organization you represent.

◯ State Transportation Agency

◯ Academic Institution

◯ Vendor or Exhibitor

◯ Other _____

Q20 How did you hear about the Forum?

◯ Email

◯ Word of mouth

◯ Save the date or other flyer

◯ Other _____

Q2 Which of the sessions did you participate in as part of the Forum on March 31, 2021?

☐ Poster and Exhibitor Session

☐ Welcome and State of Research in Tennessee

☐ Overview of Best Practices

☐ Research Framework and Database Presentation

☐ Panel Session on Putting Research into Practice

Q5 How many poster or exhibitor "booths" were you able to visit during that session?

_____

Q8 Considering your complete experience at our forum, how likely would you be to recommend a similar event to a friend or colleague?

○ Extremely likely

○ Somewhat likely

○ Neither likely nor unlikely

○ Somewhat unlikely

○ Extremely unlikely

Q29 To what extent did the Forum meet your expectations?

○ Exceeded expectations

○ Met expectations

○ Did not meet expectations

○ Unsure

Q4 Were you a presenter in the poster/exhibitor session?

○ Yes

○ No

Q28 How many individuals visited your booth during the poster/exhibitor session?

_____

Q9 Please rate the research team's organization and facilitation of the event.

0
1
2
3
4
5
6
7
8
9
10

Q10 Please rate your level of satisfaction with the following aspects of the Forum.

Q11 Registration

○ Extremely satisfied

○ Somewhat satisfied

○ Neither satisfied nor dissatisfied

○ Somewhat dissatisfied

○ Extremely dissatisfied

Q3 Ease of use of the virtual event website

○ Extremely satisfied

○ Somewhat satisfied

○ Neither satisfied nor dissatisfied

○ Somewhat dissatisfied

○ Extremely dissatisfied

Q12 Welcoming remarks and State of Research for TN

○ Extremely satisfied

○ Somewhat satisfied

○ Neither satisfied nor dissatisfied

○ Somewhat dissatisfied

○ Extremely dissatisfied

Q13 Best Practices presentation

○ Extremely satisfied

○ Somewhat satisfied

○ Neither satisfied nor dissatisfied

○ Somewhat dissatisfied

○ Extremely dissatisfied

Q14 Research Framework and Expertise Database

◯ Extremely satisfied

◯ Somewhat satisfied

◯ Neither satisfied nor dissatisfied

◯ Somewhat dissatisfied

◯ Extremely dissatisfied

Q15 Panel Discussion on Putting Research into Practice

◯ Extremely satisfied

◯ Somewhat satisfied

◯ Neither satisfied nor dissatisfied

◯ Somewhat dissatisfied

◯ Extremely dissatisfied

Q16 Time allocated for the Poster/Exhibitor Session

◯ Extremely satisfied

◯ Somewhat satisfied

◯ Neither satisfied nor dissatisfied

◯ Somewhat dissatisfied

◯ Extremely dissatisfied

Q6 Did you learn anything new about TDOT's SPR program in the State of Research presentation?

○ Yes

○ Maybe

○ No

Q27 Please share what you learned from the overview of the State of Research.

_____

Q18 Would you like to see a similar event hosted annually or bi-annually where research is shared across TN?

○ Yes, annually

○ Yes, bi-annually

○ No

Q19 If a similar event were to be held on a regular basis, which types of sessions would you want it to include?

☐ Poster session

☐ Exhibitor session

☐ Overview of the State of Research

☐ Networking

☐ Presentations of Best Practices

☐ Panels showcasing collaborations

☐ Other _____

Q21 Please indicate the level of importance that you placed on each of the following reasons to attend the Forum.

	Very Important	Somewhat Important	Not Important	Unsure
Gain more subject matter expertise	○	○	○	○
Participate in networking	○	○	○	○
Discover new products, services, or technology	○	○	○	○
Learn more about TDOT's research program	○	○	○	○
Learn more about implementing research	○	○	○	○
Learn about research happening across TN	○	○	○	○
Share my product, services, or research with others	○	○	○	○
Other	○	○	○	○

Q7 Please rank the sessions in order of most beneficial to least beneficial (with 1 being most beneficial and 5 being least beneficial).

_____ Poster/exhibitor session
_____ Welcome session
_____ Best Practices session
_____ Framework and Database session
_____ Panel session

Q24 What did you most like about the Forum?

_____

Q25 What did you least like about the Forum?

_____

Q26 What would you like to see included in future events like this (if TDOT or other state DOTs were to host them)?

_____

Q22 If there are any additional comments you'd like to leave for the team about the Forum, please provide them here.

_____

_____

_____

_____

_____

End of Block: General Overview

Appendix G. Peer Exchange Agenda

Innovation to Implementation Forum
Peer Exchange
(VIRTUAL EVENT)
April 1-2, 2021
Agenda

April 1 - Peer Exchange Day 1

8:30-8:45 a.m.   **Peer Exchange Kickoff (TDOT leadership, FHWA, and research team)**

- *Provide welcome and overview about the purpose and goals of the forum, overview of activities and expectations of participants.*

8:45-9:45 a.m.   **Working Session – Facilitating Collaborative Initiatives and Making the Business Case for Sponsored Research – Identifying Research**

- *FHWA perspective, TDOT perspective, University perspective*
- *What makes for a good research project?*
- *How are Research Needs Statements Identified and Facilitated?*
- *Are there Certain Characteristics of a Project or Types of Projects that More Easily Lends toward Implementation (e.g., differences in division needs, etc.)*
- *Who participates and are there state DOT divisions/leaders that could/should be sponsoring research given today's emerging technologies and opportunities?*
- *Non-solicited research*

9:45-10:00 a.m.   Break

10:00 – 10:30 a.m.   **Report Out from the Breakout Sessions**

10:30 – 11:30 a.m.   **SPR Program Administration (Part A – Round Robin) – Facilitating Research (Internal, External – Universities and Consultants)**

- Calls for Proposals
- Review Process/Review Committee
- Contracting Mechanisms/Processes

11:30 – 12:30 p.m.   *LUNCH*

12:30 – 1:30 p.m. **SPR Program Project Management (Part B – Facilitated Discussion) – Best Practices/Lessons Learned (share out activity)**

- *What works? What doesn't? What are the challenges? What are key implementable actions that may lead to more success for TDOT implementing research?*

1:30 - 2:00 p.m. **Wrap Up and Takeaways**

April 2 – Peer Exchange Day 2

8:30-9:00 a.m. Recap/Welcome

9:00-10:00 a.m. **Performance Metrics/Deliverables/Actual Implementation**

- Workshop/Symposium of Research
- Clearinghouse of past research on website
- Tracking Implementation

10:00-11:00 a.m. **SWOT Analysis**

- What are key strengths, weaknesses, opportunities and threats for the SPR program to move toward more effective implementation of research?

11:00-12:00 p.m. Wrap Up and Closing

Appendix H. Jamboards from Peer Exchange

Ideas for Research Opportunities

- Improved Methods for QC/QA for Construction
- Improving Infrastructure Performance
- Resiliency
- Better understanding of Impacts of Extreme Weather on Transport Infrastructure
- Environmental benefits and climate resilient
- Earthquake Hazard
- Would be interested in more safety research
- Pedestrian Safety
- Safety of micro mobility services - scooters in particular
- Best practice work zone safety on a non-divided highway construction project
- Comprehensive Highway Information Management
- Structural Health Monitoring
- Connecting IT systems for better communication
- Direct sensing to augment more expensive sensing networks
- Bridge Monitoring
- Designing for freight intensive corridors
- Bike/Ped transit opportunities
- Innovative Materials
- Drones
- Freight Data Improvement
- Transportation Systems Management and Operations (TSMO)
- Using Ultra High Performance Concrete in bridge deck repair
- studying performances measures for various asphalt mixes and when maintenance is required to maximize pavement life.
- prepping the current transportation network for Connected/Automated Vehicles
- Access of freight rail corridors for transit service
- Truck Parking
- Use of GPR for pavement health assessment
- Demonstration projects
- Infrastructural changes to DOT methodologies (i.e., DMV) in response to disruptive technologies.
- Cybersecurity of ITS infrastructure
- Data Governance/Data Management
- Pilot projects
- project management platforms
- 10 ways to Tech Transfer completed research
- standardizing performance measures not per project but national level
- Engaging transportation staff in greater participation with the research program
- Quantifying equity metrics into project selection processes.
- More Targeted Safety Analytics
- Reevaluate how we quantify the benefits of Research Products / Solutions.

What makes for a good research project?

Regular interaction with Subject Matter Experts at DOT that manage the project toward implementation.

Improves safety

Linkages between problem statement development and implementation

Clearly laid out plan to accomplish the research with a good budget and timeline

Collaborative effort - multiple groups/divisions/agencies involved

Consider implementation from the start with those who will be implementing the results pushing in forward and engaged through implementation.

Flexibility to expand on the research question to answer further questions that arise along the way.

clearly defined goals with actionable outcomes

The right project manager/lead staff

Adherence to schedule/timelines

Research oversight

Experience in the area of research by the PIs

Idea of what success looks like

input/support from cabinet-level management

Significance of the research – benefit cost ratio, quantitative benefits (time, money etc) and/or qualitative benefits (policy, spec…etc)

End deliverables and related implementation plans are considered early in the process.

Implementable

Active oversight from Lead Staff

Aligned with the needs of the state and the mission of the agency

Probability of Implementation

A strong subject matter expert that expressed the need for the research topic within the Department

Those with a vested interest engaged through implementation.

PIs with refereed publication records in the area of research

Support for end using offices

Addressing a need and starting with the end in mind.

an implementation strategy

Well-defined scope of work

Has a project champion

Clearly defined goal(s)

Expectations/Objectives are Understood

Identify the Tangible Benefits on the Front End (Begin with the End in Mind)

Well defined scope

Research objectives are met by the project

Effective communication of findings

Need / Urgency / Importance of the Research Idea

Projects that will have impact. This can be projects that will result in changes in Codes for design of bridges

Engaged technical staff

Responding to DOT needs

Project understanding and strong communication between the Department and the university staff performing the research

Defined roles for each member of the research team

Has a good ROI

Management support

Ownership/support outside of the research office.

Clear implementation plan

Involved project champion

Good communication and feedback from Lead Staff to PIs.

Shareable & digestible research results.

Database of Expertise and Leveraging It

UMass Transportation Center has a database and highlighted researchers monthly to showcase research

Caltrans has a research database that we have had for 12 years. We use it as a project management tool for our research projects. It is a great idea to add a feature to track experts.

Expand PI pool

This will help to identify underused researchers, new researchers, and new research topic ideas.

MT does not have a database of researcher expertise, but this is a great idea. Our staff work with their counterparts at our in-state and some out-of-state universities, so this is already kind of happening in a more informal way.

Get some more behavioral research expertise.

Having the database would allow the agency to reach out to a PI in the academic community when an emergency situation arises. (landslide, earthquake, material properties, etc.)

Iowa - has system to create profile where people provide interest areas, etc.

Mechanisms for Non-solicited Research or Rapid Response Research

North Carolina has a technical assistance program with dedicated funding and dedicated work done by NC University.

KY sets aside a pot of SPR-B for "Unforeseen" needs that can be used by anyone who needs research assistance with quick response. Also, we fund other technical assistance (outside of research) with Universities on request.

MPART small projects - $50k or less, one year max duration

Shared faculty between universities and state DOT in Iowa - buyout some of faculty member's time

TDOT's new Quick Response Program. Has yet to be used long enough to show efficacy.

How does your DOT facilitate ongoing communication and relationship building with universities in the state?

Innovation Summit is designed to facilitate that process.

Webinars about process updates

Be part of as many progress/update meetings possible

Monthly touch-point meeting with university

Annual meeting with the university leadership (Between GTI Leadership and GDOT)

We host a Transportation Research Day where we showcase past research projects. At this showcase, many DOT staff are there and are able to network with academia.

I am trying to build a research showcase for subject matter with each university. Takes a lot of time.

On-site visits

NCDOT Road Shows / Web Based Meetings

Hosting regular, topic specific meet & greet gatherings at DOT

Meetings and visits

Site visits

MDOT SHA Office of Policy and Research Director is a member of the NTC Advisory Board

We have new profs come to visit staff. Usually, for longer term, there are already connections that have been made and don't require research staff.

We have (virtual) meetings with our universities 2 - 3 times per year at which the Research Office participates along with the universities. It's a good time to check in with one another, ask questions + maintain relationships.

To what extent do you partner with University Faculty to go after additional funding for implementation or additional research? This type of partnership could help build relationships.

What processes (written) are used consistently to guide and facilitate research collaboration?

GDOT-No written guidelines or protocol

We don't have any written protocol, but receive many calls asking how to be a part of the program. Our office facilitates an introduction with the relevant subject matter expert within the department and hopefully the spark appears.

If we have a new researcher, we may pair them with a seasoned researcher at another university for their first project.

What can be used to facilitate collaboration with multiple universities (if you think they're beneficial)?

We currently use the Innovation Summit to encourage University collaboration.

If receiving multiple proposals from an RFP, we will often select two or more and ask the individual PIs to submit a joint proposal. This allows inclusion of the best aspects of each individual proposal.

MDT agrees with IA, we don't want to double up on IDCs and make sure we don't.

TDOT Peer Exchange - Day 1 Takeaways

Showcasing Research Projects

More discussion on how to get to successful yearly 'expo' events is needed before they can be implemented.

Considering adjusting our contract time to the academic calendar.

Create database of experts

Track experts in database. Add transparency on website.

Researcher expertise database is a good idea

Researcher evaluation process at the end of each project with input from research staff and SMEs

Want to dive into that report from UNC-Charlotte about Quantifiable Benefits of Research

Separate implementation program/funding

Contracting is very different state-by-state. More conversations needed!

I really liked the idea of a Podcast as a method of Technology Transfer / Information sharing.

Consider adding formal implementation program. Could be included in each project as earmarked funds or a separate program that completed projects are considered for.

would love a seperate webinar on the UNC Charlotte research

Evaluation of consultants

Evaluation process

Anonymous evaluation process to allow feedback to research team

Various ways of accepting research needs ideas

Management of the work program seems to vary as well - will have to look into different approaches.

Transparency of the Research Evaluation Process

Redact identifiable information when distributing proposals for review. Fantastic idea.

Risk Assessment for a PI Another great idea

Use a combination of Quantitative and Qualitative Data to improve the research process. Follow-up with all parties.

Another key take away from yesterday is that communication between the researcher, DOT subject matter expert, and the Research Unit is critical in all phases of the research process (proposal, project, implementation).

Set up all project meetings at the kickoff

Provide opportunities for collaboration between research teams/universities

Interested in researcher risk assessment

How is success defined for a research project and an implementation project? Please provide a "definition" for what success means for each of these?

Research Project

Is the research product used to improve / optimize a process, decision, or methodology?

Did the project tangibly address the problem statement (provide an answer)? Can the customer use the information that has been provided?

Research objectives were met

Implementable deliverables

Research Project: The contents of the project have been completed in a satisfactory manner (duration, budget, content).

Did the work answer the initial question?

The research might confirm that the way the process is currently being performed is accurate or could be improved. Sometimes the current process may be an over design leading to some cost savings with the research.

A path forward for further decision-making within the subject matter area for the DOT.

Objectives met

Easily shareable findings, whether they are conclusive or inconclusive.

Can I use these results to help the DOT Staff?

Original problem was accurately addressed

Products delivered matched the original problem statement, as developed by research customers.
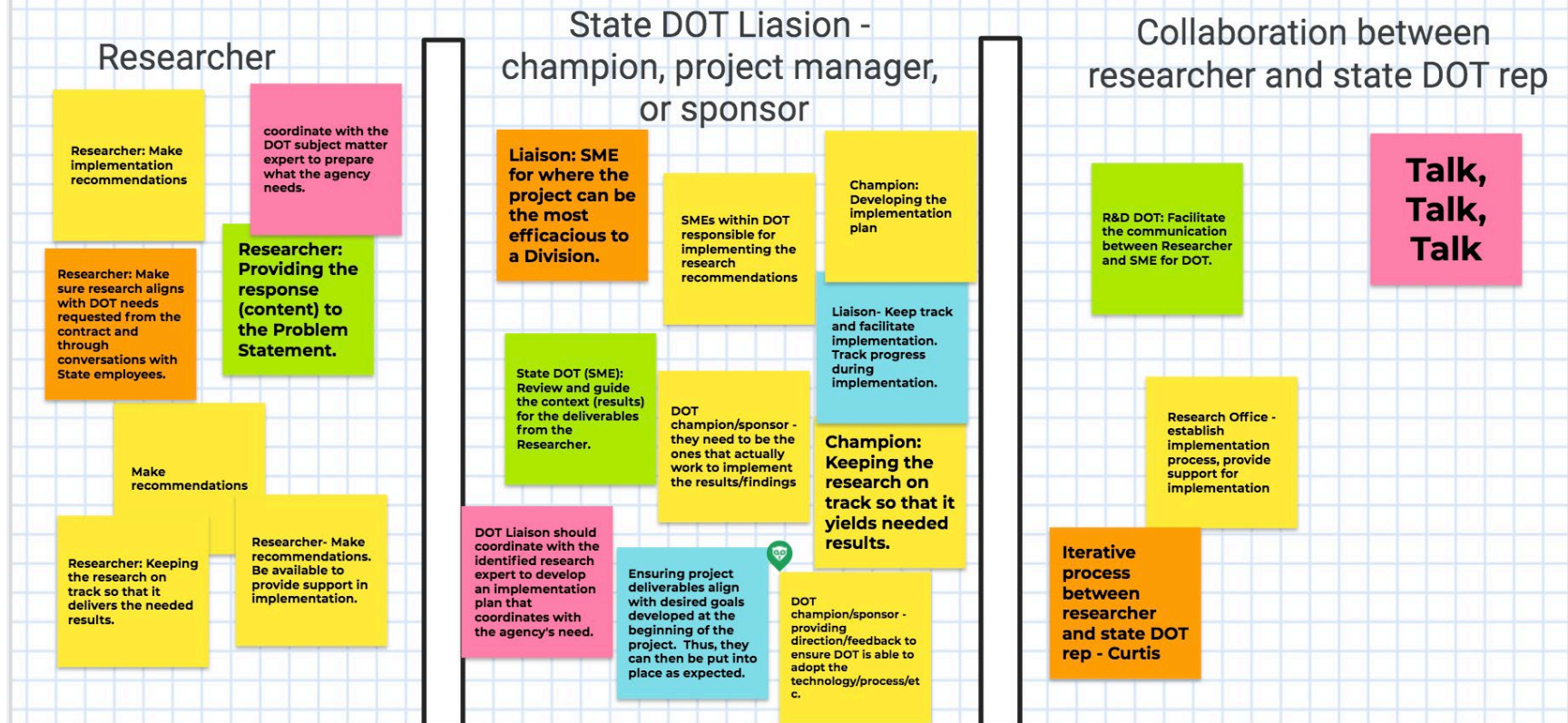
Results were integrated into DOT processes

Success is when the results are used/implemented. This could mean a follow-up project is initiated or, if just information is provided, that the information is used

Be able to publish the research.

Research leads to solutions that are implementable by a DOT and improve quality of transportation & transportation access

Implementation

Implementation: Can the results be used in a timely and satisfactory manner? (Time, technology, results, budget, practicality)

Some of the projects may not be implementable by DOT, it will be implemented by the Code officials.

Saved agency's time, money, improved safety, environment etc.

Technical program director be interested and willing to implement.

For implementation success, a current process is improved to improve safety, increase production and/or save funds.

DOT practice has been impacted: either with modifications or confirmation of existing practice.

A change in process or business model

Implementation is when a new technique or product has been incorporated into an organization as the ordinary way of doing things.

Impacted decision making at the DOT in some capacity

What are the roles and responsibilities regarding implementation? Consider the development of an implementation plan, timelines, funding, and tracking.

Researcher

Researcher: Make implementation recommendations

coordinate with the DOT subject matter expert to prepare what the agency needs.

Researcher: Make sure research aligns with DOT needs requested from the contract and through conversations with State employees.

Researcher: Providing the response (content) to the Problem Statement.

Make recommendations

Researcher: Keeping the research on track so that it delivers the needed results.

Researcher- Make recommendations. Be available to provide support in implementation.

State DOT Liaison - champion, project manager, or sponsor

Liaison: SME for where the project can be the most efficacious to a Division.

SMEs within DOT responsible for implementing the research recommendations

Champion: Developing the implementation plan

State DOT (SME): Review and guide the context (results) for the deliverables from the Researcher.

DOT champion/sponsor - they need to be the ones that actually work to implement the results/findings

Liaison- Keep track and facilitate implementation. Track progress during implementation.

Champion: Keeping the research on track so that it yields needed results.

DOT Liaison should coordinate with the identified research expert to develop an implementation plan that coordinates with the agency's need.

Ensuring project deliverables align with desired goals developed at the beginning of the project. Thus, they can then be put into place as expected.

DOT champion/sponsor - providing direction/feedback to ensure DOT is able to adopt the technology/process/etc.

Collaboration between researcher and state DOT rep

R&D DOT: Facilitate the communication between Researcher and SME for DOT.

Talk, Talk, Talk

Research Office - establish implementation process, provide support for implementation

Iterative process between researcher and state DOT rep - Curtis

What needs to be tracked and how is this done? What are the metrics used?

Project performance in general
Reports (interim, final) and deliverables
Implementation

Currently, we track schedule, reporting, and budget when a project is in progress. Progress reporting includes MPR/QPR, task reports, and any project specific deliverables. If deliverables are late, we withhold payment. When a project is 85% expended, we withhold payment until all final deliverables are accepted. We also track implementation activities.

In OK, we track percentage complete for each task of a project throughout the contract. That's how we try to keep a research 'on time"

Track % complete as well

Also want to track on-time completion.

We do evaluate the final reports - at project closeout, we evaluate the quality of each deliverable and if the research objective(s) were met to a satisfactory standard

MD requires quarterly meeting, quarterly progress reports, Final report and Summary. The SME or Technical Lead reviews each for completion.

We track the following: NCTE, deliverables submission, QPRs, Implementation, Communication. (We track other things as well)

We are working on performance measures this year. We stop payment when deliverables are late, but we don't track this. The panel, research project manager, and research program manager review all reports.

Iowa: Utilize QPRs for tracking the project.

CA-Track implementation progress, lessons learned, contacts for implementation

Would like to track the data that should be sent to Research Offices and Divisions as a result of the project completed. Being a public project, the data should be a public good.

We allow a month after the contract is complete for the research team to complete the final report. Our perspective is that the data collection/analysis is wrapped up at the end of the contract. Final Report is just the wrap up.

We track Implementation and the Measures of Success (Tangible Benefits)

Project progress: QPRs, quarterly meetings,

We also track budget as compared to task completion.

For Implementation survey form is used - type of implementation, what impacts/changes recorded (policy, procedure, specs., work method, std. drawing), types of benefits (time, money, improved safety, environment etc) are tracked.

In what ways can state DOT's leverage completed research projects (both outputs and outcomes)? What are some examples of successful practice in your state?

Public awareness/PR
Value added by research
Professional Development
State DOT staff
Practitioners

There are many ways that we use research but here are some of the high end items: Provide support for a Defensible Position; Update a Methodology (Evaluation) Practice, Evaluate a New technology (road design etc.), Communication of Safety concerns (i.e., Rail Road trespass)

Highlighted as news items/blog posts on DOT's main social media feeds or newsletters. (With the public-facing focus vs. academic/technical)

We have a poster board outside our auditorium where we share project posters, a required deliverable.

We have posted research results through our facebook page.

I liked the 2 page summary suggested yesterday for non-researcher audiences

TRB picks up our final reports for the TRB e-newsletter from our What's New RSS feed.

While not as highlightable, projects often update guidelines and procedures, which can be hard to quantify due to their indirect effects.

We coordinate with Materials Division for many projects involving concrete and asphalt. The results do not always require an implementation project, but can be applied to the mix design process and carried forward in that manner.

Greater leverage also comes from greater leadership buy-in and interaction with the Research Office.

We are considering adding a webinar presentation as a deliverable for each project. Grouping these together for a regular schedule of lunch n learns or similar.

We make sure our successes are shared widely. For example, when we have a high value research project, the notice goes out to management, in both our research newsletter and the planning newsletter. It also goes out to staff in our biweekly departmental newsletter.

Sharing on social media. For example we had a wrong way driver research and we made a video that was broadcast on the news. We also make videos and newsletter to inform DOT staff.

I would prefer that current and future research champions attend the research webinars.

Forum/Expo

We advertise webinars to staff and RAC.

We have listservs to share information. One listserv is set up to share final research products.

STRENGTHS

RAC Community

PEER EXCHANGES!

RAC CHATS!

We have each other! Would love to have a resource list of State DOT research/tech transfer/implementation contacts w/o having to find everyone, individually.

Strong Research Academic Partners

Top researchers within the state

Strengths: Provides a tangible mechanism for applied research. Research that will (should) eventually be used in DOT practices.

Able to mold research program for each agency due to "maximum flexibility" allowed by FHWA

Strength in lots of flexibility in running the office to suit Department needs.

Good stakeholder relationships

New director has a focus on innovation.

Support from leadership

Committed Champions/Technical Leads

Experienced Staff

Legislated funding source.

Flexibility in funding code/regulations

WEAKNESSES

Duplication of efforts.

leadership support

Some leadership can be apathetic to research success.

lack of champions

Who are the leading experts in transportation tech transfer?

Reliant on staff across the agency

Too few staff

Weakness: Rewards researchers with more experience to SPR program, therefore it is difficult (takes longer) for new researchers to participate.

Inconsistency between state programs & divisions.

Staffing

Limited number of staff

Sufficient resources: time and money

Lack of resources

OPPORTUNITIES

More funding for R&D in Biden's Infrastructure proposal

Ask Brian W. for a specific RAC chat(s) on some of the topics we have discussed at this peer exchange - esp. performance metrics + tech transfer

More leadership buy-in

recognition for good work

Better tech transfer

Great opportunity for NC DOT to host a webinar on that research study on performance metrics

Collaborative Peer Exchanges with other States

Can act as source of innovation at the DOT

More robust processes and procedures for implementation

60 second pitches/Elevator Talks (oh, wait-no more of those)

How about a TRB Annual Meeting session on Sharing Best Practices in Research Implementation & Tech Transfer?

Opportunities- use technology to improve tech transfer.

Get younger engineering staff on board with the research program.

Opportunities: Provides a good mechanism to merge high end research with tangible applications (fills the gap).

COMMUNICATION

Research as a priority at the organization level

Aligning program to support agency goals.

Opportunity in using dedicated tech transfer funding.

Networking with other research professionals

THREATS

Future pandemics (Ah!) that could impact funding

Reliant only on federal funding

Insufficient resources

limited funding for project implementation

Threat: Consistent Tracking mechanism for the use / applications of research.

Individual DOT website policies may not permit showcasing Tech transfer in the ways that some states are doing this - see New Jersey DOT T2 page - pretty amazing.

Researchers do not see final products considered for implementation

Knowledge Management

Perceived lack of value provided.

Reorganization

Loss of institutional knowledge

Threat of positions being taken away from office.

Staff turnover

Threat- Huge percentage of staff will be retiring in the next 5-10 years.

Lack of interest of senior staff

Lack of interest from senior management and peers

Appendix I. Compiled Links from Peer Exchange

- Jamboard: Research Opportunities - https://jamboard.google.com/d/1XEhULybXlNfc2uwmHXijmIbQTuV36mxRMayxQANMryQ/edit?usp=sharing

- Jamboard as a parking lot for Ideas, Questions, Etc.   The link is here: https://jamboard.google.com/d/1XOzGf_U3wvz3XZTkJpKI9rELBWFd5G-TAlFqT8iQZ4E/edit?usp=sharing

- Jamboard: Project Management End of Project - https://jamboard.google.com/d/1DdeiIJtGHciX1iukPZUeAyojG0NHuSRhEic0eSRIDRc/viewer?f=1

- Massachusetts - How do you manage your researcher distribution lists: - https://www.umasstransportationcenter.org/assnfe/SearchMembers.asp

- NCDOT's program and process slides: https://connect.ncdot.gov/projects/research/ResearchAnalysis/Research%20Presentation%20-%20General%20Overview.pdf

- Iowa DOT Research Development Process: https://iowadot.gov/research/Process/Development-Process

- Montana MDT Research Solicitation: https://www.mdt.mt.gov/research/unique/solicit.shtml

- Georgia GDOT
  - http://gti.gatech.edu/content/working-gdot-project-development-process
  - http://www.gti.gatech.edu/content/working-gdot

- Iowa DOT Annual Calendar: https://iowadot.gov/research/pdf/Annual_Research_Calendar.pdf

- Maryland MDOT SHA's proposal guidelines on our website - https://www.roads.maryland.gov/OPR_Research/Guidelines-for-Proposals.pdf

- Iowa DOT Proposal Guidelines: https://iowadot.gov/research/Process/Proposal-Deliverable-Guidelines

- Montana (MDT) Proposal Guidance: https://www.mdt.mt.gov/other/webdata/external/research/docs/proposal.pdf

- Iowa DOT Roles & Responsibilities: https://iowadot.gov/research/Programs-and-Partnerships/Roles-and-Responsibilities

- Montana Technical Panel Exit Survey:
https://forms.office.com/Pages/ResponsePage.aspx?id=mEypBw_zu0q9ftY_hyDcAi8rFliA4QpOtiB_JW4GcaVUQzhRS0RTSEUwQU5MUjVWOFJIM1Q3QU1MMy4u

- Montana Researcher Survey:
https://forms.office.com/Pages/ResponsePage.aspx?id=mEypBw_zu0q9ftY_hyDcAi8rFliA4QpOtiB_JW4GcaVUOE5JTUlMMFVCQzJNSlpQR01HRVMzMUxHTS4u

- North Carolina NCDOT Customer Service Survey:
https://forms.office.com/Pages/ResponsePage.aspx?id=3IF2etC5mkSFw-zCbNftGSrXIbnOZiVOgNHyVVi0V2NUNlFaOUg2SDRVNjM0S1k5WVVaQzFIWVlTWC4u&wdLOR=c5BFBE175-7488-4076-8521-9D47CA28B978

- North Carolina NCDOT Researcher Survey:
https://forms.office.com/Pages/ResponsePage.aspx?id=3IF2etC5mkSFw-zCbNftGSrXIbnOZiVOgNHyVVi0V2NUMVJVSTM4VVkxNEtLUzhGQUlYRVo4S0o4RC4u&wdLOR=cF587236D-3C46-4841-906D-C02BAA8B8221

- FHWA 508 - https://www.fhwa.dot.gov/508/

- Maryland MDOT SHA shares information on the website:
https://www.roads.maryland.gov/mdotsha/pages/oprreports.aspx?pageid=367&SA=Program%20Information

- Montana MDT Report Guidelines (508 compliance is addressed report writing requirements) -
https://www.mdt.mt.gov/other/webdata/external/research/docs/report_guidelines.pdf

- California Caltrans week-long conference: https://caltrans-innovation-expo.constantcontactsites.com/day-1

- Iowa DOT has a symposium every other year on DOT research projects hosted through ISU - https://intrans.iastate.edu/events/midcon2019/

- North Carolina NCDOT 2020 Research & Innovation Summit:
https://connect.ncdot.gov/projects/research/Pages/ProjDetails.aspx?ProjectID=2020-58

- Michigan DOT has a neat tool recently developed through ArcGIS:
https://storymaps.arcgis.com/stories/fe0cccc43c254935beff3a04585d6918

- Montana (MDOT) Implementation Plan -
https://www.mdt.mt.gov/other/webdata/external/research/forms/MDT-RES-007.pdf.

- Iowa DOT Example of two summary reports on the same project.
    - First, technical summary: http://publications.iowa.gov/33802/2/TR_754_Tech%20Brief_Corn-Based%20Deicers.pdf
    - Second, marketing/public facing summary: http://publications.iowa.gov/35238/1/Iowa%20DOT%20Research%20Solutions%20-%20Corn-based%20deicers%20-%20web.pdf

- North Carolina (NCDOT) - Capturing and Communicating the Value of NCDOT Research: https://connect.ncdot.gov/projects/research/Pages/ProjDetails.aspx?ProjectID=2017-21

- North Carolina (NCDOT) - TCE #1: https://connect.ncdot.gov/projects/research/Pages/ProjDetails.aspx?ProjectID=TCE2020-01

- North Carolina (NCDOT) - TCE #3: https://connect.ncdot.gov/projects/research/Pages/ProjDetails.aspx?ProjectID=TCE2020-03

- Montana (MDT) Project and Report - https://www.mdt.mt.gov/research/projects/structures/seismic.shtml

- Montana (MDT) Example Project - Wildlife Crossing Structures: https://www.mdt.mt.gov/research/projects/env/wildlife_crossing.shtml

- Jamboard - Key Takeaways Day 1 - https://jamboard.google.com/d/1iFBLT4_vjdqgLmplhU3YDmImAtx_gv1P-ROA30BuJ7s/edit?usp=sharing

- Jamboard 2 - Here's the link to the Jamboard - https://jamboard.google.com/d/1XyRiH3TEupoVCpA1uvJ4dCanaQdTRGAgDCQYJyJiHq8/edit?usp=sharing

- Jamboard 3 - SWOT and TDOT Review - https://jamboard.google.com/d/1FzyY55liueFqREjDSDMIHSNIWIpIXn52Yoi2_XnlLlU/edit?usp=sharing

- RAC R3 Technology Implementation Plan - https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4921

- R&I RAC info sharing site - Research.transportation.org

- RPPM - https://rppm.org/

- RAC Membership - https://research.transportation.org/rac-membership/

TDOT Innovation to Implementation Peer Exchange - Feedback

Start of Block: General Overview

Q2 Which of the sessions did you participate in as part of the Peer Exchange?

☐ Day 1 - Facilitating Innovation and Collaboration - Key Research Areas (4)

☐ Day 1 - SPR Program Administration - Facilitating Research (5)

☐ Day 1 - SPR Program Management - Best Practices and Lessons Learned (6)

☐ Day 2 - Performance Metrics, Deliverables, and Actual Implementation (7)

☐ Day 2 - SWOT Analysis and Recommendations for TDOT (8)

Q8 Considering your complete experience at the Peer Exchange, how likely would you be to recommend a similar event to a friend or colleague?

○ Extremely likely (10)

○ Somewhat likely (11)

○ Neither likely nor unlikely (12)

○ Somewhat unlikely (13)

○ Extremely unlikely (14)

Q29 To what extent did the Peer Exchange meet your expectations?

○ Exceeded expectations (1)

○ Met expectations (2)

○ Did not meet expectations (3)

○ Unsure (4)

Q9 Please rate the research team's organization and facilitation of the event.

0 (0)
1 (1)
2 (2)
3 (3)
4 (4)
5 (5)
6 (6)
7 (7)
8 (8)
9 (9)
10 (10)

Q10 Please rate your level of satisfaction with the following aspects of the Peer Exchange.

Q11 Pre-Event Information and Logistics Conveyance

○ Extremely satisfied (14)

○ Somewhat satisfied (15)

○ Neither satisfied nor dissatisfied (16)

○ Somewhat dissatisfied (17)

○ Extremely dissatisfied (18)

Q3 Ease of use of the Zoom virtual meeting platform

○ Extremely satisfied (50)

○ Somewhat satisfied (51)

○ Neither satisfied nor dissatisfied (52)

○ Somewhat dissatisfied (53)

○ Extremely dissatisfied (54)

Q12 Day 1 - Facilitating Innovation and Collaboration - Key Research Areas

○ Extremely satisfied (9)

○ Somewhat satisfied (10)

○ Neither satisfied nor dissatisfied (11)

○ Somewhat dissatisfied (12)

○ Extremely dissatisfied (13)

○ Did not attend this session (14)

Q13 Day 1 - SPR Program Administration - Facilitating Research

○ Extremely satisfied (9)

○ Somewhat satisfied (10)

○ Neither satisfied nor dissatisfied (11)

○ Somewhat dissatisfied (12)

○ Extremely dissatisfied (13)

○ Did not attend this session (14)

Q14 Day 1 - SPR Program Management - Best Practices and Lessons Learned

○ Extremely satisfied (9)

○ Somewhat satisfied (10)

○ Neither satisfied nor dissatisfied (11)

○ Somewhat dissatisfied (12)

○ Extremely dissatisfied (13)

○ Did not attend this session (14)

Q15 Day 2 - Performance Metrics, Deliverables, and Actual Implementation

○ Extremely satisfied (9)

○ Somewhat satisfied (10)

○ Neither satisfied nor dissatisfied (11)

○ Somewhat dissatisfied (12)

○ Extremely dissatisfied (13)

○ Did not attend this session (14)

Q16 Day 2 - SWOT Analysis and Recommendations for TDOT

○ Extremely satisfied (9)

○ Somewhat satisfied (10)

○ Neither satisfied nor dissatisfied (11)

○ Somewhat dissatisfied (12)

○ Extremely dissatisfied (13)

○ Did not attend this session (14)

Q30 Use of Jamboard for collecting information and as a collaboration tool

○ Extremely satisfied (9)

○ Somewhat satisfied (10)

○ Neither satisfied nor dissatisfied (11)

○ Somewhat dissatisfied (12)

○ Extremely dissatisfied (13)

○ Did not utilize Jamboard (14)

Q31 The discussions among the group

○ Extremely satisfied (9)

○ Somewhat satisfied (10)

○ Neither satisfied nor dissatisfied (11)

○ Somewhat dissatisfied (12)

○ Extremely dissatisfied (13)

Q32 Use of the Chat in the meeting for sharing information

○ Extremely satisfied (9)

○ Somewhat satisfied (10)

○ Neither satisfied nor dissatisfied (11)

○ Somewhat dissatisfied (12)

○ Extremely dissatisfied (13)

Q6 Did you learn anything new about SPR program management (in general) from the Peer Exchange?

○ Yes (1)

○ Maybe (2)

○ No (3)

Q35 What did you learn new at the Peer Exchange?

○ _____

Q33 Do you envision utilizing/integrating any of the processes, procedures, tools, etc. in your program(s) as a result of the Peer Exchange?

○ Yes (1)

○ No (2)

○ Maybe (3)

Q34 What processes, procedures, tools, etc. do you envision incorporating into your program?

○ _____

Q19 What types of future collaborative events related to SPR program management/administration would you like to see in the future?

☐ A Forum similar to what was hosted by TDOT and the research team (4)

☐ Peer Exchange focused on Tech Transfer (2)

☐ Networking Event (3)

☐ Presentations of Best Practices (5)

☐ Panel Showcasing Best Practices (researcher and state DOT perspectives) (6)

☐ Other (7) _____

Q7 Please rank the sessions in order of most beneficial to least beneficial (with 1 being most beneficial and 5 being least beneficial).
_____ Day 1 - Facilitating Innovation and Collaboration - Key Research Areas (1)
_____ Day 1 - SPR Program Administration - Facilitating Research (2)
_____ Day 1 - SPR Program Management - Best Practices and Lessons Learned (3)
_____ Day 2 - Performance Metrics, Deliverables, and Actual Implementation (4)
_____ Day 2 - SWOT Analysis and Recommendations for TDOT (5)
_____ Collecting information using Jamboards (6)

Q24 What did you most like about the Peer Exchange?

○ _____

Q25 What did you least like about the Peer Exchange?

○ _____

Q26 What would you like to see included in future events like this (if TDOT or other state DOTs were to host them)?

○ _____

- -

Q22 If there are any additional comments you'd like to leave for the research team about the Peer Exchange, please provide them here.

○ _____

○ _____

○ _____

○ _____

○ _____

End of Block: General Overview