Identifying Critical Knowledge Gaps and Assessing Cultural Readiness for Improved Knowledge Management

Final Report

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16. Abstract

For an organization to develop a sustainable strategy that supports technical capacity, workforce retention, and innovation, it is essential to develop a strong framework for knowledge management (KM) both within individual divisions as well as organization wide. For state departments of transportation (DOTs), KM has become a topic of increasing urgency as the aging and knowledgeable workforce that has been the subject of recent concern has now begun large-scale retirements. Many DOTs are faced with significant threats to organizational knowledge and technical capacity as knowledge holders leave and new workers are onboarded without the infrastructure for effective knowledge transfer. This project examined TDOT's knowledge assets, current KM practices, and organizational culture with respect to KM. This research gaps in KM practice and a set of recommendations to support TDOT in institutionalizing a robust practice and culture of KM and establishing a continuous assessment process for the organization to evolve in its KM maturity. It is expected that the results of this research will enable TDOT to develop a robust and sustainable process for the efficient transfer of knowledge that improves worker retention, technical capacity, KM culture, and continued innovation resulting in successful fulfillment of its mission.

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Executive Summary

This research examined the Tennessee Department of Transportation's (TDOT) knowledge assets, current KM practices, and organizational culture with respect to knowledge management (KM). The results of the project are intended to support TDOT in developing a robust and sustainable process for the efficient transfer of knowledge that improves worker retention, technical capacity, KM culture, and continued innovation resulting in successful fulfillment of its mission. With a sizeable fraction of the TDOT's workforce having less than five years' experience with the agency, nearly 20% eligible for retirement, and a 2.8% employee turnover rate, it is essential that a robust KM strategy is developed to ensure success in achieving TDOT's mission now and in the future.

For an organization to develop a sustainable strategy that supports technical capacity, workforce retention, and innovation, it is essential to develop a strong framework for KM both within individual divisions as well as organization wide. The first step in this process is to define an organization's intellectual capital or knowledge assets. This is a significant challenge for organizations, both public and private sector, where a formal approach to KM has not been established. The importance of developing a knowledge inventory, assessing archival and transfer practices, and enacting a framework for evolving organizational KM culture and maturity cannot be overstated. Effective KM systems improve organizational efficiency, effectiveness, resilience, capabilities, and innovation.

For state departments of transportation (DOTs), KM has become a topic of increasing urgency as the aging and knowledgeable workforce has now begun large-scale retirements. Many DOTs are faced with significant threats to organizational knowledge and technical capacity as knowledge holders leave and new workers are onboarded without the infrastructure for effective knowledge transfer. In fact, knowledge is recognized as the limiting factor for DOTs in deploying successful programs and keeping pace with changing requirements, project delivery methodologies, and customer expectations[1].

This project included five primary tasks. Task 1 focused on developing a baseline inventory and analysis of knowledge resources and practices for TDOT as a whole and within each division. This task included interviews with TDOT leadership teams to understand critical knowledge areas, knowledge gaps, current KM practices, knowledge resources, and archival methods. The goal of Task 2 was to better understand experiences, identify effective practices and challenges to building a robust KM culture, and determine impacts of KM strategies. This was accomplished through a comprehensive literature review and interviews of ten state DOTs and the Federal Highway Administration to learn more about their experience with KM. Task 3 included a culture audit in relation to KM receptiveness and current knowledge sharing behaviors within TDOT. A KM Litmus Test, KM Assessment Survey, and focus group discussions were used within this task to better understand the current culture and state of practice within the agency pertaining to KM. Task 4 focused on analysis of historical staff turnover data and exit survey results to determine opportunities for a strategic approach to KM to improve TDOTs retention outcomes. Task 5 examined knowledge flow across the agency, including both internal and external sources. It is important to note that at the time this study began, TDOT was beginning the process of reorganization and began implementing the changes during the study period. Thus, the makeup

of bureaus and divisions referenced in this report may not reflect the current structure of the organization. As most of the changes involve realigning divisions with other bureaus within the Department and not a dissolution of a division, the impact on the findings presented in this report is minimal and largely organizational in nature.

Key Findings

Tasks 1-5 resulted in the following findings that are important for both benchmarking current KM practice and culture at TDOT as well as revealing key aspects to consider in an organization-wide framework for KM.

- Both **TDOT leaders and staff recognize the value and need for a consistent and strategic approach to KM.** The **primary barrier to the implementation of a robust KM framework is the time and effort required** to do so. Thus, for an agency-wide strategy to be effective, KM activities must provide immediate value and integrate seamlessly into existing staff workflows.
- All units have implemented some practices for KM, but the level of adoption and formality varies widely. While both formal and informal approaches can be successful, for KM policies and strategies to be effective, there must be **buy-in at all levels of the organization** and **assignment of responsibility** that ensures practices are upheld.
- Creating a culture of knowledge sharing requires coordinated and continuous effort to **communicate the value of KM** and overcome outdated notions and misperceptions that result in resistance. It also important that communications are seen as transparent and that they highlight successes.
- An agency-wide **platform for knowledge management that is easily accessible and provides content in a format that is quick for staff to understand** is key to widespread adoption. While there are multiple platforms available at TDOT to facilitate knowledge capture and sharing, many staff are unsure how to best leverage these tools and indicate they are not used consistently.
- **Succession planning is critical to avoid knowledge loss.** Several innovative approaches have effectively been used by other DOTs to address this including temporary hires that work directly with retiring staff, development and archiving of 'Last Lectures' or practice memos by those leaving an organization, and creation of Job Books.

Key Recommendations

To fully realize the potential of an organization-wide approach to KM, TDOT's current strengths, potential barriers, and opportunities to accelerate adoption must be considered.

- **A leadership structure for KM accountability is the first step for implementation**. Defining this structure is crucial for ensuring development, adoption, assessment, communication, and strategy refinement of KM practices occur. This is an essential step for sustainability of the strategy. Further, demonstrating that KM is a top priority at the highest level of TDOT has the potential to enforce the importance and commitment TDOT has towards this effort.

- **Establish a consistent timeframe for collecting and archiving data that will inform KM performance metrics, such as employee exit survey data or measures of efficiency**. Data collected in each division, whether quantitative or qualitative, must be consistent for communication of impact and long-term analysis of trends.
- **Transparency and broad engagement in decision making related to the KM strategy will allow employees to take ownership and have buy-in, thereby facilitating adoption**. It is also critical that leadership across the organization understand the importance and factor in time for KM activities as part of staff duties.
- **Developing a value proposition tied to TDOT's mission and creating a marketing and communication strategy around it can further propel the organization to successful implementation**. It is important that all staff understand what KM entails, why it is important, how it will be implemented, and what TDOT expects to achieve by deploying KM agency-wide. It is also critical that staff feel there is transparent communication, they have a voice in the process, and that their insight is valued.
- **TDOT should start incrementally, such as through a pilot program, and follow an iterative process for refining the KM strategy to achieve full-scale adoption.** Such an approach will allow TDOT to limit frustrations as challenges are identified and the model is refined to best fit organizational culture and practice so that KM becomes an integrated, seamless, and essential component of all work areas and tasks.

Considering key findings from this study and integrating these recommendations into a framework for agency-wide KM will ensure that TDOT is capitalizing on its existing strengths, navigating potential barriers, and leveraging opportunities to accelerate its KM agenda. Ultimately, it is expected that this research will lead to institutionalizing a robust practice and culture of KM and establishing a continuous assessment process for TDOT to evolve in its KM maturity.

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Glossary of Key Terms and Acronyms

DOT:	Department of Transportation
KM:	Knowledge Management
CKO:	Chief Knowledge Officer
CLO:	Chief Learning Officer
CoPs:	Communities of Practice
AAR:	After-Action Reviews
ITS:	Intelligent Transportation Systems
PPRM:	Program, Project, and Resource Management System
PDPM:	Project Development and Project Management

Chapter 1 Introduction

There is no one-size-fits-all approach to KM. An in-depth organizational study is required to develop an appropriate strategy.

For state departments of transportation (DOTs), Knowledge Management (KM) has become a topic of increasing urgency as the aging and knowledgeable workforce has now begun large-scale retirements. Many DOTs are faced with significant threats to organizational knowledge and technical capacity as knowledge holders leave and new workers are onboarded without the infrastructure for effective knowledge transfer. While there is a body of literature and best practices related to KM, successful implementation depends upon the context, constraints, and starting point of an organization from a KM perspective. *There is no one-size-fits-all approach to KM, and an in-depth organizational study is required to develop an appropriate strategy*.

The 'Identifying Critical Knowledge Gaps and Assessing Cultural Readiness for Improved Knowledge Management,' project is intended to provide the Tennessee Department of Transportation (TDOT) with an understanding of its knowledge assets, current KM practices, and organizational culture with respect to KM. The goal is to enable TDOT to develop a comprehensive and sustainable process for the efficient transfer of knowledge that improves worker retention, technical capacity, KM culture, and continued innovation resulting in the successful fulfillment of its mission. With a 2.8% employee turnover rate, a sizeable fraction of TDOT's workforce having less than five years' experience with the agency, nearly 20% eligible for retirement in the next two years, and significant private sector competition for mid-career expertise, it is essential that a robust KM strategy is developed to ensure success in achieving TDOT's mission now and in the future.

The project included five primary tasks:

- Task 1: Internal benchmarking and data collection
- Task 2: External research and identification of best practices
- Task 3: Internal culture audit
- Task 4: Internal analysis of employee turnover
- Task 5: Internal assessment of knowledge flow

Internal-facing tasks were designed to develop rich understanding of the current state of KM practice within TDOT, staff attitudes and culture related to KM, and infrastructure that may accelerate or inhibit deployment of an organizational-wide approach to KM at TDOT. These tasks employed surveys, interviews, and focus groups and collected existing data related to employee turnover to support the project goals. External-facing tasks gathered content and context pertaining to best practices that have proven successful in other organizations and especially other state DOTs. A systematic literature review and agency interviews were used to gather information from relevant external sources. These results were used in combination with internal findings to inform a recommended framework for KM for TDOT.

The remainder of this report is organized as follows:

- **Chapter 2: Literature Review** – provides a brief overview of the current state of practice related to KM, especially for state departments of transportation.
- **Chapter 3: Methodology** – describes interviews, focus groups, surveys, and other data collection techniques as well as the analysis approach for each type of data collected.
- **Chapter 4: Results and Discussion** – describes key findings from all aspects of the research and emphasizes strengths, weaknesses, and opportunities to consider for implementation of an organization-wide approach to KM.
- **Chapter 5: Conclusion** – highlights the recommended framework for action for creating a strategic approach to KM within TDOT.

While TDOT was undergoing a reorganization during this study that resulted in shifts and restructuring of the agency's bureaus, this is expected to have minimal impact on the findings presented in this report. The important results are those at a macro level or that could be generalized across the agency rather than any findings related to a specific unit and its location within TDOT. Additionally, while there was some over or underrepresentation of TDOT work areas in the survey responses, it is not expected that this resulted in skewed findings, as very few differences were observed across TDOT's units in terms of culture, preferences, attitudes, and suggestions. Finally, as participation in this study was voluntary, voluntary response biases in the results may exist based upon overrepresentation of opinions of staff choosing to participate.

Chapter 2 Literature Review

Knowledge Management was first introduced in the 1950's and became a field of study in the 1980s[1,2]. This field gained traction as it became clear an organization's knowledge – often referred to as "intellectual capital" – had significant value and warranted management. KM is seen as being essential to increasing, revolutionizing, and sustaining organizational capacity. KM includes defining the knowledge that is critical to an organization's mission, assessing KM practices, and developing a proactive approach to managing and transferring knowledge assets[2,3].

The levels of adoption and varied approaches to KM within an organization make the task of creating a KM framework inherently complex. KM is also an agency-specific endeavor, and there is no one-size-fits-all approach[4]. It includes the development of a knowledge-sharing and archival system that is accessible, easy to use, unified, and protected[1,3]. The fact that multiple types of knowledge must be captured (explicit, implicit or tacit (hidden), descriptive, causal, procedural, social) and that assets are frequently both internal and external further complicates the process[1,5]. Additionally, the culture within an organization and the willingness of staff to share and transfer knowledge determines success with KM implementations[6]. Ultimately, the approach to KM must be directly aligned with the strategic goals of the organization to maximize impact[1]. This literature review first describes common aspects and practices of KM before delving into the literature related to best practices and DOT-specific studies.

2.1 Common Aspects and Practices of KM

The overarching challenge relating to an organization's knowledge assets includes WHAT kind of knowledge is possessed or needed to carry out the organization's mission; WHERE does that knowledge reside (either internally with staff or in hard/soft copies of information bases, or external to the organization); WHO possesses the knowledge (and WHO needs it); WHEN is the knowledge needed; and finally, HOW should the knowledge be used/applied.

To address the above challenges, there are two essential activities of KM: 1) knowledge acquisition and storage, and 2) knowledge dissemination or transfer[1]. Knowledge capture involves documenting knowledge from experts and ensuring it is in a form that can be archived and accessed in a timely manner, and knowledge transfer involves disseminating this archived knowledge when and where it is needed, as well as integrating more experienced employees or supervisors into projects with newer employees to aid in the transfer of the more complex tacit knowledge. These activities not only promise to improve organizational effectiveness and efficiency but can also reduce the impact of workforce transitions.

Knowledge Capture and Storage. Repositories are useful in collecting data and capturing knowledge and repositories can be more streamlined by improving information management practices whereby knowledge can be found more efficiently and repositories can be more thoroughly organized[5,9,10]. The data found in repositories can consist of job aids, workshops conducted and related documents, as well as video or written documentation of processes within the agency[8,10]. It is important to establish a common vocabulary for documentation within these databases so that searching for resources is easier and to update documentation of business processes, business procedures, and manuals within the repsository[1,5,8].

Other knowledge capture strategies include creating knowledge books with experts documenting uncommon knowledge relating to their work, creating continuity books on the processes and responsibilities of certain job positions, and conducting after-action reviews (AARs) once a project is finished to determine what can be improved for future work[1].

Knowledge Transfer/Dissemination and Application. To develop a capability of better sharing an organization's intellectual assets is to develop an organizational structure with KM-specific roles. A KM "champion" is often identified, and sometimes retains the formal role of chief knowledge officer (CKO), or chief learning officer (CLO). In addition, there may be the creation of a dedicated KM staff to help with the development of KM practices. On a less formal level, one common KM practice of knowledge transfer is to create communities of practice (CoPs). CoPs are formal or informal organizations that are comprised of employees interested in a particular practice, and in these communities, members discuss ways to improve their skills, solve work-related problems, and exchange knowledge[7]. The benefits of incorporating strong CoPs into an agency include reducing time searching for information, reducing knowledge discrepancies, orienting new employees, and implementing ways to identify knowledge needs and validate and update knowledge. The costs of incorporating CoPs are associated with the expenses regarding assessing knowledge needs, organizing information, and maintaining and updating information over time[7].

Another KM best practice is identifying and sharing lessons learned. Often occurring after the completion of projects, these after-action reviews (AARs) represent storytelling opportunities that allow employees to share challenges that they have faced and impart tacit knowledge to others[1,8]. Lessons learned can be incorporated into CoPs, and they can be formal events or informal knowledge transfer between coworkers[5]. Expert directories or "Yellow Pages" can also be utilized to streamline the identification of where knowledge resides and thus transfer knowledge more efficiently[1,5,9]. Other knowledge transfer strategies include mentoring, job rotations, or job shadowing[1,5,8,9]. When employees are nearing retirement or leaving the agency, one of the goals should be a smooth and effective succession management process. This often includes a means of knowledge transfer to lessen the impact of departures and create a smooth transition of the successor in the new position[1,5]. Succession management can include several activities that prepare a successor for their future position that a retiree is holding including desk-side reviews, phased retirement programs[1,10], and double-filling of positions[8]. As employees leave their positions, knowledge capture strategies, such as exit interviews, expert interviews and last lectures can be executed[1,5,8,9].

2.2 Implementation of KM

When initially implementing KM practices into an organization, knowledge assets, current areas of vulnerability, risks, and opportunities should be assessed and identified[1]. One method for identification is a KM "Litmus Test," which is a series of questions used to identify if an organization would benefit from adopting KM strategies. A means of assessing risks to managing an organization's knowledge assets can be accomplished by conducting a Knowledge Risk Assessment, which can be used to identify which employees are retiring or leaving in the next five years, and what critical knowledge they possess.

An implementation plan should be created for adopting KM practices which includes identifying which activities should be included, creating a KM budget, determining resources needed, creating a schedule of milestones, and developing a way to track metrics and completion of milestones[1]. Another important aspect of implementing KM is to have a KM lead that is responsible for ensuring that KM activities allow for goals to be met, while also adjusting priorities as resource availability and needs change[1]. The National Cooperative Highway Research Program (NCHRP) scanned several state DOTs, USDOT administrations, and private sector organizations to analyze current KM strategies and suggest practices that can be utilized within other state DOTs to implement KM[9]. There are various implementation strategies, and these can involve leadership, human resources, information sharing, networks, knowledge capture, and information management.

2.3 Review of the KM Literature

Our search of the extant literature on KM research resulted in 53 papers across a wide variety of public/private and DOT/non-DOT settings. The research discussed was conducted over an approximate 20-year span, suggesting KM is no longer a "new" practice. The information used to form these studies varies, spanning from case studies and experiments[11,12,15,17,20,26,32,41-49], scans of other transportation departments[1,5,9,10,14,] workshops with employees[8,9,11], or private sectors and non-transportation related industries[5,12,16,17,19,20,22,25,27,28,30,32-39,44,46-54].

Many of the papers discussed case studies that explored specific KM characteristics, e.g., KM strategies[1,8,9,10-22], KM implementation[1,3,8,12,17,21,22], KM instrument development[2,10,13,21], KM costs[7,19,26,28,29,34,45,48,54,55], and specific KM practices and their impact on the organization, such as CoPs[7,17,29]. Others tested or validated specific KM models[2,21,22,24-38]. In general, it is important not to draw strong conclusions in the relationships reported as many of the studies report on case studies (sample sizes of one) or were designed to uncover relationships that were correlational versus causal.

Nonetheless, the overall takeaway from the research is that most findings are intuitive, i.e., there are no real surprises in what a logical person might assume when it comes to the benefits of KM. For example, several studies suggest that there is a positive linkage between KM initiatives and improved individual performance[32,41] or firm performance[18,35]. This makes sense, since KM initiatives provide helpful information and resources (or locations of resources) that can help individuals be more effective in their jobs, which logically may result in the overall organization performing better. Following similar logic, larger networks of people, or networks of people with strong communication linkages should result in more knowledge transfer[15], and thus better firm performance (i.e., kind of a "more heads are better than one" phenomenon). Finally, large organizations with high turnover may benefit more from KM than other organizations as KM provides valuable resources for those new in their positions[22]. Additionally, implementation of KM practices may mediate the relationship between organizational culture and organizational performance[31].

For specific details, the reader can refer to Appendix A. It is probably more instructive to focus on specific DOT-related KM studies described in the next section.

2.4 DOT Case Studies

Vermont. There have been several KM studies conducted for state DOTs in recent years. A study for the Vermont Agency of Transportation (VTrans) included an organizational assessment, a scan of practices in other DOTs, and a pilot project[10]. Findings related to staff turnover indicated that the reasons for high rates of turnover were low pay, a disproportionate quality in supervision among managers, and managers not being accountable for their own performance or addressing performance problems of other employees.

A Litmus test was then conducted with forty-eight VTrans managers, and the test results portrayed that many senior managers will retire in the next five years, which could lead to a large loss of information[10]. The test also suggested that different parts of VTrans do not know what other sections are doing, and there are no standards in place for relaying information to employees, contractors, or consultants. A KM pilot project then introduced KM strategies to VTrans that attempted to capture and document tacit knowledge within the agency[10].

The results of the study presented some recommendations for future KM strategies within VTrans, which included more thoroughly organizing electronic repositories, developing more KM tools and templates, documenting tasks performed less frequently, establishing an internal expert locator, as well as enhancing communication across departments[10].

Kentucky & Virginia. The Kentucky Transportation Cabinet (KYTC) has also noticed a need for more KM practices within their agency as in the last three decades internal employment has decreased, and outsourcing has increased[5]. A study conducted for the KYTC incorporated a literature review, a scan of other DOT practices (seven states, including three common to the VTrans study), and a survey of KYTC staff. The project resulted in a set of KM strategies with potential for positively impacting the KYTC's KM efforts.

The literature review conducted in this study determined benefits of implementing KM strategies as well as the current KM practices implemented in KYTC. The benefits of KM included an increase in organizational efficiency, effectiveness, resilience, and workforce capabilities[5]. KM also has aided in decreasing the negative impact occurring with employee retirement or transitions. Some of the most difficult knowledge to transfer is tacit knowledge, which is a gap that KM practices may help close.

KYTC KM best practices include various training opportunities for supervisors, potential supervisors, and entry and mid-level employees, including online courses and in-person programs[5]. KYTC also uses a Lessons Learned Database to collect information from project stakeholders, value engineering studies and change proposals, and constructability and post construction reviews to present Cabinet employees with solutions to prior issues.

The examination of state DOTs found that Virginia Department of Transportation's (VDOT) KM practices were most beneficial to KYTC, which implemented CoPs that allowed for in-person meetings between groups of employees to share knowledge and establish best practices for improving KYTC issues[5]. VDOT also has a KM division in which its purpose is to gather and share institutional knowledge; this type of division was determined to not be necessary for KYTC, but the practices used by VDOT could be added to current KM strategies within KYTC.

A survey of KYTC staff assessed the current methods of knowledge acquirement used, and most employees reported that they referred to other coworkers or supervisors for advice on work-related problems[5]. Most employees preferred acquiring knowledge by using updated guidance manuals, consulting with supervisors or coworkers, or a Wikipedia-style policy guide. Some employees recommended strategies with the potential to positively impact KYTC's KM efforts such as workforce tools, workforce planning, and informal and formal collaborations[5].

Wisconsin. In 2010, best practices for knowledge retention and management were collected for the Wisconsin Department of Transportation (WisDOT) to ease the workforce transition process as many of the employees across all departments were eligible for retirement in the coming five years[8]. A guidebook with steps for WisDOT managers to incorporate knowledge retention practices in their departments was created using the information found in a literature review as well as interviews with essential WisDOT staff. There are numerous strategies described in the guidebook, with some being documenting processes, communities of practice, mentoring, storytelling, job rotations, sharing of lessons learned, exit interviews, last lectures and expert interviews with departing staff, and phased retirement or doubling filling of positions for training newer employees. This guidebook was presented at a workshop with WisDOT managers, and managers in all five WisDOT divisions utilized some of the knowledge retention strategies discussed in the workshop and guidebook in their departments.

WisDOT currently uses a range of KM tools, such as writing down or videotaping processes for employees to reference, formalizing and automating processes, cross-training, double-filling essential positions, leadership and rotational programs, a decision system that incorporates expert judgement, exit and expert interviews, last lectures, and storytelling opportunities[1].

2.5 Assessment Tools and Strategies

Several KM instruments, some broad and some specific to DOTs, are available to organizations wishing to assess their state of practice and maturity. Kulkarni and Freeze, 2004, validated a KM Capability Assessment Model that includes both behavioral and infrastructure assessment, with the capability areas evaluated being expertise from formal education, lessons learned from previous projects, knowledge documents stored for future reference, and historical data stored in databases for use in future operations[2]. Another tool was developed to assess KM that includes five dimensions including the KM process, leadership, culture, technology, and management[11]. The KM Capability Assessment tool developed by the American Productivity and Quality Center not only captures current state of KM practice but also measures level of maturity and enables organizations to develop a plan for advancing maturity[12]. NCHRP 8131 provides a set of tools, including a Litmus Test, Senior Leadership Workshop facilitation guide, In-Depth Knowledge Survey, and Knowledge Risk Assessment that are specifically crafted to support state DOT KM initiatives. The KYTC has a seven-item survey that was developed to assess critical knowledge, training and educational initiatives, and suggestions for improving knowledge transfer[5]. VTrans[10] published focus group protocols, a KM Litmus Test, and a Knowledge Exchange Tool adapted from NCHRP 8131.

The methodology for this research was designed to enhance findings from this literature review related to understanding of KM practices that are relevant for TDOT, to learn more about recent KM developments within state DOTs, and to assess TDOT's status with respect to KM.

Chapter 3 Methodology

This project is intended to provide TDOT with an understanding of its knowledge assets, current KM practices, and organizational culture with respect to KM to enable development of a comprehensive and sustainable process for KM organization wide. Such an approach is critical to successful fulfillment of TDOT's mission.

The project included five primary tasks:

- Task 1: Internal benchmarking and data collection
- Task 2: External research and identification of best practices
- Task 3: Internal culture audit
- Task 4: Internal analysis of employee turnover
- Task 5: Internal assessment of knowledge flow

The data collected and analysis methodology for each of these tasks is described in the subsequent sections in this chapter. Each task and its methodology were designed considering overall project objectives and the need to triangulate findings to inform a recommended framework for KM for TDOT.

3.1 Task 1. Internal Benchmarking and Data Collection

The purpose of Task 1 was to develop a baseline inventory and analysis of knowledge resources and practices for TDOT. The inventory included in-depth discovery of strategies or policies related to how information is currently documented, shared, and managed, training/cross-training is provided, succession planning is developed, and technology transfer is performed. A questionnaire was developed by the research team in collaboration with TDOT by adapting content from several existing reports and instruments to TDOT's specific needs[1,5,9,10]. The questionnaire included seventeen questions on the following topics:

- Interviewee information
- Defining knowledge management (KM)
- Critical knowledge areas
- KM practices
- KM culture
- KM awareness and suggestions

A copy of the interview guide is included in Appendix B.

An Institutional Review Board (IRB) application was submitted, and this aspect of the study was reviewed and approved as Exempt by the University of Memphis. Interviews were conducted with leadership from each TDOT Bureau, Division, and Regional Office as well as with specific personnel with specialized knowledge related to KM and members of TDOT's Succession Planning Team from the EPIC Academy. The interviews for this study are referenced based on the organizational structure in place at TDOT in March 2023. Generally, each interview included

1-3 staff, except for the Succession Planning Team which included five individuals. A total of 38 interviews were conducted from March – May 2023 from each of the following units:

- Administration Bureau (9 interviews)
    - Central Services
    - Civil Rights
    - Finance
    - Internal Audit
    - HR
    - Information Technology
    - Procedure & Contracts
    - Strategic Planning
    - Aeronautics
- Engineering Bureau (12 interviews)
    - Bid Analysis & Estimating
    - Program Development & Administration
    - Strategic Transportation Investments
    - Roadway Design
    - Right of Way
    - Structures
    - Construction
    - Traffic Operations
    - Asset Management
    - Materials & Tests
    - Occupational Health & Safety
    - Program Management
- Environment & Planning Bureau (4 interviews)
    - Environmental
    - Freight & Logistics
    - Long Range Planning
    - Multimodal Transportation Resources

- Regional Offices (4 interviews)
    - Region 1
    - Region 2
    - Region 3
    - Region 4
- Specific Personnel (7 interviews)
    - Community Relations
    - EPIC Academy Succession Planning Team (1 interview)
    - Information Technology
    - Legislative Services
    - Records Management

Each interview lasted between 30 minutes and one hour, depending on the number of individuals participating. Interviews were conducted via online conference platforms, with members of the research team facilitating the conversations and taking notes. Summaries of each of the interviews were prepared, and qualitative analysis was conducted to determine core themes that emerged from the conversations. Additionally, tabular summaries were prepared for aspects of the conversations, such as for knowledge resources, so that this information could be assessed quantitatively in terms of frequency of use as well as identifying the number of resources used by particular divisions within each Bureau.

3.2 Task 2. External Research and Identification of Best Practices

Interviews of state DOTs were necessary to further explore and develop in-depth understanding of KM experience and potential for translation or replication by TDOT. The interview instrument was developed collaboratively by the research team and TDOT staff based upon existing published questionnaires[9,1,5,10] and TDOT's areas of interest. The interview questionnaire included 14 items in three general categories: 1) organizational policy and structure, 2) KM practices and culture, and 3) KM and workforce development. The questionnaire is provided in Appendix C.

States of interest were identified through the literature review process, knowledge of existing KM practices via relationships of state DOTs with the research team, and insight from TDOT. An Institutional Review Board (IRB) application was submitted for this task, and this portion of the study was deemed 'not human subjects research' by the University of Memphis, and thus IRB approval was not required.

Eleven states were identified to invite to participate in the interview process. Email invitations were sent to DOT staff identified either through existing relationships or membership of the AASHTO Knowledge Management Committee. Ten states and the Federal Highway Administration participated in the interview process November 2022-March 2023:

- Federal Highway Administration (FHWA)
- Kentucky
- Michigan
- Mississippi
- Missouri
- New Hampshire
- Texas
- Utah
- Virginia
- Washington
- Wisconsin

Members of the research team facilitated discussions with KM leaders within each DOT, took notes, and developed case summaries for each.

3.3 Task 3. Internal Culture Audit

The purpose of Task 3 was to develop a deeper understanding of the current culture and state of practice regarding KM within TDOT. While Task 1 engaged TDOT leadership and Task 2 external agencies, Task 3 focused on the comprehensive engagement of TDOT staff across its diverse bureaus, divisions, staff levels, and occupations. Three instruments were used to collect data related to KM culture and practice for this task, including a KM Litmus Test shared with division leaders, a KM Assessment Survey shared with all TDOT staff, and a set of focus group discussions with TDOT volunteers. An Institutional Review Board (IRB) application was submitted, and this aspect of the study was reviewed and approved as Exempt by the University of Memphis.

The KM Litmus Test used for this TDOT study was adapted from an instrument published by the National Academies of Sciences, Engineering, and Medicine in a 2015 KM guidebook[1]. The language from the published instrument was softened to make participants feel less personally responsible and thus more comfortable sharing honest feedback. Ten additional statements were added to the KM Litmus Test to encompass the cultural trait dimensions identified by Milton and Lambe, 2016[61], that may impact organizational learning and knowledge sharing. These traits include:

1. Open vs. Defensive
2. Honest vs. Dishonest
3. Empower vs. Disempowered
4. Learner vs. Knower
5. Need to Share vs. Need to Know
6. Challenge vs. Acceptance
7. Collaborative vs. Competitive
8. Remembering vs. Forgetting
9. Strategic Patience vs. Short-Termism
10. Relentless Pursuit of Excellence vs. Complacency

The modified instrument used in this study was developed and disseminated by TDOT lead staff in the Strategic Planning Division. An invitation to participate was sent to the 52 leaders who were engaged in interviews for this project as part of the Task 1 effort. The results from the Litmus Test were shared with the research team to include as part of the Task 3 analysis. A summary of the findings is provided in Chapter 3. A copy of the KM Litmus Test instrument and summary prepared by TDOT lead staff is included in Appendix D.

The survey questionnaire was adapted from an existing instrument[1] by the research team in collaboration with TDOT to make terminology more appropriate to TDOT and to streamline items to focus on TDOT's interests. The questionnaire included thirteen questions on the following topics:

- Respondent information
- Defining knowledge management (KM)
- KM practices
- KM tools and resources
- KM culture
- Barriers to knowledge access and sharing
- Suggestions for improving KM practice

The survey was developed and administered using the Qualtrics online platform. Questions were structured so as not to collect personally identifying information and settings were selected within Qualtrics so that anonymous responses were obtained. The survey invitation was shared via TDOT's internal weekly newsletter, Road Ahead, beginning January 22, 2024. Reminders were shared periodically through the newsletter until mid-April. A copy of the survey instrument is included in Appendix E.

Survey data was analyzed in both aggregated (all responses) and disaggregated (responses by work area, length of time with TDOT) form. For single or multiple-choice items, frequency analysis was conducted. For Likert scale items, mean response values were computed for aggregated data as well as computed and compared between groups (such as by work area) to determine if there were any differences of interest. Finally, sentiment analysis was conducted on open-ended responses within the Qualtrics platform. The Text iQ natural language processing tool within Qualtrics was employed for this analysis. This AI-based tool uses machine learning to analyze text responses and group similar responses into categories based on similarity of language. The research team reviewed and adjusted categorization of responses and labeled each category thematically. The team also examined the associated sentiment rating determined by the tool and adjusted where incorrect assignments of sentiment were identified. Where no categorization or sentiment assignment was able to be made using Text iQ, research team members manually applied appropriate assignments. Both frequency of topics and overall sentiment for open-ended items was of interest for this study.

Focus group participants were also solicited through TDOT's Road Ahead newsletter to provide additional insight regarding survey topics. Individuals were provided a link to provide their name, role, and division information through an online form to opt-in or volunteer to

participate in focus group meetings. The form was only viewable by the research team, and volunteer names were not shared with TDOT. As TDOT's bureau and division leaders were engaged through interviews as part of Task 1, the focus groups included staff outside of these ranks. Generally, each focus group included 2-5 staff who were grouped according to similarity in job function and level. A total of 5 focus groups were conducted from April – June 2024. Each focus group lasted one hour and was conducted via an online conference platform (e.g. Zoom or Teams). A total of 18 staff participated in these discussions.

A questionnaire containing 8 items, supplied in Appendix E, was developed by the research team with collaboration from TDOT lead staff. The questions covered three general topics:

- KM Practices
- KM Culture
- Other Strategies

All questions were discussed within each focus group. Summaries of the interviews were developed by the research team member that facilitated the discussion. The team examined all results and identified core themes that emerged from the conversations.

3.4 Task 4. Internal Analysis of Employee Turnover

The purpose of Task 4 was to analyze TDOT's employee turnover rates to determine how a robust KM framework might impact staff retention. The data that was available for examination for this task were retention summaries, turnover data by job classification and department under the prior organizational structure and exit survey summaries. All the data summaries were prepared by the HR Division. The research team evaluated 10+ years of data across 267 job classifications, and 90 departments. With EPIC and reorganization, analysis by department would be inconsistent and therefore, focus was maintained on key generalizable takeaways.

3.5 Task 5. Internal Analysis of Knowledge Flow

Task 5 focused on examining how divisions within TDOT are sharing or acquiring knowledge as well as the tools used to do so. This task involved more detailed examination of division interviews from Task 1 to identify mechanisms of knowledge transfer and determine which tools are used by each division or region. From this analysis, a knowledge flow diagram was constructed to identify opportunities for shifting existing practices to incorporate more modern approaches to KM, such as use of specialized online platforms such as those available within Microsoft Teams.

Finally, findings from each of the five project tasks were used to inform development of a recommended framework for implementation of organization-wide KM. Assessment of current strengths, weaknesses, and opportunities related to sustainable KM practice was conducted to provide recommendations for TDOT. Central to the recommended approach was consideration of elements most likely to align with TDOT's infrastructure, recognition of potential barriers, and leveraging current successes.

Chapter 4 Results and Discussion

For TDOT to meet its mission of providing a safe & reliable transportation system to support economic growth & quality of life, an essential component is a sustainable strategy for managing the agencies knowledge resources. This is critical not only to achieving operational efficiencies but also to retaining and developing talent. This study is designed to:

- assess the current state of KM practice at TDOT,
- evaluate cultural attributes, opportunities, and challenges to organization-wide KM,
- identify best practices for knowledge acquisition, collection, and transfer, and
- recommend a framework for strategic KM within TDOT.

To accomplish these goals, the research team included a benchmarking study within TDOT, an assessment of TDOT's culture related to KM, an examination of staff turnover data, and interviews with state DOTs to identify practices relevant for TDOT. Findings from each of these activities are described in the following sections.

4.1 Current State of KM Practice

While few units formally discuss 'knowledge management,' all units have at least a baseline understanding of what is included and the value of KM.

Overall, discussions with TDOT leadership indicate that while few units formally discuss 'knowledge management,' all units have at least a baseline understanding of what is included and the value of KM. Emphasis is typically placed on the specific components, such as succession planning or documentation, with each Division and Business Unit being at different levels of adoption. There is agreement that a strong KM strategy across TDOT would improve organizational efficiency, communication, collaboration, and would support innovation.

Critical knowledge areas vary, particularly as it relates to technical expertise of each organizational unit within TDOT. However, there were cross-cutting trends for both explicit and tacit knowledge, as shown in Figure 4.1. Some explicit knowledge areas represented in numerous units included knowledge of federal and state regulations, design standards, project management, and computer skills. Tacit knowledge similarities included elements such as on-the-job experience, understanding how to be a good mentor, communication skills, institutional knowledge, and understanding how to build relationships.

Many of the significant gaps identified by those interviewed were related to personnel issues such as vacancies or high turnover that limited talent resources. Communication and training needs were also frequently reported, along with succession planning and lack of time to implement robust KM approaches. Figure 4.2 further depicts some of the discussions related to gaps.

Figure 4.1 Cross-cutting Critical Knowledge Areas

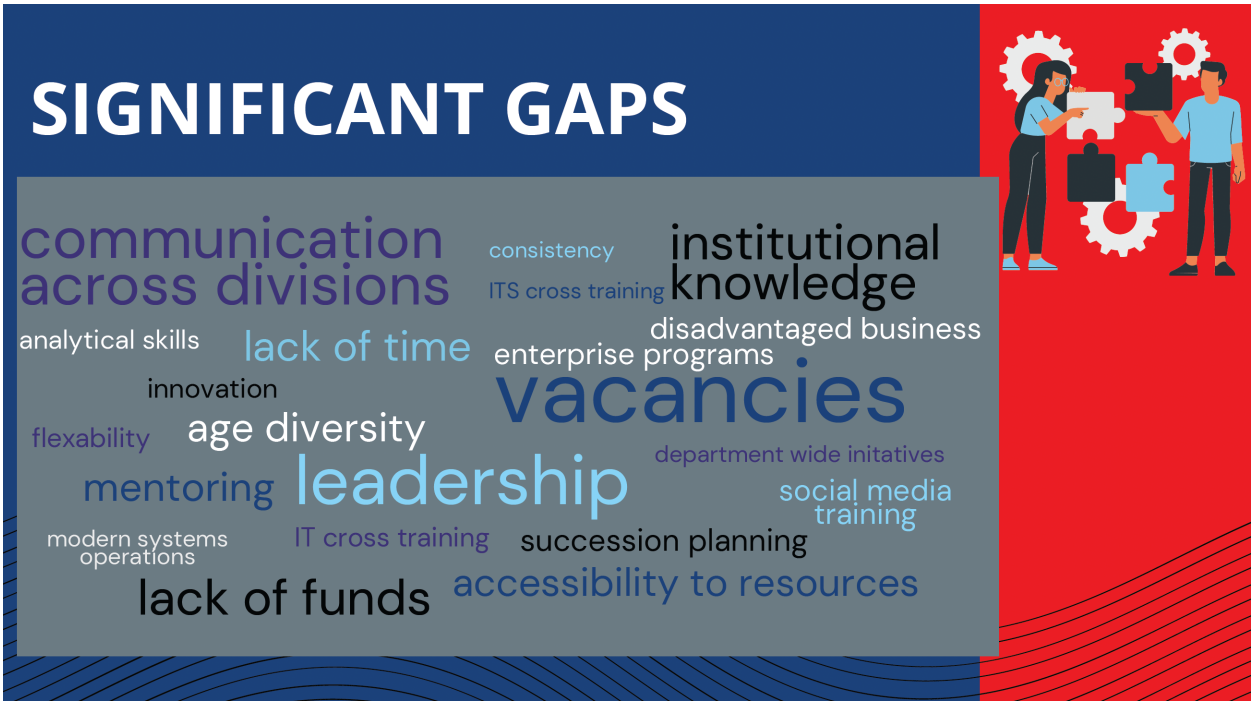


Figure 4.2 Significant Gaps Limiting Ability to Achieve Mission and Goals

The primary issues expressed by interviewees pertaining to KM were organized into seven categories. Categories are presented in order of the frequency that concerns were reported, with examples of specific issues described for each. Figure 4.3 shows the number of divisions reporting challenges related to KM in each of these categories. Primary issues include:

- **Knowledge Transfer and Retention**:
  - Knowledge gaps due to retirements.
  - Need for formal training and development, especially for younger staff.
  - Lack of documented processes hinders knowledge retention and transfer.
- **Technology and Skills Development**:
  - Limited staff with technical skills, especially in IT.
  - Need for training in specific tools and technologies.
  - Support for skill development in areas like project management and data analytics.
- **Communication and Collaboration**:
  - Communication gaps between divisions.
  - Lack of understanding of others' roles and needs.
  - Silos within the organization.
  - Need for better information sharing within division.
- **Leadership and Management**:
  - Need for leadership training.
  - Limited staff with management skills.
  - Need for succession planning.
- **Resource Management**:
  - Difficulty balancing resources and projects.
  - Need for more staff and resources.
  - Challenges in hiring and retaining talent due to salary competitiveness.
- **Process Improvement**:
  - Support for Lean and Six Sigma methodologies.
  - Need for better workflow organization and efficiency.
  - Desire for improved documentation and planning processes.
- **Flexibility and Adaptability**:
  - Lack of flexibility in service delivery.
  - Difficulty in adapting to changes and new challenges.

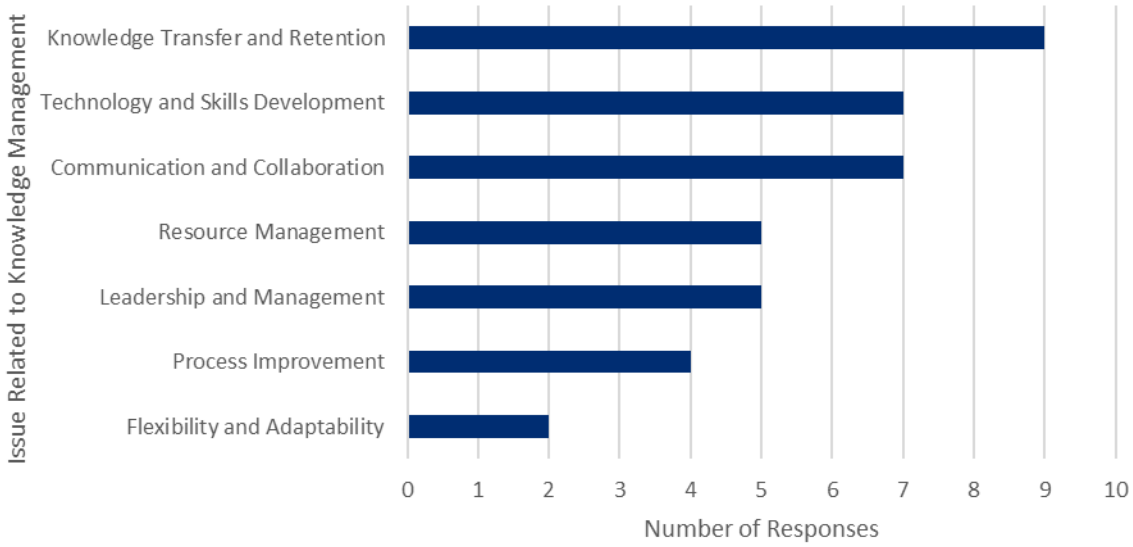


Figure 4.3 Primary Issues Related to KM

Most interviewees reported at least some effort toward documentation of knowledge and processes. Many had informal means to support learning and development. Cross-training was less frequently reported and is institutionalized primarily within the Human Resources Division, the Environmental Division, and the Occupational Health and Safety Division.

A variety of essential knowledge resources were reported, including both internal and external sources, as depicted in Figure 4.4 and described for Bureaus, Regions, and specific personnel in Appendix F. The primary categories of internal resources identified during the interviews were:

- Guidance documents and manuals
- Subject matter experts (SMEs)
- Formal cross-training
- Internal training programs
- TN Track
- Collaboration and communication tools

Guidance documents and manuals, SMEs, internal training programs, and collaboration and communication tools were identified by nearly all TDOT divisions as being an essential resource. Some specific examples of the internal resources included cross-training programs, personnel with institutional knowledge, EPIC Academy, TDOT's Learning Network, TDOT newsletters, project dashboards and databases, and the internal drive and SharePoint sites.

The primary categories of external resources identified as essential by interviewees included:

- Industry committees and organizations
- Publications or research journals
- Pooled Fund Study groups
- FHWA resources
- ITS resources

Industry committees and organizations and publications or research journals were the most frequently cited essential resources by the interviewees. Specific external resources included journals and news publications, AASHTO committees, the Transportation Research Board, ITS TN / America, and Pooled Fund Study groups.

Evaluation of knowledge flows across divisions revealed that there are practices currently in place that can be replicated across units as well as opportunities for modernizing practices. Figure 4.5 shows that all TDOT divisions currently use traditional approaches for knowledge exchange, while fewer are employing newer knowledge exchange tools such as shared drives, TDOT repositories, and Microsoft Teams. Figure 4.5 also identifies divisions that could benefit from implementing newer forms of knowledge exchange through the blue arrows. Essential knowledge resources identified by each bureau are provided in Appendix F.

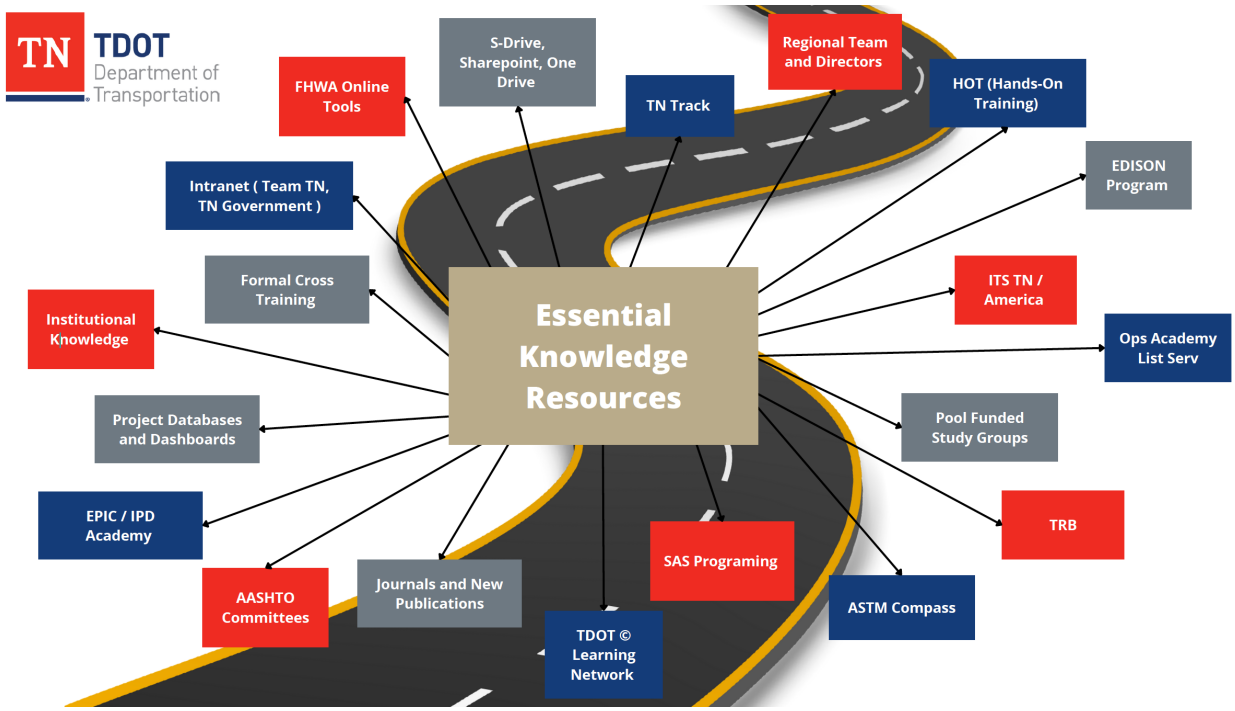


Figure 4.4 Essential Knowledge Resources for TDOT Bureaus and Divisions

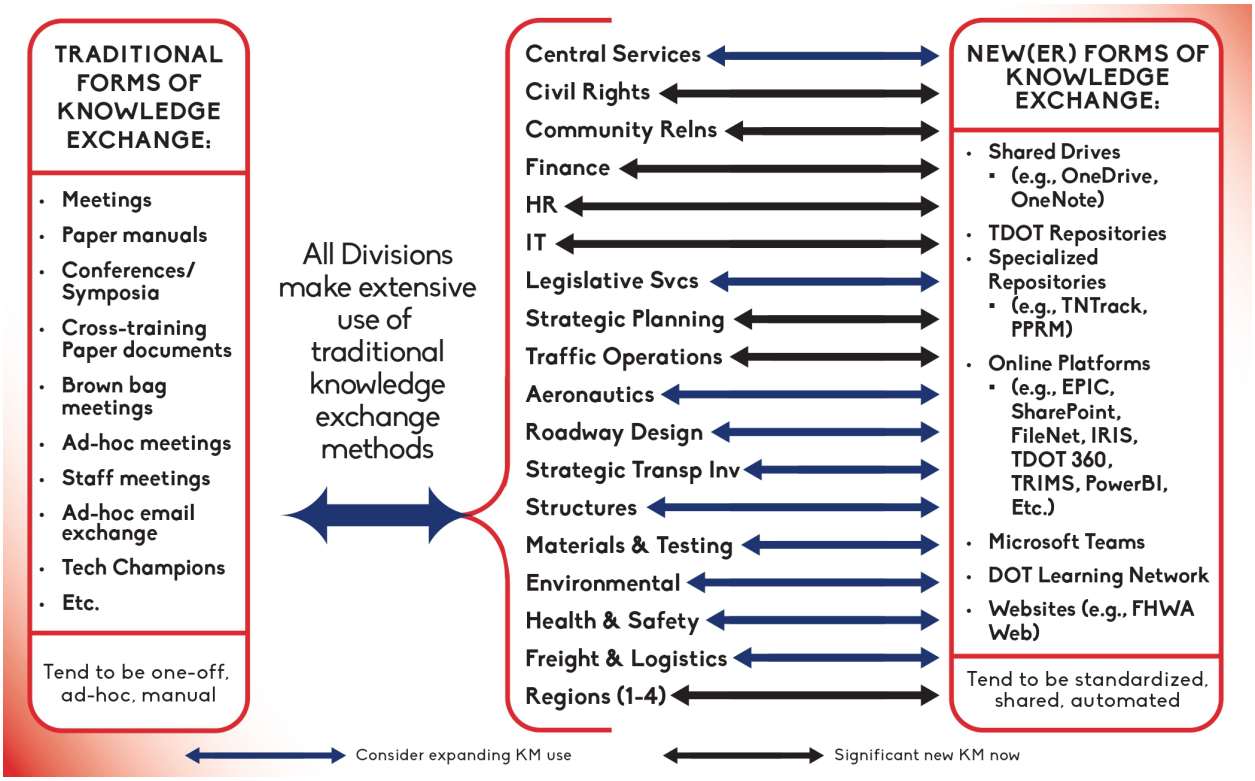


Figure 4.5 Knowledge Flow Diagram for TDOT Bureaus and Divisions

Challenges that TDOT divisions encounter related to KM include the time it takes to develop documentation, lack of clear vision or consistency in how information is collected and shared across the organization and feeling overwhelmed by the tools available to archive and share information. However, those that have been successful in developing a consistent practice report improved efficiencies, better working environment, and a 'deeper bench' of talent within the unit.

Communities of practice (CoPs) that TDOT staff engage in are both internal and external. There is a need to catalog internal CoPs so that gaps in coverage can be identified. There is also a desire to have more sharing of knowledge from CoPs across the organization rather than keeping the sharing contained to CoP participants. Interviewees see the utilization of internal CoPs increasing as TDOT transforms to a matrix organization and enhanced collaboration and teamwork becomes the norm.

In terms of information or knowledge that TDOT will need to execute its mission and improve organizational effectiveness, leaders interviewed identified several areas where new skills or knowledge are required, particularly as TDOT's organizational transformation continues and technology rapidly evolves. These areas include:

- Contract administration, project evaluation, and regulation enforcement
- Management and motivation of people
- Enhanced technology expertise, especially in information technology
- Data governance
- Data-driven decision making
- Managed lanes
- Alternative delivery methods
- Progressive design-build methodologies

To establish an agency-wide KM framework, leaders reported that developing a consistent approach that is simple and easy to implement and that results in staff seeing immediate value is key to its success. Staff are already overloaded, and they must find value in spending the time to add KM activities to daily workflows. Additionally, communicating the value and highlighting successes will be critical to success of the effort.

Finally, to promote a culture of innovation and knowledge sharing, effective communication and deliberate hiring must take place to keep staff motivated and momentum going toward establishing a robust KM strategy. Initiatives such as innovation challenges instituted by other states are seen as a promising way to increase innovative ideation and problem-solving. Institutionalizing such practices can not only catalyze innovation and knowledge sharing but can also lead to increased staff satisfaction as they are recognized for valuable contributions to the organization.

4.2 Cultural Attributes, Opportunities, and Challenges to Organization-Wide KM

A total of 251 TDOT staff, representing a 7% response rate, responded to the KM survey. However, all respondents did not answer all questions, so the number of responses for each item varied. The first survey question recorded 247 responses, with respondents indicating their work areas. When comparing response rates to staffing levels within TDOT as shown in Table 4.1, it is noted that staff from the Administration, Engineering, and Planning Bureaus are overrepresented while those from regional offices are underrepresented.

TABLE 4.1 COMPARISON OF SURVEY RESPONSE RATES TO TDOT STAFFING LEVELS

	Representation in Survey Responses	Representation in TDOT Staffing Levels
Administration Bureau	15%	8%
Engineering Bureau	40%	17%
Planning Bureau	8%	5%
Regional Office	27%	70%

In summary, the largest groups of respondents were from the Engineering Bureau (around 40%) and the HQ region (42%). Staff from regional offices were underrepresented in survey responses but they comprise of a larger percentage of TDOT overall staffing. The regional representation consisted of 14% from Region 1, 9% from Region 2, 26% from Region 3, and 9% from Region 4.

The last question in this category sought to determine how long each employee had been employed full time at TDOT. A significant portion (around 31%) of respondents have been employed at TDOT for 5-10 years, closely followed by those with over 20 years of experience, indicating a mix of mid-career and highly experienced employees make up most participants in the survey.

4.2.1 Perceptions and Attitudes Regarding KM

Two questions were posed to assess the perceptions and attitudes of TDOT staff toward KM. The first question aimed to understand employees' immediate feelings upon hearing the term KM. Two hundred thirty-nine (239) responses were collected and categorized into a diverse range of six sentiment groups: neutral, negative, positive, mixed, very positive, and very negative. This variety of sentiment groups reflects the diverse opinions and feelings of TDOT staff.

Each response was carefully analyzed to identify the most appropriate sentiment category based on the words used by respondents. For instance, 48% of responses were classified as neutral words such as "digital," "sharing," "communication," "leaders," and "training" as they did not convey strong positive or negative emotions. Positive words (18%) like "good," "important," "sufficient," and "safe" indicated favorable sentiments. Conversely, very negative terms (27%) such as "long overdue," "non-existent," "uh oh," and "joke," suggested strong negative emotions. Some responses (7%) indicated mixed opinions. Figure 4.6 provides a graphical overview of the sentiments identified in the responses using a word cloud. The term ‘training’ was the most frequent response of survey participants.

Figure 4.6 Sentiment Related to the Term 'Knowledge Management'

The second question in this category asked respondents to specify how they feel when considering TDOT's potential adoption and implementation of a more robust approach to KM. The question format was a smiley face with a slider bar that allowed participants to drag it up or down to produce a range of faces including big frown, small frown, neutral face, small smile, big smile. The faces were assigned a scale of 1 to 5, with 1 (big frown) representing very negative and 5 (big smile) very positive. A total of 226 responses were gathered. The average rating was 3.7, falling between neutral (3) and positive (4). Figure 4.7 shows the results of how TDOT employees feel about the potential adoption and implementation of more robust KM; 46% are positive, 24% are neutral, and about 3% had very negative perceptions. There were no significant differences in responses between respondent categories (i.e. work area or length of time with TDOT).

Overall, employees tended to have a neutral or positive stance rather than expressing negative sentiment regarding KM. Neutral responses to the first question indicated TDOT staff understand what KM means, as many of the responses were simply defining aspects of KM or who might be involved. The significant positive response on the second question, with more than half of participants expressing positive sentiment about potential adoption and implementation of a more robust KM strategy, indicates there is interest and support for moving in this direction.

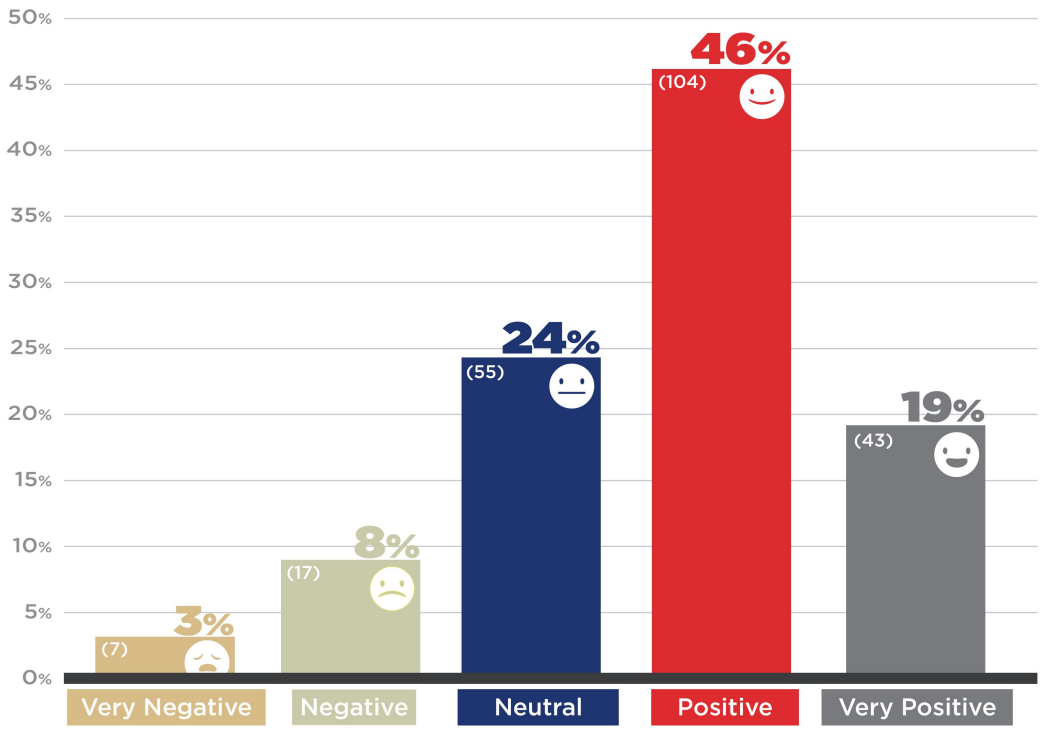


Figure 4.7 Feeling towards Potential Adoption and Implementation of More Robust KM

4.2.2 Knowledge Resource and Tool Preferences

Three questions on the survey were designed to reveal knowledge resource preferences among TDOT employees. Figure 4.8 highlights the most frequently used resources by employees. The survey collected responses from 250 unique individuals for this item, each of whom was allowed to select up to two preferences. Consequently, the percentages shown represent the proportion of respondents who selected each option, which allows the summation across all categories to exceed 100%. For instance, 64% of the respondents chose to email or talk to a colleague at TDOT as one of their preferred methods, while 52% favored using online TDOT resources. This indicates the relative popularity of each method among the respondents. The question regarding least frequently used resources aligned with findings shown in Figure 4.8, with posting a message on a listserv or online community identified as the least preferred resource, followed by searching hardcopy documents and emailing or talking to colleagues outside of TDOT.

When asked about the preferred methods for sharing useful information among TDOT staff, the largest number (30%) of respondents indicated they would send a memo or a copy through e-mail. Another significant portion (21%) preferred to tell others about it or distribute a copy personally. Fewer respondents chose other methods, with only 7% including it in weekly updates and 6% selecting other methods.

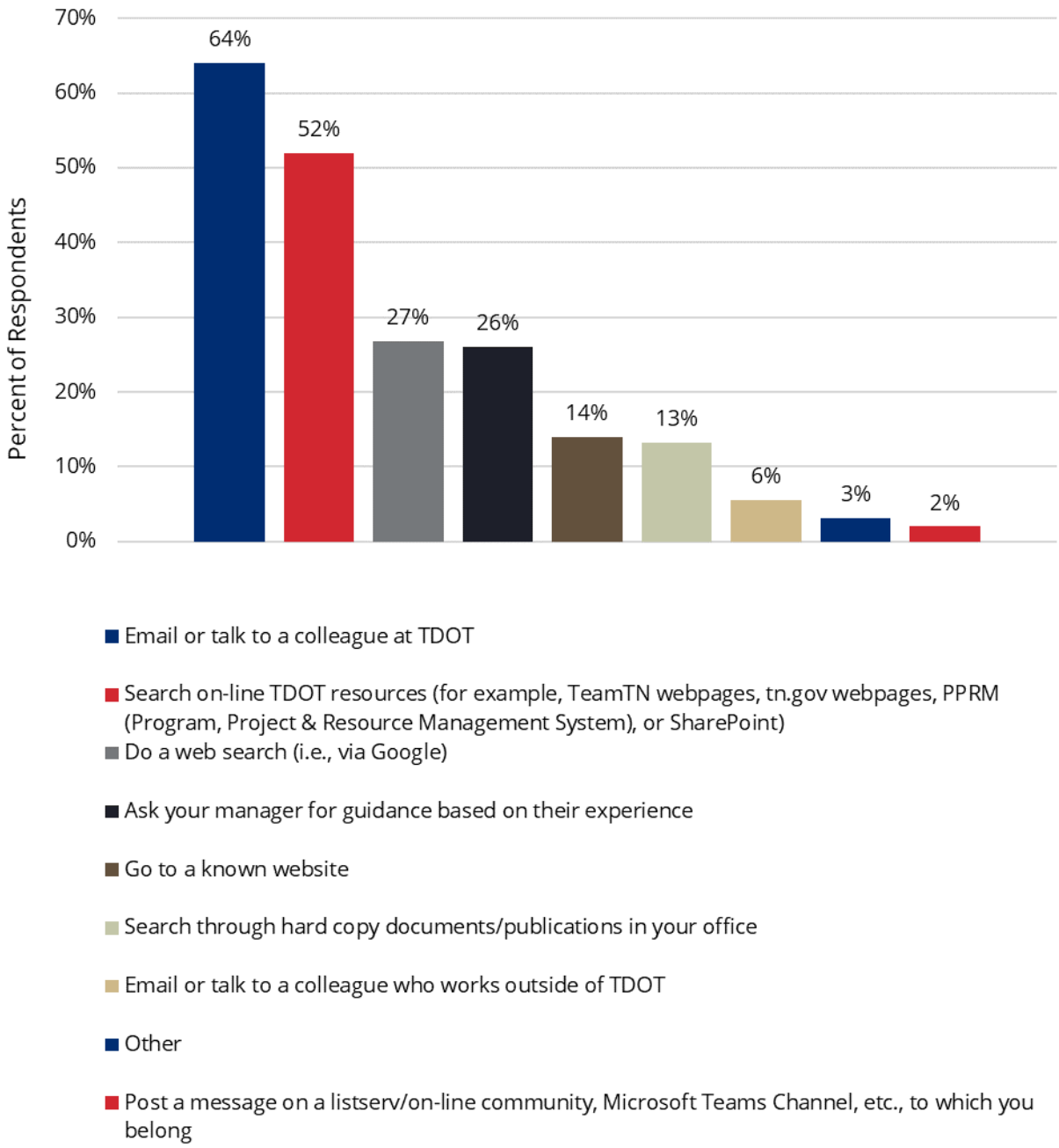


Figure 4.8 Top Resources Utilized by TDOT Employees for Knowledge and Information Retrieval

Figure 4.9 shows the tools and resources TDOT employees prefer for executing their jobs. From 250 respondents, a total of 1022 responses were recorded, as participants were allowed to select multiple items. Of these respondents, 76% prefer their colleagues to help them do their jobs, which fosters teamwork and collaboration. Following this resource is the use of electronic documents accessed through TDOT-shared (internal) drives and formal training programs or workshops.

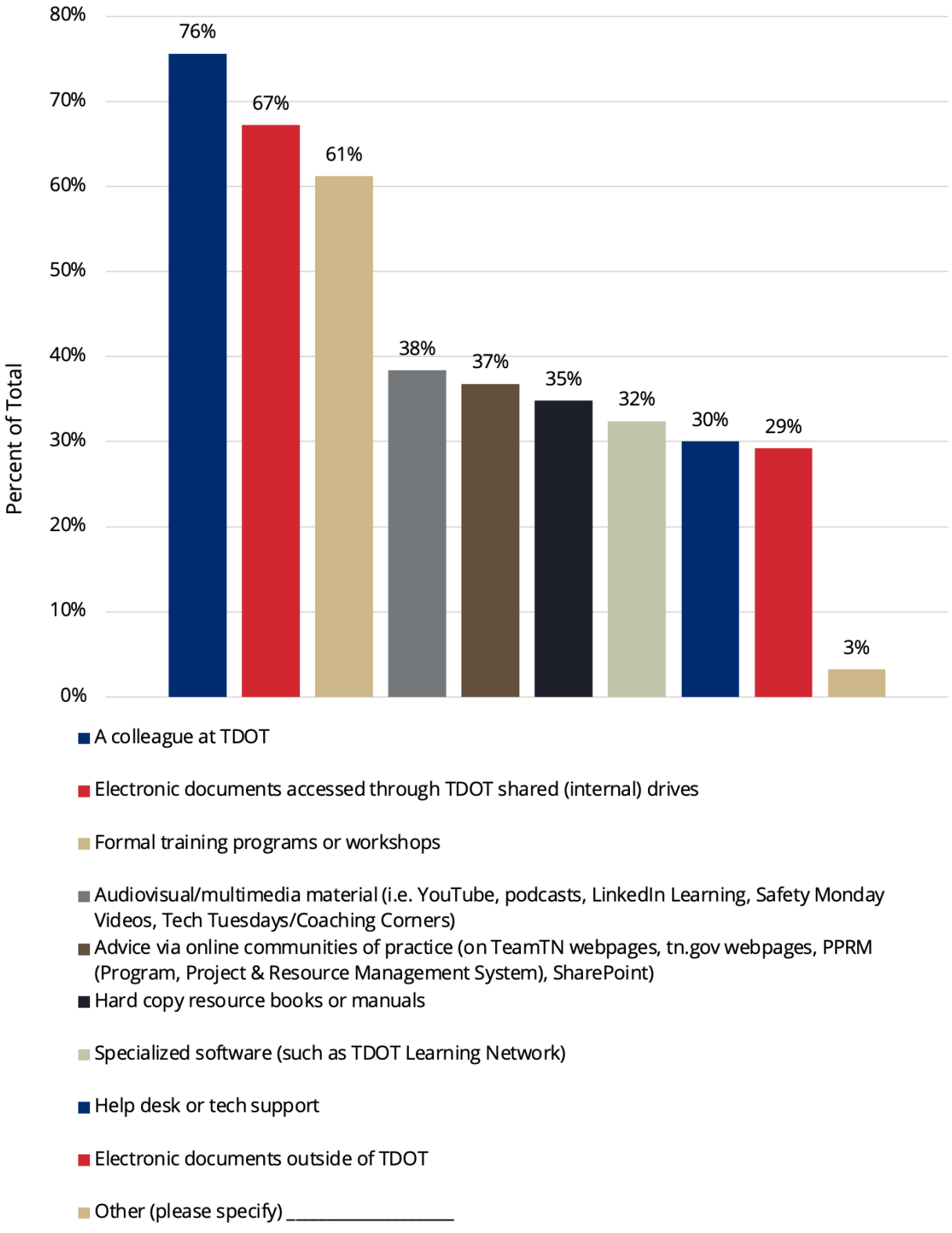


Figure 4.9 Preferred Tools for Work at TDOT

4.2.3 Challenges and Constraints in Accessing and Sharing Knowledge

Respondents were also asked to identify constraints in accessing or sharing knowledge or information, and 221 responses were recorded. The responses were categorized into various themes using the advanced text analysis tool Text iQ, leading to 279 total occurrences of different themes, as some responses included multiple themes. Table 1 presents each theme along with its total number of occurrences.

All responses were grouped into the themes listed in Table 4.2, with a significant number identifying the lack of a consistent knowledge and information-sharing platforms as a major barrier. Terms such as "information," "knowledge," "info," "knowledge base," "information platform," "knowledge share," "sharing info," "outlet to share knowledge," "share information," and "information sharing platform" were grouped under the theme of lack of proper knowledge and information sharing platforms. This categorization was based on how closely the responses aligned with each theme, highlighting the urgency of addressing this issue for effective knowledge sharing within TDOT.

TABLE 4.2 DISTRIBUTION OF THEMES IN CONSTRAINTS FACED BY TDOT STAFF IN ACCESSING OR SHARING KNOWLEDGE

Themes	Percent of Total	Total comments
Consistent knowledge and information sharing platforms	28%	78
Time constraints in knowledge sharing	14%	40
Minimal or no constraints	11%	32
Access and permission issues	11%	31
Limited awareness of available resources within TDOT	11%	30
Proper channels for knowledge sharing within TDOT	10%	28
Individual attitudes and mindset	10%	27
Adequate training and knowledge transfer mechanisms	5%	13

Figure 4.10 shows similar responses among regional office staff and other TDOT staff, although region staff indicated access and permission issues as a challenge at a significantly higher frequency than other units. There were no significant differences in responses with any other category (i.e. work area or length of time with TDOT).

A perceived lack of appropriate knowledge and information sharing platforms was indicated by the largest number of respondents as a constraint. Time constraints related to KM was the second most frequently cited issue. Interestingly, individual attitudes and mindset and training were the least frequently identified constraints. This indicates that aversion to knowledge sharing is likely not a significant issue that TDOT will have to overcome. Figure 4.11 depicts the sentiment associated with each of these themes. Most responses indicated negative sentiments related to the constraints or challenges in effective knowledge and information

sharing. This is expected as the question was structured to illicit challenges. However, there were some responses that included positive statements related to a particular issue, and 11%

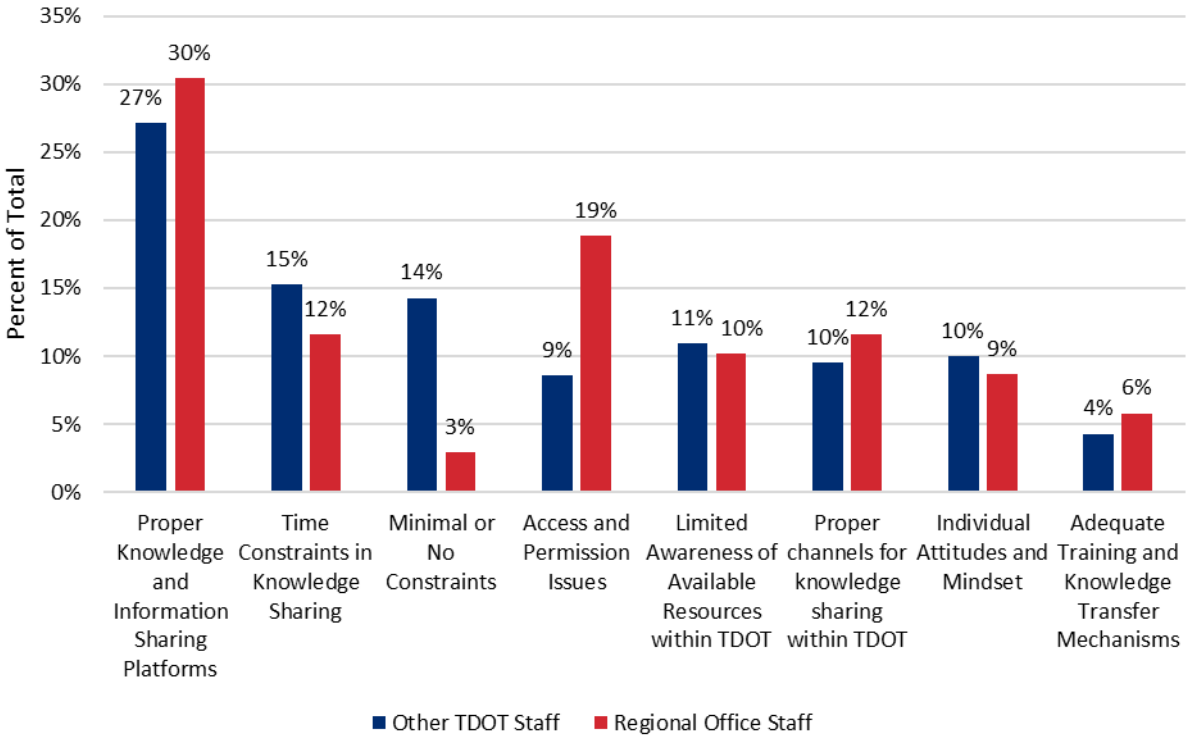


Figure 4.10 Comparison of Constraints Identified Among Regional Office Staff and Other TDOT Staff

of responses indicated that there are no significant barriers to accessing and sharing information. Responses noted as 'mixed' included both positive and negative statements, while those noted as 'neutral' wrote in comments that did not mention having constraints.

4.2.4 KM Practices, Tools, and Culture

Two sets of survey questions were presented to TDOT employees, each offering multiple statements for respondents to indicate their level of agreement related to KM practices, tools in use, and culture within their division or work area. The first set of statements includes:

1. I am comfortable using Adobe PDF, SharePoint, OneDrive, OneNote, and other Microsoft web-based applications to share documents within my unit.
2. I understand the process or system for how files are stored and shared within my unit.
3. Sharing knowledge and information is encouraged in my unit.
4. I am comfortable sharing what I know with others.
5. Sharing practices in my unit makes my job easier.

These statements assessed employees' attitudes, perceptions, and experiences regarding knowledge-sharing practices and the culture within their work units or teams at TDOT. Figure 4.12 displays the survey results, revealing that the largest percentage of respondents strongly agreed with each statement: 43% for the first statement, 40% for the second statement, 58% for the third statement, 72% for the fourth statement, and 58% for the fifth statement.

Figure 4.11 Sentiment Analysis of Constraints and Challenges Faced by TDOT Staff in Accessing or Sharing Knowledge and Information

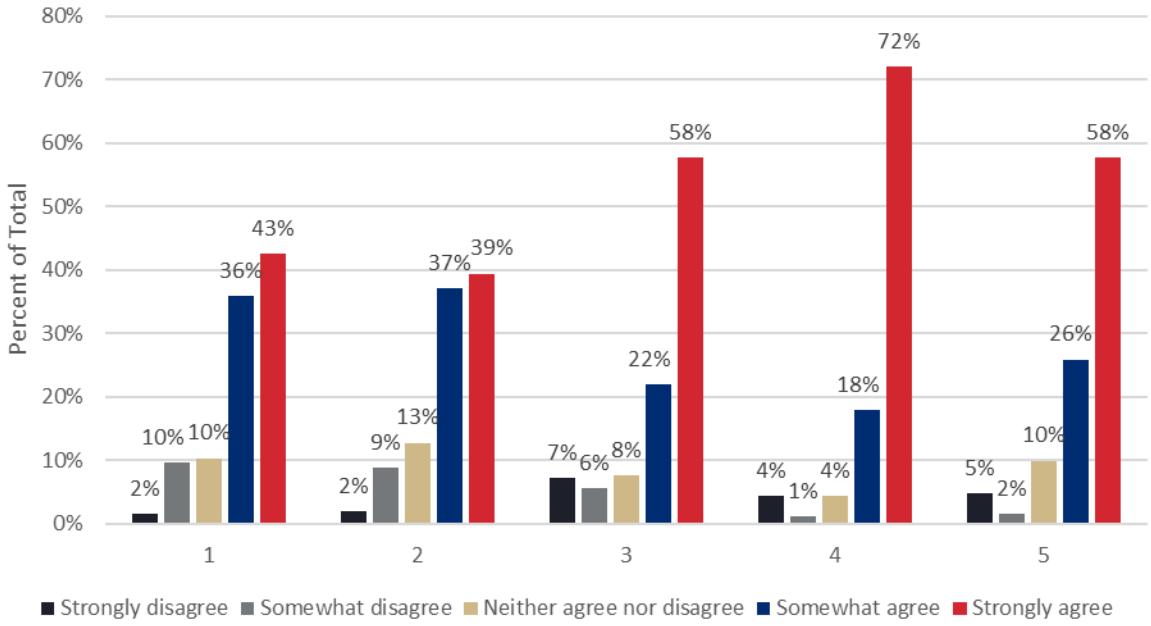


Figure 4.12 KM Practices, Tools, and Culture - Set 1

The second set of statements includes:

1. I would benefit from having access to documents that contain introductory knowledge that I have to acquire from experts directly.
2. I would benefit from templates to help me more easily record or document knowledge and information.
3. I would benefit from formal processes to help me contribute knowledge that I don't currently document or share.
4. I would benefit from support to determine the most relevant knowledge and information to share for various audiences and how best to share it.
5. I have knowledge in areas that I know the organization could benefit from but no way or understanding of how to make it available to others.

For statements 1-3, the largest percentage of respondents indicated they strongly agreed: 42% for the first statement, 44% for the second, and 34% for the third. In contrast, for statement 4, the largest percentage of respondents only somewhat agreed, at 39%. For statement 5, the most frequent response was neutral, with 41% neither agreeing nor disagreeing. These results are shown in Figure 4.13.

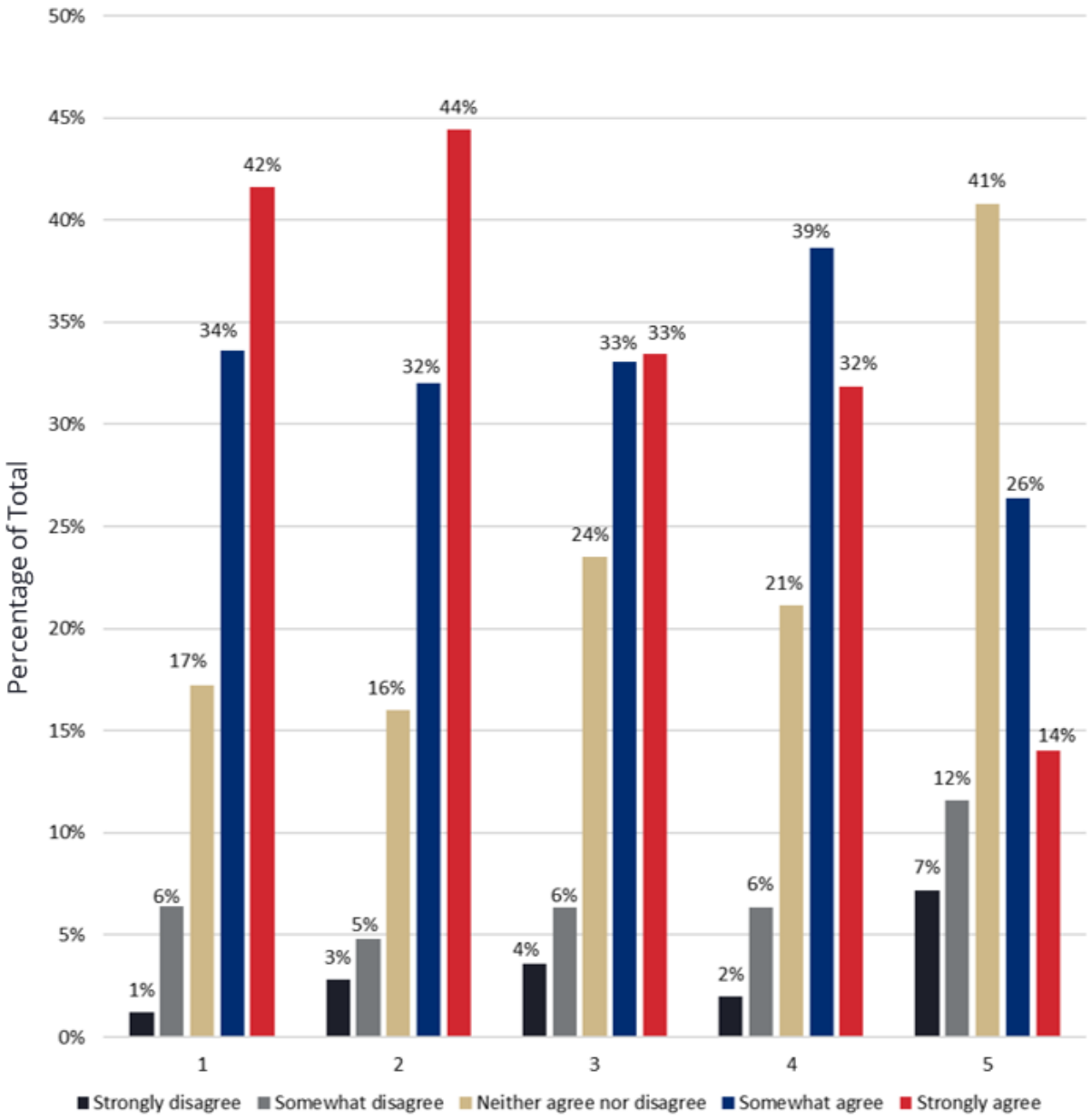


Figure 4.13 KM Practices, Tools, and Culture – Set 2

The responses to these questions suggest that TDOT staff are comfortable with tools, practices, and culture pertaining to KM within their divisions or work areas. They also see value in additional resources and processes that would create a formal structure and consistent practice related to KM.

4.2.5 Suggestions for Improvement

Finally, respondents were asked to contribute to TDOT's culture of knowledge sharing and innovation by providing suggestions via an open-ended item on the survey. This item elicited a total of 147 responses. The responses were processed using the advanced text analysis tool within Qualtrics, Text iQ, which categorized the responses into various themes. This led to a

total of 163 occurrences of different themes, as some responses encompassed multiple themes. Table 4.3 provides a detailed breakdown of each theme and its corresponding frequency.

Categorization of responses was based on how closely a response aligned with a particular theme. Many respondents recommended that TDOT streamline knowledge-sharing platforms to make finding the information being sought easier.

TABLE 4.3. DISTRIBUTION OF THEMES IN SUGGESTIONS FOR IMPROVEMENT

Themes	Percent of Total	Total comments
Streamlined knowledge sharing platforms	36%	58
Minimal or no suggestions made in response	17%	27
Developing training and education initiatives	14%	23
Promote a culture of support and knowledge sharing	13%	21
Foster open and transparent knowledge sharing	9%	15
Promote knowledge retention and experiential leadership	7%	11
Optimizing change management and ensuring project continuity	3%	5
Leverage technological advancements	2%	3

Figure 4.14 shows the variation between regional office staff and Other TDOT staff in their suggestions for improvement. Generally, all TDOT staff suggested similar strategies for improvement.

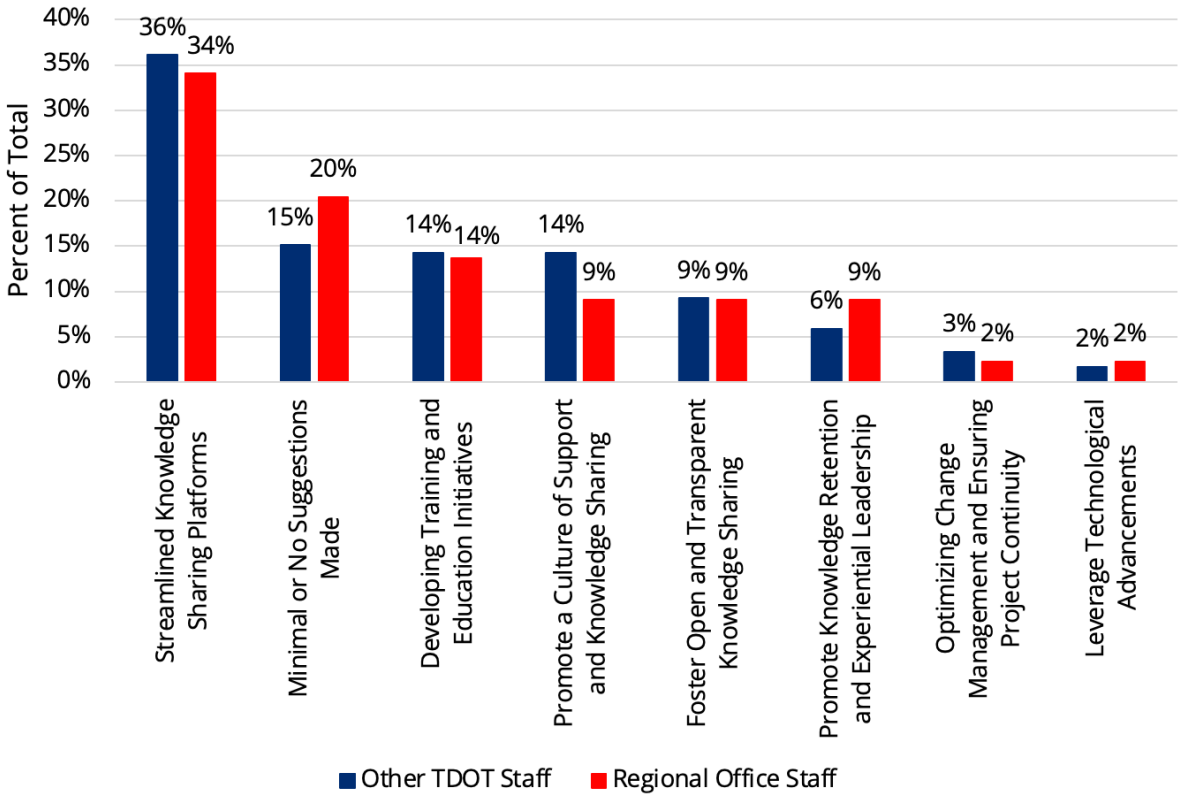


Figure 4.14 Comparison of Suggestions for Improvement Identified Among Regional Office Staff and Other TDOT Staff

Figure 4.15 depicts the sentiment associated with each of these themes. Most of the suggestions presented had negative sentiments indicating respondents were sharing specific concerns related to implementing a more comprehensive KM strategy. Some example negative responses include:

- *Hire better managers that are not threatened by employees that try to improve things.*
- *The online learning is nice but, it doesn't help if you get lost or confused during the online learning. It would be nice if you offered some in person training so questions can be asked.*
- *Actually being transparent. Actions speak louder than words.*
- *Stop overloading with changes and updates with no benefits. We have seen many projects started but nothing is updated for future use or kept current.*
- *Stop having managers that make you feel like information you think could be useful to the team is a waste of their time, not good enough, or have their own agenda to share. Plenty of us have information that could be helpful but having a manger that isn't open or want to hear what we have to say is what we're stuck with.*

Example positive or neutral responses include:

- *Normalize use of sharepoint sites - they exist for most (all?) teams/groups/divisions, but many or most remain on their default settings and are not used for information sharing.*
- *Maybe a database or something you could enter key words that pertain to the information you are looking for and it provide a contact person/group or a document with a general overview.*
- *Imbed cross training in IPP's. Support staff should know how to step in if a leader is out and vice versa.*
- *Improve data systems to link data across divisions and eliminate siloed data.*
- *We should have an internal TDOT Academy.*

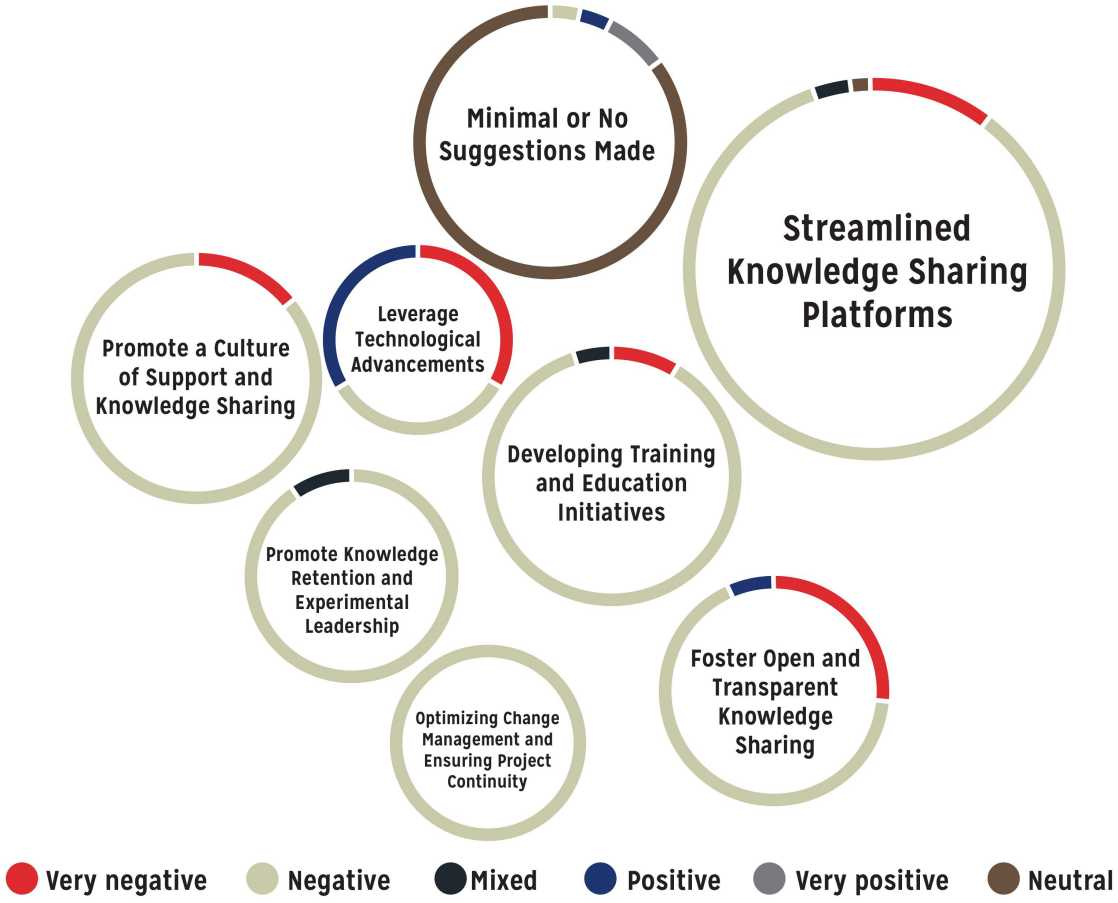


Figure 4.15 Suggestions for Improvement

4.2.6 Summary of Survey Findings

The survey results indicate that there was overrepresentation of the Administration, Engineering, and Planning Bureaus and underrepresentation from the regional offices. However, analysis of responses comparing results for representatives from regional offices to that of other TDOT work areas are similar enough that the results should be representative. The largest fraction of respondents, 31%, have been employed at TDOT for 5–10 years. Employees' perceptions and attitudes towards knowledge management (KM) are mixed, with

neutral and positive sentiments prevailing related to the potential for KM at TDOT, with 46% of respondents optimistic about adopting more robust KM practices. Regarding knowledge resource preferences, most employees favor emailing or speaking with colleagues, while posting messages on listservs or online communities is the least preferred. The main constraints to effective KM include a need for proper knowledge and information-sharing platforms, time constraints, and access or permission issues.

TDOT Employees prefer using colleagues and electronic documents and value formal training programs and workshops. Currently, most employees are comfortable using tools like Adobe PDF and SharePoint, but there is a need for better access to introductory knowledge and formal knowledge-sharing processes. Finally, the top recommendations for improving KM include streamlining knowledge-sharing platforms, developing training initiatives, and promoting a supportive culture. The open-ended responses revealed some concerns related to managers, training, and communication, and highlighted opportunities to improve cross-training, standardize use of SharePoint, and remove data silos.

4.2.7 Focus Group Analysis

TDOT staff participating in the focus groups had a generally positive outlook on KM activities and their importance for TDOT. They indicated that there are open lines of communication and a willingness to share knowledge. While there are some staff who are hesitant about sharing information out of concern that they might share having done something 'wrong' and don't want to call attention to this, the participants felt this could be addressed by making it standard practice to share what to do as well as what not to do to destigmatize mistakes and turn these into regular learning opportunities. Creating a 'safe space' for sharing was emphasized as an important element of KM.

Most of the KM practices at this point are somewhat informal from the perspective of focus group participants. For example, in many cases more experienced staff are paired with new staff to help transfer knowledge, but there are no set requirements or goals for this interaction. Sharing of knowledge occurs informally through meetings, but interest was expressed in formal communities of practices being formed at TDOT. One of the primary barriers to sharing comes from staff not knowing others in other areas of the state who might have experience or knowledge that could help with issues being experienced in another part of the state. Participants expressed that in the past, there were more opportunities for people at the same level/title to meet on a regular basis to facilitate knowledge sharing and to ensure everyone knew one another. There were also meetings after large projects wrapped up where those involved shared lessons learned. The participants thought it would be helpful to bring these practices back and formalize them. Some participants also expressed the importance of external communities of practices as well, such as those led by AASHTO and other relevant state and national organizations.

The groups also expressed a need for more frequent formal training to ensure all staff remain up to date on current practices and processes. They recognized the importance of standardizing practices but noted that training is needed to make sure everyone is on board and has the understanding needed to do this. They also highlighted the importance of having well-trained mid-level leadership to ensure practices are communicated effectively across all levels of staff. Furthermore, documentation of practices and procedures will take time and

effort, which many felt was not prioritized at present. The GTA program was highlighted as an exemplar for knowledge sharing with new employees rotating through various offices and divisions to learn about TDOT and various programs, but it was noted that much of this stops once an employee leaves the GTA program and it is limited to only select positions but could be beneficial to many other staff members. Additionally, having a proactive approach to succession planning was seen as an important aspect for KM. Further, using internships to identify high-potential future employees and having newer employees participate in activities through shadowing, etc., was suggested as a good way to build future skills in the TDOT work force.

The EPIC reorganization has created some uncertainty in terms of career pathways that mean that staff are not as certain what it takes to advance. Some staff are also concerned that sharing information/knowledge that is unique to oneself may jeopardize their position. However, most participants expect advancement pathways will become clearer as EPIC is fully implemented throughout the organization.

In terms of tools that are used, the use of a unit drive, OneNote, and Teams has facilitated sharing of information across roles. A concern was expressed that the OneNote platform would no longer be used in a year, and there is uncertainty about what will replace it. The ability to search within OneNote is seen as a positive attribute. Several participants expressed they regularly use and value Teams Channels for sharing of knowledge within their units. The ability for inspectors to access information within Teams from state-issued phones is also a positive step towards information sharing. The participants noted that there is some uncertainty as to when and how Teams should be used. They suggested a 'Microsoft Teams 101' training that could be provided to all staff, with continuing training that could advance skillsets, such as demonstrating screen sharing and control within meetings to facilitate collaboration and a standardized way of organizing information so that everyone understands how to access what they need and best utilize this tool.

Finally, the participants expressed the need to show the benefits in terms of operational efficiencies, better working relationships and consistencies across the department to get everyone on board with an agency-wide approach to KM. This requires a better way of getting information out to everyone, explaining changes, and how to interpret them. It also requires that information is organized well and easy to find on internal systems, including TDOT's website. In addition, there is interest in leaders and managers creating a culture that supports and advocates for KM practices while also allocating time and resources for employees to do the necessary documentation, sharing, and learning that is needed. Participants also shared that it is important to ensure all voices are heard and valued, even those of less experienced staff, for a true culture of sharing to take hold at TDOT.

Discussions with focus group participants indicate staff are very supportive of KM initiatives, most of which can be described as previously documented processes that are shared or used by employees, or now more recently, shared via IT platforms, e.g., Teams Channels. There are no major barriers to increased KM usage, but time can be a factor at times. Upper management "walking the talk" helps to build credibility and support for KM. Culture for KM is overall positive, and challenges to this are mostly confined to individual personalities vs. larger organizational beliefs.

4.2.8 Turnover Analysis

The research team evaluated 10+ years of data across 267 job classifications, and 90 departments. With EPIC and reorganization, analysis by department would be inconsistent and therefore, focus was maintained on key generalizable takeaways.

The impacts of the COVID-19 Pandemic are noticeable, but not necessarily significant compared to other years. Region 3 has consistently had more employee turnover than other regions in the past decade. Data specific to Headquarters employee turnover was not explicitly discernable. Overall, TDOT seems to be doing better on retaining workers following the pandemic in comparison with pre-pandemic staffing with the lowest number of employee turnovers in 2023 for the past decade, as shown in Figure 4.16.

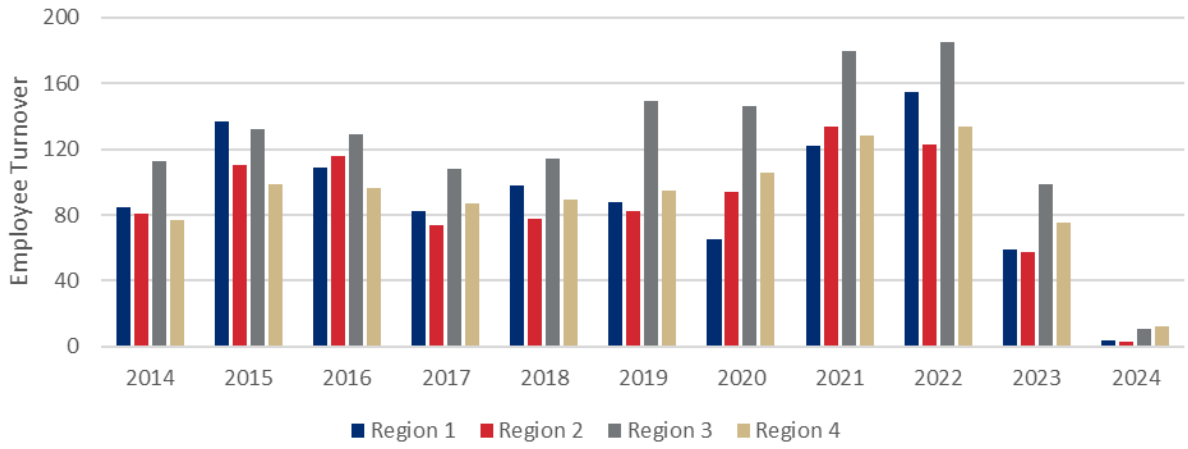


Figure 4.16 Employee Turnover Reported by Region, Independent of Job Classification

Data from several years of employee exit surveys dating back to 2017 (6 years of data) reflect the agency's turnover challenges through both the pandemic and administrative changes. Response rates for exit interviews of employees leaving voluntarily have remained somewhat steady, as shown in Figure 4.17, despite increased numbers of employees leaving during the pandemic period of 2020-2022.

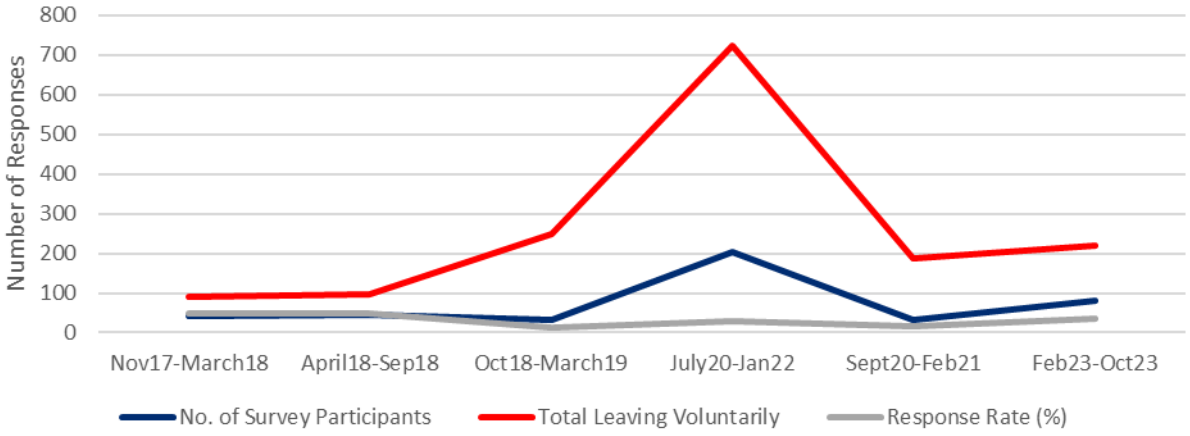


Figure 4.17 Employee Exit Survey Response Rate Trends

While the data available does not present a consecutive time period and the surveys have evolved over time, some of the key reasons for turnover have remained consistent. The key reasons for leaving include retirement, pay, career development, and family, as shown in Figure 4.18.

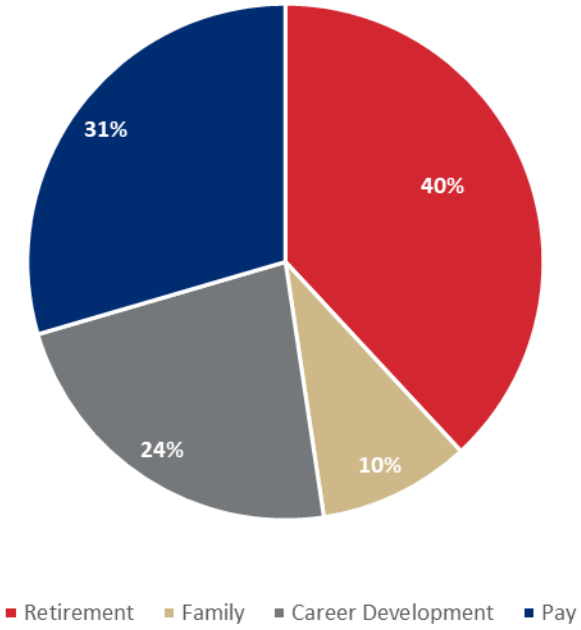


Figure 4.18 Reasons for Leaving - Compilation from 261 Exit Surveys, Nov 2017 - Nov 2023

Overall, most employees leaving TDOT voluntarily have positive sentiment associated with the agency. Consistently over 70% of exit survey participants rank the agency highly (good or great) in terms of the application and interview experience, onboarding, and performance management. Similarly, over 70% would recommend TDOT to others for employment as a

great place to work. Consistently, survey respondents indicated that the job itself (activities) and coworkers were what they liked best about their time at TDOT. This is a good indication of a positive culture at TDOT.

Employees were allowed to provide comments about various aspects of their experience for a limited number of survey periods. Key comments that align with KM practices and opportunities for improvement include the following:

- Increased training and resources for employees and supervisors are needed (especially regarding safety).
- More transparent communication is needed from upper management.
- Employees would like to be involved in decision making and updates for the agency.
- Improved, well-defined information on advancement and off-boarding is needed.

Each of these items could be improved with a robust KM strategy. Key findings from the analysis of retention data and exit surveys include the following:

- A consistent timeframe for collecting and archiving exit survey data is important for longitudinal tracking purposes. Ensure questions are consistent from one survey to another for long-term analysis of trends.
- While some factors leading to employees leaving cannot easily be addressed by improved strategies, pay and career development may be areas where TDOT can focus on reducing turnover.
- Transparency and broader engagement in decision making can be improved through KM practices to allow employees to take ownership and have buy-in for improved job satisfaction.

4.3 Best Practices for Knowledge Management

For an organization to develop a sustainable strategy that supports technical capacity, workforce retention, and innovation, it is essential to develop a strong framework for KM both within individual divisions as well as organization wide. Ten state DOTs and FHWA were interviewed to determine how they define KM within their organization, the type of organizational structure and policies in place to support KM practices, details of practices and programs that have been successful or that have encountered challenges in encouraging knowledge capture and sharing, and how the organization connects KM and workforce development strategies.

Summaries of these interviews are provided in the following sections. The discussion is organized around three central areas of KM: 1) organizational policy and structure, 2) KM practices and culture, and 3) KM and workforce development. Links to specific resource examples, guides, or policies are provided in each section where appropriate.

4.3.1 Organizational Structure & Policy

Agencies interviewed provided a range of definitions for KM. For example, the Federal Highway Administration (FHWA) does not have a specific definition of KM, which is by design. This unstructured approach allows the scope of KM practices to be based on what each entity within

FHWA needs – from strategic planning to how employee supervision or collaboration takes place. The Michigan DOT (MDOT) defines KM as a continuous practice of capturing, sharing, and applying knowledge and information. There is an emphasis of knowledge 'flow with a purpose' and for information to be readily accessible across the department. The Utah Department of Transportation (UDOT) defines KM through its Connect-Learn-Share tagline. The agency focuses on getting the right information at the right time to the right people to get the job done and enable good decision-making.

In terms of organizational structure, states with the most robust practices also had an assigned position or structure with accountability for KM. The Virginia Department of Transportation (VDOT) has had a formal, agency-wide approach to KM for many years, starting with a KM unit established in 2005. VDOT has struggled with terminology for their dedicated KM group until it was recently rebranded as the "Learning Organization." The agency has built a solid brand around this function statewide. A key success of the strategy has been establishing strong lines of communication between central administration and VDOT's nine districts. The Washington State Department of Transportation (WashDOT) has had a formal approach to KM for several years. At present the state agency has a KM strategist to lead KM efforts. KM is integrated throughout WashDOT across divisions and at all levels.

The Michigan DOT instituted a formal, organization-wide KM strategy following a departmental evaluation process in 2019 that found that 40% of the MDOT workforce was eligible to retire within 5 years and 40% were mid-career experts who were prime candidates for being recruited to private industry. This evaluation led to development of a comprehensive Workforce and Succession Planning System, MDOT House, that includes five pillars of focus for the organization – one of which being KM. A central tenant of MDOT House is that all staff within the organization have responsibility for taking care of it, including responsibility for KM. A KM team was put into place with the implementation of MDOT House. The team includes volunteers from across the organization that lead KM efforts. There are no FTEs dedicated to KM. A new section within MDOT, the Office of Organizational Development, has been created and will ultimately oversee KM and workforce development strategies, with two members of the Office now serving on the KM team. The Kentucky Transportation Cabinet (KYTC) also has an active KM program that is technically based across its three pillar areas: highway infrastructure/construction, asset management, and highway safety. The program has been in place for several years and includes centralized leadership. There is a staff position focused on KM for the KYTC, although the position is split between KM and research and innovation. Approximately half of the position is dedicated to KM, although frequently other administrative focuses and innovation practices require additional effort, resulting in the KM effort ranging between 20-50% of a full-time position. KYTC also employs the Kentucky Transportation Center, housed at the University of Kentucky, to support KM activities, including development of their new Highway Knowledge Portal (HKP) (https://kp.uky.edu).

4.3.2 KM Practices and Culture

A variety of practices are being employed by state and federal agencies to support KM efforts, including communities of practice, specially developed training series, intentional communications, and cultural transformations. FHWA has been very successful with its KM Collective, which is a peer exchange. Coffee & KM is another successful program held one

Friday a month, providing a forum for staff to come with problems and someone either walks through solution or the group troubleshoots together to figure it out. This creates a community that is very supportive for knowledge sharing. Most programs are offered virtually. KYTC has been very successful with a few recently developed training series intended to provide knowledge transfer:

- *Construction Project Managers Academy* – New as of 2022, the program includes a series of eight professional development sessions
- *Project Managers Bootcamp* – Created approximately five years ago, the Bootcamp is a week-long training program on the project development process
- *Project Managers Bootcamp Express* – Designed for consultants, primarily covering technical topics.

These training programs are used along with annual conferences hosted by KYTC to facilitate knowledge transfer and identify points of contact for questions. These programs also provide a venue for sharing stories of situations that may be encountered in work tasks and developing bonds between peers so that they are more comfortable seeking advice and asking questions.

Among the most effective practices to support KM broadly throughout the Mississippi DOT is the use of technology for improved documentation and regular staff meetings to share information. The agency has its own Information Systems Division which develops in-house workflows and project management systems, manages an extensive intranet system with a range of applications including project development and project management (PDPM), electronic workflows and invoicing, and also manages a large archive of electronic documents that are readily available to staff, including construction plans and engineering drawings, library volumes, and commission minutes dating back nearly 10 years. The Mississippi DOT was an early adopter of Microsoft SharePoint (SharePoint) software, which has resulted in improved documentation for data and information sharing. The agency also recently adopted Microsoft Teams and that shift has improved communication and knowledge sharing across divisions.

MoDOT's most effective practice or strategy for KM is making sure that everyone in leadership and supervisory positions understands that employee development is part of their job. There were cultural challenges and a generational divide in implementing this approach, with some staff still holding onto the idea that 'knowledge is power,' and being reluctant to train others. Working to overcome resistance to knowledge sharing is an ongoing process. MoDOT is promoting a culture of career development as a continuous process rather than a "one-and-done' mentality.

For UDOT, the Connect-Learn-Share communication strategy has been highly successful in building a culture of collaboration and knowledge sharing. Additionally, after-action reviews, where it is made clear that the focus is not to generate blame but to figure out what they have learned, have been effective. UDOT also shares stories in video form in Innovations & Efficiencies reports. These videos highlight best practices from staff across the state so that others are aware and do not reinvent the wheel. This has established a culture of storytelling across the organization.

At the Texas DOT (TxDOT), a policy requiring the agency to go paperless combined with a new consolidated campus in Austin and an intentional organizational change management effort, including removal of file cabinets and requiring universal sharing and discoverability via IT, have helped to reduce agency silos. When designing the new campus, working groups began thinking about how agency staff would work together for the next 100 years. They developed specific goals around flexible workplaces, with an emphasis on work being, "what you do," rather than, "where you go." The agency has developed a robust capability for managing a remote workforce and is being intentional about how they meet, how they collaborate, and what is in-person versus remote.

FHWA noted that the least effective strategies they have tried have been those where staff felt they were forced on them. FHWA has found that KM needs to provide an immediate value and not add to burdens. This is particularly important when considering required reporting and metrics or assessments. To overcome resistance to knowledge sharing, FHWA encourages collaboration and knowledge sharing early on. They have found it is important to get sharing started when it is not critical and to grow the culture rather than waiting until it is essential. FHWA uses a Fully Leveraging Expertise, or FLEX, assessment to identify where knowledge is held internally and to provide support when gaps are identified. In some cases, FLEX expertise is leveraged across states.

The least effective practice that MDOT tried was creating KM tools, mostly as fillable forms. The intent was for these to be simple and valuable, for example, providing mini desk manuals. This form was designed to be 1-2 pages long and to capture key information about job function. Another example is a project status at-a-glance form. However, none of these tools have caught on with staff, as they are perceived as taking too much time to complete.

The least effective practices that the Wisconsin DOT (WisDOT) has tried to implement focused on "story telling." WisDOT brought key people in to tell their stories for this initiative. But it has not been seen as effective because while efforts like this start out exciting, they tend to diminish over time. Thus, "story telling" is an area that WisDOT has not capitalized on.

4.3.3 KM and Workforce Development

Varied KM efforts have also been successfully used to support workforce development. The WashDOT has developed a new employee mentoring program where new employees have a network to rely on for information and knowledge sharing. Through the interview process and acceptance of an offer, a team is assigned to support each new employee. Some staff meetings are open to improve engagement and communication. UDOT has a position playbook that focuses on a high-level overview of policies, manuals, contacts in and out of the organization, committees to which the position is assigned, and critical information about the role rather than technical information. UDOT also conducts both exit and stay interviews and assesses learning regularly to make sure professional development opportunities are meeting staff needs.

VDOT's Job Book Program has been very successful in supporting the onboarding of new employees at VDOT. Job Books provide information to help new staff get started, understand behavioral characteristics important for the role, training course and certification requirements, and provide on-the-job element sets for each level or series of the job. Creation

of Job Books is prioritized based on areas of high turnover or areas where significant numbers of managers are eligible to retire. One other resource created to support the onboarding process is VDOT's Organizational Guide, outlining its mission, goals, structure, districts, divisions, and responsibilities. The Guide has proven to be very valuable and is passed out to new staff in both paper and digital formats.

To support retention efforts, career paths are mapped for specific positions in SharePoint to outline various jobs you need to hold to get to a desired endpoint. While these pathways have not been developed for every position, they are in place for many key positions. VDOT has also recently completed its VDOT of Tomorrow study to determine jobs needed in the future and knowledge gaps that exist. The operations area is of significant focus, particularly from a standpoint of security, the Internet of Things, and advanced data analytics.

KYTC recruitment staff have been developed several new strategies to address employee onboarding challenges. The first is through a new KYTC 101 course that helps onboard staff and arm them with information they will need to be successful in their job – including procurement, understanding Cabinet structure, and research and innovation programs. The course is for all new KYTC employees, not just engineers. Another practice that has been developed is that of hiring temporary workers to work alongside individuals who are retiring prior to them leaving the agency, with the intent that these temporary staff will be prepared to transition to a permanent role later. The practice is intended to address an issue in the hiring process that prevents knowledge transfer from occurring because permanent positions cannot be posted until a position is vacant. The program has helped with KM, although a problem arises when the temporary worker is not a good fit for the role, as they are not encouraged to apply for the permanent job.

The one area that WisDOT has focused on to capture and retain critical knowledge is through the identification of staff that have retired, are nearing retirement age, or are leaving the organization for other reasons. If someone is leaving WisDOT they would like the employee to document as much as they can about what types of work they do, the processes they follow, and the key people they interact with so that a new person will know who or where they can go for assistance. It is also possible for WisDOT to rehire the retiree back for limited-term employment so they can provide mentoring and guidance to new employees and staff. WisDOT also reviews knowledge gaps through a retirement vulnerability analysis looking at workforce data to determine who might leave their positions, and when, and the resulting gap in knowledge. For example, if 30% of Advanced Engineers in WisDOT were able to retire in three years, then that would be a potential knowledge gap they would identify since Advanced Engineers typically possess significant expertise. And while ideally WisDOT would like to hire at entry levels and grow individuals, it is in cases like this where WisDOT would need to hire people with more experience, which can be tricky due to the corresponding level of pay in the private sector.

4.4 Informing a Framework for Action

Considering benchmarking findings, organizational culture, attitudes of staff, and turnover analysis along with best practices that have worked well for other state DOTs allows assessment of strengths, weaknesses, and opportunities for TDOT in terms of undertaking a

strategic approach to KM. Most divisions within TDOT are already using some form of KM strategy, although the level and maturity of adoption varies. Leaders and staff are generally positive about the potential for organization-wide KM to lead to positive transformation, but greater transparency, a seamless process, and well-developed communication is essential for such an approach to be effective. The following are important considerations as TDOT begins to implement an agency-wide approach to KM:

Core Agency Strengths

- Many divisions and groups are already actively implementing KM practices while often not being termed as such.
- The EPIC program and the changed processes/procedures for project management was identified as a means of better sharing information across departments and staff as well learning from successes and challenges.
- There is broad uptake and adoption of technology for document sharing and archiving of plans, etc. to foster transfer collaboration and information transfer.
- Most TDOT employees are positively disposed towards KM activities.
- KM champions exist throughout many TDOT divisions today.
- There is a strong culture of collaboration and knowledge sharing within some divisions.
- Many divisions use IT tools and existing platforms, such as using Microsoft Teams, SharePoint, and email for knowledge sharing and communication, so staff are familiar with technology tools.
- There is a focus on process documentation within some divisions, such as using Project Development and Regional Process Documents, or emphasis on the importance of Standard Operating Procedures (SOP)s.

Weaknesses or Barriers to Successful KM Adoption

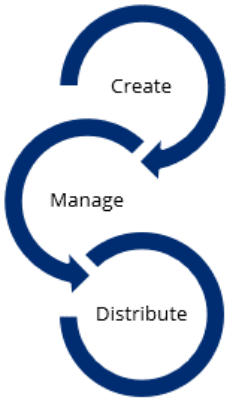
- Repeatedly, individuals felt that the amount of time that could be devoted to KM activities was minimal or non-existent with their existing workload
- Several platforms exist, many of which are used to some extent by the various divisions. This opens the door for redundant information and possible confusion about where to go for specific knowledge.
- Regions are somewhat disconnected from Headquarters and from one another. Communications need to be strengthened to ensure everyone is on board and that there is buy-in at all levels.
- There are inconsistent practices across departments and regions, for example, the lack of uniformity in processes between headquarters and regional teams. This inconsistency creates knowledge silos and hinders knowledge transfer.
- Several divisions reported issues related to limited access to information. There are challenges in accessing information due to a lack of centralized documentation and varying security levels within Microsoft tools.
- Data retention policies hinder knowledge capture and long-term knowledge retention. TDOT's data retention policies lead to the disappearance of valuable information over time, such as emails and Teams chats.
- There is no comprehensive approach to knowledge capture. While some documentation exists, some divisions emphasized the need for capturing informal knowledge through

shadowing and conversations. There is a concern within some divisions about losing valuable expertise from retiring staff.

Opportunities for advancing KM Practice

- TDOT could champion and foster a culture of supporting KM strategies by creating a position for a Knowledge Management Officer at a director level. Regardless, a formal structure for accountability is essential for successful agency-wide implementation.
- An early action that could lead to further exploring integration of KM strategy at TDOT would be to host a Peer Exchange with other state DOTs to augment and add to the findings from interviews in Task 2 of this project and inform a pilot approach for TDOT. The Peer Exchange could also help to identify KM champions across the organization, with key staff participating.
- As a next step from the Peer Exchange, an internal TDOT exchange with similar structure could be hosted to engage staff at all levels and refine the pilot strategy prior to implementation.
- TDOT Leadership can foster a culture of KM through leading by example. This is a critical component to demonstrating the value and importance of KM agency wide.
- Many employees are interested in becoming more engaged in decision-making and could be empowered to participate more by leaders of divisions and directors. This could also foster innovation and sharing of lessons learned from the bottom-up.
- TDOT could assess existing knowledge sharing platforms to identify if a "best of breed" platform (or platforms) exists that could be used across TDOT.
- Streamlining processes and creating centralized documentation would improve knowledge transfer and ensure consistent practices across TDOT.
- Bridging communication gaps between headquarters and field teams by standardizing processes would enhance knowledge sharing and foster a more cohesive organizational culture.
- Implementing mentorship programs and other knowledge transfer initiatives can capture and preserve valuable expertise from retiring staff before it is lost.

The first step in deploying a KM framework is to decide on the leadership structure that will be used to ensure accountability. This may involve a new KM leadership position, designation of a lead division to oversee KM adoption, developing a team-based strategy with leadership assembled from diverse units and levels within the organization, or some combination of these strategies. TDOT must also clearly define its goals for the initiative and a timeline for implementation. The framework for organization-wide KM should include creating, managing, and distributing knowledge enabled by the following actions:



- Establishing KM leadership structure
- Defining KM and developing a value statement tied to agency mission
- Establishing a timeline and hallmarks of maturity for knowledge creation, capture, and transfer
- Developing a communication strategy
- Establishing metrics to measure progress

- Engaging perspectives across the organization
- Building a program from internal and external best practice

The process for refining and sustaining the approach is iterative. Once the leadership and accountability structure is determined, it is suggested that a process similar to that depicted in Figure 4.19 be adopted. Finally, a KM program must include comprehensive strategies for creating, capturing, and transferring knowledge as well as assessing progress. For TDOT, there are specific strategies likely to be effective because of its existing infrastructure, interest of staff, and organizational experience. For each of these areas, specific recommendations are described in the following sections and are illustrated in Figure 4.20.

Knowledge Creation – TDOT has a track record of successful leadership of and participation in external peer exchanges for knowledge generation. This experience should be built upon to include both internal and external peer exchange as TDOT implements its agency-wide KM approach. Brainstorming sessions, such as through a Lunch & Learn format, are another way of building topic-specific knowledge by bringing together relevant staff from across TDOT's Bureaus and regions. Finally, after action reviews (AARs) were recommended by TDOT leaders and staff as a practice that had at times been in place for some project types or areas within TDOT. These reviews were seen as highly valuable for generating an understanding of best practices, lessons learned, and new approaches to consider for future projects. AARs also provide an opportunity for those involved in a project to have a voice in shaping future practices. Institutionalizing AARs, particularly given TDOT's new approach to project management under EPIC, is likely to uncover important findings that can lead to operational efficiencies, safety improvements, avoidance of duplication, and more effective navigation of challenges.

Knowledge Capture – One of the most important decisions TDOT KM leaders will need to make is selecting the technology platform that will be used for KM. Determining a standardized platform across the organization means understanding the ways in which the system must be used and accessed and the varied forms of information that must be captured. This includes understanding needs for both internal and external users as well as the long-term implications of inhouse versus external KM software tools. Many divisions within TDOT already rely heavily on SOPs for knowledge capture. This practice can be built upon and replicated organization wide.

VDOT's Job Book approach may also work well for TDOT. The new efforts underway within TDOT's HR division, especially the resources that have been developed for ProPath and the newly revamped Graduate Transportation Engineer (GTE) program, have already generated similar resources to the VDOT Job Book. These resources could be tailored and expanded across other job functions to assemble targeted information about all TDOT positions.

TDOT is already collecting exit information periodically, primarily focused on reasons why the staff member is leaving TDOT and perceptions of their manager and the work environment. Creating a systematic approach that provides consistent data, in terms of both timing and content, would enhance the value of this existing practice. This could take the form of automatically generated exit interview forms that employees must complete as part of the separation process that include the questions that are currently part of TDOT's practice, along

with job shadowing or exit interviews to document important functions and processes for key positions.

Finally, organization-wide digitization of information is essential. While many units within TDOT have moved to this practice, there are still groups where information is maintained in hardcopy format, limiting access. TxDOT realized a significant transformation in its KM culture and practice when it moved to a paperless environment, and a similar benefit is likely to be obtained by TDOT.

Knowledge Transfer – Training programs, whether formal or informal, are essential for knowledge transfer. Expanding Lunch & Learn opportunities and increasing other formal training requirements will support TDOT's KM goals. Existing innovative programs that can be expanded or replicated include TDOT's ProPath and GTE programs, where training for these job functions has been both formalized and standardized with employees and leadership able to track progress. Expanding this approach to other job areas within TDOT can help ensure all staff receive essential training while also enhancing retention as staff understand advancement pathways. Examples of other existing successful knowledge transfer practice include Safety Monday and Material Minutes. A similar approach can be applied to other topics, including KM.

Supporting TDOT staff in attending conferences and professional meetings, with these staff returning to provide training or knowledge sharing activities for other TDOT staff can also be highly effective. With limited agency budget to support conference travel and professional memberships, it is important to strategically select topics of high importance, identify staff who are willing to actively engage, and implement knowledge transfer activities to spread this knowledge to other TDOT staff.

Communities of practice (CoPs) are shown in literature and in other DOTs to be successful forums for knowledge transfer. Multiple staff mentioned CoPs that existed previously within TDOT and indicated these were quite useful for knowledge sharing. Bringing this approach back, especially to engage regions with one another, is recommended for enhancing knowledge sharing.

TxDOT found success in developing targeted mentoring and job shadowing programs for job functions where the agency identified a 'broken rung.' This approach can also be translated to TDOT to improve KM and retention. For critical jobs where turnover is high or retirements are impending, identifying candidates at lower rungs for a formal mentoring or job shadowing program can assist the organization in filling these gaps.

KM Assessment – One important element of assessment includes knowledge mapping and gap analysis within each division. While this information was benchmarked through this study, it should be refined and greater detail added through an exercise within each functional unit. This is one way to kickoff KM agency-wide that would engage staff at many levels.

Efficiency metrics, such as tracking growth in the number of users in the KM platform, numbers of staff accessing SOPs, numbers of digital documents and other data analytics enabled by the software platform TDOT selects are important not only for developing the business case for continued KM but also capitalizing on automated measures that do not require a lot of effort for data collection. Consistent tracking of retention and advancement statistics by job position

should also be automated. An annual deployment of a modified KM Litmus Test can also track the pulse of the organization and its KM progress. Conducting a culture audit on a consistent cycle that determines whether staff feel they have a voice, see themselves with TDOT long term, and documents their attitudes toward KM is also important. With the Litmus Test and culture audit, it is important that the instruments used for these assessments are quick and easy for staff to complete, so limiting items to just those deemed essential for gauging progress is recommended.

Integrating the proposed KM framework along with an iterative process and comprehensive program structure will allow TDOT to embed a culture and practice of KM throughout the organization in a sustainable manner.

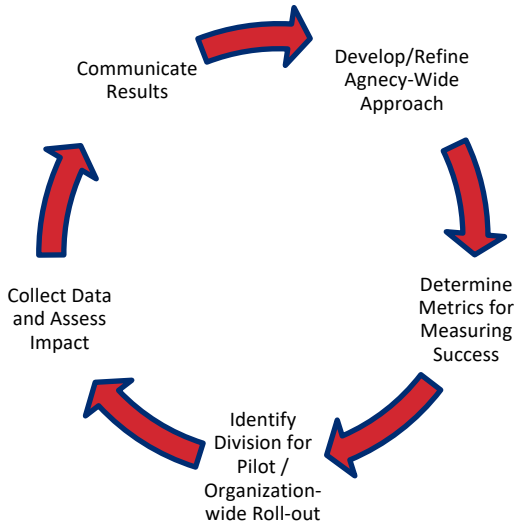


Figure 4.19 KM Implementation Process

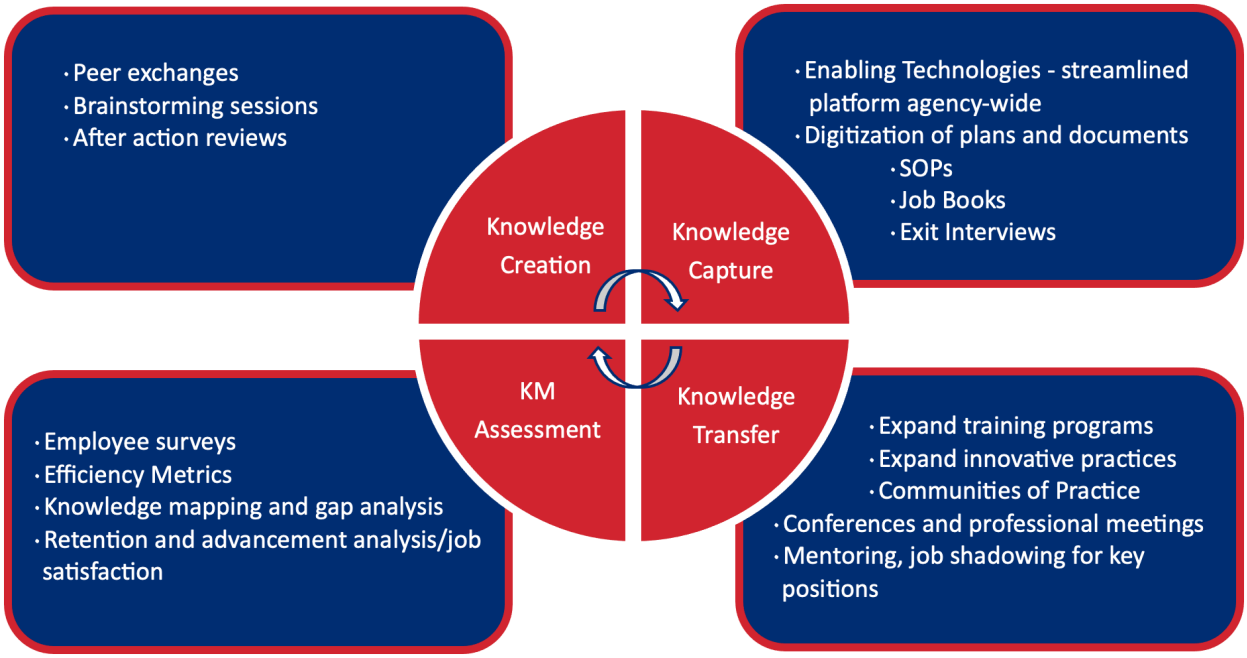


Figure 4.20 Comprehensive KM Program

Chapter 5 Conclusion

Supporting an organization's technical capacity, workforce retention, and innovation, requires developing a strong framework for knowledge management both within individual divisions and organization wide. For state DOTs, KM has become a topic of increasing urgency as the aging and knowledgeable workforce that has been the subject of recent concern has now begun large-scale retirements. Many DOTs are faced with significant threats to organizational knowledge and technical capacity as knowledge holders leave and new workers are onboarded without the infrastructure for effective knowledge transfer. With a sizeable fraction of the Tennessee DOT's (TDOT) workforce having less than five years' experience with the agency, nearly 20% eligible for retirement, and a 2.8% employee turnover rate, it is essential that a robust KM strategy be developed that ensures success in achieving TDOT's mission now and in the future.

This research examined TDOT's knowledge assets, current KM practices, and organizational culture with respect to KM while exploring best practices found in literature and employed by other DOTS through five primary tasks. Task 1 focused on developing a baseline inventory and analysis of knowledge resources and practices for TDOT as a whole and within each division. The goal of Task 2 was to better understand experiences, identify effective practices for as well as challenges to building a robust KM culture, and determine impacts of KM strategies. Task 3 included a culture audit in relation to KM receptiveness and current knowledge sharing behaviors within TDOT. Task 4 focused on analysis of historical staff turnover data and exit survey results to determine opportunities for a strategic approach to KM to improve TDOTs retention outcomes. Task 5 examined knowledge flow across the agency, including both internal and external sources. It is important to note that at the time this study began, TDOT was beginning discussions regarding reorganization and began implementing the changes during the study period. Thus, the makeup of bureaus and divisions referenced in this report may not reflect the current structure of the organization. As most of the changes involve realigning divisions with other bureaus within the Department and not a dissolution of a division, the impact on the findings presented in this report is minimal and largely organizational in nature.

Key Findings

Results from this research include the following key findings that are important for both benchmarking current KM practice and culture at TDOT as well as revealing elements to consider in an organization-wide framework for KM.

- Both TDOT leaders and staff recognize the value and need for a consistent and strategic approach to KM. The **primary barrier to the implementation of a robust KM framework is the time and effort required** to do so. Thus, for an agency-wide strategy to be effective it must provide immediate value and integrate seamlessly into existing staff workflows. Equally important is ensuring a process for measuring impact so that challenges can be identified, and successes communicated effectively.
- All units have implemented at least some practices for KM, although the level of adoption and formality varies widely. While both formal and informal approaches can be successful, for KM policies and strategies to be effective, there must be **buy-in at all levels of the organization** and **assignment of responsibility** for ensuring practices are

upheld. This means that TDOT leaders must consider how best to engage staff and ensure accountability.

- Creating a culture of knowledge sharing requires coordinated and continuous effort to **communicate the value of KM** and overcome outdated notions and misperceptions that result in resistance. It will also require staff engagement at all levels and recognition of successes. Creating a safe space for staff to share lessons learned and ensuring that knowledge sharing is not seen as a threat to an individual's value to the organization is important for transforming culture.
- An agency-wide **platform for knowledge management that is easily accessible and provides content in a format and at a level that are quick for staff to understand** is key to widespread adoption. While there are platforms available currently at TDOT to facilitate knowledge capture and sharing, many staff are unsure about how best to leverage these tools and indicate they are not currently used consistently. Training is also critical once a platform and process is established to make sure they are adopted and used appropriately and that capabilities of the tools for improving efficiencies are maximized.
- **Succession planning is critical to avoid knowledge loss.** Several innovative approaches have effectively been used by other DOTs to address this including temporary hires that work directly with retiring staff, retired staff hired on a temporary basis to mentor those filling their previous role, development and archiving of 'Last Lectures' or practice memos by those leaving an organization, and creation of Job Books. TDOT will need to consider which strategies have the potential for adoption given current policy or hiring constraints.

Key Recommendations

To fully realize the potential of an organization-wide approach to KM, TDOT's current strengths, potential barriers, and opportunities to accelerate adoption must be considered. The approach to agency-wide KM must be thoughtful, well-planned, and well-executed. An organization cannot afford missteps at the outset that may result in staff losing interest or confidence in the potential for KM to positively impact an agency's mission, goals, and objectives.

- **A leadership structure for KM accountability is the first step for implementation**. Defining this structure is crucial for ensuring development, adoption, assessment, communication, and strategy refinement occur. This is an essential step for sustainability of the strategy. There are numerous forms that this structure can take from KM offices and directors to committees. The structure selected should align with current infrastructure within the organization and long-term vision for KM.
- **Establish a consistent timeframe for collecting and archiving data that will inform KM performance metrics, such as employee exit survey data or measures of efficiency**. Data collected in each division, whether quantitative or qualitative, must be consistent for communication of impact and long-term analysis of trends. It is equally important that this not be a burdensome activity, as time requirements for KM are a challenge. Determining opportunities for automation and streamlining of data collection processes is central to an effective strategy.
- **Transparency and broad engagement in decision making related to the KM strategy will allow employees to take ownership and have buy-in, thereby**

facilitating adoption. It is also critical that leadership across the organization understand the importance and factor in time for KM activities in staff duties. Conducting both external and internal peer exchanges may be an effective means of engaging staff in the process. Ensuring a diverse range of staff are included in KM strategy evaluation activities will also ensure that voices are heard, and that staff feel valued in the process.

- **Developing a value proposition tied to TDOT's mission and creating a marketing and communication strategy around it can further propel the organization to successful implementation**. It is important that all staff understand what KM entails, why it is important, how it will be implemented, and what TDOT expects to achieve by deploying KM agency-wide. It is also critical that staff feel there is transparent communication, they have a voice in the process, and that their insight is valued. Sharing spotlights of successful outcomes that highlight staff from a range of work areas and levels can support communication and value proposition efforts.
- **TDOT should start on a smaller scale, such as through a pilot program, and follow an iterative process for refining the KM strategy to achieve full-scale adoption.** Such an approach will allow TDOT to limit frustrations as challenges are identified and the model is refined to best fit organizational culture and practice so that KM becomes an integrated, seamless, and essential component of all work areas and tasks. There are multiple divisions in TDOT already using advanced KM practices and having a relatively strong KM culture that could serve in this role. In particular, the Administration Bureau may be an appropriate place for the pilot, as multiple divisions, including Strategic Planning, HR, and IT will be critical to the success of agency-wide implementation.

Regarding study limitations, there was some over or underrepresentation of TDOT work areas in survey responses. However, this is not expected to have significantly skewed the findings, as very few differences were observed across TDOT's units in terms of culture, preferences, attitudes, and suggestions. Similarly, the reorganization occurring within TDOT during this study is expected to have limited impact on the findings as the important results are those at a macro level or that could be generalized across the agency rather than any findings related to a specific unit and its location within TDOT. Finally, participation in this study was voluntary, thus, voluntary response biases in the results may exist based upon overrepresentation of opinions of staff choosing to participate.

The results of the project are intended to support TDOT in developing a robust and sustainable process for the efficient transfer of knowledge that improves worker retention, technical capacity, KM culture, and continued innovation resulting in successful fulfillment of its mission. Leveraging the findings and recommendations from this research will allow TDOT to take advantage of the organization's strengths. It is expected that TDOT will also adapt its strategy considering potential challenges and capitalize on opportunities to facilitate KM adoption.

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Appendices

Appendix A

Tabular Literature Review

Title	Author(s)	Date	Case Studies/ Experiments	DOT Scans	Implementation	KM Strategies	KM Models	CoPs	Instrument Development	Workshops	Private/ Non-DOT Sectors	KM Costs	Notes
Frequency (out of 53)			16	5	7	16	18	3	4	3	29	10	
Organizational Self Assessment of Knowledge Management Maturity	Kulkarni, U., St. Louis, R.	2003							X				Development of an instrument for organizations to measure their KM maturity.
Development and Validation of a Knowledge Management Capability Assessment Model	Kulkarni, U., Freeze, R.	2004					X		X				Validation of KM capability assessment (KMCA).
21st Century Workforce Development Summit	Wittwer, E., Adams, T., Toledo-Duran, E.	2009	X			X				X			WisDOT Workshop, discusses importance of K-12 pipeline.
Linking organizational culture, structure, strategy, and organizational effectiveness: Mediating role of knowledge management	Zheng, W., Yang, B., McLean, G.N.	2010					X						KM mediates impact of organizational culture on organizational effectiveness and partially mediates impact of organizational structure and strategy on organizational effectiveness.
Managing Know-How	Lee, D., Van den Steen, E.J.	2010				X					X		Discusses which firms benefit from KM systems (larger firms, high turnover, face same issues frequently, and face issues with little accessible knowledge) and practices to avoid (recording failures, recording moderately successful practices).
The Interaction Between Knowledge Codification and Knowledge-Sharing Networks	Liu, D., Ray, G., Whinston, A.B.	2010									X	X	Interaction between knowledge sharing networks and knowledge codification: increased codification can harm exisiting networks.
The World Is Not Small for Everyone: Inequity in Searching for Knowledge in Organizations	Singh, J., Hansen, M.T., Podolny, J.M.	2010	X								X		Finding knowledge can more difficult for people with less connection to experts, and periphery status and homophily work to increase inefficiency.
Best Practices for WisDOT Workforce Transition	Yeh, D.	2011			X	X				X			WisDOT Guidebook for KM created with collection of best KM practice. Brief includes low-cost implementation strategies as well.
Best Practices in Selecting Performance Measures and Standards for Effective Asset Management	Amekudzi, A., Meyer, M.	2011		X		X							Assess GDOT's Transportation Asset Management (TAM) & give guidance on selecting factors to measure performance.
Developing Strategic Systems Supporting Communties of Practice in the Georgia Department of Transportation	Kingsley, G., Knox-Hayes, J., Rogers, J.	2011						X				X	Analysis of current CoPs within GDOT, costs and benefits to CoPs, and knowledge exchange within CoPs.
Dynamic Resource Capabilities: Managing Workforce Knowledge with a Technology Upgrade	Gaimon, C., Özkan, G.F., Napoleon, K.	2011					X					X	Model considers technology upgrades with respect to workforce KM. Implementation of upgrades may have more costs than benefits.
Knowledge Exploration and Exploitation: The Impacts of Psychological Climate and Knowledge Management System Access	Durcikova, A., Fadel, K.J., Butler, B.S., Galletta, D.F.	2011									X		Examines the relationship between KM system access and solution reuse and solution innovation: KM systems can increase innovation when organizations operate within an innovative climate.
Profiting from Knowledge Management: The Impact of Time and Experience	Ko, D., Dennis, A.R.	2011					X				X		Uses a heirarchial linear modeling stastical analysis to find a positive relationship between KM systems and individual performances.
Strategic knowledge management, innovation and performance	López-Nicolás, C., Meroño-Cerdán, A.L.	2011					X				X	X	Codification and personalization KM strategies impact innovation and organizational perforance.
Transferring Stored Knowledge and Storing Transferred Knowledge	Jasimuddin, S.M., Zhang, Z.	2011			X		X				X		Implementation of knowledge transfer and storage in firms.

Title	Author(s)	Date	Case Studies/ Experiments	DOT Scans	Implementation	KM Strategies	KM Models	CoPs	Instrument Development	Workshops	Private/ Non-DOT Sectors	KM Costs	Notes
A Knowledge-Based Model of Radical Innovation in Small Software Firms	Carlo, J. L, Lyytinen, K., Rose, G.M.	2012					X				X		Absorpative capacity (ACAP) model for external base innovations studied on small software firms.
Bridging the Knowledge Gap: The Influence of Strong Ties, Network Cohesion, and Network Range on the Transfer of Knowledge Between Organizational Units	Tortoriello, M., Reagans, R., McEvily, B.	2012	X			X							Network features (tie strength, network cohesion, and network range) positively affect knowledge collected in cross-unit knowledge transfer relationships.
Developing a Corporate Knowledge Management Strategy	Oluikpe, P.	2012	X		X	X		X			X		Development of KM framework at Central Bank of Nigeria using benchmarking and current problems in the organization.
Factors of stickiness in transfers of know-how between MNC units	Montazemi, A. R., Pittaway, J. J., Saremi, H. Q., Wei, Y.	2012					X				X	X	Meta-analysis of various firms' abilities to use new tacit knowledge & the issue of "factors of stickiness" that slow the transfer of knowledge.
How does social software change knowledge management? Toward a strategic research agenda	von Krogh, G.	2012									X	X	Addresses protecting firm knowledge and concerns of using social platforms in knowledge sharing.
How Knowledge Transfer Impacts Performance: A Multilevel Model of Benefits and Liabilities	Levine, S.S., Prietula, M.J.	2012										X	Knowledge transfer becomes less benefical to performance when there are more employee learning opportunities and more organizational memory. Knowledge exchange may not benefical in organizations in disordered environments.
Motivating Employees to Share Their Failures in Knowledge Management Systems: Anonymity and Culture	Heurta, E., Salter, S.B,. Lewis, P.A., Yeow, P.	2012	X										Studied the willingness of people from different cultures to share failures, openly or anonymously. Collectivist cultures were more likley to share failures, and anonymous failures were shared more often.
Organizing Thoughts and Connecting Brains: Material Practices and the Transition from Individual to Group-Level Prospective Sensemaking	Stigliani, I., Ravasi, D.	2012					X				X		Develops a model for the interaction between conversational & material practices from individual to group level sense making.
Tacit knowledge sharing between IT workers: The role of organizational culture, personality, and social environment	Borges, R.	2012					X				X		Examination of influence of organizational, individual, and environmental factors on tacit knowledge sharing between IT professionals.
To share or not to share: a critical research perspective on knowledge management systems	Young, M., Kuo, F., Myers, M.D.	2012					X				X		Application of flow theory in knowledge sharing and interemployee helping.
Information technology to support informal knowledge sharing	Davison, R.M., Ou, C.X.J., Martinsons, M.G.	2013	X			X					X	X	Case studies of Chinese public relation firms and using IT applications to informally share knowledge.
Reconceptualizing rhetorical practices in organizations: The impact of social media on internal communications	Huang, J., Baptista, J., Galliers, R.D.	2013	X										Analysis of the impact of social media on organizations rhetorical practices: social media allows for increase reach of communication, multiple rhetors, and consumption & production of content simultaneously.
Social Influence and Knowledge Management Systems Use: Evidence from Panel Data	Wang, Y., Meister, D.B., Gray, P.H.	2013	X								X		Analysis of social influence on usage of KM systems.
Strategic Alignment and Misalignment of Knowledge Management Systems: A Social Representation Perspective	Dulipovici, A., Robey, D.	2013	X									X	Discusses challenges of implementing KM systems with social interactions and user perceptions.

Title	Author(s)	Date	Case Studies/ Experiments	DOT Scans	Implementation	KM Strategies	KM Models	CoPs	Instrument Development	Workshops	Private/ Non-DOT Sectors	KM Costs	Notes
The role of knowledge-oriented leadership in knowledge management practices and innovation	Donate, M.J., Sánchez de Pablo, J.D.	2013					X				X		Knowledge-oriented leadership in KM practices encourages KM exploration and exploitation.
Advances In Transportation Agency Knowledge Management	Hallkowski, J.S., Burk, B., Dabling, L., Dexter, A., Ellis, A., Hammer, M.L., Michel, C., Oman, L., Wilkinson, L., Harrison, F.D.	2014		X		X				X			Scan workshop of KM in state and federal DOTs and private sectors. Discusses KM strategies and practices.
How Knowledge Validation Processes Affect Knowledge Contribution	Durcikova, A., Gray, P.	2014					X					X	Analysis of the impact of strict validation processes of KM repositories on contributors' perceptions and behaviors. Reccomends more transparent validation processes.
Learning from Peers: Knowledge Transfer and Sales Force Productivity Growth	Chan, T.Y., Li, J., Pierce, L.	2014	X				X				X		Models peer-based learning in a retail setting:employees learn from observation and active teaching from peers.
Overcoming Localization of Knowledge--The Role of Professional Service Firms	Wagner, S., Hoisl, K., Thoma, G.	2014									X		Examines the extent at which firms acquire external knowledge through repositories.
Social Media, Knowledge Sharing, and Innovation: Toward a Theory of Communication Visibility	Leonardi, P.M.	2014									X		Theory that suggests visibly communicating (on social networking site) allows third-parties to learn metaknowledge which can lessen knowledge duplication and increase
A Guide to Agency-Wide Knowledge Management for State Departments of Transportation	Spy Pond Partners, LLC	2015		X	X	X							Guide for state DOTs to implement KM. Looks at WisDOT practices and VDOT measurement framework.
Anticipatory Work: How the Need to Represent Knowledge Across Boundaries Shapes Work Practices Within Them	Barley, W.C.	2015	X								X		Importance of graphics in knowledge sharing in groups of different backgrounds. Follows 4 weather research teams' practices of developing weather model outputs depending on the needs of their partners.
From knowledge sharing to firm performance: A predictive model comparison	Wang, Z., Sharma, P.N., Cao, J.	2016				X					X		Knowledge sharing can increase firm performance through intellectual capital & innovation.
Investigating knowledge management: can KM really change organisational culture?	Corfield, A., Paton, R.	2016	X										How KM has affected the culture in non-profit organizations: strong leadership and technology innovation were the long-term changes found.
Leadership Guide for Strategic Information Management for State Departments of Transportation	Frances, H., Gordon, M., Allen, G.	2016			X	X							Guide for leaders of DOTs to implement information management into agency for decision making.
Structured knowledge processes and firm performance: The role of organizational agility	Cegarra-Navarro, J., Soto-Acosta, P., Wensley, A.K.P.	2016					X				X		There are positive relationships between knowledge acquisition and conversion and knowledge conversion and application, and organizational agility mediates knowledge application and firm performance.

Title	Author(s)	Date	Case Studies/ Experiments	DOT Scans	Implementation	KM Strategies	KM Models	CoPs	Instrument Development	Workshops	Private/ Non-DOT Sectors	KM Costs	Notes
A Nomological Network of Knowledge Management System Use: Antecedents and Consequences	Zhang, X., Venkatesh, V.	2017	X		X	X					X		Effectiveness of KM system implementations was examined. KM system features were identified and tested in study in finance industry to identify which features would be
Knowledge Management System Use and Job Performance: A Multilevel Contingency Model	Zhang, X.	2017	X										Job performance is improved with extensive KM system (with contigency factors).
Developing Knowledge Management Strategies	Gibson, B., Wallace, C., Kreis, D.	2018		X		X							Researched KM strategies & determined which would be most effective, specifically for KYTC. Highlighted current KYTC KM programs & strategies.
Estimating Contextual Motivating Factors in Virtual Interorganizational Communities of Practice: Peer Effects and Organizational Influences	Zhao, K., Zhang, B., Bai, X.	2018					X	X			X		Analysis of virtual interorganization CoPs (IOCoPs) using an econometric identification method. Motivating factors from peers and organizations determine community participation.
Relationship between team culture and team performance through lens of knowledge sharing and team emotional intelligence	Jamshed, S., Majeed, N.	2018									X		Examination of the relationship between team culture and performance from knowledge sharing and emotional intelligence of the team for health-care professionals.
Strategic knowledge management and enterprise social media	Archer-Brown, C., Kietzmann, J.	2018									X		Enterprise social media (ESM) complements strategic KM.
Vermont Agency of Transportation Employee Retention and Knowledge Management Study	McRae, G., Vallett, C., Jewiss, J.	2018		X		X			X				Analysis of Vtrans' employee turnover and knowledge management assets, as well as pilot projects and suggested KM strategies.
A dual-pathway model of knowledge exchange: linking human and psychosocial capital with prosocial knowledge effectiveness	Singh, S.K., Mittal, S., Sengupta, A., Pradhan, R.K.	2019	X				X						Dual pathway model: formal & informal knowledge sharing & knowledge helping.
Benchmarking and Comparative Measurement for Effective Performance Management by Transportation Agencies	Crossett, J., Batista, A., Park, H., Louch, H., Voros, K.	2019				X			X				Guidance for state DOTs to use benchmarking to compare to organizations doing similar work & improve. Creating transportation comparative benchmarking platform to access & share data across agencies.
Data Analytics Supports Decentralized Innovation	Wu, L., Lou, B., Hitt, L.	2019				X					X		Data-analytics technology has more positive effect on firms with a decentralized innovation.
Top management knowledge value, knowledge sharing practices, open innovation and organizational performance	Singh, S.K., Gupta, S., Busso, D., Kamboj, S.	2019	X								X		Top management knowledge value and knowledge crearing practices allow for open innovation which improves organizational performance.
Sustaining Effectiveness in Global Teams: The Coevolution of Knowledge Management Activities and Technology Affordances	Gibson, C.B., Dunlop, P.D., Majchrzak, A., Chia, T.	2021			X		X						Global teams' reliance on a single technology can limit KM and reduce effectiveness of the team. A coevolution of KM and technology can be beneficial.
State Study No. 325 – Knowledge Management (KM) Roadmap for MDOT	Battey, R., Jones, C.	2022		X	X	X		X					Consultation of KM strategies to implement in MDOT, including interviews with employees.
Frequency (out of 53)			16	5	7	16	18	3	4	3	29	10	

Appendix B

Task 1 Interview Guide

TDOT Division Knowledge Management Interview Guide

Interviewee Information

1. Interviewee Info
    a. Division
    b. Role
    c. Length of time with TDOT
    d. Length of time in current position

For this interview, when we say knowledge management, we are referring to strategies or policies related to how you document, share, and manage information and knowledge, provide training/cross-training, develop succession planning, perform technology transfer, etc.

Defining KM

2. Does your division engage in any of these KM practices (defined above)? How do you refer to these activities (i.e. what do you call them)?
3. What kind of impact would a strong KM strategy have on your division (e.g. cross-training, succession planning, documentation)?
4. What Key Performance Indicators (KPIs) do you currently use to measure success? How do you see these changing over the next 2-3 years?

Critical Knowledge Areas

Knowledge can be categorized in one of two ways:

    a. **Explicit knowledge** is more tangible and obvious. Checklists and manuals often document explicit knowledge, which is easier to write down and share.
    b. **Tacit knowledge** can be described as the "know-how" or "tricks of the trade" we carry in our heads based on our experience –it's what we've learned from the past and are then able to use to make better decisions and be more effective. This personal knowledge is harder to write down and transfer to other people. It gets more at the "how" and "why" of making decisions and judgment calls.

5. What key skills/knowledge areas are essential for your division?
6. What tacit knowledge held by staff members within your division needs to be captured?
7. Where are the most significant gaps currently for your division in terms of skills and capabilities necessary to achieve your goals and TDOT's mission?

KM Practices

8. Does your division have KM strategies or resources in place (**formal**, such as job guidance documents, tools/platforms for archiving and sharing information and knowledge, regularly scheduled training on core topics, cross training, updating position descriptions, etc.; or **informal** – such as emails sent by staff members to others within a division after finding information to resolve a question that others are likely to encounter, informal mentoring or roundtable discussions)?
    a. What benefits have resulted from these practices?
    b. Where have challenges/constraints been encountered?

    c. What are the essential knowledge resources for your division? Where do you and/or staff most often go to find this?
9. What KM practices do you wish were in place in your division?
10. What barriers do you see to establishing a robust KM approach in your division?

KM Culture

11. Are there existing communities of practice for KM within your division or TDOT that you are aware of? Communities of practice are groups that engage in discussions regularly (either in person or through virtual platforms), such as regional/state working groups, practitioner round tables, online discussion boards, informal brown bag seminars, etc. If so, please describe them.
12. Is there value to establishing communities of practice for KM within TDOT? Please explain your answer.
13. Who are the KM champions in your division?
14. Do you perceive staff to be open to sharing knowledge? If they are not open to sharing, why do you think this is?

KM Awareness/Suggestions

15. What information or knowledge that TDOT currently does not have do you think it should or will need to have to execute its mission, improve organizational effectiveness, and serve its customers with excellence?
16. Do you have any suggestions for establishing an agency-wide KM framework for TDOT?
17. What more should TDOT be doing as an organization to promote a culture of knowledge sharing and innovation?

Appendix C

Task 2 Interview Guide

Questionnaire for State DOT's

Organizational Structure/Policy

1. How does your organization define knowledge management (KM)?
2. Do you have an established function within your organization specifically charged with fostering innovation and knowledge sharing? If so, how many staff are paid to work on KM, how many volunteer (and how many hours do they devote to KM), and what are the backgrounds of the staff involved?
3. Describe your organization's KM policy/strategy.
    a. Is it organization-wide or within specific business areas?
    b. Are succession planning, cross-training, and documentation formalized within the organization's policies?
    c. What was the motivation for developing this policy/practice? How long has it been in place?
    d. Do you have any publicly available reports/documentation of your KM policy/process that we may review? (let them know what we have already found from their websites)
4. What infrastructure/tools (social media, knowledge portals, intranets or other tools & technologies) do you have in place for content management (capture, retention, and sharing of knowledge resources)?
5. Do you have specific metrics/performance measures in place to assess KM maturity? If yes, how do you measure success and support sustainability of KM?

KM Practices and Culture

6. Consider your KM practices and strategies.
    a. What do you think are some of your most effective practices or strategies with respect to KM? How have these practices improved outcomes for your agency (specifics/measurable)?
    b. What are the least effective strategies/practices you have tried? Please describe the context and barriers to success.
    c. How have you overcome resistance to knowledge sharing?
7. How do staff in your organization go about identifying experts available to help on particular topic areas – both within and outside of your organization?
8. How does your organization work to foster a culture of collaboration and knowledge sharing? Are there specific tools or strategies you recommend for building this culture? We are particularly interested in stories about how noticeable cultural change has been accomplished, and cultural attributes you would characterize as necessary for success.
9. How do people in your organization get together (in formal or informal ways) for learning, development and information sharing (e.g. storytelling activities)? We are particularly interested in hearing about examples of how these communities are making a difference in your organization.

KM and Workforce Development

10. What techniques have proved successful in your agency for onboarding new employees – to get them quickly up to speed and aware of policies, procedures, resident experts, etc.?
11. What strategies does your agency use to retain valuable employees and provide career paths? (e.g. cross training, step programs)
12. Has your agency undertaken any initiative to capture and retain critical knowledge from (a) staff that have retired or are nearing retirement age, or are leaving the organization for other reasons, (b) contractors that have completed an assignment and are moving on, or (c) project teams completing their work?
13. How do you review knowledge gaps? Does this influence or inform work systems, such as hiring or training?

14. Is there other information that you would like to share that I did not cover during our interview today?

Appendix D

KM Litmus Test Instrument and Summary

KM Litmus Test Summary

Earlier this year, senior leaders and information technology experts were interviewed for the RES2023-01 Research Project, 'Identifying Critical Knowledge Gaps and Assessing Organizational Readiness for Improved Knowledge Management (KM),' to develop a baseline inventory of knowledge resources and practices within each division and for TDOT. After the interviews, follow-up invites to participate in a knowledge management (KM) litmus test for TDOT were sent to the interviewees. The results of the KM Litmus Test will help to **establish a baseline for the most at-risk areas of knowledge management and KM culture at TDOT**.

The litmus test was adapted from a test featured in the National Cooperative Highway Research Program (NCHRP) article titled "A Guide to Agency-Wide Knowledge Management for State Departments of Transportation," as well as from a set of cultural trait dimensions from *The Knowledge Manager's Handbook* by Nick Milton and Patrick Lambe. Microsoft Forms was used to administer the test, in which participants were asked to assess whether they agreed or disagreed with a series of statements about TDOT. The statements featured in the litmus test were phrased in a negative connotation to encourage participants to actively think about our department's knowledge management practices and culture. Participants were asked to provide open feedback at the end of the KM Litmus Test. The results will help shape TDOT's KM Framework by setting priorities for improving knowledge management.

Resources

- A Guide to Agency-Wide KM for State DOTs | National Academies Press
- The Knowledge Manager's Handbook | Google Books

There were 20 statements for participants to evaluate. The top two statements selected-were:

- **"Processes for debriefing employees, contractors and consultants to capture lessons learned and other valuable knowledge before they leave are not standardized."** (81.25% of responses)
- **"A division may not know what another division is doing—even if working on a similar task or problem."** (81.25% of responses)

This **identifies standardized knowledge capture and transfer as two priority gaps** in TDOT's knowledge management.

Participation Rate

32 of the **52** interviewees submitted responses for the KM Litmus Test for a **61.5%** participation rate.

Average Response Time

9 minutes, 35 seconds
Average time for participants to fill out the KM Litmus Test form.

The next most checked statements were:

- **"Decisions, judgements, knowledge, and other tacit information are not systematically recorded for future reference"** (71.88% of responses)
- **"Many knowledgeable mid-career employees are likely to leave the organization over the next few years to pursue other opportunities"** (68.75% of responses)

Those statements further indicate the need to capture knowledge, specifically for onboarding, training, and succession planning.

Regarding culture traits, the most checked statement was **"Decisions, judgements, knowledge, and other tacit information are not systematically recorded for future reference,"** which indicates a **culture of forgetting versus remembering**. According to *The Knowledge Manager's Handbook,* this culture represents "the extent to which people acknowledge and incorporate the past when making plans for the future and the extent to which they consciously record decisions, judgements, knowledge, etc. for future reference." This is an indicator that our organizational culture is currently **struggling with succession planning** through knowledge capture and transfer.

On a positive note, **less than 25%** of the participants believed the following to be true for TDOT:

- **"Employees are not able to act on knowledge, independent of their leader's approval."** (This statement assessed empowerment culture)
- **"The organization places low value on acquiring new knowledge."** (This statement assessed learning culture)
- **"Employees are only motivated by competition within the organization."** (This statement assessed collaboration culture)
- **"The organization does not actively seek improvement."** (This statement assessed pursuit of excellence culture)

This demonstrates stronger cultural traits of empowerment, learning, collaboration, and pursuit of excellence (these traits may sound familiar → Strategic Direction). Given these results, **a roadmap for improving knowledge management has emerged**. The Strategic Planning Division will begin identifying tools and best practices to leverage our strong cultural traits to close the gaps of knowledge capture and transfer.

Comments of note from the open feedback section:

- Information and knowledge may be recorded but is not actively shared.
- There is an inconsistent culture around knowledge management and mentoring within TDOT.
- There is a lack of training around basic information, such as bureau, division, and business unit roles and responsibilities.
- TDOT Leadership supports knowledge management improvement, but the initiative is disjointed and ineffective.
- The survey statements were uneven in severity.
- The survey statements may have different implications for each business unit, division, or bureau.

The Strategic Planning Division SharePoint is being updated, so please review the complete results through this MS Forms link: TDOT Knowledge Management Litmus Test Results.

Thank you to all participants!

Please contact Jordan Rock (Jordan.Rock@tn.gov | 615-971-9763) for any questions!

Appendix E

Task 3 Survey and Focus Group Instruments

TDOT Division Knowledge Management
Agency-Wide Questionnaire

Knowledge management (KM) refers to practices or processes related to how you document, share, and manage information and knowledge, provide training or cross-training, develop succession planning, perform technology transfer, etc. TDOT plans to develop a strategic approach to organization-wide KM. A key part of developing a KM strategy is to find out how people gain access to and share knowledge throughout the organization. Researchers from the University of Memphis, Tennessee State University, and Vanderbilt University are working with TDOT to collect information and develop recommendations for a TDOT-wide KM framework.

This survey seeks to gather fairly detailed information about the ways in which you access, share and use knowledge resources in your work. In answering the questions below, please keep in mind the following: answer for yourself, not how you think someone else in your job might answer; answer for *how you actually work now*, not how you wish you worked or think you should work.

We expect that some questions will require you to think carefully about the nature of the tasks you perform and how you interact with people both inside and outside the organization day-to-day. Carefully completing this survey will probably take about 15 minutes. Your participation is voluntary and you may skip questions you are unsure how to answer. To ensure your responses are anonymous, TDOT has retained the University of Memphis, Tennessee State University, and Vanderbilt University to receive the completed questionnaires and interpret the findings. No response will be linked to any individual person. We encourage you to provide candid feedback.

We appreciate your effort in helping us meet a strategic goal designed to make TDOT more efficient and effective and to make it easier for all of us to do our jobs on a daily basis!

1. Please select your division: (drop-down list of TDOT Divisions)
2. Please select your Region (1, 2, 3, 4, HQ): (drop-down list)

3. How long have you been a full-time employee at TDOT?
   - 0-5 months
   - More than 5 months – 1 year
   - More than 1 year – 5 years
   - More than 5 years – 10 years
   - More than 10 years – 20 years
   - More than 20 years

4. What is the first word that comes to mind to describe how you feel when you hear the term knowledge management? (open ended)

5. When considering TDOT's potential adoption and implementation of more robust KM practices and strategies, this is how I feel (smiley bar – frustrated to hopeful)

6. In the course of doing your job, which resource do you MOST often turn to first when looking for knowledge or information? (please select top two)

- Email or talk to a colleague at TDOT
- Email or talk to a colleague who works outside of TDOT
- Do a web search (i.e., via Google)
- Go to a known website
- Search on-line TDOT resources (for example, TeamTN webpages, tn.gov webpages, PPRM (Program, Project & Resource Management System), or SharePoint)
- Search through hard copy documents/publications in your office
- Post a message on a listserv/on-line community, Microsoft Teams Channel, etc., to which you belong
- Ask your manager for guidance based on their experience
- Other (please specify) _____

7. In the course of doing your job, which resource do you LEAST often turn to first when looking for knowledge or information? (please select two)

- Email or talk to a colleague at TDOT
- Email or talk to a colleague who works outside of TDOT
- Do a web search (i.e., via Google)
- Go to a known website
- Search on-line TDOT resources (for example, TeamTN webpages, tn.gov webpages, PPRM (Program, Project & Resource Management System), or SharePoint)
- Search through hard copy documents/publications in your office
- Post a message on a listserv/on-line community, Microsoft Teams Channel, etc., to which you belong
- Ask your manager for guidance based on their experience
- Other (please specify) _____

8. When you come across a news item, article, magazine, book, Web site, announcement for a meeting or course, or some other information that may be useful to other organization staff, what are you most likely to do? (check only one)

- Tell them about it or distribute a copy to them personally
- Post a message or link in a shared group platform (e.g. Teams, SharePoint, etc.)
- Send a memo or a copy through e-mail
- Intend to share it but usually too busy to follow through
- Include it in the weekly update meeting, memo, or email
- Save it until I think it is beneficial to share
- Other (please specify)

9. What are the constraints you face in being able to access or share knowledge or information? (open ended)

10. What kind of tools or resources do you prefer to help you do your job? (check all that apply)

- A colleague at TDOT
- Help desk or tech support
- Advice via online communities of practice (on TeamTN webpages, tn.gov webpages, PPRM (Program, Project & Resource Management System), or SharePoint)
- Hard copy resource books or manuals
- Electronic documents outside of TDOT
- Electronic documents accessed through TDOT shared (internal) drives
- Audiovisual/multimedia material (i.e. YouTube, podcasts, LinkedIn Learning, Safety Monday videos, Tech Tuesdays/Coaching Corners)
- Specialized software (such as TDOT Learning Network)
- Formal training programs or workshops
- Other (please specify) _____

11. To what extent do you agree with the following statements? (Strongly agree- strongly disagree; also need an NA in case they don't use this at all)

- I am comfortable using Adobe PDF, SharePoint, OneDrive, OneNote, and other Microsoft web-based applications to share documents within my unit.
- I understand the process or system for how files are stored and shared within my unit.
- Sharing knowledge and information is encouraged in my unit.
- I am comfortable sharing what I know with others.
- Sharing practices in my unit makes my job easier.

12. To what extent do you agree with the following statements? (Strongly agree- strongly disagree)

- I would benefit from having access to documents that contain introductory knowledge that I have to acquire from experts directly.
- I would benefit from templates to help me more easily record or document knowledge and information.
- I would benefit from formal processes to help me contribute knowledge that I don't currently document or share.
- I would benefit from support to determine the most relevant knowledge and information to share for various audiences and how best to share it.
- I have knowledge in areas that I know the organization could benefit from but no way or understanding of how to make it available to others.

13. Do you have any suggestions for TDOT to enhance its culture of knowledge sharing and innovation? (open ended)

TDOT Division Knowledge Management
Focus Group Questionnaire

Focus Group Questions

For this discussion, when we say knowledge management, we are referring to practices or processes related to how you document, share, and manage information and knowledge, provide training/cross-training, develop succession planning, perform technology transfer, etc.

KM Practices

1. Of the practices that we just described as being part of KM, what are the most successful/effective practices in your division?
2. Are there KM practices not used at TDOT that you have used at other jobs or organizations and found successful/effective? What barriers might TDOT have to implementing those practices?
3. What IT tools are used to help with KM in your division? Are these tools easy to use? Have you run into any challenges in using them effectively?
4. Communities of practice are groups that engage in discussions regularly (either in person or through virtual platforms), such as regional/state working groups, practitioner round tables, Teams channels, online discussion boards, informal brown bag seminars, etc. Are there existing groups for collecting and sharing knowledge, best practices, or lessons learned within your division or outside of TDOT that you participate in regularly? What are these, and how do they provide benefits?

KM Culture

5. Do you perceive staff to be open to sharing knowledge or not? Do you have any examples you can share to support this?
6. What other barriers do you see to improving KM practices or integrating KM into your workflow?
7. What do you think would make staff more likely to 'buy in' or be motivated to support KM activities?

Other Strategies

8. Is there anything else you would like to share that you think is important for TDOT to consider in developing a KM approach for the organization?

Appendix F

Essential Knowledge Resources

RESOURCE INVENTORY

Internal Resources	Administration Bureau								
	Central Services	Civil Rights	Finance	Internal Audit	HR	Information Technology	Procedure & Contracts	Strategic Planning	Aeronautics
Guidance Documents & Manuals	✓	✓	✓	✓	✓	✓	✓	✓	✓
Subject Matter Experts	✓	✓	✓	✓	✓	✓	✓	✓	✓
Formal Cross Training	✓	✓					✓		✓
Internal Training Programs	✓	✓	✓	✓	✓	✓	✓	✓	✓
TN Track									
Collaboration & Communication Tools	✓	✓	✓	✓	✓	✓	✓	✓	✓

External Resources	Adminstration Bureau								
	Central Services	Civil Rights	Finance	Internal Audit	HR	Information Technology	Procedure & Contracts	Strategic Planning	Aeronautics
Industry Committees & Organizations		✓	✓	✓	✓	✓	✓	✓	✓
Publications & Research Journals	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pooled Fund Study Groups	✓								
FHWA Resources								✓	
ITS Resources									

RESOURCE INVENTORY

Internal Resources	Engineering Bureau										
	Bid Analysis & Estimating	Program Development & Administration	Strategic Transportation Investments	Roadway Design	Right of Way	Structures	Construction	Traffic Operations	Materials & Tests	Occupational Health & Safety	Program Management
Guidance Documents & Manuals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Subject Matter Experts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Formal Cross Training					✓						
Internal Training Programs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TN Track											
Collaboration & Communication Tools	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

External Resources	Engineering Bureau										
	Bid Analysis & Estimating	Program Development & Administration	Strategic Transportation Investments	Roadway Design	Right of Way	Structures	Construction	Traffic Operations	Materials & Tests	Occupational Health & Safety	Program Management
Industry Committees & Organizations			✓	✓	✓	✓	✓	✓	✓	✓	✓
Publications & Research Journals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pooled Fund Study Groups											
FHWA Resources				✓				✓			
ITS Resources								✓			

RESOURCE INVENTORY

Internal Resources	Environmental & Planning Bureau			
	Environmental	*Freight & Logistics*	*Long Range Planning*	*Multimodal Transportation Resources*
Guidance Documents & Manuals	✓	✓	✓	✓
Subject Matter Experts	✓	✓	✓	✓
Formal Cross Training		✓	✓	
Internal Training Programs	✓	✓	✓	✓
TN Track				
Collaboration & Communication Tools	✓	✓	✓	✓

External Resources	Environmental & Planning Bureau			
	Environmental	*Freight & Logistics*	*Long Range Planning*	*Multimodal Transportation Resources*
Industry Committees & Organizations	✓	✓	✓	✓
Publications & Research Journals	✓	✓	✓	✓
Pooled Fund Study Groups		✓		
FHWA Resources		✓		
ITS Resources	✓			

RESOURCE INVENTORY

Internal Resources	Regional Offices			
	Region 1	Region 2	Region 3	Region 4
Guidance Documents & Manuals	✓	✓	✓	✓
Subject Matter Experts	✓	✓	✓	✓
Formal Cross Training				
Internal Training Programs	✓	✓	✓	✓
TN Track				
Collaboration & Communication Tools	✓	✓	✓	✓

External Resources	Regional Offices			
	Region 1	Region 2	Region 3	Region 4
Industry Committees & Organizations			✓	✓
Publications & Research Journals	✓	✓		✓
Pooled Fund Study Groups				
FHWA Resources				
ITS Resources				

RESOURCE INVENTORY

Internal Resources	Specific Personnel				
	Community Relations	EPIC Academy Succession Team	Information Technology	Legislative Services	Records Management
Guidance Documents & Manuals	✓		✓		✓
Subject Matter Experts	✓	✓	✓	✓	✓
Formal Cross Training					
Internal Training Programs	✓	✓	✓	✓	✓
TN Track				✓	
Collaboration & Communication Tools	✓	✓	✓	✓	✓

External Resources	Specific Personnel				
	Community Relations	EPIC Academy Succession Team	Information Technology	Legislative Services	Records Management
Industry Committees & Organizations	✓	✓	✓	✓	✓
Publications & Research Journals	✓	✓	✓	✓	✓
Pooled Fund Study Groups					
FHWA Resources					
ITS Resources					