INTEGRATING EFFECTIVE TRANSPORTATION PERFORMANCE, RISK, AND ASSET MANAGEMENT PRACTICES

FINAL PROJECT REPORT

Prepared for
National Cooperative Highway Research Program
Transportation Research Board
of
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Table of Contents

Executive Summary

Transportation agencies have matured significantly over the past decade through the advancement of practices in transportation asset management (TAM), transportation performance management (TPM), and the use of risk management and assessments. Departments of Transportation (DOTs), however, need advanced, comprehensive guidance and case studies to help them bring the pieces together to answer tough questions such as:

- How to achieve the best possible results with limited resources and under specific threats;

- How to make corrective action when performance does not meet expectations; and

- How to best empower and motivate staff to advance the agency's mission.

Federal transportation performance management requirements, advances in the availability and access to new and traditional data sources, the maturation of enterprise information management portals, and practices within and among other industries (for example, power, water, communications, aviation, maritime, transit) combine to help drive transportation agencies to modify and improve their management practices to foster more efficient and sound investment and operations decisions.

The objective of this research is to help transportation agencies by providing them with practical guidance, recommendations, and implementation practices for:

- Integrating performance, risk, and asset management practices into decision making processes;

- Identifying, evaluating, and selecting appropriate management frameworks; and

- Recruiting, training, and retaining human capital to support integrated asset management practices and related functions.

This research highlights effective practices; introduces management frameworks to facilitate implementing effective practices; and presents agile, flexible guidance that reflects where individual agencies are in their journey. In completing Phase I of NCHRP Project 08-113, the research team performed an extensive review of technical literature related to asset, performance, and risk management integration, drawing from domestic and international sources and across a range of transportation and other commercial sectors. These sectors include roadway transportation, air transportation, water utility, and more. Additionally, during Phase I, the research team presented a national webinar based on findings from this literature review, inviting input from transportation agencies and adjacent professionals to help capture the state of management integration in the United States through live polling and a follow up survey.

From there, the research team performed a series of quick-scan case studies, engaging voices from a diverse set of agencies throughout the United States, the United Kingdom, Europe, and Australia. These case studies provide valuable insights that have been captured in a set of one-page documents summarizing key findings related to the key areas of approaches to integration, data needs, personnel and skills, policy and agency structure, and resource requirements. Four agencies were selected from these quick scan case studies to be analyzed further in a set of deep-dive case studies. The research team documented the deep dives extensively, sharing in-depth insights into experiences, approaches, and lessons-learned by these agencies as they have pursued integration of asset, performance, and risk management practices.

Emerging from this extensive research and from collaborations with agency professionals with diverse backgrounds and experiences who are at various stages of integration, are valuable findings summarized in the NCHRP 08-113 final report. These initial findings indicate that more forward-leaning agencies have a better grasp of their performance goals and current asset condition. These agencies are now turning their attention to tracking performance and understanding how external threats have the potential to undermine future performance goals. They are anticipating moving next toward developing methods enabling them to model risk and understand to what degree risk can affect performance goals (such as travel time reliability). The broader effort is ultimately directed at measuring risk of destructive events that can accelerate asset deterioration, increasing the long-term costs of maintaining system assets in a state of good repair. Some

specific findings related to management integration include the following:

- The necessity of executive-level buy-in when pursuing integration and what this may look like;

- The need to modify or change agency culture to support integration efforts and to lay a foundation for long-term success, measuring the effects of agency size, context, and geography on integration efforts;

- The important role of enterprise standards such as ISO 55000 and ISO 31000 in devising a successfully integrated management program;

- The importance of identifying and addressing data needs to support agency evolution and implementation of advanced management practices;

- Identifying and building policy frameworks for management area integration that are most effective for transportation agencies;

- Understanding the value of long-term investment planning and how to support it through agency policy, standards, and partnerships; and

- The need to motivate agencies to integrate performance, asset, and risk management while recognizing the need for standardized methods of modeling how threats may undermine performance goals or accelerate asset deterioration.

Building on the findings of this research, the team presented a proposed framework to understand agency progression to integration maturity. The framework defined six unique levels of integrated management program maturity, describing an agency's increasing capability to deliver effective performance, asset, and risk management practices as their program evolves. This framework was integrated into the final guidance document that is intended for transportation professionals responsible for developing programs and processes to use and integrate practices of asset, risk, and performance management. Key features of this guidance include the following:

- 13 case studies for successful integration of performance, risk, and asset management;
- 4 Deep Dives for successful integration of performance, risk, and asset management;
- Integration maturity assessment;
- Five sample agency roadmaps; and
- Simple, visually attractive:

    – Executive Summary
    – Fact Sheet

The work completed in NCHRP 08-113 demonstrates the value of a fully integrated asset management program. Efforts were made to reinforce the value of such a program to motivate agencies as they seek methods to build an integrated performance, asset, and risk management program.

Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
AATC	Atlanta Airlines Terminal Company
AMPB	Asset Management and Performance Bureau
ASFiNAG	Autobahn and Highway Financing Stock Corporation
ATL	Hartsfield-Jackson Atlanta International Airport
Caltrans	California Department of Transportation
CDOT	Colorado Department of Transportation
CIP	Capital Improvement Plan
DOT	Department of Transportation
FHWA	Federal Highway Administration
GCWW	Greater Cincinnati Water Works
GIS	Geographic Information System
I-70	Interstate 70
ISO	International Standards Organization
IT	Information Technology
KPI	Key Performance Indicator
LRTP	Long Range Transportation Plan
MAP-21	Moving Ahead for Progress in the 21st Century Act (Public Law 112-141)
MnDOT	Minnesota Department of Transportation
MODA	Multi-Objective Decision Analysis
MRWA	Main Roads Western Australia
MSA	Maturity Self-Assessment
NCHRP	National Cooperative Highway Research Program
PAS	Publicly Available Specification
PIARC	World Road Association
RIS	Road Investment Strategy
RIS2	Second Road Investment Strategy
SB-1	California Senate Bill 1: Road Repair and Accountability Act of 2017
SDOT	Seattle Department of Transportation
SHOPP	State Highway Operation and Protection Program
SHSMP	Strategic State Highway System Management Plan
SPR	State Planning and Research
SRN	Strategic Road Network
STIP	Statewide Transportation Improvement Program
TAM	Transportation Asset Management
TAMP	Transportation Asset Management Plan
TriMet	Tri-County Metropolitan Transportation District of Oregon
UDOT	Utah Department of Transportation
VTrans	Vermont Agency of Transportation

1. Introduction

This document details the research conducted for National Cooperative Highway Research Program (NCHRP) Project 08-113: *Integrating Effective Transportation Performance, Risk, and Asset Management Practices.* This report contains findings from a state of the practice literature review, industry webinar, surveys and interviews with state and local transportation agencies for "quick scans" and "deep dive" case studies, and stakeholder/agency workshops for guidance test and roadmaps.

The primary purpose of this report is to document the NCHRP 08-113 research efforts. Another deliverable of the research, under separate cover, provides guidance, tools, and a roadmap for integration performance, risk and asset management practices. The steps outlined in this companion document are designed to walk an agency through the process of developing the knowledge, environment, projects and buy-in to guide transportation agencies on how to perform integration of performance, risk and asset management practices.

1.1 Background

Transportation agencies have matured significantly over the past decade through the advancement of practices in transportation asset management (TAM), performance management, and the use of risk assessment. However, Departments of Transportation (DOTs) need advanced, comprehensive guidance and case studies to help them bring the pieces together to answer the tough questions like how to achieve the best possible results with limited resources, how to right the ship when performance does not meet expectations, and how to best empower and motivate staff to advance the agency's mission. Federal transportation performance management requirements, along with advances in the availability and access to new and traditional data sources, the maturation of enterprise information management portals, and practices within and among other industries (for example, power, water, communications, aviation, maritime, transit) once again challenges and drives transportation agencies to evolve their   management practices to foster more efficient and sound investment and operations decisions.

1.2 Research Objectives

The objective of this research is to help transportation agencies by providing them with practical guidance, recommendations, and implementation practices for:

- Integrating performance, risk, and asset management into transportation agencies;

- Identifying, evaluating, and selecting appropriate management frameworks; and

- Recruiting, training, and retaining human capital to support asset management and related functions.

This research will highlight best practices, introduce management frameworks, and present agile, flexible guidance that is reflective of where the agencies are in their journey. The research team has

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Research Objectives:

Integrate performance, risk, and asset management into transportation agencies

Identify, evaluate, and select appropriate management frameworks

Recruit, train, and retain human capital to support asset management and related functions

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defined management framework as the structuring of people, processes, and technology to meet business objectives. Universally, there is a need to incorporate all three aspects: people, process, and technology to implement change. The research approach will provide practical guidance, case studies, and implementation roadmaps that can be readily applied by agencies to help them:

- Focus on managing for results rather than to "feed the performance indicator/data beast";

- Advance capabilities in human capital, organizational structuring, and asset management drawing from international and cross industry applied standards and methodology (for example, Publicly Available Specification [PAS] 55, International Standards Organization [ISO] 55000); and

- Become more efficient and responsive, performance-based and data-driven organizations.

1.3   Overview of Report

This NCHRP 08-113 final report is organized as follows:

- **Chapter 1. Introduction** – This chapter introduces the background, objectives, and overview of the report.

- **Chapter 2. Integration Basics** – This chapter provides an overview of performance management, risk management, asset management, and the integration of management practices in transportation sector.

- **Chapter 3. State of Practice Review** – This chapter synthesizes the findings from a review of literature in the management practices integration.

- **Chapter 4. Surveys and Interviews of Integrated Management Practices** – This chapter describes the methodology for and findings from a webinar survey and targeted interviews of 13 agencies that have integrated some or all three management practices.

- **Chapter 5. Best Practices for Management Practice Integration** – This chapter presents the results of the follow-up interviews with four agencies and the findings in the five core areas.

- **Chapter 6. Framework for Integration Maturity Assessment** – This chapter presents an outline for of a framework for assessing integration maturity level for transportation agencies. The framework outline is based on a compilation of the findings to date from the NCHRP 08-113 research.

- **Chapter 7. Guidance Development** – This chapter describes the process for development of the guidebook, development of the maturity assessment matrix, a roadmap and agency workshops to test the guidance.

- **Chapter 8**. **Conclusions of Research** – This chapter summarizes the key conclusions based on literature review, webinar, surveys and agency workshops.

- **Chapter 9. Research Outputs** – This chapter lists and briefly describes all other documentation that was created as part of the research effort, including a guidebook, state roadmaps, briefing slides, executive summary, and implementation technical memorandum. This chapter also includes recommendations for future research.

- **Bibliography and Appendices** – Included here are detailed findings from agency interviews, project documentation reviews, and survey and interview questions.

2.   Integration Basics

2.1   What is Performance, Risk, and Asset Management Integration

Across the entire globe, one of the most central charges that transportation agencies are responsible for is providing transportation networks that are well-maintained, operational, and reliable. To do this and to serve the public through effective roads and infrastructure, it is imperative that agencies effectively manage asset condition and performance, while identifying and addressing potential risks and uncertainties that may impact their assets. This is achieved through practices of performance, risk, and asset management.

- **Performance management** is defined as a strategic approach that uses system information to make investment and policy decisions to achieve desired performance goals.

- Similarly, **risk management** is a process of analytical and management activities that focus on identifying and responding to the inherent uncertainties of managing a complex organization and its assets.

- Finally, **asset management** is the application of asset data and maintenance strategies to manage the condition of the infrastructure assets that are needed to provide for mobility and safety on the transportation system.

Traditionally, these three management areas are generally operated separately within the environment of a public transportation agency, with practices working in silos with little interaction or overlap of effort. Though this has been common practice in recent times, practical experience by industry-leading agencies and other organizations, as well as research, are showing that intentional integration of these management areas can lead to significant efficiencies, synergies, and improved overall agency performance (Figure 2-1).

Figure 2-1. Integrated Management Areas Schematic

The integration of performance, risk, and asset management will look different for each agency depending on various attributes of their network, their organizational structure, and their political environment. Though this inherent complexity may be a reason for the practices historically being left separate, it does not mean that integration is always inaccessible or overly cumbersome. Management area integration can come in the form of resource sharing, such as integrated data governance structures that allow for sharing data and data responsibilities across practices, combined or overlapping funding mechanisms, or staff resources that are intentionally linked between agency departments or divisions.

Additionally, it may be established through agency policies that create common goals and leadership or accountabilities structures, injecting integration mechanisms directly into agency practice. Finally, integration can grow from within the rank and file of an agency through the creation of an internal culture of integration that links the values and goals of management practice integration, inventiveness, and proactivity to the daily responsibilities of agency staff. All these manifestations of management practice

integration require intentional leadership through identified agency integration champions, political momentum, and vision/goal setting.

2.2　Basic Requirements

The research team identified five key areas that can be used to assess an agency's management practices, their level of integration, their achieved outcomes, and their future goals for further integration. These areas are outlined below.

2.2.1　Approaches to Integration

Before beginning their management area integration, it is important that an agency assess their existing management structures and identify a practical approach for what integration may most effectively look like given their organizational structure and their unique resources and limitations. This may include reviewing funding mechanisms and budgets, data governance structures, policy and political limitations, public obligations, etc., to identify how these may impact integration efforts. As an integration approach is identified and executed, it will likely change over time as new opportunities and limitations come up, as lessons are learned, and as staff and structures begin to adapt.

2.2.2　Data Needs

In modern practice, data—on asset condition, historical finances, project outcomes, etc.—has become a central and extremely valuable resource for agencies when pursuing effective, integrated performance, risk, and asset management. Because data acquisition, management, and governance are often complex and expensive necessities for transportation agencies, they also are often a natural target of management practice integration. Centralizing and standardizing data governance policies and practices can lead to significant efficiencies by eliminating duplicated data collection or management efforts and potential disparities among different applications of key data across divisions within a transportation agency. Similarly, with efforts and goals integrated across multiple areas, advanced data analytics, tools, and practices may cross-pollinate and lead to further improvements in agency practices and experiences. Agencies also should consider how data can be used to evaluate the outcomes of management area integration, leading to a feedback loop to guide integration over time.

2.2.3　Personnel and Skills

People are the greatest resource available to agencies for all areas of practice; this is certainly the case for integrating management practices as well. Because an agency's staff will be the ones implementing the identified approach to integration and using the agency's data and other resources, it is imperative the agency invest in necessary training and skill development systems so staff are equipped to serve an evolving program. This may happen through updates to standard trainings provided to new staff, periodic trainings for existing staff as responsibilities and internal structures are modified, as well as ongoing programs for advancing staff capabilities and competencies. Additionally, agencies must plan to effectively react to and deal with staff turnover through intentional skill and knowledge retention practices at all levels of their integrated management program.

2.2.4　Policy and Agency Structure

For many agencies, some of the most effective outcomes of management area integration will be achieved through structural changes and the execution of new agency policies. Because policy and structure are so fundamental in defining the capabilities and regular operations of an agency, changes to these elements can have persistent effects throughout the agency. As a result, agencies that have the most advanced examples of management area integration often have taken major steps in applying their integration. This is seen through policy directives, restructuring agency staff and responsibilities, and developing central guiding documentation and reporting frameworks, such as strategic road investment plans and formalized long-term investment programming.

2.2.5　Resource Requirements

Naturally, the fuel that enables agencies to perform their regular operations are their resources—both financial and otherwise. It also is essential that agencies identify how funding limitations may impact plans

to integrate performance, risk, and asset management practices. Though integration may be expected to lead to efficiencies and overall cost savings, such outcomes are not immediate and may not be feasible or discernable during early stages of the evolution. Agencies must therefore assess their own financial capabilities, understanding management area integration as a long-term investment. For this reason, it also is valuable for agencies to continuously evaluate the outcomes of their integration efforts, gaining insights on the financial and other impacts over time, and relating this back to similar evaluations of previous management practices.

Figure 2-2. Key Areas for Management Integration

2.3 Integration Resources

2.3.1 Successful Approaches and Practices

In developing guidance for transportation agencies on how to effectively integrate the practices of performance, risk, and asset management, it is important to consider the approaches currently in practice within some agencies. Though most available technical documentation indicates that such integration is not broadly taking place, several agencies have initiated such efforts. By reviewing literature produced by these agencies, the following lessons for successful practices have been identified:

- **Local and Regional Input**. Successful implementation of risk management requires input from local agencies, metropolitan planning organizations, and other owners and operators who can offer insight into unique regional and historical risks. Some states have performed surveys to identify and prioritize risks related to asset management and maintenance, others convene regular meetings to share information, and still others are developing and deploying online tools to compile and share information about recent or historical damage and disruption, providing a more continuous historical record for a more comprehensive network.

Successful integration resource approaches and practices include local and regional input, risk registers, data dashboards and visualization, and data limitations.

- **Risk Register**. Development of a risk register to identify and rank potential risks and uncertainties based on institutional and industry knowledge has been a focus of multiple state transportation agencies in integrating risk management into their asset management programs. Such a tool helps agencies to develop frameworks to respond to risks, if and when they occur, in a timely, strategic, and effective manner. Agencies also are moving toward quantitative assessment of risk and developing risk metrics that will allow for easier integration with performance goals.

- **Data Dashboards and Visualization**. Because better information allows for better decision making,

some transportation agencies are investing in developing interactive asset management dashboards. These dashboards are capable of dynamically visualizing asset information based on current data as well as projected data. In addition, data dashboards and visualization also are used in communicating other critical transportation information including financial, human resources, and customer-focused metrics. They allow key agency executives, stakeholders, and decision makers to quickly understand the state of the agency's assets as well as the potential impacts of various investment scenarios.

- **Data Limitations**. Effective implementation of performance management within an asset management approach is limited by the quality of data available to agencies. Modern asset management is largely data driven, requiring detailed metrics on pavement and other asset condition and performance. If such data are not available, decisions must be based on other metrics.

2.3.2   Management Frameworks

Beyond identifying successful practices currently in use by some transportation agencies, reviewed literature also has identified some broader management frameworks for consideration when integrating asset, performance, and risk management. The following indicate some larger-scale frameworks currently in use by some transportation agencies to support their integrated management approaches.

- **Enterprise Risk Management**. A holistic approach to risk management should include more than just risks directly related to assets. Additional considerations should include road user safety, external factors, financial uncertainties, information security, business risks, and program- and project-level risks. NCHRP 08-93, *Managing Risk Across the Enterprise: A Guidebook for State Departments of Transportation,* offers an in-depth review of enterprise risk management for additional information.

- **Risk Management in Project Selection**. Agencies within transportation as well as those in other industries, such as municipal stormwater management, have most commonly integrated performance and risk management in the project selection stage. Insights related to identified performance metrics as well as identified risks and uncertainties can influence project prioritization on a local, regional or statewide level.

Examples of management framework resources include enterprise risk management, risk management in project selection, and performance management to serve road users.

- **Performance Management to Serve Road Users**. Incorporating performance management considerations into an agency's asset management program helps to ensure results better suit the needs and safety of its customers. It is important to find balance when identifying performance metrics, however, to ensure maintenance and restoration is provided broadly throughout the agency's asset program.

2.3.3   Human Capital

As agencies consider an integrated asset management approach and as their practices evolve to support this approach, it is important to consider the impact of human capital. Because needs for recruitment and training may be impacted, and because institutional knowledge and experience may become essential for successful deployment, agencies should proactively consider strategic approaches to human capital needs.

- **Information Technology (IT)**. To support an integrated asset management approach, it is often necessary to manage, analyze, and visualize large amounts of asset and related data. This may require additional recruitment or training and should be a consideration when pursuing an integrated management approach.

- **Loss of Institutional Knowledge Considered as a Risk**. Because of the long-term nature of asset management plan implementation, it is important that agencies recognize loss of institutional knowledge and experience as a continuous risk, requiring predetermined mitigation plans. Several states have included such a risk within a risk register, providing strategies for avoiding and dealing with institutional knowledge losses.

- **Training at All Levels**. With the holistic nature of the integrated asset, performance, and risk management approach, appropriate training should be made available at all applicable levels, including state and local levels, for best results. Multiple states have identified the expansion of training programs related to integrated asset management as a priority within their transportation asset management plans (TAMPs).

Human capital includes information technology, loss of institutional knowledge considered as a risk, and training at all levels.

3. State of Practice Overview

In conducting the literature review, the research team assembled a vast inventory of existing research, tools, and products and summarized key products of previous research that are most relevant to this project. The team looked at best practices guidance, summaries of domestic and international scans, peer exchange summaries, training materials, self-assessment tools, capabilities maturity models, and results of benchmarking exercises from within and outside the transportation sector. The team specifically searched for best practices of integration of performance, risk, and asset management, or integration of any two out of three. Key findings are highlighted and summarized below.

- Overall, the research team found some examples of successful integration of performance, risk, and asset management; for example, risk registers, data dashboards, and visualizations are becoming widespread. Beyond identifying successful practices currently in use by some transportation agencies, reviewed literature also has identified some broader management frameworks for consideration when integrating asset, performance, and risk management. Transportation agencies in the United States are exploring Enterprise Risk Management; specifically, risk management is being used in needs assessment and project selection, particularly for resilience-oriented projects.

- Human capital (recruiting, training, and retaining human capital) will require significant focus and investment if the transportation sector, as a whole, wants to see improvements.

- Links between performance, risk, and asset management exist informally within the leading transportation agencies, but the research team has not discovered a well-documented working model of how to integrate performance, risk, and asset management in the domestic transportation sector. Leading transportation agencies have integrated two of the three areas, but none has successfully integrated all three. Also, while personnel may be identified as leads in the areas of performance, risk, or asset management, sufficient documentation of management frameworks does not exist that facilitate communication and coordination across transportation agency silos. Emerging topics captured within some state DOT TAMPs is the idea of integrating risk into asset or performance goals, but the research team was not able to identify a fully integrated example at the DOT level. Typical agency responses to federal performance management requirements have been to assign the "go-to" people to lead the first iteration of their TAMP development processes. Those processes have revealed how important it is to have the right people at the table to discuss needs, available revenues, capital program development, and impacts on overall performance outcomes.

- Where links between asset management, risk management, and broader performance outcomes do exist, they seem to be the strongest at transit agencies and agencies outside the transport sector. Transit asset management plans are formally addressing potential impacts of asset performance on safety, some are addressing operational performance outcomes such as on-time performance and travel speeds/times, and some are asking questions about asset condition on customer satisfaction surveys. Companies in the energy sector (for example, power generation and transmission) tend to have a head start in addressing risk, performance, and asset management jointly, in part because of their profit motive, requirements imposed by state and federal regulators, and more widespread adoption of national and international standards such as ISO 55000 (*Asset Management*) and ISO 31000 (*Risk Management*). In the water sector, passage of the America's Water Infrastructure Act in the fall of 2018 is mandating risk assessments and emergency response plans of water systems serving more than 3,300 customers no later June 2021 (due dates vary by customers served). State DOTs have an awareness that these links exist, but there is little movement on formal means of strengthening them via improvements to information systems, organizational changes, or staff training.

- While risk management has been well studied, agencies struggle most with implementing these practices within their organization. Ideally, an agency's performance management and asset management plans would support a robust risk-based asset management plan that strives to meet the agency's strategic objectives; however, implementing risk management practices within a DOT has proven to be far more difficult. One factor may be that risks are harder by nature to quantify. There also are often political challenges associated with acknowledging and investing in these areas.

- A significant value can be realized through peer-peer information exchanges and other opportunities to review and disseminate lessons learned from the process of developing the TAMP. The real-life application of these themes, their cross-functional nature, and how state DOTs are tackling these challenges offers great value and insight for transportation practitioners. From these meetings, events, and documents, agencies can gain an understanding of the real-life application of these themes, how approaches may differ, and how a practitioner may improve their own practices, processes, and outcomes.

- Agency-wide data collection, management, and analysis remains a challenge for most state DOTs. Agencies are struggling to implement data governance. Some reasons for these challenges include a lack of available staff, resources, and other issues taking priority. For agencies to have better access to the data necessary to go forward with their TAMP, an agency must focus resources (financial and personnel) on refining and connecting their data management systems.

4. Surveys and Interviews of Integrated Management Practices

4.1 Webinar and Survey

The research team conducted an hour-long webinar on October 4, 2018 at 2:00 PM ET to share findings from the recently completed literature review and to collect topical input from attending agencies and industry professionals. The national webinar, facilitated by the American Association of State Highway and Transportation Officials (AASHTO), explored key findings from the ongoing research of NCHRP Project 08-113, framing the state of the practice as it relates to the integration of performance, risk, and asset management in the context of transportation agencies. The webinar followed the five key topic areas identified by the research team:

- Approaches to integration
- Data needs
- Personnel and skills
- Policy and organizational structure
- Resource requirements

Each of these topic areas was led by one member of the research team and included an overview discussion of its importance in integrating management practices, discussion of key findings from the literature review, and selection of related questions.

Webinar Topics:

- *Approaches to integration*

- *Data needs*

- *Personnel and skills*

- *Policy and organizational structure*

- *Resource requirements*

The webinar, which was hosted through the GoToWebinar online meeting platform, was shared across a broad variety of communities through announcements at multiple conferences and events, email communications to multiple AASHTO and other email lists, and general distribution of informational materials. The webinar had 55 unique registrants. Attendees were primarily employees of state DOTs, with some representation from the Federal Highway Administration (FHWA) and other entities.

4.1.1 Webinar and Survey Responses

Through a series of polls during the webinar and a brief survey distributed after the webinar, a series of questions were posed to attendees to collect valuable information on what their management programs look like, how they have evolved over time, and what their needs are. Additionally, agencies were asked to what degree their performance, risk, and asset management practices are being integrated and what challenges they have encountered along the way. Looking ahead to the Quick Scans that were to follow, attendees were asked to provide recommendations for agencies—themselves or others—who may be good candidates for the upcoming case studies and who may be interested in participating in an interview. Below are the results from the poll questions during the webinar.

- Risk management tends to be the area with highest potential for improvement among the three areas of asset, risk, and performance management.

- Most of the agencies have been working with asset condition and cost data effectively. On the other hand, data visualization has been a common challenge in the asset, risk, and performance management practices.

- The needs for personnel and skills in the areas of quantitative analyses and evaluation methods were unveiled to improve and/or encourage the integration of asset, performance, and risk management.

- The top three biggest policy barriers that might impede efforts to integrate asset, performance, and/or risk management practices are management systems, organizational culture, and consistency in communication.

- Sufficient resources and funding are critical to the integration. The greatest needs for effective integration include better systems development, additional personnel, more training, and additional funding.

4.1.2   Summary of Survey Results

The post-webinar survey included follow-up questions requesting attendees to provide further details on their agencies' management programs and histories, with the results summarized below.

If your agency is integrating management programs, what are the greatest challenges your agency faces in integrating asset, performance, and/or risk-based asset management?

- Missing or unreliable forecasts and projections (future conditions).
- Missing or unreliable data (current or historical conditions).
- Lack of asset management tools and information systems.
- Lack of information sharing.
- Unclear or broken business processes.
- Agency or policy barriers.
- Lack of established performance goals/measures for asset, performance, or risk management.
- Lack of staff resources.
- Unclear or broken business processes.
- Lack of leadership support.

Does your agency currently utilize any publicly available or proprietary software programs for analyzing and/or visualizing infrastructure data to support your asset, performance, and/or risk-based asset management programs?

- The ArcGIS tool is used for the display of asset data and condition data. The agency has not developed a risk-based management program yet.

Does your agency currently survey road users or otherwise solicit input from the public to support decision-making with your asset, performance, or risk-based asset management programs?

- The agency tried to solicit information from the public through the Long-Range Transportation Planning Process, but participation was lacking.

What initiatives can help make way for an integrated management program?

- Improving data management and visualization.
- Developing risk registers and implementing effective risk management practices.
- Improving data management and visualization.

What initiatives can help make way for an integrated management program?

- We will need a fundamental change; our construction jobs are selected by a highway commission (political). This negates many of the asset or performance improvements decisions that are made at the expert level or through our management systems.

- Need management buy-in.

How does federal funding uncertainty, short-term funding extensions, continuing resolutions, and the lack of timely annual appropriations affect your ability to predict and integrate performance, risk, and long-term asset management strategies?

- This is most certainly in every risk register and makes it difficult to maintain consistent performance and reduce the risk of a failure of the highway systems.

4.2   Quick Scan Interviews

The Quick Scan interviews were conducted to identify agencies that understood and deployed some or all aspects of integrated asset, risk, and performance management or have experience in the application of management frameworks and maximization of human capital to support these functions. The Quick Scans included a more thorough examination of documents provided by the agency along with a remote interview and exchange of information. Interview findings from 13 Quick Scans were presented, and each is briefly summarized below. The full case study summaries can be found in Appendix A.

4.2.1   Atlanta Airlines Terminal Company Interview Findings

Atlanta Airlines Terminal Company (AATC) engages in the operation and maintenance of the Central Passenger Terminal Complex at Hartsfield-Jackson Atlanta International Airport (ATL). The company offers structural and systems maintenance services. AATC has successfully integrated the performance, risk, and asset management practices through ISO 55001, ISO 9001, and quarterly business reviews, which includes key performance indicators (KPIs) under five major categories of safety, cost, schedule, quality, and operational continuity.

Within AATC, robust data and information systems are a major requirement for the management practices. A wide range of data sources are housed in the data management systems, including asset information, building systems, IT data, financial and accounting information, materials, etc. AATC uses data analysis and projections to inform decision making for funding and staffing allocation.

During the past couple of years when AATC developed and implemented ISO 55001, the senior management team has gained invaluable experience on the project delivery while AATC has developed a robust team with complimentary skillsets and ISO capabilities. Key skillsets to support integration include business process improvement, asset management, and data analytics. The turnover rate is low at AATC, but it also is important to hire and train skilled staff to maintain the high standards AATC has set in the management areas. In the meantime, AATC has observed some challenges in attracting staff with certain skillsets in a competitive market.

AATC has a well-defined organizational chart with specific staff assigned to each management area. During the integration process, three integration champions were identified. AATC also has established common objectives, policies, and procedures across the company.

The budget for asset, performance, and risk management are combined at AATC. The company has put forth funding to support the integration of the management areas and is looking to assign a full-time person to manage the certification in the future. The ISO 55001 certificate covers areas of risk, performance, and business continuity beside asset management, and the company has already seen tangible return on investment.

AATC leverages intense trainings to make sure everyone in the organization understands the goals and are on board. There is a robust communication plan, in which quarterly business reviews are used as one of the communication channels. AATC also posts goals and copies of the Strategic Asset Management Plan in various areas in its offices. Upper management encourages staff trainings and credentialing, including Institute of Asset Management training courses, Certified Facility Manager and Certified Reliability Leader certification, and other related opportunities.

4.2.2   Autobahn and Highway Financing Stock Corporation Interview Findings

The Autobahn and Highway Financing Stock Corporation (ASFiNAG) is an Austrian publicly owned corporation that oversees the planning, financing, construction, maintenance, and toll collection of Austrian autobahns. This includes approximately 1,720 kilometers of roadway, leading to toll collections of more than €1.2 billion euros annually. Though a large portion of funds go directly toward maintaining existing roadways, the company obligates much of its annual funds toward constructing new portions of roadway as ASFiNAG moves to expand its network and provide more robust connections around the nation.

ASFiNAG has identified the need to advance its asset management practices, integrating performance and risk considerations into its decision-making processes. The agency has some performance-based metrics already integrated into its asset management program, such as traffic safety, impacts of construction zones, and levels of congestion. Additionally, ASFiNAG is working to complement these practices with additional considerations of risk at the enterprise and project levels, using frameworks developed by the World Road Association (PIARC) to support decision making. This works to support greater efficiencies and effectiveness in agency programming of limited funds over a broad, dispersed network, spanning the entirety of Austria. Additionally, project-level risk considerations provide a basis for prioritization of treatments in terms of economic and service impacts, often helping to distinguish projects that are competing for funds.

ASFiNAG internally maintains data on a broad variety of asset classes. ASFiNAG's data on pavement, bridges, tunnels, noise and retaining walls, and gantries are well kept and robust; however, some more minor asset classes, such as restraint systems, safety infrastructure, and buildings, are not as robust and are developing to catch up with the major assets.

Additionally, ASFiNAG is using other data to support its management processes as well as the integration of these processes. ASFiNAG is considering such data sets as congestion hours; lane kilometers influenced by construction sites over time; measures of pavement performance such as their road safety index, frequencies and rates of crashes; and average daily traffic. This data helps to further illuminate the unique needs of various assets, their relative performance, and potential risks on the project and enterprise levels.

ASFiNAG has four staff partially assigned to asset management. This small level of staffing poses some challenges to its program as ASFiNAG looks forward to pursuing more robust integration. The agency recognizes the importance of developing staff and enterprise experience in its asset management practices. Because asset management for bridges and pavement have the longest history of more than 20 years, ASFiNAG is the most deeply developed. Meanwhile, other practices continue to develop, covering other aspects of the asset management process. Because staff turnover is inevitable, it is important to retain knowledge and continue the momentum of practice development to avoid slowdowns.

ASFiNAG is taking steps to integrate risk management into its asset management practices. For the first step of this process, the agency is defining a simple risk management system and structure that would be most appropriate for its needs and limitations. Next, the agency is providing a training program according to the outcomes of the PIARC workgroup for dissemination and education, providing support for key staff and further developing the risk management system. Once this is complete, ASFiNAG will evaluate the system, engaging agency executives to review its benefits and effectiveness, for potentially further investment and integration within the agency's policy and structure.

To have success in integrating performance and risk into its asset management practices, ASFiNAG has identified executive buy-in as a key resource. Because such integration requires modifications to a broad variety of agency practices, it is important to have the support of executive leadership throughout the course of the integration, influencing policy, structure, and resource allocation. Additionally, evaluation of

integrated practices provide the opportunity to share results with agency executives and stakeholders, potentially influencing future levels of investment.

Because funding remains a consistent limiting factor for ASFiNAG as it does for most similar agencies, it is important that the asset management staff is able to identify opportunities for improved efficiency in the short and long term. Integration of asset, performance, and risk management helps to achieve this, potentially making ASFiNAG's budget go further each year.

4.2.3   California Department of Transportation Interview Findings

The California Department of Transportation (Caltrans) has gone beyond the FHWA-required TAMP to produce a more detailed and strategic state highway system management plan (SHSMP). This plan introduces vulnerabilities in a performance-based framework at a district level. In addition, Caltrans has rolled out a State Highway Operation and Protection Program (SHOPP) 10-year Project Book that "will undertake the most ambitious highway repair program the state has seen in generations." This project book is an extension of the TAMP and will detail the projects needed to restore the state highway system to meet performance requirements of the Road Repair and Accountability Act of 2017 (Senate Bill 1 [SB-1]).

Caltrans is made up of 12 districts that report to the central agency. Each district has a set budget that is allocated for 5 years and updated every other year. Every other year, there is a goal-constrained needs assessment that is used to create a report for the governor and legislature to show the unfunded liability. Caltrans uses transportation system equity to make sure all districts are meeting their required performance targets. This pushes responsibilities to district directors, who then must address how many of the 34 metrics have improved between each period.

Caltrans is working with its 12 districts to meet 34 performance objectives based on SHOPP. Caltrans has organized these 34 objectives by the strategic plan of the agency, which are addressed at the district level. By doing this, the agency can create fiscally constrained investments that rely on funding based on performance gaps. With the help of a custom-created tradeoff tool, each district receives a single lump sum budget to meet statewide goals such as safety, deficiencies, vulnerabilities, performance, etc. Instead of funding individual asset classes, Caltrans funds districts in a manner that allows for project development in support of the agency's overall objectives. As projects are developed and executed, four performance snapshots are taken to track performance objectives against agency goals: pre-planning, post-planning, project award, and construction closeout.

In addition, California recently passed a gas tax based on the SHSMP that resulted in an increase in funding that will meet 100% of funding gaps for pavement; some other asset classes are still underfunded. Each district has its own model for pavement; all other assets use statewide deterioration models. The funding is permanent and provides Caltrans with the means to close the gaps. The tax covers half of the agency needs and is allocated for core assets such as pavement, bridges, culverts, and TAM system elements, which are all funded at 100%.

Implementation of these programs has required extensive training to avoid data limitations because of consistency and accuracy. In addition, Caltrans is working to secure funding toward an enterprise asset management software system. The system will be geographic information system (GIS) centric and will help staff understand where critical assets are and help with project visualization. Caltrans also is looking at risk management and will be conducting state-funded research to develop a department-wide vulnerability and impact risk profiling process to inform better decision making across all vulnerabilities.

Caltrans conducted an extensive business process mapping exercise to determine how the agency would implement a performance-based allocation program. The exercise is supported by the State of California and allowed the agency to understand the methods and processes used to allocate funding in the past and how those methods and processes may need to change to move toward a performance-based

allocation program. The review also revealed the need for additional staff to meet the changing needs of the agency.

Across the 12 districts, Caltrans has seen an increase in staffing. To increase the asset management program, some districts have added district-level asset managers, and to ensure the accuracy of Caltrans data, there has been extensive training as well as staff and program expansion.

4.2.4 Colorado Department of Transportation Interview Findings

The goal of the Colorado Department of Transportation's (CDOT's) asset management program is to "minimize life-cycle costs for managing and maintaining the departments assets subject to acceptable levels of risk." The four primary areas of focus include safety, infrastructure condition, system performance, and maintenance. The agency is integrating the threat of geologic hazards to the transportation system by developing a risk-based geohazards management system. In addition, the agency has invested in risk assessment at the individual asset level through a pilot study of Interstate 70 (I-70) that built upon a process used in the recovery process of the 2013 flood event that resulted in more than $750 million of damage and repair and a $10 million rockfall event in 2016 on the I-70 corridor.

CDOT is working to integrate a risk-based performance metric to demonstrate and obtain asset management funding and select projects for the geohazard program. In addition, this process will include event tracking, risk mitigation, and geohazards monitoring as well as maintaining a recognized emergency response group.

CDOT's risk-based TAMP has multiple goals (safety, asset condition, travel time reliability, etc.), and the agency has recognized a range of threats that can undermine these goals. In the geotechnical asset management area, research is underway to visualize these risks and impacts to performance goals in a cubic form, which allows for recognition of multiple threats, how to address these threats, and how best to communicate these decisions to others. In an example of risk-based geotechnical asset management done by the TRB, risk analysis at CDOT includes, "qualitative and quantitative approaches in accordance with data availability. The quantitative estimate of risk is expressed in terms of exposure cost for all assets, risk types, and performance goals and then used by CDOT subject matter experts for project selection and planning."

In the future, CDOT is planning to increase confidence in threat likelihood through remote sensing and other data-driven decision-making methods. Also, the agency would like to determine how geohazard threats affect the total risk to assets such as pavement, bridges, etc.

The geohazards asset management program has established a risk-based geohazards performance metric that has been helpful in supporting investment by the agency to reduce risk from geohazards. To further support the use of the metric, CDOT is working to improve acquisition management and data visualization to improve management buy-in of the relatively new geotechnical asset management program. The additional data and visualization tools will improve the confidence in the prediction of future geohazards that will further support estimations of anticipated losses to highway assets and impacts to the traveling public. CDOT relies on its bridge program to collect project data (including cost information) that is federally required to make business decisions. The bridge program has established an asset management team to address data governance, including developing governance documents such as the bridge design manual, ratings manual, inspection guidelines and manuals, structures management manual, etc. CDOT has an inspection program that relates all assets to each other; for example, several asset programs (culverts, tunnels, walls, signs, and signals) are based on its bridge inspection program, allowing the agency to use consistent grading assessments across structural asset programs.

The geohazards program is a relatively new asset management area in CDOT. One of the challenges faced was staff knowledge on the risks associated with geohazards across the state, prediction of future threats, and how to quantify those risks to align geohazards with other more traditional asset programs such as pavements and bridges. In addition, because the geotechnical asset management program is

such a new program, efforts are still developing to measure the effectiveness of the program within the agency.

CDOT has an established Delphi process that engages all asset management programs annually to determine funding needs across the identified asset areas based on specific performance goals. According to CDOT's Risk-Based Asset Management Plan, using the Delphi consensus building technique, "CDOT brings together asset managers, budget staff, senior management, and region staff for a workshop to develop the staff recommendations on the asset management budgets for the upcoming fiscal year."

CDOT also is moving toward and using a multi-objective decision analysis (MODA) process for project prioritization. This approach assists with funding allocation – which directs the agency toward optimal investment across the range of asset areas in support of the agency's overall strategic objectives. MODA is being using by multiple asset types and will be used to initiate cross-asset prioritization. One area of improvement that CDOT bridge staff noted would be additional federal standards established for less-tracked asset classes in areas such as risk, target setting, life-cycle analysis, and asset management plans to provide guidance for states while allowing for flexibility in application.

4.2.5 Greater Cincinnati Water Works Interview Findings

The Greater Cincinnati Water Works (GCWW) is a municipally owned and operated utility providing water supply and supporting environmental sustainability. According to Critical Business Analysis (CBA), "GCWW supplies more than 48 billion gallons of water a year through 3,000 miles of water mains to about 235,000 residential and commercial accounts." The service area now includes the entire city of Cincinnati, a majority of Hamilton County, and pieces of Butler and Warren counties. In 2003, GCWW installed a pipeline under the Ohio River and began selling water to Boone County and Florence, Kentucky.

Within GCWW, different divisions including maintenance, operation, IT, and data work together for the overall management of utility. Guidelines and reporting systems are set up for utilities of different divisions, and they are responsible for all assets in their area of responsibility. The decision-making process is clearly defined. A capital plan is developed and managed by the Capital Improvement Plan (CIP) committee. The CIP committee evaluates business cases and risks associated and then forwards information to division heads for approval or clarification. Each business case has a description of the problem statement, prepared solutions, alternative solutions, and risk score, which is a scale of up to 25 of the condition and consequences together as a numerical value for each project. Public surveys for performance management are conducted every 2 years and received favorable results.

Data sets are standard per group per asset within GCWW, and all data sets are managed internally. Technicians and maintenance supervisors manage and use the detailed source data in their system. Although some data are still managed manually, most of the data sets are in electronic format, and GCWW is improving the data management approach.

Each division is responsible for their data sources, and the CIP committee uses the same data to make project decisions. There is a well-established process to evaluate capital projects, whether needing replacement or new assets. Data analysis also is performed to determine strategy. GCWW is hiring an asset management director and working to improve the organization and documentation of processes and procedures. GCWW also has established a steering committee, which is formed with the heads and directors from all divisions, and GCWW has a new department for business architects to push new strategic business plans.

Although no one is specifically responsible for asset management, the agency has identified in the 5-year strategic business plan that it is critical to have an asset management director on board. With the addition of the asset management department, GCWW will be able to improve the agency structure and asset management line of sight to better achieve their organizational objectives.

GCWW developed a risk score tool and has been using it for more than 5 years to support decision making. The tool takes into consideration the asset condition, probability of failure, urgency, criticality, etc. The risk score can be a key differentiator when multiple projects have the same cost. GCWW has developed and implemented a risk-based asset management practice with performance management processes managed by each division. The departments have the expertise to take care of their assets. Ad-hoc analysis of all performance reviews showed a reduction of leak and break on the operations and maintenance side. Around 90% of the work orders are non-reactive, and only 10% of the work orders are reactive.

GCWW primarily performs technical practices and decision making in house and uses external services only as a supporting option if needed. GCWW appreciates staff with utility background who know about the assets GCWW is responsible for. At the same time, GCWW notices the increasing usage of computers and mobile devices, especially in the distribution areas. The agency recognizes that the new generations is more IT-oriented, and GCWW is transitioning to hire more business analysts or analytical type of people.

It also is important for GCWW to hire and train staff with skills in the utility space. There is a rotation program for new hires to immerse in different divisions in the first couple of days before they settle into a specific division. GCWW has experienced some challenges with staff retention and knowledge transfer.

Within GCWW, the funding and staffing for each management areas are not separate. Prioritization and decision-making processes are performed across the board to achieve highest benefit or return.

GCWW recognizes that some improvements are needed in this area. Human resource is one of the highest priorities to address the challenges. With limited revenue budget, the agency manages to balance the various critical projects. With limited staffing resources, the agency is looking to perform business process reengineering to improve efficiency and effectiveness.

4.2.6   Highways England Interview Findings

Highways England is a government-owned company in charge of operating, maintaining, and improving the motorways and major A roads of England, known as the strategic road network (SRN). The SRN includes more than 4,000 miles of paved roadways as well as a broad variety of structures and ancillary assets. The SRN roads make up only approximately 2% of England's total roadway network; however, they carry about one-third of England's motor vehicle traffic.

Within Highways England, the asset management division oversees major projects, maintenance, and support activities and planning. The division includes a cross-functional group that intentionally incorporates cross-discipline considerations into decision making. Additionally, Highways England has developed a road investment strategy (RIS), monitoring KPIs such as safe journeys, customer satisfaction, environmental performance, and network condition. In this manner, asset management serves as an umbrella, with risk and performance management practices being fed into the larger operations of the team. ISO 55000 is used to support these practices.

Highways England recognizes that risk is ubiquitous and needs to be considered, mitigated, and acted upon in all levels of asset management and therefore have been working to fully deploy a risk-based approach to asset management on the national level. Different practices within Highways England are responsible for a variety of data sources; however, most are housed in a common repository. Although some elements are more actively maintained and monitored than others, there are standards for common referencing that are well-established, improving compatibility. Though there is no overarching data management system, the agency is exploring options for achieving this.

Robust data and information systems are a major requirement for the effective integration of management practices. At times, this has been a challenge for Highways England because of limitations in available

data and modeling procedures for determining asset deterioration and financial forecasting. This is important to support dynamic, forward-looking decision making. Additionally, for agencies such as Highways England that are working to modernize their asset management practices, inconsistent or incomplete historical data can be a challenge as data acquisition and management practices catch up with the asset management program.

Highways England primarily in-sources its technical practices and decision making; although previously, the agency commonly used external services to support this. This has been decided to create a smarter agency with more comprehensive skills and insights to provide a more sustainable practice. This change has presented challenges along the way, though it is expected to pay off in the long term.

It also is important to Highways England to hire and train multiskilled staff to allow for cross-discipline practices for improved efficiency and effectiveness of asset management programs. Specifically, staff with experience in both engineering and finance, as well as modern technology and autonomous and connected vehicle systems will be important moving forward. The agency has experienced some staff retention, recruiting, and training difficulties because of resource scarcity and competition with other organizations.

Highways England has established common objectives across different departments that cascade throughout the organization. The agency has worked to develop a platform that encourages and incentivizes its staff to think and behave creatively and to break through walls between practices to serve the greater good of its road users and the general public. This structure of constructive challenge is largely cultural, stemming from effective leadership throughout the organization working to create a cohesive, innovative, and cooperative environment.

Because of several contributing factors, Highways England has encountered some difficulty in establishing a system-based, forward-looking mindset among some specific practices within its asset management group and adjacent groups. As staff work to address these factors and pursue the guidance outlined in its RIS, Highways England hopes to expand the vision of its agency for longer-term planning and consideration, allowing for greater efficiency and improved customer experience.

With risk and performance considerations being fed into the existing asset management group, Highways England can achieve efficiencies in using resources that would be difficult for less holistically thinking agencies. However, as with all comparable agencies, scarcity of resources at times limits the capability and capacity of the agency to pursue systemic changes. Because Highways England is such a large company, it faces many competing interests and initiatives. This can sometimes limit the level of resources Highways England is able to acquire to support integration efforts. Additionally, the size of its network can make developing data financially cumbersome, and implementing new policies and initiatives can take time. To address such issues, Highways England hopes to more broadly implement modern technology to monitor assets, automate data collection, and produce dynamic interfaces to improve agency efficiency with asset management practices, making room for more innovative approaches and strategies.

4.2.7   Minnesota Department of Transportation Interview Findings

The Minnesota Department of Transportation (MnDOT) has used a performance-based approach to manage its transportation assets since the mid-1990s and made it a formal part of its business process in 2003. According to the MnDOT's Transportation Asset Management Plan, MnDOT's performance-based approach relies on performance measures to "assess system performance, identify needs, and develop investment priorities."

Based on the understanding of transportation as a means to other ends, and not an end itself, MNDOT launched the Minnesota GO visioning process. This has allowed the department to better align their transportation system with what residents expect for their quality of natural environment, economy, and life.

MnDOT's approach to developing the TAMP as part of a family of investment plans has been its most complete integration of performance, risk, and asset management. MnDOT has been incorporating risk into the agency's functional areas, including capital and highway operations planning and business planning, aided by their understanding of the value of accounting for and managing risk. The Minnesota 20-year State Highway Investment Plan, published in 2013, fully incorporated risk assessment and played a prominent role during its development. MnDOT also produced an Enterprise Risk Management Framework and Guidance document in 2013, which "establishes the standards, processes, and accountability structure used to identify, assess, prioritize, and manage key risk exposures across the agency." Risk also factors into the most recent statewide Highway Systems Operation Plan, where it influences tradeoff discussions and funding prioritization.

MnDOT has struggled to think about risks globally and cross-asset risks. It has been easier to think about risks within a single asset class, but broader risks are not well addressed. For example, MnDOT has been challenged to think about risks to operations, public health, and broader outcomes. That said, MnDOT is moving in the right direction. Performance targets may be thought of as an "acceptable" level of risk. As part of developing MnDOT's 10-year plan, the central office has been asking districts about risks they are not able to mitigate and rebalancing funding in response.

MnDOT's web-based performance dashboard communicates risks to meeting performance targets. With this information, staff can tie risk back to MnDOT's decision-making process. MnDOT often looks at risk while considering cross-asset tradeoff levels (for example, what level of performance will MnDOT see in various assets—informed by risk-informed targets).

MnDOT has not yet integrated a clear, documented way how risk can be integrated into the project selection process. MnDOT thinks about risk management in planning and project development process, but not to the same extent in programming. MnDOT has acquired data that will be used to monitor performance across a broad range of measures. The agency will need some time to look at trends in data, and the intelligence gained from that analysis will influence decisions.

MnDOT has been involved in the question of how to use data to implement performance management for more than 15 years. MnDOT's first Data Business Plan gave the agency focus, addressing structure, process, and overall understanding of what information the agency has and what MnDOT needs to make better decisions. The Data Business Plan and data governance in general have given MnDOT structure to provide focused data management. MnDOT views data as an asset; today, MnDOT's data governance structure includes data stewards and leadership.

Nevertheless, MnDOT has a long way to go in understanding what data exist and what data are needed. Data needs should be driven by performance and include risk management/risk assessment considerations.

MnDOT is moving away from job descriptions such as "technician." To support data governance, MnDOT has started to look at more tailored job descriptions such as "data librarians" and "data stewards"; although, replicating a position in eight districts is difficult. MnDOT faces challenges identifying staff in all eight districts that fill common needs related to data management, risk management, and performance management.

MnDOT has an asset management office to lead development of the TAMP. The asset management office is responsible for coordinating across MnDOT, including district offices, to compile data needed to complete the TAMP, including data to support risk assessments. Increasingly, MnDOT is moving toward shared services within district offices. By sharing resources across silos and making job descriptions more flexible, MnDOT can find people with the skillsets needed to manage a combination of performance, assets, and risk.

MnDOT has been implementing performance management for decades; thus, discrete resources are not allocated to performance, risk, and asset management. MnDOT has not identified specific resource requirements for integrating performance, risk, and asset management, other than the general need to hire staff who can understand the relationships between the three concepts.

4.2.8   Seattle Department of Transportation Interview Findings

The Seattle Department of Transportation (SDOT) is a municipal government agency responsible for maintaining the city's public transportation, bridges, and roads. It's main source of funding comes from taxes supplemented by levies from other sources, approved by voters.

Within SDOT, asset management and performance management teams reside in the same office directed by the asset management program manager. With the combined team, SDOT has been collecting comprehensive data for new projects and conducted asset condition assessment for current assets. The visualized asset and performance dashboards help improve political and public support in allocating budget to where they are needed. The asset management team also has been acting as an internal consultant team to help other divisions with a long-term strategic view.

SDOT is looking forward to setting up a risk management team soon. SDOT is conducting a series of workshops with senior management teams to discuss risks from all departments, and enterprise risk, corporate risk, and asset risk are the three main risks SDOT is facing.

SDOT has an asset data repository to centralize data, including new assets built, but different tools are used for different functions and different types of assets for better performance. Each asset owner is responsible to maintain the relevant data. SDOT recognizes the challenge to establish a centralized way to manage data in all assets. Five of the 47 asset classes represent 95% of the overall value, and resources are directed to maintain high competency of these five classes, which include arterial and non-arterial pavements, bridges, sidewalks, and retaining walls.

A transparent public database, which is regularly updated, is available on the city website to monitor performance. SDOT has been using the data sets to develop prioritization tools that serve as reference guide to help engineers picking the right projects to invest in. With a lot of achievement on data utilization within the department, risk data and cost data have been expected to be gathered in the future.

SDOT has asset management and performance management teams managed by the same office, and there is about 60% to 70% overlap between the two teams; however, there is no real strategic direction on integrating the two areas of management with risk management. There is not a specific risk management team in the organization, but there is a legal group mainly responsible for legal risks.

Within SDOT, there is budget for each management area, and SDOT believes there is still room for improvements. SDOT has the privilege to accomplish a lot in the asset and performance management areas that its peer cities do not have a chance to do. The agency recognizes the need for more people with IT skills and people who understand economics and finance to support better integration of the management areas. The talent types for the asset management team needs are the group of people with combined knowledge of finance, economics, and engineering. The current asset management team is composed of economists, engineers, and an IT employee, while the performance management team has data scientists and project managers. Since SDOT is working on data collection, analysis, and visualization, people with data analysis, data visualization, and IT skills are in great need; however, there is a challenge of getting and keeping young people with data and IT skills because of the competition with so many IT companies, which dominate the market in Seattle.

The agency worked under the Moving Ahead for Progress in the 21st Century Act (Public Law 112-141) (MAP-21)-focused regulation and mandate to make sure compliance is achieved with improvements in the asset and performance management program. Transportation in general is a slow rolling industry, but this also forces the agencies to grow asset management practices with federal support. Within SDOT, the asset management and performance management practices have been rolled out gradually in a business practice type of way.

SDOT also has been pushing trainings throughout the team and would like to see if any higher education institutions would offer asset management degree in the future. In the meantime, the Institute of Asset Management training and certification is considered as a good resource. While federal agencies have pushed various peer exchange at the state level, SDOT would like to have more formalized opportunities for local agencies to communicate and collaborate.

4.2.9   Transport Scotland Interview Findings

Transport Scotland is the national transportation agency for Scotland, formed in 2006. The agency, headquartered in Glasgow, oversees multiple sectors of transportation, including aviation, maritime, rail, and trunk roads. Transport Scotland also is responsible for managing Traffic Scotland, a service aimed to deliver safe and reliable trunk roads. As described in its 2018 Scottish Trunk Road Network Asset Management Strategy document, Transport Scotland maintains a variety of assets, including over 3,000 kilometers of roadways, 2,000 bridges, and many ancillary assets.

Since 2010, Transport Scotland has been working to integrate performance and risk management practices into its asset management branch, moving toward the ISO 55000 standard. Internal policy and documentation are being developed to institutionalize this effort and create a structure to support the agency's innovative vision. Transport Scotland uses a variety of KPIs to support its data-driven methods and employs asset condition models to perform financial forecasts. Over time, evaluations are conducted so that such forecasts are producing expected results. Transport Scotland also uses a complex risk register, which is reviewed annually, to inform its auditing processes.

Integration is most effective on higher-level assets, and as policies and programming continue to evolve, it will begin permeating into lower-level assets more completely as well. Effective integration requires access to comprehensive, reliable, and up-to-date data sources for all asset classes. Transport Scotland performs its own pavement surveys to ensure quality data, although data on some ancillary assets is limited. Information on the performance of its roadways is sourced through Traffic Scotland. Currently, Transport Scotland does not employ a robust data governance structure, with most data being managed by the branch responsible for collecting the data. This results in some inefficiencies and duplication of efforts and will be a focus of the agency in the future, as Transport Scotland works to reform the system to achieve better data management and analytics through modern software tools and methods. Transport Scotland has found great benefits in monitoring and reporting on the direct financial benefits of its innovative integrated management approaches, helping bolster further evolution of its branch's practices.

The Transport Scotland asset management branch makes extensive use of consultants to support its day-to-day efforts as well as to bring in specific packages of expertise and technical abilities to support management practices. The agency also works to ensure knowledge transfer takes place to support the development of such skills within its own agency staff, reducing the need to expedite certain tasks. A formal process does not exist to ensure this takes place; however, staff regularly achieve this through informal means.

Transport Scotland recognizes the importance of acquiring the right level of staff, ensuring a quality workforce that can support existing practices and the evolution of their practice. Not doing so can result in long-term negative impacts on the agency's performance and stagnation of program development.

Transport Scotland's asset management branch has taken ownership of its integration efforts and with the support of the branch manager, has established a distinct vision and plan. This has brought in a variety of leaders within the organization and has helped cut across the largely siloed nature of the agency. In this way, the asset management branch manager has been established as a champion for the integration effort, playing an invaluable role in the branch's evolution.

As Transport Scotland pushes toward a more integrated approach to asset management, the agency is working to draft policy that will directly support this. Because integration is complex and requires buy-in from a broad variety of agency roles, and because integration must be conducted over a long period, it is important that such efforts be formalized through policy. This ensures practices remain consistent and effective despite periodic changes in leadership, staffing, and resources.

Asset management budgets are largely broken down by asset classes within Transport Scotland. Structures and pavements tend to have the most stable, best protected budgets, while ancillary assets are often substantially underfunded.

Current budgeting is largely based on historical funding patterns and is only partially influenced by agency data. However, as the asset management branch continues to evolve its program, Transport Scotland has been able to demonstrate financial savings as a result of the integration of risk and performance management into its asset management practices. This ability to exhibit improvements in financial efficiency and the quantitative value added that such an innovative approach offers has been valuable to the branch; however, it remains a challenge to move this upward beyond the branch. The economic benefits of the approach have been noticed by many staff and have been able to bolster ongoing efforts to achieve a robustly integrated system.

4.2.10   Tri-County Metropolitan Transportation District of Oregon Interview Findings

The Tri-County Metropolitan Transportation District of Oregon (TriMet) is a public agency that provides light rail, commuter rail, bus, and other mass transit services to an urban region spanning most of the Portland metropolitan area. The agency averages more than 300,000 rides per weekday and operated with an annual budget of approximately $526 million in 2018. TriMet owns $2 billion of capital assets, including buses, trains, and right-of-way. Because of this, it is essential that the agency continuously invest in maintaining and replacing critical assets using cost-effective, multidisciplinary means.

TriMet is making a coordinated effort to develop an integrated management approach, bringing together the practices of asset, performance, and risk management. TriMet has modified its agency structure to support this integration and have developed a guiding 2019-2023 Business Plan, which will be updated annually with a 5-year horizon. This plan is intended to provide a holistic outline for managing operations and capital budgets through contemporary, integrated business practices. The agency's efforts have led to increased coordination and cooperation among the business planning and asset management, performance management, and risk management groups. This has improved efficiency, customer experience, and helped the agency make more effective decisions in the face of scarcity, where there are consistently more projects than the agency can regularly fund. TriMet's integration effort is still young; however, it is evolving quickly through the help of agency leadership and culture.

TriMet collects and maintains a broad variety of asset data, with a lot contained and managed through a central database system and some in unconnected environments. Because disbursed data require additional effort to access and maintain, the agency is continuously working to further develop its data governance systems to improve efficiency.

With recent developments, operational and maintenance data are being used internally to support TriMet's asset management program, feeding into its developed MODA approach.

TriMet is constantly collecting data through the operation of its fleet, pushing user-friendly, customer-side results to provide for customer needs and help with trip planning. Because of the massive size of TriMet's data operations, it can be challenging to effectively parse the information as it is collected, distilling it and visualizing it to support the needs of its management practices. Additionally, the agency has focused on pursuing high-quality data to support high-quality analysis.

TriMet is lightly staffed relative to comparable agencies across the West Coast. This requires them to be highly focused and intentional as TriMet pursues integrated management practices, necessitating

agency-wide buy-in to lead the effort to completion. This also means that staff must be organized around needs and projects as they come up, leading to more effective cooperation and cross-discipline partnership. Additionally, having low staffing numbers leaves them susceptible to staff turnover, making knowledge retention a key goal as the agency continues to develop its practices.

As an agency providing public services, TriMet looks to hire new staff whose vision is aligned with its goals of providing excellent services to the general public through safe, reliable transit systems. The agency also has highlighted the value of diversity of backgrounds, emotional intelligence, and collaborative skills in hiring key staff.

TriMet employs unique staff for the three areas of business planning and asset management, performance management, and risk management. The asset management group is made up of just a few dedicated staff, requiring them to work directly with other groups to perform operations, with maintenance staff addressing most day-to-day needs. The risk group deals primarily with insurance, claims, and more recently, enterprise risk analysis. The performance group is staffed with analysts to support operations, security, database management, and more.

The agency puts a great deal of focus on the importance of developing effective workplace culture, which is focused on developing progressive, integrated practices. TriMet's general manager and director of business planning and asset management have worked jointly to develop agency structure and policy that support integrated management approaches, while also fostering a culture where these practices are sustainable, self-motivated, and highly effective.

TriMet has identified team and executive level buy-in as one of the key resource requirements for successful management area integration. With collective support of progressive management approaches and expectation- and culture-setting from the top down, integration can happen more effectively despite limitations in financial and other resources.

TriMet's budget does not line up with its integrated approach to asset, performance, and risk management. Funds are allocated separately among the three divisions, with flexibility within each division but not between divisions. This is largely defined by external factors such as state law and cannot be directly modified by the agency. TriMet does not directly track returns on investments or other objective evaluations of its integrated approach; however, executive leadership maintains the expectation that such integration will improve efficiency and the customer experience that the agency provides.

4.2.11   Utah DOT Interview Findings

The Utah Department of Transportation (UDOT) 2018 TAMP objectives involve using a data-driven, performance-based approach incorporating asset management and risk management in its decision-making processes for planning and resource allocation. The 2018 TAMP outlines three asset management tiers: performance-based management, condition-based management, and reactive management. UDOT is working to establish a process to integrate asset, risk, and performance management into its Statewide Transportation Improvement Program (STIP). As a first step, UDOT will complete a process to incorporate risk, asset, and performance management into its corridor planning process in 2019.

UDOT also is working on a verification process for quantifying risk by obtaining 2017 data to compare how close its performance modeling is to actual data. Additionally, UDOT is moving forward with developing a concept report process to better manage the life cycle of assets and bring together risk and asset management. UDOT is focused on performance metrics, with each metric having specific measures that are used to support its strategic goals that are often evaluated to make sure they are the correct measures to meet goals. UDOT is working to better understand the benefits of projects before they are developed at the project level to determine how these projects will help meet strategic goals. Along those lines, UDOT's current efforts to identify threats through a risk assessment and system resilience analysis for corridors is moving toward the goal of fully integrating asset management, risk management, into

corridor planning to support system performance goals. UDOT's innovative corridor planning process provides information on typical performance measures such as safety, operations, and mobility. The agency's efforts also will provide information on physical threats to the corridor upstream of the project development process so adequate resources can be allocated to address corridor needs.

UDOT is a data-rich agency that organizes around its data and has implemented data collection processes to understand asset location and condition. In addition, UDOT's performance management committee is comprised of division managers who establish specific performance measures within each division to support the overall agency strategic goals. The performance management committee tracks progress toward these goals on a public facing dashboard http://www.udot.utah.gov/strategic-direction/ tcak). UDOT also has heavily invested in its UPLAN data portal that serves as a foundation for multiple geo-referenced databases to support system management.

In addition, UDOT has employed a multi-objective optimization program to prioritize STIP projects to maximize performance outcomes for safety, preservation, and mobilization measures. The project is still a work in progress as the agency is working to incorporate better data for better results catered specifically to UDOT.

The maintenance program has standardized the process of data collection, which is updated every time there is a life-cycle event for an asset. This has helped with more consistent data as well as maintenance crew having more ownership over the process. In the future, this could be replicated in different programs. Of note, UDOT expressed that staffing for the management areas is not adequate but is moving to improve staffing needs with approval of a requested block grant in the 2020 budget.

Recently, UDOT integrated data analytics into the performance group and organized it as a business unit. It is expanding across the department within all business units. In the future, UDOT is looking to use asset management in support of performance goals, as it is believed that performance management is the way UDOT does business, and it needs to be a function of every group throughout the department. Also, a focus has been placed on GIS by bringing the process into different regions, with some regions hiring their own GIS analysts.

In addition, the agency noted a need for coordination across the four UDOT regions to define process for meeting the performance management needs. The agency is working toward this but believes additional guidance would be helpful to expedite the development of such a process.

UDOT has established a budget that is set aside for pavement, bridges, advanced traffic management systems, and signs, and the other assets rely on money that is set aside by the regions for transportation solutions. The agency has requested a block grant that could improve the integration of asset management, performance management, and business systems. UDOT has strategic goals and performance measures but lacks a clearly defined process to support the agency in meeting these goals. The agency lacks standardization throughout the four regions, and without this, it is difficult to implement new processes and tools with buy-in from the separate regions.

4.2.12   Vermont Agency of Transportation Interview Findings

Vermont Agency of Transportation (VTrans) has long-standing measures that guide funding and investment decisions for congestion, safety, bridge, pavement, and congestion-related projects. The agency has connected performance to asset management, but risk is just starting to be integrated into business processes and information systems. VTrans's key question is, "What stands in the way of achieving a certain goal?" The agency is challenged with helping staff understand that daily tasks are important to meeting longer-term performance targets.

VTrans views risk management as a tool to help understand how it can achieve performance goals. Asset management is a tactile planning process, with activities that are undertaken daily. VTrans staff mitigate risks in their daily jobs without explicitly acknowledging that they are practicing risk management,

although they fully acknowledge that the agency would benefit from more formal and consistent risk management practices.

VTrans views risk management from bottom-up and top-down perspectives. Management sets broad policies (for example, explicitly addressing risk in the state's asset management plan) and is starting to communicate how everyone in the organization can help VTrans meet its performance and asset management targets just by making small changes in their day-to-day job performance. Staff implement risk mitigation strategies every day, but do not view it as risk management. Management's goal is to help people prioritize and rethink their assignments based on risk to meet the agency's performance goals.

According to VTrans, the journey is still ongoing in developing an agency-wide risk registry to "enhance its decision-making processes by documenting internal and external risks that may affect its performance objectives." These risks are identified at the enterprise level and across VTrans programs, projects, and activities. To achieve the Agency's strategic goals, performance and risk management play integral roles supporting asset management activities.

VTrans has begun to emphasize asset management policy and incorporate business processes, brought on by the risks and challenges of managing transportation infrastructure assets in a sustainable and fiscally responsible manner. This ensures quality decisions are based on accurate analysis and data, while also mitigating the identified risks.

VTrans has a robust process to consider KPIs in funding and investment decisions at a program level. The agency considers how various levels of funding might impact performance, under business as usual conditions. VTrans is less certain about its ability to consider what risks stand in the way of achieving a performance target or outcome when circumstances vary from historical trends and conditions.

A specific data need is related to damage assessments, in terms of extent and cost of damage from unpredictable events like extreme weather events and the economic disruption resulting from the damage (which, in turn, is a key input to benefit-cost analysis for repair and replacement projects). VTrans is looking at operational data from emergency management agencies so the agency can use historical information to help inform decision about discrete adaptation projects and systematic design changes to prepare for future extreme weather events.

VTrans employees practice some form of risk management in their daily jobs, but it is not clear that this is applied consistently and done in a way that benefits the entire agency's performance. VTrans is working to develop training and resources to educate staff and give them tools to better integrate performance, risk, and asset management. VTrans' organization is a key obstacle to integrating performance, risk, and asset management, and risk is a scary term to many people. When the concept is explained in terms of threat, vulnerability, and consequence, people can better understand how to consider risk in their daily decisions.

According to the Vermont Agency of Transportation, "The VTrans' Asset Management and Performance Bureau (AMPB) coordinates the management of effective and realistic scopes, accurate cost estimates, and reliable schedules for these activities. The AMPB is committed to providing these services at an acceptable level of risk to the Agency and within current forecasted revenue projections while delivering customer service levels that the public expects and decision makers require. VTrans utilizes asset management, performance management, and risk management principles to effectively manage the physical and financial conditions of its assets to achieve its strategic objectives. This renewed commitment and focus on asset management complements the Agency's customer service focus."

VTrans has found it challenging to integrate performance and risk management in its transportation system management and operations and transit divisions, as those programs are more independent and siloed in the organization. The agency hopes to develop agency structure and policy that support integrated management approaches, while also fostering a culture where these practices are sustainable, self-motivated, and highly effective. By establishing an AMPB, VTrans has taken a large step toward integration those two areas.

4.2.13 Main Roads Western Australia Interview Findings

Main Roads Western Australia (MRWA) is the transportation agency of the state of Western Australia, which is responsible for managing, maintaining, and improving more than 18,500 kilometers of roads as well as implementing state policies regarding network operations and compliance. The public highways and main roads under MRWA's purview make up much of the Australian state's arterial roadway network, providing statewide connectivity. These roads complement the networks managed and maintained by local agencies throughout the state and are an essential element of Western Australia's economy.

MRWA has identified the integration of asset, performance, and risk management as an important objective of its agency. Although integration is still developing, MRWA employs several practices to implement a more modern, holistic approach to managing its network. For MRWA, this is largely top-down, with a corporate risk process that reaches through each branch of the agency, across regional and divisional divides. Additionally, MRWA has a performance management system that looks at the cost-benefit of capital projects, driver exposure and safety, high-level congestion management, and more, requiring these measures to be reported up the management structure to be reviewed at the corporate level. This helps centralize management efforts across the geographically vast jurisdiction of the agency and relies largely on cross-coordination between branches and interactions of branch managers. This high-level approach, however, can be difficult to reflect in low-level asset management decision making.

MRWA maintains a corporate database that contains geometric data on all roads as well as deterioration data, crash data, and more. Additionally, MRWA has implemented a maintenance management system that helps prioritize maintenance projects and supports economic analyses. Additionally, traffic and similar data are collected internally by performance management staff. In recent years, MRWA has made strong pushes to verify its data, especially geometric data, which largely rely on human updates. Though this is a large effort, the data have been improving over time, with broad staff efforts and understanding the importance of data validation. The agency also maintains a risk management database that includes information that cascades throughout the enterprise. MRWA has implemented software programs such as Microsoft Power BI and Tableau to help with data visualization and support decision-making processes, and hopes to implement more advanced data analysis techniques, such as machine learning, to bring additional efficiencies strengths to its analysis programs.

MRWA includes about 1,000 staff, making it large yet still small enough that people across the agency know each other. This helps support collaboration between agency divisions and regions, which is essential for integrating management practices within such a geographically wide and diverse agency.

In recent years, MRWA has faced difficulties because of losses in institutional knowledge related to region-specific maintenance and operations practices. In response to this, the agency is working to provide diverse experiences for staff to achieve more well-rounded skillsets, giving staff the opportunity to work in various regions and divisions. This helps achieve cross-collaboration, professional network building, and knowledge transfer among regions and divisions, providing assurance against staff turnover. Additionally, MRWA is working to improve documentation of agency methods and practices to avoid productivity loss during staffing changes.

MRWA has a siloed structure, with separate divisions responsible for different management areas. Despite this separation of operations, a good deal of collaboration and cooperation occurs between divisions, due in large part to partnerships between branch managers. The agency's risk management group works primarily as a provider, facilitating practices of risk management for other areas of practices, regularly crossing boundaries and collaborating with outside staff. MRWA also is working on developing a more complex internal reporting system to further support the integration of practices through agency policy.

MRWA has a strong structure for process risk management; however, it is working on expanding this to better cover risks related to its network assets. This would include considerations of risks related to asset

failure and environmental impacts. Because of the diversity of regional experiences, it is possible that this would need to be managed separately among regions.

With MRWA's current structure, budgets for different branches remain separate. This requires that staff work intentionally on all collaboration efforts, identifying means to circumvent the limitations to budget fluidity. This can be a barrier to some efforts for integration, limiting the degree to which branches work together on various tasks.

MRWA has been pushing to focus on longer-term views of funding to achieve greater effectiveness and improved efficiency in using limited resources. To support this, the agency has been working on developing data visualization techniques that can be presented to executives and government officials, demonstrating the needs related to its assets, its backlog of ongoing efforts, and the economic benefits of more robust maintenance measures and an integrated management approach. A strategic asset plan is developed annually to capture this information and add justification to the agency's efforts and funding allocations.

4.3   Summary of Findings Quick Scan Interviews

During the Quick Scan interview process, the research team summarized the resources, tools, and methodologies that are being used to determine the benefits gained and management resources applied during the integration of asset, performance, and risk management practices. In the following subsections, the research team has captured a selection of noteworthy practices related to each of the five key topic areas of approaches to integration, data needs, personnel and skills, policy and agency structure, and resource requirements.

4.3.1   Approaches to Integration

Agencies and organizations take various paths to achieve successful integration of management practice areas. The research team has found that an integration effort requires a shared goal throughout an organization, with strong support from executive sponsors and common understanding from the employees and expanded staff within the organization. It is crucial to establish centralized management for asset, performance, and risk management as well as executive-level directions that cascade throughout the various divisions of an organization. Cross-functional collaboration is key to bring together expertise in each practice area. Integration is an effort that everyone in the organization ought to contribute to as part of their daily work, through the execution of agency strategies and by providing feedback to decision makers to support the improvements of the approach and performance.

4.3.2   Data and Software Needs

Data and information systems are viewed as a foundation for asset, performance, and risk management at many organizations. The research team has found that organizations with all three areas integrated at a high level have established management systems to support integration with a strong data governance practice. Data tends to be centralized; trend analysis and target setting can be conducted at a cross-program level to consider the tradeoffs and maximize return on investment. Clear rules and documented procedures for acquiring, managing, analyzing, reporting, and disposing of data have added tremendous value to integration efforts. With quality data from a variety of sources, integrated decision making can be informed by the analysis of historical, present, and projected performance data to support planning, programming, and implementation. Some organizations take the proactive approach to the next level by suing real-time data monitoring and trending to get ahead of potential issues. Additionally, the use of visualization techniques and interactive data dashboards has been valuable for decision making and communicating ideas to executives and stakeholders.

4.3.3   Personnel and Skills

It is critical to have the right capacity and competency of staff to drive the strategic agenda of integrating management practice areas. The research team has observed that strong leadership support motivates staff to take on the action items for integration. The right skills and appropriate training offerings are

important to help employees understand and support their critical roles in the integration. Expectations should be communicated clearly, and sometimes, incentives tied to measures of integration can promote employee engagement. Documented processes for knowledge retention and succession planning also are critical to maintain long-term momentum. Additionally, many agencies are focusing on building experience and skill internally, ensuring knowledge transfer between hired consultants.

4.3.4   Policy and Agency Structure

Organizations that have identified one or more integration champions tend to demonstrate higher efficiency and effectiveness in their integration process. Through the modification of organizational structure to adapt to the integration needs, some organizations have achieved a high level of integration within a short time. While the mindset of being willing to change is imperative, some organizations also have benefited from innovation. They encourage and incentivize innovation to foster collaboration among different practices. A common strength at organizations where the practices are highly integrated is that their policies, processes, and procedures are well documented and communicated throughout the organization in alignment with the strategic vision and objectives.

4.3.5   Resource Requirements

Funding, staffing, and executive support are three vital resources to laying a strong foundation for integration efforts. Organizations with strong integration practices tend to have the budgets for asset, performance, and risk management combined or flexibly dispersed. It is necessary to establish funding specifically to support management area integration aside from the regular operations budget. Some organizations recognize that better results can be achieved if the program can be expanded with more staff with specific skills. It also is common to share staff among practice areas given the transferable skills and understanding of the integrated management approach. Establishing support and buy-in from executive leadership and legislators in early stages also can set the stage for effective integration from the beginning, largely improving efficiency and helping to clear roadblocks along the way.

Integration Category		Minnesota DOT	Vermont AoT	CalTrans	Colorado DOT	Utah DOT	TriMet	AATC	Highways England	Transport Scotland	ASFiNAG	Seattle DOT	Main Roads Western Australia	Greater Cincinnati Water Works
Overall Assessment of Integration	High			n				n				n		
	Med	n	n		n	n	n		n	n			n	n
	Low										n			
Integrated Practices	Performance Management	n	n	n	n	p	n	n	p	p	p	n	p	p
	Risk Management	p	p	p	p	p	p	n	n	n	p	p	p	p
	Asset Management	n	n	n	n	p	n	n	n	n	p	n	p	p
Policy and Agency Structure	The agency has identified an integration champion	n	p	n		p	n	n		n			p	
	Agency structure has been modified to support management area integration	n	n	n	p	p	n	n	p			p		n
	Agency policy has been modified to support management area integration	p	p	n	p	p	p	n	n	n	n	p		p
	Innovation in management practices has been identified as a priority for agency leadership	n	p	n	p	p	n	p	n	n	p	p	n	p
Human Capital (Capacity and Competency)	Strong leadership support for integration motivates staff	n	p	n	p	p	n	n	n	n		p	p	p
	Employees have skills and training needed to understand and support their roles in integration	p	p	n	p		p	n	p	p	p	n	n	p
	Expectations and incentives for employees and groups are tied to measures of integration			n	p		p							
	Knowledge retention and succession planning are in place	p	p	p			p	p	p	p	p		p	
Resource Requirements	The budgets for asset, performance, and risk management are combined			n	n	n		n	n	n				n
	The agency has established funding specifically to support management area integration			n		p	p	n						
	The agency has developed flexible programming plans to account for variations in available funding	n	n	n	p	p	p	n	n			n	p	n
	The agency has established support from executive leadership and/or legislators for integration	p	p	n	p	p	n	n	n	n	n	p	n	p
Data and Information Systems	Management systems support integration (e.g., cross-program tradeoff analysis and target setting)	p	p	n	p	p	p	n	p	n		p	p	
	Data governance is being implemented, with rules and procedures for acquiring, managing, analyzing, reporting, and disposing of data to support integration	p	p	n	p	p	p	n	p	p	p	p	n	p
	Historical, current, and projected future performance data and indicators support planning, programming, implementation, and other integrated decision making	p	p	n			n	n	p	p	p	p	p	p

n = Mostly/full implemented   p = Partially implemented/ongoing

Figure 4-1. Quick Scan Case Study Rubric of Integration

5.   Best Practices for Management Integration

As a follow on to the Quick Scan interviews, the research team performed deep dive case study interviews with four organizations that included extended phone calls and site visits with panel sessions among key staff engaged in performance, risk, and asset management. This chapter synthesizes the information and understanding as to best practices in integrating performance, risk, and asset management, with a focus on applying management frameworks and maximizing human capital as well as identifying needed skillsets to enable an effective management integration. The complete case study summaries can be found in Appendix B.

5.1   AATC Deep Dive Highlights

Atlanta Airlines Terminal Company (AATC) is a privately held airport operation and maintenance company, officially formed in September 1979 by several major airlines, namely American, Delta, Frontier, Southwest, and United Airlines, with the principle being Delta. AATC, which is owned and controlled by its founding airlines, is based in Atlanta, Georgia and located within Concourse T at ATL.AATC's goal is to deliver world-class performance in airport facility maintenance and operations. AATC provides outstanding value to its shareholders and customers through its passion for innovation, responsiveness, and excellence in industry best practices.

AATC's management integration efforts make ATL the first international airport in the United States and the third organization in North America to   receive asset management system certification. To that end, AATC plans to remain at the forefront of emerging operational trends. Working to maintain ISO 55001 certification gives AATC the tools to be proactive, rather than reactive, so it can maintain ATL's worldwide reputation as one of the best- maintained passenger terminal complexes.

Integration started at a conceptual level by examining interactions between the management processes of the company. AATC has consultants on board to support the integration and certification, and it conducted a series of interviews with each person to discover lessons learned and identify roles in the business process. After the initial audit, 7 core business processes were identified that include the different areas of AATC's business management and daily operations:

- Business performance
- Training
- Business administration
- Asset performance management
- Asset integrity and risk management
- Project delivery
- Maintenance and operations

The overarching asset management framework and integrated processes focus on asset, performance and risk management. AATC improved its asset management system to establish a structured, best-practice approach to managing the life cycle of assets with risk-based, information-driven planning and decision making.

The keys to success were understanding every employee has a stake in its management system and must strive for continual improvement of processes and improved relations with service partners. Achieving ISO 55001 is now the foundation for AATC's future. With ISO 55001 ingrained into the work culture, AATC can efficiently and effectively improve management of asset, risk, and performance; plan for successful expansion; and pursue additional recognitions and certifications. Similarly, AATC keeps refining the standards and processes and commits to continuous improvements.

AATC has identified coordination and consensus at the executive level of the company as a key requirement for successful management integration. Because integration causes some overlap of responsibilities, it is important that leadership recognize opportunities for expanding roles to benefit the efforts of the company through its ongoing evolution. For similar companies and organizations to be successful in integration, it is crucial to establish initial buy-in from the leadership and retain the momentum throughout daily work activities. Similarly, a significant part of effective leadership is building an organization with a healthy and strong culture. Culture is a foundation of a good management system for asset heavy organizations and a key ingredient of its success.

The integration and ISO certification efforts are a long-term, time-consuming commitment. AATC has identified ISO champions to own the processes internally and manage employee participation in the roles identified in the integration roadmap and implementation action plan. Sometimes the executives delegate to the integration champions to develop documents for review and approval, adding to the responsibilities of the champions. AATC believes in the management approach and the processes. The ISO certification requires top-level executive buy-in, and each process owner needs to show continuous commitment through completion.

Key Findings from AATC

- AATC has successfully integrated its performance, risk, and asset management practices. The integration effort has largely benefited from the ISO 55001 certification process.

- The quality standard ISO 9001 helps AATC set up solid foundation for performance, risk, and asset management by organizing processes, improving efficiency, and continually improving quality.

- Executive support is a key factor in AATC's successful integration.

- A significant part of effective leadership is building an organization with a healthy and strong culture.

- Culture is a foundation of good management system for asset heavy organizations and a key ingredient of its success.

- The development and initial implementation of the integrated management system is a journey that spans over several years. The journey does not stop after the initial system and processes are set up. AATC keeps refining the standards and processes and commits to continuous improvements.

5.2   Caltrans Deep Dive Highlights

The California Department of Transportation "Caltrans"manages approximately 51,280 lane miles of interstate freeways and state routes. In addition, Caltrans coordinates with regional and local governments that operate and maintain more than 335,000 lane miles of public roads and streets. Caltrans also funds and manages three intercity rail routes, five light rail systems, and commuter rail service such as the BART system in large metropolitan areas. Additionally, Caltrans manages more than 400 public use airports and hospital heliports.

State-level oversight is provided by the California State Legislature, California State Transportation Agency, California Transportation Commission that consists of 11 appointed voting members and 2 non-voting ex-officio members and Caltrans. Caltrans coordinates with multiple tribal planning organizations and local governments to move toward its overall agency mission to "Provide a safe, sustainable, integrated, and efficient transportation system to enhance California's economy and livability" . The agency seeks opportunities to support the mission with the approximately 109 federally recognized tribal nations, 18 metropolitan planning organizations, 26 regional transportation planning agencies, 482 incorporated cities, and 58 counties in the state.

In 2017, Caltrans developed the SHSMP to fulfill the requirements of the Streets and Highways Code Section 164.6 that addresses requirements for SHOPP and federal asset management requirements. The plan included a needs assessment to identify funding requirements to address performance targets and an investment plan to address management of the state highway system. Historically, Caltrans has used an asset-based approach that the SHSMP replaced with a performance-based approach that has the flexibility to ensure multiple objectives can be met within a single project. It is noted that the SHSMP is a significant shift in the way Caltrans manages funding by focusing on measured conditions and performance objectives that moves away from historical silo-based approaches to provide more flexibility at the Caltrans district level that is anticipated to improve coordination with local partners.

Caltrans conducted an extensive business process mapping exercise to determine how the agency would implement a performance-based allocation program. The exercise was supported by the State of California and allowed the agency to understand the methods and processes used to allocate funding in the past and how those methods and processes may need to change to move toward a performance-based allocation program. The business process mapping effort took approximately 6 months to complete by the Lean Six Sigma group, who has been trained to complete this sort of analysis for various divisions of Caltrans. The result was a dramatic change in how the agency funds asset management. Before the exercise, funds went to 34 different people at Caltrans headquarters for determining projects to fund. This made it difficult to combine assets because so many people had to agree to a project outside their silo. Caltrans reduced the project approval process and moved more decision-making regarding funding and development of projects to address agency needs and goals to the district level. Caltrans is working on documenting this effort but has not yet published the overall effort for public use.

In 2017, the California congress passed SB-1, Road Repair and Accountability Act of 2017, which is anticipated to generate more than $5 billion annually through increased motor fuel taxes. This has empowered Caltrans to move forward on its path to become more performance-based, transparent and accountable. Through its asset management plans and SHOPP, Caltrans has successfully integrated performance and asset management in it's 2018 TAMP and is working toward more quantitative risk assessment and integration of this information into its performance management goals. Caltrans is working with 12 districts to meet 34 performance objectives based on the SHOPP. The current version includes fiscal years 2018-2019 to 2021-2022 and identifies approximately 1,000 projects with approximately 450 of the projects addressing specific performance goals for four primary asset classes (pavement, bridges, culverts, and traffic management systems).

For each project in the SHOPP, a project initiation document is developed to convey the intended needs and goals of each project that provides transparency in plain language to the legislature and public on how the proposed SHOPP projects will work toward the TAMP goals. When possible, a projection of the improvements in performance goals is noted in the project description, such as the anticipated reduction in crashes as a benefit of the proposed project.

Through SHOPP, Caltrans has worked to integrate existing and forecasted performance goals with asset management and project development. The next area of integration Caltrans is working toward is fully integrating risk and climate change into its asset management program. Recognizing risks come in many forms (i.e., faster than anticipated deterioration rates of assets, higher than anticipated project costs, climate change, extreme weather and natural disaster events) Caltrans is initiating several activities to incorporate these risks into its performance metrics and goals.

Caltrans is working to integrate risk into other management areas by looking at vulnerabilities that have been developed over the years, including seismic, rockfall/slide, bridge scour, high load vehicle hits to

bridges, etc. As noted in the 2018 TAMP, multiple bridges have been struck by high load vehicles, and several landslide areas have experienced events that have resulted in emergency projects. Caltrans also is working toward developing mitigation plans for these types of risks that result in emergency projects. Additionally, an extensive climate change vulnerability assessment is being executed that takes sea level rise and climate change into account. As of the spring of 2019, five districts have been mapped to understand how climate change may affect highway assets.

Looking into the future, it was noted that how climate change will affect the agency is still an unknown; it could easily cost the agency billions and take away from other areas of investment. Caltrans is grappling with funding to deal with a whole new set of vulnerabilities brought on by climate change, such as sea level rise, extreme weather patterns, and fire damages. Balancing the needs of the system across multiple demands such as safety, asset condition, and operations is something still up for debate in the agency. One change that has occurred because of the recent substantial fire seasons is a move toward steel-only guardrail systems to avoid losses from fires. Another change related to design is the requirement that new bridges be built to 2100 sea level rise elevations, typically 8 feet higher in elevation than current standards.

Key Findings from Caltrans

- Caltrans conducted an extensive business process mapping exercise to determine how the agency would implement a performance-based allocation program.

- The passage of SB-1, Road Repair and Accountability Act of 2017, is anticipated to generate more than $5 billion annually through increased motor fuel taxes.

- Caltrans is working within its 12 districts to meet 34 performance objectives based on the SHOPP.

- For each project in the SHOPP, a project initiation document is developed to convey the intended needs and goals of each project that provides transparency in plain language to the legislature and public on how the proposed SHOPP projects will work toward the TAMP goals.

- Each of the 12 Caltrans districts has an asset manager that meets with the central asset management team through monthly calls and statewide meetings held annually.

5.3   Highways England Deep Dive Highlights

The primary responsibility of the government-owned company Highways England is to provide a safe and serviceable network for its road users and stakeholders. The agency constructs, renews, maintains, and operates the SRN infrastructure, which encompasses more than 20,000 miles of roads and an extensive portfolio of ancillary roadside assets such as bridges, structures, drainage, geotechnical, lighting, vehicle restraint systems, technology, signage, and road markings. The SRN carries more than 4 million vehicle journeys every day, moving more freight than all other transportation modes put together and acting as the backbone of the national economy.

The agency, previously known as England's Highways Agency, transformed into Highways England in 2015, creating a new governance structure and new management mechanisms that enable the business to plan and deliver work more effectively. Because of this, there have been and continue to be significant organizational changes associated with leadership, objectives, culture, and priorities, including the evolving relationship with the Office for Road and Rail, which is Highways England's regulatory monitor. Central to this new structure is the requirement to measure delivery as well as performance and, in turn, better understand the relationship between investments and outcomes.

Highways England is approaching the end its first 5-year period under this new agency structure and is working on the strategic business plan that will define the investment choices and set the level of performance for the second road investment strategy (RIS2) period, 2020-2025 (Figure 5-1). In support of the business transformation, Highways England embarked on a newly reconfigured asset management

program with the ambition of embedding an integrated asset decision-making framework consistent with ISO 55000. The asset management framework was adapted from an ISO 55000-compliant solution that had been successfully implemented in the airport sector. This blueprint has been successfully reconfigured for several other clients from across different sectors. The blueprint is underpinned by 19 core asset management processes, which are based on a plan-do-check-act continuous improvement cycle and aligning strategic objectives with regional and lifecycle asset management plans.

Figure 5-1. Highways England Road Investment Strategy Outline

Under its new asset management framework, Highways England has been able to successfully integrate elements of performance and risk management into its asset management practices. This integration is exemplified in Highways England's identification of several KPIs. Some KPIs are quantitative, such as safety performance or pavement surface condition, which feed into an enterprise database that tracks these performance measures and more. These measures may trigger interventions for maintenance and capital improvement and will commonly influence decision making in concrete manners. Others are qualitative and bottom-up, such as customer satisfaction and focus group response, which often have tenuous linkages with decision making because of their subjective nature and being difficult to act upon. Some KPIs also may have goals that are in competition, such as roadway availability and roadway condition. Roadway availability concerns the agency's whose intention is to make key routes available to road users at all times, conflicting with the agency's goal of providing continuous maintenance and improvement to roads that may result in lane and road closures because of construction and inspections.

As Highways England continues to work toward developing a more integrated and progressive approach to asset, performance, and risk management, it has noted several key lessons. As such, Highways England discusses the importance of buy-in from the executive level. Because structural change is initiated from the top, it is important that leadership identify integrated management practices as a priority to help ensure success at all levels. This feeds into a cultural change within an agency and allows for the alignment of practices to a new set of goals. Such goals include cooperation and collaboration, where practices are able and encouraged to breach the traditional silos, which are commonly in place in government agencies. This leads to greater efficiencies, newfound synergies, and more effective day-to-day performance.

Highways England also highlights the importance of continuous improvement through its informal implementation of ISO 55000, guiding the agency by its principles of effective and flexible asset management. Because of the unique context of each transportation agency as well as its unique asset portfolio, it is imperative that an agency produce an asset management program that is appropriate and efficient for their needs. Along with this, it is important that the program is dynamic, able to evolve over time to better suit and adapt to all needs that arise. Because Highways England is working to advance an already established asset management program, it recognizes the importance of providing consistency and reliability over the course of its evolution. It is important to understand the individual goals of the transition, taking steps to achieve a steady evolution, knowing that many challenges will be encountered along the way and that being prepared to deal with them is essential for long-term success.

It also is important that agencies be aware of the data needs associated with such progressive approaches to management practice integration. Data quality and availability often can be a limiting factor for agencies that are looking to expand their methodologies. This can relate to data about existing assets or asset deterioration models in addition to historical finances related to maintenance and capital improvement, which may impact an agency's ability to perform accurate and effective long-term investment planning, which is a key element of effective management. However, because of the time it often takes to collect and refine data, it is important that agency staff work to optimize using available data in the meantime instead of waiting for improved data.

Key Findings from Highways England

- Highways England underwent a major restructuring in 2015, impacting leadership, objectives, and culture. Changes include implementing 5-year road investment periods under the supervision of a regulatory monitor and developing strategic documents for achieving its performance specification.

- The Highways England asset management program is being designed to be consistent with ISO 55000, drawing lessons and practices from the airport and water sectors.

- Several KPIs cover quantitative metrics, such as safety performance or pavement surface condition, as well as qualitative metrics, such as customer satisfaction.

- Executive-level buy-in, cultural change, collaboration across practices, and continuous improvement are necessary to support effective integrated management.

- It is important to take a sophisticated approach to using available data and modeling for uncertainties and unknowns, while constantly striving toward improved data.

- Longer-term investment periods aid in finding efficiencies and effective solutions; however, it is important to maintain complete records of spending and budgets to support such decision making.

- Moving toward in-sourcing technical activities related to asset management can be challenging and may take time; however, it may provide long-term benefits through expanded agency competencies and experience.

5.4   VTrans Deep Dive Highlights

VTrans, headquartered in Montpelier, Vermont, is a relatively small agency, with 1,300 employees and a $620 million annual budget. The agency is responsible for planning, constructing, and maintaining state-owned transportation facilities across Vermont, including roadway networks, airports, bicycle and pedestrian facilities, and public transportation systems. VTrans has established a mission that focuses on providing safe and efficient movement of people and goods while delivering excellent and effective service to all customers, with a vision of "a safe, reliable and multimodal transportation system that grows the economy, is affordable, and protects the vulnerable."

In 2014, VTrans created the AMPB within its highway division. Through the creation process, AMPB has established a three-part mission:

- Preserve the state's assets and minimize their whole life cost
- Operate in a financially sustainable manner
- Provide a framework to improve performance on a long-term basis

VTrans has established a well-integrated performance and asset management process; for example, using the results-based accountability framework and the annual Fact Book to show connections between asset performance and broader strategic goals. Currently, integration of risk into asset management is not as developed. Project delivery and resilience (facility-level and network-level) are two areas where risk is being integrated into asset and performance management.

VTrans' efforts to improve and link asset and performance management date back to the initial acquisition of a pavement management system in 1995. VTrans adopted its first Asset Management Vision and Work Plan in 2002. Then, in 2006, Vermont Governor James Douglas and Transportation Secretary Neale Lunderville advanced the "Road to Affordability" initiative in light of the increasing cost of maintenance as well as a recognition that proactive preservation interventions could result in long-term savings on reconstruction projects. As detailed in the "Policy and Agency Structure," the initiative set into motion changes in VTrans' agency culture that persist today, most notably by linking asset management tools and processes more strongly to the VTrans' project prioritization and capital program development process and by emphasizing a back to basics approach to project design and delivery.

Two discrete events put tremendous strain on the agency's resources but also provided opportunities and momentum for integrating asset, performance, and risk management at VTrans: the funding made available through the American Recovery and Reinvestment Act of 2009 (and the performance tracking requirements associated with the funds) and the enormous damage to the state's transportation system wrought by the remnants of Tropical Storm Irene in 2011.

The APMB focuses on integrating asset, performance, and risk management for highways. There is a separate performance section of the finance and administration division with a broader mission of implementing continuous improvement throughout VTrans and supporting the specific data, management systems, process improvement, and staffing needs of individual VTrans offices.

VTrans cites improved communication, collaboration, and trust among staff as among the chief benefits of its efforts to integrate performance, risk, and asset management. VTrans has been able to break down institutional barriers and get people to share data and knowledge more readily. People see that VTrans is using the data they are collecting and the analyses they are conducting to make better investments and other decisions. There also are fewer "fire drills" to collect redundant information for ad hoc performance reports.

Being able to see the impacts of investment decisions on spending levels has improved VTrans' predictive capabilities and helped it set more realistic and achievable performance targets. VTrans is beginning to experiment with efficiency frontiers to determine the optimal level of investment for a given program area or project type in asset management and other program areas. Specifically:

- VTrans now delivers 80% to 90% of projects on time and on budget.

- The percentage of structurally deficient highway bridges has declined from 18.4% in 2008 to 4.8% in 2018. With 2.8% of bridges rated poor (compared to a national average of 7.7%), Vermont ranks sixth in the nation.

- Pavement rated very poor reduced from 28% in 2010 to 13% in 2018. Pavement rated good increased from 28% in 2010 to 49% in 2018.

VTrans learned several lessons as it implemented asset management and integrated asset management with performance and risk management. VTrans noted how becoming more proactive and managing risks to improve performance requires a shift in leadership and a shift in an emphasis on what is important. It may require policy or cultural changes. Exposing the data and improving transparency inside and outside the agency was a key to making asset management effective and making risk- and performance-based decisions. Data-driven processes require quality, accessible, consumable data. Sharing data was one key way to engage staff in the performance discussion, and open sourcing certain

data has allowed for improved data quality, opening the door for other asset stewards to add their data to VTrans' emerging information systems.

Additionally, being honest about performance has held VTrans accountable and built credibility with various external partners. In the early years of asset and performance management, VTrans executive leadership owned the fact that the agency's performance lagged others in the United States. To address this, VTrans delivered a consistent, annual message to the legislature and has shown significant improvement over the years. Though VTrans initially had limited success with implementing change management for asset management, the agency has found great improvements in recent years through consistent and concerted efforts. At first, lack of resources and a focused vision established at the executive level hampered grassroots efforts to implement change management, causing confusion and frustration in early implementation and integration. However, as the agency has worked to address these challenges, it has found strong improvements in program efficiency and has been better able to achieve its goals of safe and effective transportation services.

Key Findings from VTrans

- VTrans cites improved communication, collaboration, and trust among staff as among the chief benefits of its efforts to integrate performance, risk, and asset management.

- Exposing the data and improving transparency inside and outside the agency was a key to making asset management effective and making risk- and performance-based decisions. Data-driven processes require quality, accessible, consumable data.

- Being honest about performance has held VTrans accountable and has built credibility with the agency's external partners.

- VTrans' leadership at the highest levels is dedicated to performance management and understands the value of integrating risk and asset management with performance. The agency's culture of performance management is getting stronger, and it is spreading a culture of asset management and risk management.

6.   Guidance Development

A draft guidebook was developed building off the literature review, gap assessment, industry webinar, interviews and deep dive case studies with a wide range of stakeholders as presented in Chapters 4 and 5. The guidance is based on the five key areas for management of integration and implements a Maturity Self-Assessment Matrix presented in Figure 6-1 and the roadmap for implementation presented in Figure 6-2. In addition, practical examples on the needs and how the integration efforts are taking place are presented in the guidance.

6.1   Framework for Integration

The research team developed an framework for a Transportation Performance, Risk and Asset Management Integration Self-Assessment – Capability Maturity Matrix. This will be the basis for a tool that was later developed that transportation agencies can use to assess how well they are integrating performance, risk, and asset management within their organization. It will assist in evaluating the maturity of their integrated program, identifying areas where they can take steps to improve and expand their capabilities. The full framework outline document can be found in Appendix C.

The framework defines six unique levels of integrated management program maturity (Figure 6-1), describing an agency's increasing capability to deliver effective performance, asset, and risk management practices as their program evolves. Agencies that have not yet begun the process of integrating their management practices or have not shown commitment to do so will not have reached the initial level and will fall under the pre-integration level. The work completed in NCHRP 08-113 is intended to demonstrate the value of a fully integrated asset management program. Efforts will be made to reinforce the value of such a program to motivate agencies to begin to seek methods to move toward an integrated performance, asset, and risk management program.

- **Level 0 – Pre-Integration Stage.** The agency has not yet begun the process of integrating its management practices or has not shown a commitment to do so.

- **Level 1 – Initial Stage.** The agency has identified a need to integrate its risk, asset, and performance management programs and intends to undertake such work. At this stage, the agency is identifying agency and leadership champions and determining the overall structure needed for establishing such an integrated program.

- **Level 2 – Defined Stage.** The agency has established metrics for measuring the integration of risk, asset, and performance management. It also has established agency goals and developed initial documentation for the intended system. The agency also is working toward measuring its current level of maturity and establishing a roadmap toward a fully integrated asset management program, including developing a timeline to put the program in place. The agency has undertaken work to integrate risk, asset, and performance management in at least one asset class. Processes also have been put into place that allow specific departments to further undertake such work on a small scale, which may be reactive.

- **Level 3 – Expanded and Repeatable Stage.** The agency has identified its approach to systematically and consistently achieving management area integration across asset classes and budgeting periods. The management system is not yet fully coordinating among important assets, and there may be discrepancies in approach, data management, and results across agency departments.

- **Level 4 – Managed Stage.** The agency has worked to deploy an integrated management program across appropriate asset classes and departments. The agency is systematically measuring and monitoring its business, practices, and operations to ensure documented processes are followed consistently. The agency also is ensuring that coordination and integration occur across the organization. These processes are producing results as expected at the project and program levels.

- **Level 5 – Optimizing Stage.** The agency is committed to continuous improvement, constantly optimizing and working toward a system with fully integrated performance, risk, and asset management practices to advance the organization's mission and achieve strategic goals.

Level 0: Pre-Integration — Intergration not yet begun

Level 1: Initial — Identified the need for intergration; determining structure and approach

Level 2: Defined — Established metrics, initial documentation, and monitoring; developing a roadmap and initiating small-scale intergrated practices

Level 3: Expanable Repeatable — Processes are becoming systematic and repeatable, producing consistent results; not yet fully intergrated across agency departments

Level 4: Managed — Intergration is being performed across all appropriate asset classes and agency departments; processes are well-documented and effictive

Level 5: Optimizing — Processes are fully deployed throughout the agency and are highly effective; cimmitment to continuous improvement

Figure 6-1. Integration Maturity Descriptions

6.2   Roadmap for Integration

A roadmap to help transportation agencies towards integration of performance, risk and asset management practices was developed as part of the guidance. The roadway clearly defines the steps, personnel, and timetable for integration. The roadmap has five major steps beginning with a vision that identify the needs and purpose of integrating management processes, along with a set of goals or agency-specific objectives for making that vision real. Each objective has an action plan with metrics and timebound milestones that are used to track progress regularly for managers and executives. Lastly, the roadmap will set forth a process for evaluation and revision so that the innovative nature behind integrated management can be utilized and efforts can be optimized or repositioned as needed. The five main steps of the roadmap are presented in Figure 6-2.
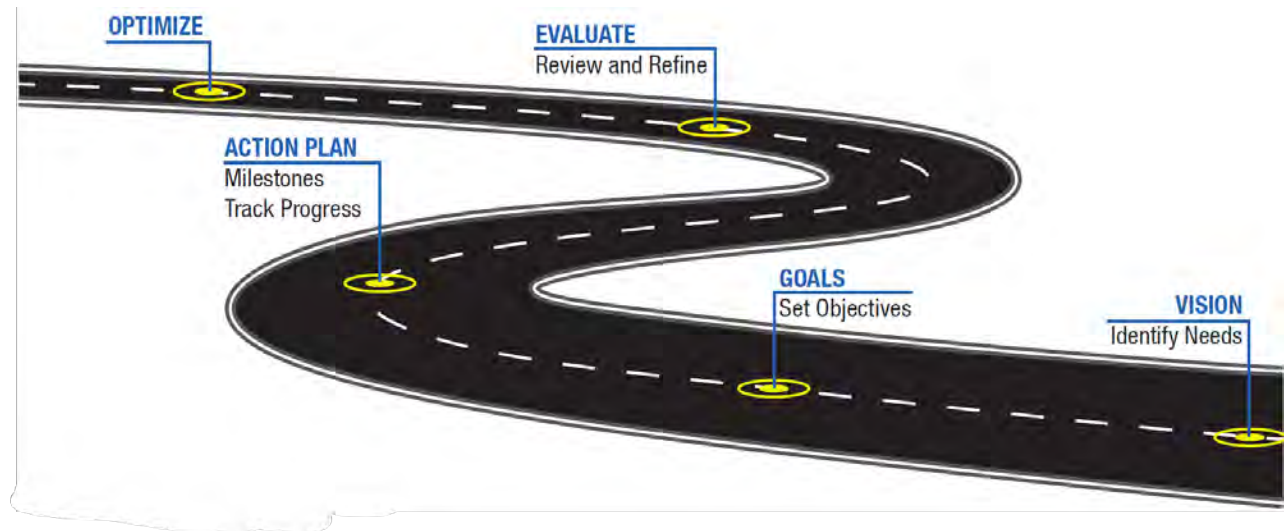
Figure 6-2. Roadmap Development Process

6.3   Guidebook Testing

After the draft guidebook was completed, the research team developed a series of workshops with transportation and transit agencies for testing the guidance and obtaining feedback for improvement.

6.3.1   Agency Workshops

To test the NCHRP 08-113 guidance, the research team engaged with transportation agencies to apply the research principles and recommendations to an operational scenario and receive operational, agency-specific feedback. To sample the outcome on a variety of agencies, agencies were selected based on agency size and various stages of integrated management maturity. Candidate agencies were selected from a wider list that the research team had previously performed either a quick scan or deep dive analysis on, gauging their level of integration and specific characteristics, personnel and efforts that were impacting their progress.

Supported by the initial research, the primary method for gaining feedback on the guidance was facilitated workshops with each agency. The team initially completed two workshops (with VTrans and UDOT), followed at the research panel's request by three additional similar workshops with MnDOT, TriMet and Caltrans.

Prior to each workshop, the research team worked with each agency points of contact, typically an integrated management champion and a lead within the agency in either performance, risk or asset management. The research team met multiple times with each agency contact group prior to the workshop and worked with agency staff on who from the agency should participate, the method by which the workshop would be administered and content and objectives from the workshop. The agency point of

contact also facilitated an executive or senior manager to "open" each workshop with a message of support for the efforts and objectives of the workshop. Each workshop had such a statement of support and in several workshops, the executive representative stayed in the workshop for a time and provided additional feedback.

Due to the Covid-19 pandemic, the VTrans workshop was the only such engagement that took place in-person, the other 4 workshops were held virtually. The research team worked with each agency weeks prior to the workshop to identify and test-run the several virtual engagement platforms used to ensure there were no security or access restrictions while executing the workshop. The tools used for the content presentation and facilitated discussion, Google Slides and PowerPoint, were both cloud-based and able to be open and edited by multiple people at the same time. This setup was crucial in having an effective virtual discussion while collecting agency feedback. The platforms used in each workshop are indicated in Figure 6-3.

Engagement Tool	VTrans	UDOT	MnDOT	TriMet	Caltrans
Audio/ Video	In-person	GoToMeeting	MS Teams	WebEx	WebEx
Presentation/ Discussion	MS PowerPoint/ Post-It Boards	Google Slides	PowerPoint	PowerPoint	PowerPoint
Polling	N/A	PollEverwhere	Mentimeter	Mentimeter	Mentimeter

Figure 6-3. Workshop Engagement Tools

Each section of the workshop included discussion points and opportunities for participants to engage and apply the five key areas of integration of the guidance to their specific agency's situation.

In addition, a live-polling exercise was conducted with each agency to perform a Maturity Self-Assessment (MSA) for each of the five key categories. The assessment was conducted using the maturity level breakdown depicted Figure 6-1. The self-assessment for each agency was conducted toward the conclusion of each workshop to capitalize on the content, understanding and discussion around the five key areas of integration and how they applied specifically to each agency. The polling was done blindly, and results shared afterward and yet there are trends to be observed in how each group saw their general location along their agency's integration journey. Results from the self-assessments are included below.
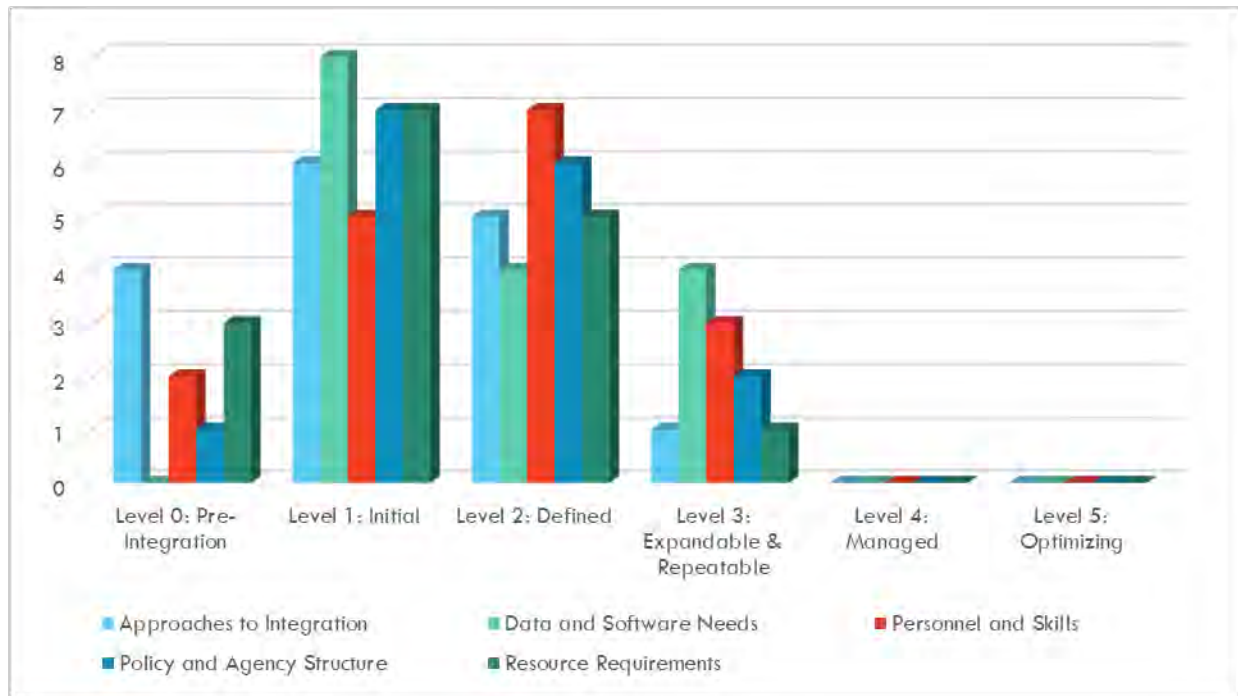
Figure 6-4. UDOT MSA Polling Results
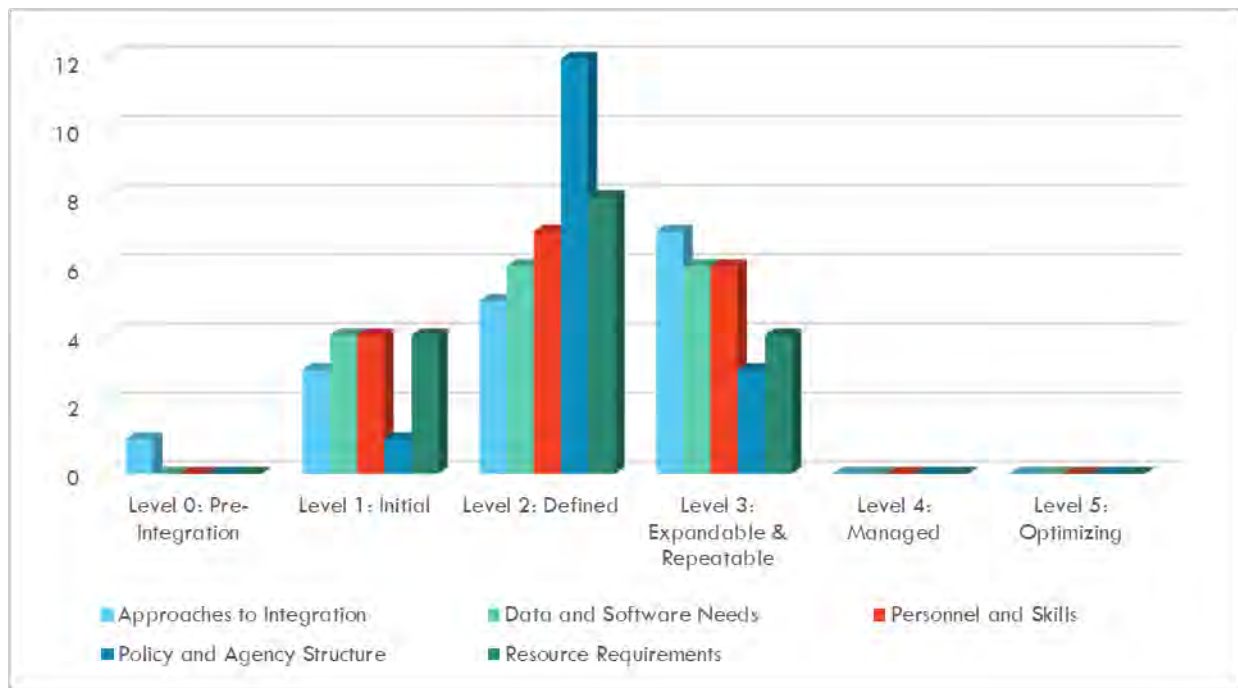
Figure 6-5. MnDOT MSA Polling Results
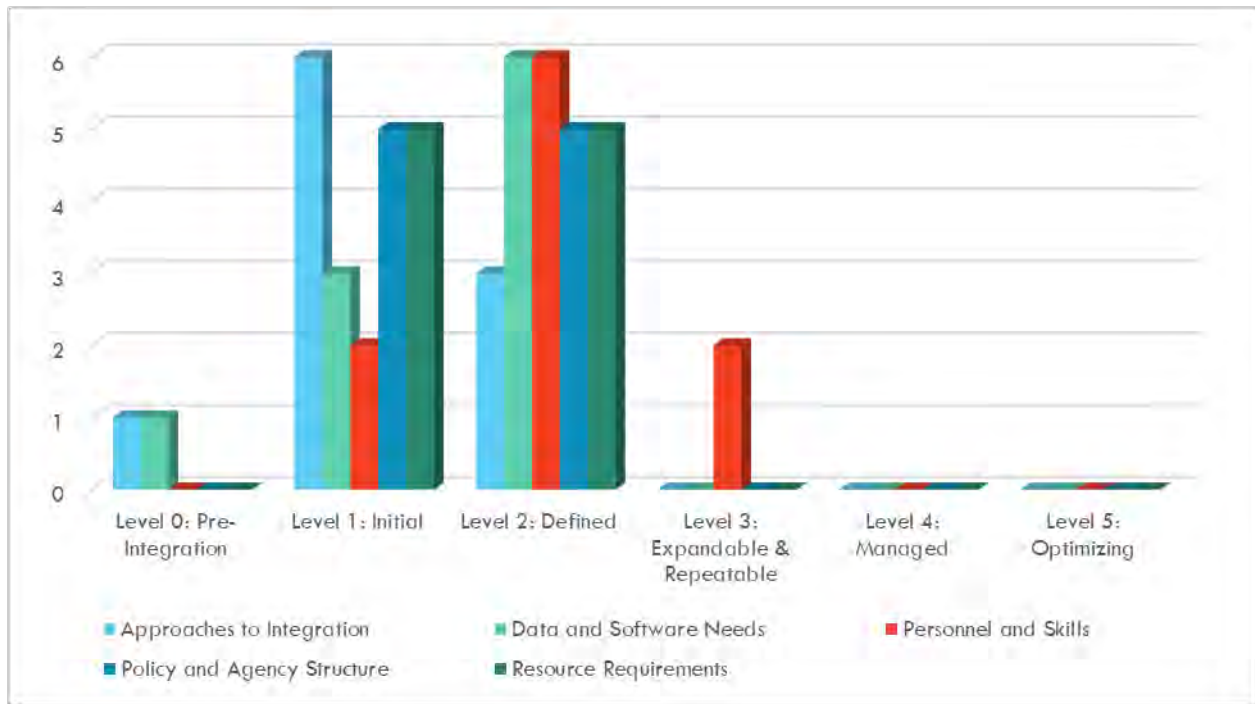
Figure 6-6. TriMet MSA Polling Results
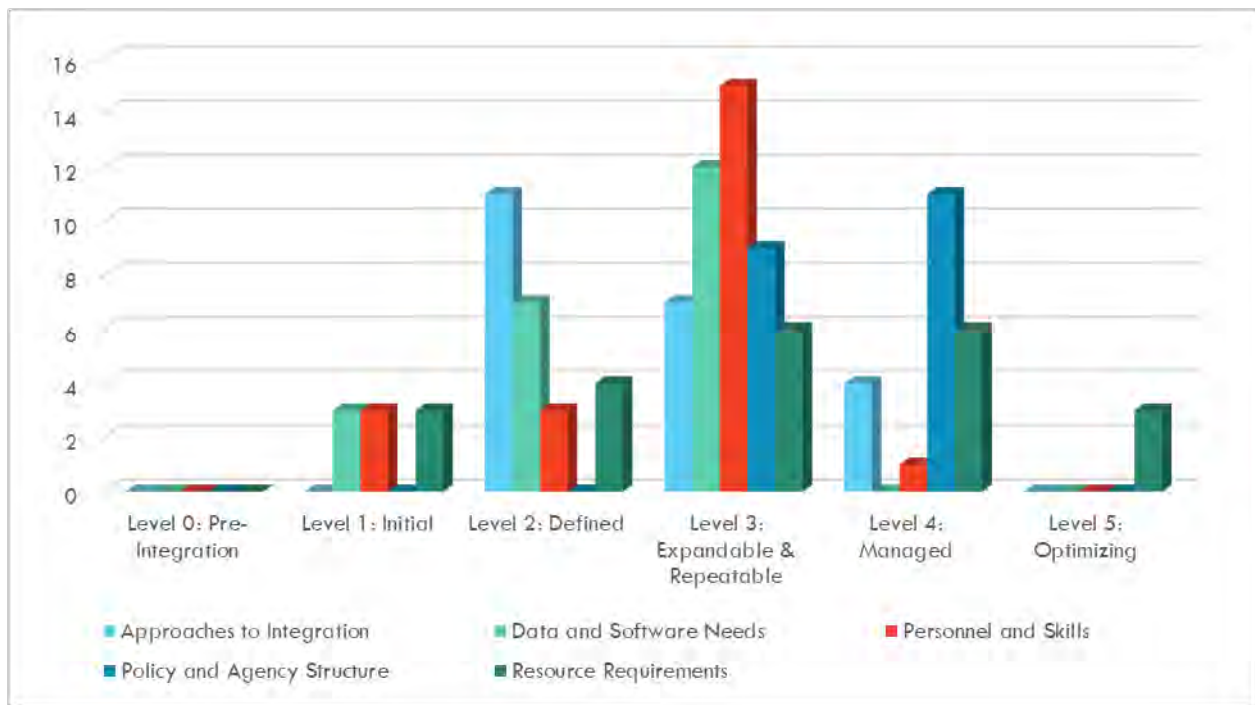
Figure 6-7. Caltrans MSA Polling Results

After each workshop was concluded, the research team communicated a timeframe in which the agency would receive an agency specific sample roadmap for review and comment. Upon receiving any comments from the agency, the research team made the necessary changes and provided the agency a revised version for final review.

6.3.2 Guidance Feedback

It was apparent in the workshops that each agency, considering their unique circumstances, had the capabilities and interest to use the guidance to move their practice forward. While the discussions had similar themes and the roadmaps were built on a shared structure, each agency brought its own ongoing efforts, strengths, weaknesses, and opportunities to the table.

In addition, it is clear that the content of the roadmap, (the vision, objectives, action plan and timetable for integrated management progress) is highly dependent on the unique situation of the existing state of the agency. The three primary factors that impacted next steps for each agency were:

- current level of integrated management maturity,
- an organizational structure that either encourages or restricts integrated management, and
- data management practices including access, maturity, understanding and inclusion of uncertainty and risk included within the data and understood

The guidance was shown to be effective in providing the strategic framework to integrating performance, risk and asset management in a wide range of transportation agencies. The diversity in structure, staffing and situation between the larger DOTs of Caltrans, UDOT and MnDOT and those of the smaller agencies such as TriMet and VTrans were all able to engage in all five key focus areas and identify a vision and action plan. The more general trends within each of those key areas although shared were intended to be customized in implementation and so the guidance was successful in providing the correct development consideration and trajectory as well as pilot examples for ideation motivation.

A summary of notable feedback received in the different workshops is included in greater detail and yet there were general sentiments that seemed to be shared throughout the participating staff. These principles are captured as critical observations (all added to the guidance) for any agency considering integrating their performance, risk and asset management practices.

- The necessity of **executive-level buy-in** and a supportive organizational structure when pursuing integration management, how it can be done and what that can look like.
- The need to modify or change **agency culture** to support a more inclusive working process and enable integration efforts.
- **Data governance can play a pivotal role** in identifying where integration strengths and barriers are. The impact of an ongoing discussion of data needs and sharing support the evolution of an agency's integrated framework.
- The important role of **enterprise standards** such as ISO 55000, ISO 31000 or data glossaries to lay the foundation for integrated processes, communications, data and resource sharing and other central tenants to help create a successfully integrated management program.
- **Identifying and building policy frameworks** for management area integration that are most effective for transportation agencies.
- Understanding the value of **long-term investment planning** and how to support it through milestone development, agency policy, standards, progress tracking and partnerships.
- The need to motivate agencies to integrate performance, asset and risk management while recognizing the need for **standardized methods of modeling** which help to identify how threats may undermine performance goals or accelerate asset deterioration.

Feedback received was incorporated into the guidance and objectives identified to further develop the agency's integrated management were included in the subsequent roadmap provided to each agency. The sample roadmaps for each agency can be found in the guidance.

7.   Research Conclusions

Through research conducted, the CORE team determined several key conclusions. Findings from the literature review, webinar surveys, and quick scans and deep dive case studies were reviewed, and the conclusions summarized in the following sections.

7.1   Key to Successful Integration

- **Executive-level buy-in is essential.** As found through all examples of agencies and companies interviewed throughout the research process, executive-level buy-in is essential for integration success. Support from leadership serves as a common starting point among most successful agencies and companies and provides an environment which is conducive to other key factors related to agency structure, culture, business planning, and more. Similarly, the identification of a central champion of integration who can maintain the goals of integration and advocate for it at many levels can lead to great success, especially during the initial stages of integration.

- **Agency culture should support integration and collaboration**. Agencies which have found the greatest success in their integration have highlighted the value of establishing a supportive internal culture. This involves staff at every level of the organization shifting from siloed to cooperative mindsets, where integration is manifested in management structures, daily practices, and internal communications. Agency culture should reward collaboration across practices and divisions, fostering creativity and innovation. Modifications in policy to support these goals is also valuable, embedding the cross-agency network format into the operations of the agency. Such cultural shifts will support long-term success of integration, outliving the tenure of an individual integration champion or other key staff. It is important to note that though such cultural shifts take place within the broad body of an agency's staff, they must be initiated by agency leadership, especially at the executive level.

- **Adopting enterprise standards leads to long-term success.** Research suggests that the entities who have achieved the greatest success in management practice integration incorporate practices from international standards. These agencies and companies often strive for agency-wide compliance, whether or not they have identified certification in such standards as a goal. The strong, time-tested values of these standards, such as ISO 55000 and ISO 31000, as well as the international community of practitioners and entities similarly integrating these standards, provides an effective model for agencies to structure their practices after. These standards also provide highly actionable information which is beneficial for agencies as they work to develop their context- and objective-specific management programs.

- **Establish an agency-wide, modern, transparent data governance structure**. An established, reliable data governance structure provides an essential basis for effective management area integration. Moving risk, performance, and asset management practices forward to a place where they can be incorporated in a structured manner requires shifting from traditional practices to modern, data-driven practices. Exposing data and improving transparency inside and outside the agency is another key to making asset management effective and making risk- and performance-based decisions. Data-driven processes require quality, accessible, consumable data.

- **Dealing with imperfect data generates value**. Quality data is essential for effective integration of management practices as decision-making across practices should be data-driven. Because some elements of agency data are often incomplete, outdated, or otherwise unreliable, it is important to take a sophisticated and intentional approach to understanding these limitations and best utilizing what data is available. This may involve modeling for uncertainties and unknowns, actively optimizing what is available through statistical or analytical methods. Additionally, it should involve constantly striving toward improved data through long-term data collection and maintenance plans, strong data governance, and advanced analytical techniques.

- **Continuously improve an integrated management program through evaluation**. An integrated management program should constantly be monitored, evaluated, and improved. Between investment periods as well as across individual investment periods, an agency should work to determine the bottom-line impacts of management practice integration. Understanding the impacts

along with intentional leadership will lead to continuous improvement, moving towards the long-term vision of integration to provide efficiencies and improved results. Because integration is an investment in this long-term vision, it is possible that these values may not show up in the short-term, so it is also critical that agencies understand the timeline of integration and how to best adopt it within the context of their environment and resources.

- **Modify agency policy and structure to support integration**. To support the operational changes that are necessitated by the integration of management practices, it is often valuable to modify agency policy and organizational structure. This can involve reconfiguring business processes to better serve an integrated structure, realigning agency objectives, or institutionalization of new key practices. This will look different for each agency depending on their unique context and needs, though it may occur in a few common ways. In the case of Highways England, the agency underwent a major restructuring ahead their integration process. Changes included implementing an extended 5year investment schedule under the supervision of a national regulatory monitor. Structural changes can similarly include new reporting or accountability structures, re-formatting of agency divisions related to asset management, operations, and more, or modifications to how agency funds are dispersed.

- **Long-term investment planning leads to large-scale solutions**. Longer-term investment periods aid in finding efficiencies, devising large-scale solutions, and achieving stable, effective agency structures. This is a common practice among agencies with more advanced integration practices as it empowers them to operate on a larger scale. However, such a major shift in funding structures can be very challenging and considerations of an agency's unique needs and objectives are critical. It is also important to maintain complete records of spending and budgets throughout each investment period to support decision making and to help improve the program across multiple periods. Proper documentation and institutionalization of budgeting and planning approaches are also necessary to ensure consistent and reliable application.

- **Cross-practice performance metrics for comprehensive decision-making**. One of the most beneficial results of integrating management practices is the ability to bring together performance measures of asset, performance, and risk management. This can bring these three areas together in practical and quantitative ways through a comprehensive project scoring methodology, data reporting dashboards, and more. Combinations of quantitative and qualitative performance metrics from each area can also improve the effectiveness of integration. The development of a risk register to create a standardized risk evaluation approach for use in decision-making, the incorporation of crowd-sourced public polling data to guide performance monitoring, and more active measures are often key to integration success.

7.2   Challenges to Successful Integration

- **Risk management is uniquely challenging for some agencies.** Research has shown that risk management is often the most challenging management area to integrate within the context of a department of transportation. Practices of risk management are often young and underdeveloped when compared with other practices. This may be due to the complex nature of the types of risks many agencies deal with related to asset failure, environmental impacts and weather events, funding uncertainties and more. These risks are also often difficult to effectively quantify, presenting further challenges when attempting to incorporate such considerations in decision-making and financial planning. Additionally, risk management can take many forms, from enterprise-level to project-level, sometimes qualitative, through the use of risk registers and similar tools, and sometimes quantitative, through the use of predictive or statistical methods. Risk management therefore may require specialized skillsets or unique data resources, making it more difficult to implement in some cases. Further specialization may also be required to connect risk management practices with those of performance an asset management.

- **Limitations in resources may preclude an agency from integration**. A major obstacle for agencies who are looking to integrate their asset, performance, and risk management practices may be limited financial resources. This can result from poor state funding mechanisms, inefficiencies in programming, or backlogs of planned asset maintenance programming. If an agency's roadway

network is in relatively poor condition or if they are behind on maintenance, ongoing programming may consume too much of an agency's time, budget, and attention. Such resource limitations may preclude them from the possibility of advancing their program and taking intentional steps towards an improved system because such steps require some level of investment, planning flexibility, and prioritization. As their program develops, investments are expected to begin providing returns through added efficiencies and improved outcomes and overall performance, however the initial requirements of integration may be difficult for some agencies to achieve.

- **Contextual instability may increase risks of agency evolution**. Unstable or unpredictable contexts may also prove to be a sizeable barrier for agencies hoping to integrate their management practices. As a state undergoes political, environmental, and financial changes, resources may regularly be in flux. If funding is uncertain year-to-year, agencies may prefer to maintain their standard practices to avoid exacerbating potential future instabilities. Such changes also produce varying risk profiles, making risk management uniquely challenging. However, though stable circumstances may be most conducive to effective and expedited agency evolutions, integration can take place in the face of change through effective leadership, executive and political support, and proper planning.

7.3   Impacts of Agency Type on Integration Success

- **Agency size and geographic area may impact integration effectiveness**. Large agencies may struggle with coordinating changes to policy and practice across large geographies, extensive staff networks, and a decentralized structure. These challenges can lead to slower integration as changes make their way through the agency and can cause confusion or inefficiencies during integration as the changes settle in. To get around this, agencies may implement a management structure which reaches across the agency, overseeing the implementation of new practices and coordinating between geographies, divisions, and the agency's central management. For example, in California, each of the 12 Caltrans districts has an asset manager that meets with the central asset management team through monthly calls and statewide meetings held annually. This helps to keep districts in-step with one another, leading to consistent practices throughout the agency.

- **Integration may be easier for private companies and smaller agencies**. Research has shown that private companies and smaller agencies, particularly transit agencies such as the Tri-County Metropolitan Transportation District of Oregon (TriMet), tend to have the greatest short-term success in management practice integration. Similarly, such entities have a stronger tendency to achieve international standards certifications, such as ISO 55000, and to explore more innovative practices related to data analysis, program planning, and customer satisfaction. For private companies, this tends to be led by their profit-driven nature, where the efficiencies of integrated management make such a framework attractive and accessible. Smaller agencies tend to find success due to the small size of their workforce and their limited geographic area, where practices can more easily be modified on a short timescale. The types of asset classes an entity is responsible for also has an impact on their ability to quickly and easily adopt integrated management practices. Extensive linear assets such as roadways and water conveyances tend to be more difficult to collect data on and are more expensive to maintain, while discrete assets such as fleet vehicles and buildings may be simpler to assess and maintain.

- **Investment in staff and knowledge retention leads to long-term success.** Public agencies often struggle with staff and knowledge acquisition and retention and it is often simpler to outsource some specialized tasks. Moving toward in-sourcing technical activities related to asset management can be challenging and may take time; however, it may provide long-term benefits through expanded agency competencies and experience.

8.   Research Output, Recommendations for Future Research and Next Steps

This section summarizes the outputs of this NCHRP 08-113 project, recommendations for future research and recommended next steps.

8.1   Research Outputs

In addition to this final research report, other outputs of this research include:

- **Guidebook for Integrating Effective Transportation Performance, Risk, and Asset Management Practices** – The guidebook corresponding to this research report builds off the industry webinar, interviews and deep dive case studies with a wide range of stakeholders presented in Chapters 4 and 5. The guidance is based on the five key areas for management of integration and implements the Maturity Self-Assessment Matrix presented in Figure 6-1 and well as the roadmap for implementation presented in Figure 7-1. In addition, practical examples on the needs and how the integration efforts are taking place are presented in the guidance.

- **Executive Summary** – The executive summary is meant to be a stand-alone document targeted to key decision makers that summarizes the key points of the guidance and the critical elements needed for effective integration. It should serve as a quick reference for agencies to turn to for information on the key focus areas for effective integration and how the "added value" in doing so.

- **Fact Sheet** – The fact sheet is aimed at agencies managers and serve as a means to simply and concisely explain the importance and benefits of an integrated management approach

- **Technical Memorandum** – The technical memorandum titled, "*Implementation Plan and Additional Research Priorities*," describes the actionable findings and recommendations of the research, opportunities to implement the guidance, and the need and priorities for specific additional research concepts.

8.2   Actionable Findings and Recommendations

This research provides the basis for guiding transportation agencies on how to integrate performance, risk and asset management practices and provides a tool to measure their maturity level at each of the five key areas for integration. However, there are still further research opportunities that may be pursued by NCHRP, AASHTO, FHWA, and State Planning and Research (SPR) grants pooled fund studies, University Transportation Centers, and other state-level research programs.

The research found future opportunities on the five key areas of integration as follows:

- **Approaches to Integration**. Develop business practices, standard operating procedures, and cyclical schedules for capital investment, resource allocation, life cycle management, operations and maintenance, and other key functions that integrate performance, risk, and asset management. Seek out opportunities to pool funds to develop these approaches or to embrace regional and national research on the subject.

- **Data and Software Needs**. Ensure that data and software are governed, digitized, and documented consistently. Develop bridge, pavement, and other asset management software systems and models that account for uncertainty, vulnerability, and resilience.

- **Personnel and Skills:** Establish and implement a list of core essential skills, both technical and non-technical, that high-functioning staff should possess. Support cross-functional interactions, including less-formal opportunities such as coffee chats. Build a central hub for performance, risk, and asset management activities through text/voice/video chat and file sharing.

- **Policy and Agency Structure**: Identify or establish who is responsible for both implementing an overall implemented vision and for individual actions and tasks. Ensure that these people feel supported, collaborative, and empowered.

- **Resource Needs**. Assess the agencies financial capabilities, understanding management area integration as a long-term investment. Continuously evaluate the outcomes of integration efforts, gaining insights on the financial and other impacts over time, and relating this back to similar evaluations of previous management practices.

8.3   Opportunities to Implement the Guidance

As noted by members of the research panel, the research will likely be most helpful to agencies if it is incorporated into existing business processes, specifically those that are cyclical and foundational for planning and investments. These may include:

- A periodic capital investment plan, work program, ten-year plan, etc.

- Development of the annual State Transportation Improvement Plan (STIP) in partnership with metropolitan planning organizations.

- Development of a Transportation Asset Management Plan (TAMP) required by FHWA – currently DOTs are required to submit a new TAMP in 2022, 2026, 2030, etc.

- A periodic long-range transportation plan (LRTP) required by FHWA every 4 years.

- A periodic or live-updated performance scorecard or dashboard.

- Development of periodic business or management plan that impact agency vision and goals as well as organization of department or agency management structure

    Additional foundational documents and periodic planning efforts may exist in agencies, regions, and states.

8.4   Need and Priority for Additional Research Concepts

Research that builds on NCHRP 08-113 speaks to both the actionable findings of this project and an agencies' most effective implementation opportunities. Consequently, these concepts are framed using both the implementation opportunities and the focus areas. Instead of a typical priority system, the concepts are assigned to four categories:

- **Time Sensitive |** These concepts may be useful for the 2022 TAMP round and as such may need to be initiated/completed in 2021 or early in 2022.

- **Direct Follow-Up for NCHRP 08-113 |** These concepts build directly from the findings of this research and have similar approaches and lines of inquiry.

- **High-Value Assistance |** These concepts were suggested or inspired by participants in 08-113 workshops as well as the project panel and could bring significant benefits to agencies in the areas discussed in this work.

- **Ongoing Efforts |** These concepts build upon prior or current research efforts that relate to the areas discussed in this work.

    The concepts and their need/priority are listed on the proceeding pages.

Opportunity	Focus Area	Concept	Need	Priority
TAMP Development	Approaches to Integration	Develop clear guidance and best practices for Risk Management in the 2022 TAMP round.	These concepts would assist DOTs in developing more robust TAMPS that fully execute risk management practices. In addition, there are time-sensitive if they are to be implemented during the 2022 TAMP process.	Time-Sensitive
TAMP Development	Approaches to Integration	Develop clear guidance and best practices for communicating and visualizing performance uncertainty in the 2022 TAMP round.		Time-Sensitive
General	Approaches to Integration Policy and Agency Structure	Develop guidance for chartering and maintaining cross-functional task forces for management area integration at transportation agencies, including tips for facilitation, outreach, and championing.	This concept addresses the expressed priorities of agencies that participated in NCHRP 08-113 workshops.	Direct Follow-up to NCHRP 08-113
Capital Investment	Approaches to Integration Resource Requirements	Develop guidance for cross-functional investment planning as an interpersonal process, crossing silos and evolving legacy approaches for program sizing and project selection through collaboration.	Panel members expressed enthusiasm for implementing in capital planning.	Direct Follow-up to NCHRP 08-113
Capital Investment	Policy and Agency Structure	Explore how uncertainty can be applied to performance-based project scoring and ranking approaches.	These concepts dovetail with those presented in NCHRP 20-123(04). Establishing risk management skills can be a predicate to better data and technical approaches.	Direct Follow-up to NCHRP 08-113
Maintenance/ Preservation	Approaches to Integration	*Explore how uncertainty can be implemented in* maintenance management approaches for scheduling, resource availability and consumption, bene*fits of preservation etc.*		Direct Follow-up to NCHRP 08-113
LRTP Development	Approaches to Integration	Develop guidance for risk and uncertainty in LRTPs, including scenario planning, return-on-investment, economics, asset condition, traffic volume, etc.	This concept helps to realize the value add for 08-113 in agencies for whom and LRTP (or other long-range plan) is the core of cyclical planning.	Direct Follow-up to NCHRP 08-113

Opportunity	Focus Area	Concept	Need	Priority
General	Data and Software Tools	Develop and maintain a database of asset management software tools and purchasable datasets with metadata and technical details for use in the development of consistent, detailed documentation across agencies.	Most transportation agencies could use a leg up in system/data documentation, and the technical details of systems are consistent across adopters in most cases. This is particularly helpful for smaller agencies.	High Value Assistance
Maintenance/ Preservation	Data and Software Tools	Explore how uncertainty can be implemented in maintenance management systems.	Maintenance management systems measure productivity and costs of repeated tasks where statistical analysis can be applied.	High Value Assistance
Maintenance/ Preservation	Data and Software Tools	Develop guidance for the collection and digitization of historic hard-copy records for work history and asset condition.	Many agencies have backlogs of old hard-copy diaries, reports, etc. that may contain insights on productivity of work, life cycle costs, and the condition and history of assets that still exist on the network.	High Value Assistance
Performance Reporting	Data and Software Tools	Develop an open-source code base for online performance dashboarding that can be picked up, customized, and applied across agencies.	Attractive, user-friendly dashboards have tremendous benefits for agency credibility and public image with effort that is relatively small and can be performed for many agencies at once.	High Value Assistance
Performance Reporting	Data and Software Tools	Continue to explore new technological avenues for system performance data collection, including location-based services, unmanned aerial vehicles, etc.	Agencies participating in NCHRP 08-113 workshops cited performance data (delay, reliability) as a key growth area in coming years.	High Value Assistance

Opportunity	Focus Area	Concept	Need	Priority
General	Data and Software Tools	Develop guidance for use of collaboration tools and hubs at agencies to coordinate performance, risk, and asset management activities.	Tools such as Microsoft Teams and 365, G Suite, Dropbox, Zoom, etc. are being rapidly rolled-out during COVID-19. The NCHRP 08-113 workshops showed the promise of these platforms as well as the benefit that could come from guidance and advice for taking best advantage of them.	Ongoing Efforts
Capital Investment	Data and Software Tools	Continue to develop user-friendly performance-based project ranking and investment selection tools, following the lead of NCHRP Report 806 among many others.	Agencies across the country have begun to invest in cross-asset resource allocation and project selection platforms. The next frontier may be simplicity and effectiveness of the user-interface, as well as broadening the performance and data basis for the tools.	Ongoing Efforts
Capital Investment	Personnel and Skills	Explore how uncertainty can be incorporated into project proposal development, drawing on best practices for risk management and return-on-investment already in use in states.	Project development is one area where many DOTs already implement elements of risk management.	Ongoing Efforts

8.5   Recommended Next Steps

The research team recommends three tracks of next steps: development of research strategic plans and research roadmaps; research to support agencies in enhancing cyclical planning (including TAMPs); and direct follow-up projects that build on elements of this research:

- **Development of research strategic plans and research roadmaps.** The research team is already engaged in NCHRP 20-123(04) to develop a research strategic plan and research roadmap for Risk Management. NCHRP 20-123(01) is performing the same process for Asset Management. NCHRP may wish to consider similar planning efforts for Performance Management or for Integrated Management. Improvements in Performance Management strategy, development and use of tools and data visualization was a common interest heard during research on NCHRP 08-113 and collaborated efforts on all three management functions could reinforce and build upon 08-113 efforts and conclusions.
- **Research to support agencies in enhancing cyclical planning.** The research panel impressed on the research team that the value add for agencies implementing the guidance will likely be found in core cyclical planning processes. These may include TAMP development, capital planning, maintenance/preservation work planning, and Long Range Transportation Plan (LRTP) development, among others. With every DOT required to certify a TAMP update in 2022, supporting

research along the lines of the suggestions on page 3 could bring significant short-term benefits to DOTs and to FHWA.

- **Direct follow-up projects to NHCRP 08-113.** While all of the concepts outlined in this document build upon NCHRP 08-113 in some way, direct follow-ups maintain the same framing and explorative nature of this project in drilling down further on some of its themes. They are also linked to the prior point on enhancing cyclical planning, as the concepts in this category on page 3 include support for integrating the findings of NHCRP 08-113 into capital planning and LRTP development.

At a high-level, any of the concepts in this document would be an excellent next step for NCHRP and other researchers to take in helping agencies implement and realize the value of this research.

9.   Conclusion

At the time of this research, most successful integration is only between performance and asset management (i.e., not including risk) and has occurred at a pilot scale. With further development of risk management techniques, agencies are finding ways to incorporate risk into the decision-making process. These techniques included federally required risk-based state agency TAMPs with a prioritized risk register.

As defined in the maturity assessment, a fully deployed, understood and "successful" integration of asset, performance, and risk management requires a commitment to continuous improvement. As systems, staff, and assets change and capabilities in evaluating and tracking performance and risk are enhanced, champions should always be willing to raise the bar even higher on the maturity scale.

The work completed in NCHRP 08-113 demonstrates the value of a fully integrated management program. Each agency can find its own unique path toward integrated management by assessing itself in the five key areas, then building a roadmap from vision to tasks assigned to accountable staff and managers. By doing so, they will become more efficient, more productive, and more resilient.

APPENDIX A
Quick Scan Case Studies

NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Atlanta Airport Terminal Corporation	**ISO-55001:**	Yes
Location:	Atlanta, Georgia	**ISO-9001:**	Yes
Sector:	Transportation		
Contact Title/Dept.:	Jacobs Facility Service Delivery Team Program Manager		

OVERVIEW

Atlanta Airlines Terminal Corporation (AATC) engages in the operation and maintenance of the Central Passenger Terminal Complex at Hartsfield-Jackson Atlanta International Airport (HJAIA). The company offers structural and systems maintenance services that include fire alarm and fire prevention; utility plants support; electrical distribution; plumbing; HVAC; vertical transportation; public address; operation and maintenance of building/ baggage management system; de-icing system containment and operation; ramp sweeping and striping; and roof management.

LEVEL OF INTEGRATION

- ☒ **High**
- ☐ Moderate
- ☐ Low
- ☐ None

INTEGRATED PRACTICES

- ☒ **Asset Management**
- ☒ **Performance Mgmt.**
- ☒ **Risk Management**

APPROACHES TO INTEGRATION

AATC has coveted ISO-55001 asset management system certification at HJAIA. The system establishes a best practice approach to decision-making and managing assets with risk-based and information-driven planning across the lifecycle of the asset.. Through the process, AATC gained a comprehensive knowledge of asset-related risks, costs and performance through the full life cycle of their assets. Quality management is also a huge success at AATC with a robust quality practice.

AATC has identified 20 KPIs; the measurements are described and the effectiveness are measured in the Quarterly Business Report (QBR), which informs and directly impacts funding decision, staff allocation, risk and performance management.

The keys to success within AATC are the support from executive sponsors, identification of clearly defined goals, development of well-thought-out plans, and commitment from the team and resources to get it done.

INTEGRATION HIGHLIGHTS

- ISO-55001 certified.
- ISO-9001 certified.
- Quarterly review of KPIs under 5 key categories including safety, cost, schedule, quality and operational continuity.

DATA NEEDS

Within AATC, robust data and information systems are a major requirement for the management practices. A wide range of data sources, are housed in the data management systems, including asset information, building systems, IT data, financial and accounting information, materials, etc.

Th facility service delivery team defines work order and asset data into the system and AATC has quality control and audit process to ensure the data quality following the standards as part of ISO-9001. With the quality review and feedback approach, AATC's data governance becomes a continuous improvement loop. Trends identified in QBR support dynamic, forward-looking decision-making. Regular monitoring and trending of the work order and financial data allows AATC to proactively identify areas of improvements.

AATC recognizes the needs to bring in real-time dashboard so that proper actions can be taken before any issues happen. The company has begun toutilize a cloud-based software platform to visualize specific metrics based onreal-time data including data collected from

user experience survey at the terminal facilities.

DATA HIGHLIGHTS

- Data sources managed include asset, building information management, and financial data.

Data projections inform funding and staff allocation

PERSONNEL & SKILLS

AATC has been working with consultant facility service delivery team on their technical practices and decision-making. During the past couple of years when they developed the ISO-55001, the senior management team has gained invaluable experience on the project delivery while AATC has developed a robust team with complimentary skillsets and ISO capabilities. Some of AATC staff are certified as ISO auditors and can help the company stay ahead of the game.

The turnover rate is very low at AATC. It is also important to hire and train skilled staff to maintain the high standard they have set in the management areas. In the meantime, AATC has observed some challenges in attracting staff with certain skillsets in a competitive market.

In the QBR process, AATC trains up the leadership and the expanded staff to achieve shared goals and common understanding of the KPIs throughout the company.

KEY TAKEAWAYS

- Develop a robust team with consultant support to improve the management practices.

- Leverage trainings through QBR and the technical operating and management systems.

KEY SKILLS TO SUPPORT INTEGRATION

- Process improvement

- Asset management

- Data analytics

POLICY & AGENCY STRUCTURE

AATC has a well-defined organizational chart with specific staff assigned to each management area. During the integration process, three integration champions were identified in AATC to represent the three management areas. In AATC, asset, risk and performance are managed in the project Quality Management System (QMS). The 3 areas are structured separately and reside in the same centralized QMS.

AATC has established common objectives, policies and procedures across the company. Well-documented policy directives are published as part of the ISO-9001 and ISO-55001.

AGENCY HIGHLIGHTS

- ☑ **The agency has identified an integration champion**
- ☑ **Agency structure has been modified to support management area integration**
- ☑ **Agency policy has been modified to support management area integration**
- ☐ Innovation in management practices has been identified as a priority for agency leadership

RESOURCE REQUIREMENTS

The budget for asset, performance and risk manage are combined at AATC. The company has put forth sufficient funding to support the integration of the management areas and is looking to assign a full-time person to manage the certification in the future. The ISO-55001 certificate covers areas of risk, performance and business continuity beside asset management, and the company has already seen tangible return on investment.

AATC leverage intense trainings to make sure everyone in the organization understand the goals and are on board. There is a robust communication plan, in which QBR is used as one of the communication channels. AATC also posts goals and copies of the Strategic Asset Management Plan in various areas in their offices. Upper management encourages staff to expose to trainings and credentialing including Institute of Asset Management training courses, Certified Facility Manager and Certified Reliability Leader certification, and other related opportunities.

RESOURCE ALLOCATION HIGHLIGHTS

- ☑ **The budgets for asset, performance, and risk management are combined**
- ☑ **The agency has established funding specifically to support management area integration**
- ☑ **The agency has developed flexible programming plans to account for variations in available funding**
- ☑ **The agency has established support from executive leadership and/or legislators for integration**

NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	ASFiNAG	**AMP Date:**	2017
Location:	Austria	**PMP Date:**	NA
Sector:	Transportation	**RMP Date:**	NA
Contact Title/Dept.:	Managing Director		

OVERVIEW

The Autobahn and Highway Financing Stock Corporation (ASFiNAG) as an Austrian publicly-owned corporation which oversees the planning, financing, construction, maintenance, and toll-collection of Austrian autobahns. This includes approximately 1,720 km of roadway, leading to toll collections of over 1.2 billion euros annually. Though a large portion of funds go directly towards the maintenance of existing roadways, the company obligates much of their annual funds towards the construction of new portions of roadway as they move to expand their network and provide more robust connections around the nation.

LEVEL OF INTEGRATION

☐ High

☐ Moderate

☑ Low

☐ None

INTEGRATED PRACTICES

☑ **Asset Management**

☑ **Performance Mgmt.**

☑ **Risk Management**

APPROACHES TO INTEGRATION

ASFiNAG has identified the need to advance their asset management practices, integrating performance and risk considerations into their decision-making processes. The agency currently has some performance-based metrics already integrated, into their asset management program, such as traffic safety, impacts of construction zones, and levels of congestion. Additionally, they are working to complement these practices with additional considerations of risk at the enterprise and project levels, using frameworks developed by PIARC to support decision-making. This works to support greater efficiencies and effectiveness in agency programming of limited funds over a broad, disperse network, spanning the entirety of Austria. Additionally, project-level risk considerations provide a basis for prioritization of treatments in terms of economic and service impacts, often times helping to distinguish projects which are competing for funds.

INTEGRATION HIGHLIGHTS

- Some performance-based metrics currently integrated into their asset management practices.

- Some integration of risk at the enterprise and project levels to support decision-making and project prioritization.

- Use of PIARC risk management frameworks.

DATA NEEDS

ASFiNAG internally maintains data on a broad variety of asset classes. In particular, their data on pavement, bridges, tunnels, noise and retaining walls, and gantries is well-kept and robust. However, some more minor asset classes, such as restraint systems, safety infrastructure, and buildings, are not as robust and are currently developing in order to catch-up with the major assets.

Additionally, ASFiNAG is utilizing other data to support their management processes as well as the integration of these processes. They are considering such data sets as congestion hours, lane-kilometers influenced by construction sites over time, measures of pavement performance such as their road safety index, frequencies and rates of crashes, and average daily traffic. These data help to further illuminate the unique needs of various assets, their relative performance, and potential risks on the project and enterprise levels.

KEY DATA NEEDS

- Key asset classes such as pavement, bridges and tunnels.

- Ancillary asset classes are not as robust and are continuously being improved.

- Supplementary data related to roadway performance and safety also support agency efforts.

PERSONNEL & SKILLS

Currently, ASFiNAG has four staff partially assigned to asset management. This small level of staffing poses some challenges to their program as they look forward to pursuing more robust integration. The agency recognizes the importance of developing staff and enterprise experience in their asset management practices. Because asset management for bridges and pavement have the longest history of over 20 years, they are the most deeply developed. Meanwhile, other practices continue to develop, covering other aspects of the asset management process. Because staff turnover is inevitable, it is important to retain knowledge and to continue the momentum of practice development to avoid slow-downs.

KEY PERSONNEL TO SUPPORT INTEGRATION

- ASFiNAG currently has four staff working on asset management.

KEY SKILLS TO SUPPORT INTEGRATION

- Staff experience and institutional knowledge is key to providing robust management practices.

- Knowledge retention is important to maintain agency momentum.

POLICY & AGENCY STRUCTURE

ASFiNAG is taking steps to integrate risk management into their asset management practices. For the first step of this process, the agency is defining a simple risk management system and structure which would be most appropriate for their needs and limitations. Next, they are providing a training program according to the outcomes of the PIARC workgroup for dissemination and education, providing support for key staff and further developing the risk management system. Once this is complete, ASFiNAG will evaluate the system, engaging agency executives to review its benefits and effectiveness, for potentially further investment and integration within the agency's policy and structure.

AGENCY HIGHLIGHTS

☐ The agency has identified an integration champion

☐ Agency structure has been modified to support management area integration

☒ **Agency policy has been modified to support management area integration**

☐ Innovation in management practices has been identified as a priority for agency leadership

RESOURCE REQUIREMENTS

To have success in integrating performance and risk into their asset management practices, ASFiNAG has identified executive buy-in as a key resource. Because such integration requires modifications to a broad variety of agency practices, it is important to have the support of executive leadership throughout the course of the integration, influencing policy, structure, and resource allocation. Additionally, evaluation of integrated practices provide the opportunity to share results with agency executives and stakeholders, potentially influencing future levels of investment.

Because funding remains a consistent limiting factor for ASFiNAG as it does for most similar agencies, it is important that the asset management staff is able to identify opportunities for improved efficiency in the short- and long-term. Integration of asset, performance, and risk management helps to achieve this, potentially making ASFiNAG's budget go further each year.

RESOURCE ALLOCATION HIGHLIGHTS

☐ The budgets for asset, performance, and risk management are combined

☐ The agency has established funding specifically to support management area integration

☐ The agency has developed flexible programming plans to account for variations in available funding

☒ **The agency has established support from executive leadership and/or legislators for integration**

NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Caltrans	AMP Date:	2015-2020
Location:	California, United States	PMP Date:	2015-2020
Sector:	Transportation	RMP Date:	NA
Contact Title/Dept.:	State Asset Management Engineer		

OVERVIEW

The California Department of Transportation (Caltrans) has gone beyond the FHWA required TAMP to produce a more detailed and strategic State Highway System Management plan. This plan introduces vulnerabilities in a performance-based framework at a district level. In addition, Caltrans has rolled out a State Highway Operation and Protection Program (SHOPP) 10-year Project Book that "will undertake the most ambitious highway repair program the state has seen in generations." This project book is an extension of the Transportation Asset Management Plan (TAMP) and will detail the projects needed to restore the State Highway System to meet performance requirements of the Road Repair and Accountability Act of 2017 (SB-1).

LEVEL OF INTEGRATION
- ☑ **High**
- ☐ Moderate
- ☐ Low
- ☐ None

INTEGRATED PRACTICES
- ☑ **Asset Management**
- ☑ **Performance Mgmt.**
- ☐ Risk Management

APPROACHES TO INTEGRATION

Currently, Caltrans is working with its 12 districts to meet 34 performance objectives based on SHOPP. Caltrans has organized these 34 objectives by the strategic plan of the agency, that are addressed at the district level. By doing this, the agency can create fiscally constrained investments, that rely on funding based on performance gaps. With the help of a custom created trade off tool, each district receives a single lump sum budget to meet statewide goals such as safety, deficiencies, vulnerabilities, performance, etc. Instead of funding individual asset classes, Caltrans funds districts in a manner that allows for project development in support of the agency's overall objectives. As projects are developed and executed, four performance snapshots are taken to track performance objectives against agency goals; pre-planning, post-planning, award of the project, and construction close out.

In addition, California has recently passed a gas tax that resulted in an increase in funding that will meet 100% of funding gaps for pavement, some other asset classes are still under funded. Each district has their own model for pavement, all other assets use statewide deterioration models.

With the size of California, Caltrans must prepare for risks that typically can cost up to $350 million annually. To prepare for this, money is held at a statewide level from district allocations that is then distributed to districts as emergencies occur. Currently, Caltrans is completing vulnerability assessments for districts, as well as planning for climate change and sea-level rise.

INTEGRATION HIGHLIGHTS
- SHOPP
- Flexible approach to funding

INTEGRATION MEASURES
- Safety & Asset Management
- Mobility & Asset Management
- Operational & Asset Management

DATA NEEDS

The implementation of these programs has required extensive training to avoid data limitations due to consistency and accuracy. In addition, Caltrans is working to secure funding towards an enterprise asset management software system. The system will be GIS centric and will help staff understand where critical assets are and help with project visualization. Caltrans is also looking at risk management and will be conducting state-funded research to develop a department wide vulnerability/likelihood/system impact risk profiling process to inform better decision making across all vulnerabilities

KEY DATA NEEDS
- Heat maps at district level

PERSONNEL & SKILLS

Caltrans conducted an extensive business process mapping exercise in order to determine how the agency would implement a performance-based allocation program. The exercise is supported by the State of California and allowed the agency to understand the methods and processes used to allocate funding in the past and how those methods and processes may need to change in order to move towards a performance-based allocation program. The review also revealed the need for additional staff to meet the changing needs of the agency.

Across the 12 districts, Caltrans has seen an increase in staffing. To increase the asset management program, some districts have added district-level asset managers. In order to ensure the accuracy of Caltrans data, there has been extensive training as well as staff and program expansion.

KEY PERSONNEL TO SUPPORT INTEGRATION
- Additional staff

KEY SKILLS TO SUPPORT INTEGRATION
- Extensive training

POLICY & AGENCY STRUCTURE
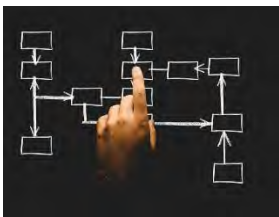
Caltrans is made up of 12 districts who report to the central agency. Each district has a set budget that is allocated for five years and updated every other year. Every other year, there is a goal constrained needs assessment that is used to create a report for the governor and legislature to show the unfunded liability. Caltrans uses transportation system equity to make sure that all districts are meeting their required performance targets. This pushes responsibilities to district directors, who then must address how many of the 34 metrics have improved between each period.

AGENCY HIGHLIGHTS

☑ **The agency has identified an integration champion**

☑ **Agency structure has been modified to support management area integration**

☑ **Agency policy has been modified to support management area integration**

☑ **Innovation in management practices has been identified as a priority for agency leadership**

RESOURCE REQUIREMENTS

In order to secure the funding needed to meet agency objectives, a gas tax was passed based on the State Highway System Management Plan. The funding is permanent and provides Caltrans with the means to close the gaps. The tax covers half of the agency needs and is allocated for core assets such as pavement, bridges, culverts and transportation asset management system elements, that are all funded at 100%.

RESOURCE ALLOCATION HIGHLIGHTS

☑ **The budgets for asset, performance, and risk management are combined**

☐ The agency has established funding specifically to support management area integration

☑ **The agency has developed flexible programming plans to account for variations in available funding**

☑ **The agency has established support from executive leadership and/or legislators for integration**
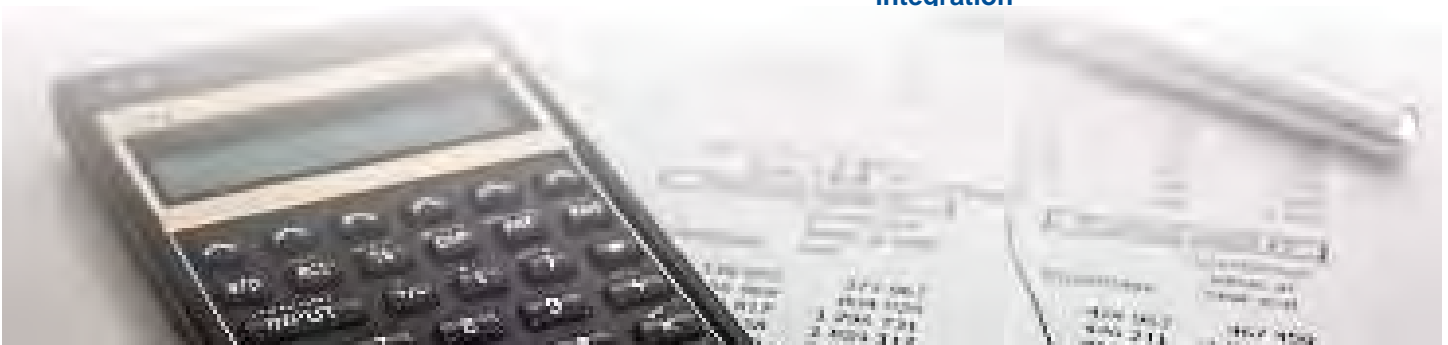
NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Colorado Department of Transportation	AMP Date:	2013
Location:	Colorado, United States	PMP Date:	NA
Sector:	Transportation	RMP Date:	2013
Contact Title/Dept.:	Performance and Asset Management Branch Manager		

OVERVIEW

The goal of the Colorado Department of Transportation's asset management program is to "minimize life-cycle costs for managing and maintaining the departments assets subject to acceptable levels of risk." The four primary areas of focus include safety, infrastructure condition, system performance, and maintenance. Currently, the agency is integrating the threat of geologic hazards to the transportation system by developing a risk-based geohazards management system. In addition, the agency has invested in risk assessment at the individual asset level through a pilot study of I-70 that built upon a process utilized in the recovery process of the 2013 flood event that resulted in over $750 million of damage and repair and a $10 million rockfall event in 2016 on the I-70 corridor.

LEVEL OF INTEGRATION

☐ High

☑ **Moderate**

☐ Low

☐ None

INTEGRATED PRACTICES

☑ **Asset Management**

☑ **Performance Mgmt.**

☑ **Risk Management**

APPROACHES TO INTEGRATION

CDOT is working to integrate a risk-based performance metric to demonstrate and obtain asset-management funding and select projects for the geohazard program. In addition, this process will include event tracking, risk mitigation and geohazards monitoring as well as maintaining a recognized emergency response group.

CDOT's Risk-Based Transportation Asset Management Plan has multiple goals (safety, asset condition, travel time reliability, etc.) and the agency has recognized a range of threats that can undermine these goals. In the geotechnical asset management area, research is underway to visualize these risks and impact to performance goals in a cubic form which allows for recognition of multiple threats, how to address these threats, how best to communicate these decisions to others. In an example of risk-based geotechnical asset management done by the TRB, risk analysis at CDOT includes, "qualitative and quantitative approaches in accordance with data availability. The quantitative estimate of risk is expressed in terms of exposure cost for all assets, risk types and performance goals and then used by CDOT subject matter experts for project selection and planning.

In the future, CDOT is planning to increase confidence in threat likelihood through remote sensing and other data-drive decision-making methods. Also, the agency would like to determine how geohazard threats affect the total risk to assets such as pavement, bridges, etc.

INTEGRATION HIGHLIGHTS

- Risk-based performance metric
- Emergency-response group
- Event tracking, risk mitigation, geohazards monitoring

INTEGRATION MEASURES

- Geohazard risk to traditional performance goals (safety, asset condition, etc.)
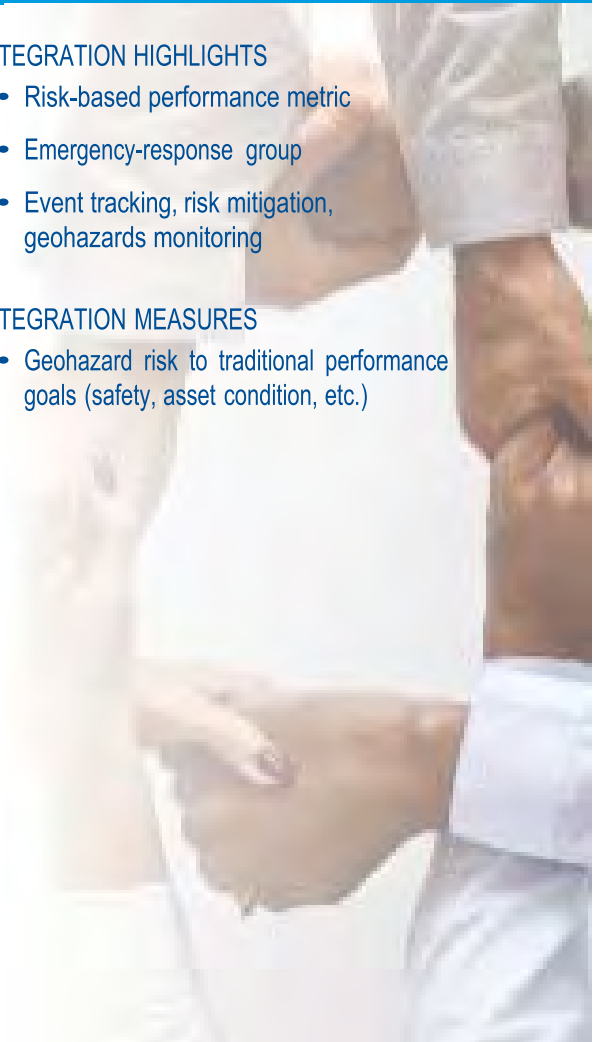
DATA NEEDS

The geohazards asset management program has established a risk-based geohazards performance metric that has been helpful in supporting investment by the agency to reduce risk from geohazards. To further support the use of the metric, CDOT is working to improve acquisition management and data visualization to improve management buy-in of the relatively new geotechnical asset management program. The additional data and visualization tools will improve the confidence in the prediction of future geohazards that will further support estimations of anticipated losses to highway assets and impacts to the traveling public.

CDOT relies on their Bridge program to collect project data (including cost information) that is federally required to make business decisions. The bridge program has established an asset management team to address data governance, including the development of governance documents such as the bridge design manual, ratings manual, inspection guidelines and manuals, structures management manual, etc. CDOT has an inspection program that relates all assets to each other for example, several asset programs (culverts, tunnels, walls, signs and signals) are based on their bridge inspection program, allowing the agency to use consistent grading assessments across structural asset programs.

KEY DATA NEEDS
- CDOT Bridge Program

PERSONNEL & SKILLS

The Geotechnical asset management is a relatively new asset management area in CDOT and one of the challenges faced was staff knowledge on the risks associated with geohazards across the state, prediction of future threats, and how to quantify those risks to align geohazards with other more traditional asset programs such as pavements and bridges. In addition, given the geotechnical asset management program is such a new program, efforts are still developing to measure the effectiveness of the program within the agency.

KEY PERSONNEL TO SUPPORT INTEGRATION
- Maintenance
- Data Management

KEY SKILLS TO SUPPORT INTEGRATION
- Data Collection
- Knowledge of geohazard modeling

POLICY & AGENCY STRUCTURE
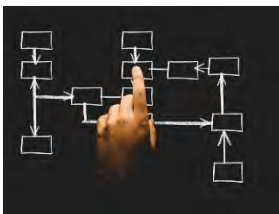
CDOT has an established Delphi process that engages all of the asset management programs annually to determine funding needs across the identified asset areas based on specificperformancegoals. According to CDOT's Risk-Based Asset Management Plan, using the Delphi consensus building technique, "CDOT brings together asset managers, budget staff, senior management, and region staff for a workshop to develop the staff recommendations on the asset management budgets for the upcoming fiscal year."

CDOT is also moving towards and utilizing a multi-objective decision analysis (MODA) process for project prioritization. This approach assists with funding allocation – which directs the agency towards optimal investment across the range of asset areas in support of the agency's overall strategic objectives. MODA Is currently being using by multiple asset types and will be used to initiate cross asset prioritization.

AGENCY HIGHLIGHTS
☐ The agency has identified an integration champion

☑ **Agency structure has been modified to support management area integration**

☑ **Agency policy has been modified to support management area integration**

☑ **Innovation in management practices has been identified as a priority for agency leadership**

RESOURCE REQUIREMENTS

One area of improvement that CDOT Staff Bridge noted would be additional federal standards established in for less tracked asset classes in areas such as risk, target-setting, life-cycle analysis, asset management plans to provide guidance for states while allowing for flexibility in application.

RESOURCE ALLOCATION HIGHLIGHTS

☑ **The budgets for asset, performance, and risk management are combined**

☑ **The agency has established funding specifically to support management area integration**

☐ The agency has developed flexible programming plans to account for variations in available funding

☑ **The agency has established support from executive leadership and/or legislators for integration**
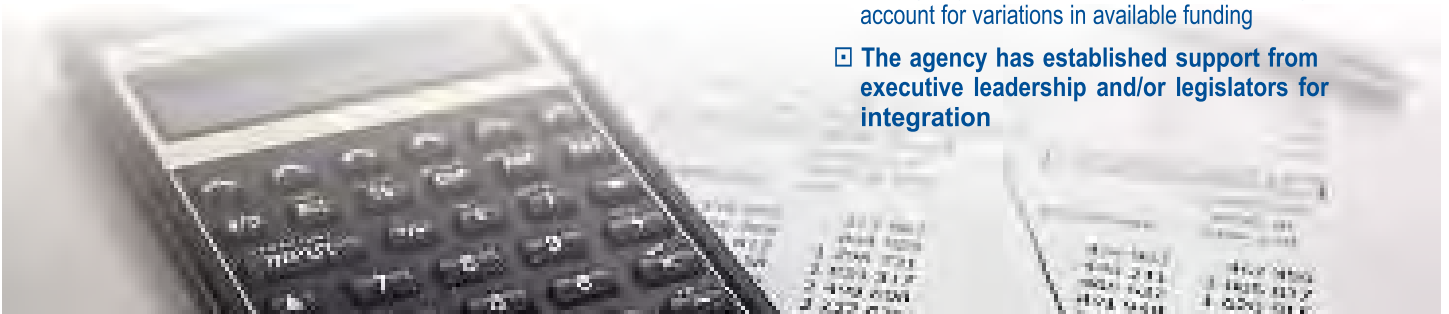
NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Greater Cincinnati Water Works	AMP Date:	NA
Location:	Cincinnati, OH	PMP Date:	NA
Sector:	Water	RMP Date:	NA
Contact Title/Dept.:	Client Relationship Management (Jacobs)		

OVERVIEW

Greater Cincinnati Water Works (GCWW) is a municipally owned utility providing supply of water and supporting environmental sustainability. According to Critical Business Analysis, "GCWW supplies more than 48 billion gallons of water a year through 3,000 miles of water mains to about 235,000 residential and commercial accounts." The service area now includes the City of Cincinnati, a majority of Hamilton County and parts of Butler and Warren Counties. In 2003, GCWW installed a pipeline under the Ohio River and expanded service to Boone County and Florence, Kentucky.

LEVEL OF INTEGRATION
- ☐ **High**
- ☑ **Moderate**
- ☐ **Low**
- ☐ **None**

INTEGRATED PRACTICES
- ☑ **Asset Management**
- ☑ **Performance Mgmt.**
- ☑ **Risk Management**

APPROACHES TO INTEGRATION

Within GCWW, different divisions including maintenance, operation, IT and data work together for the overall management of utility. Guidelines and reporting systems are setup for utilities of different divisions and they are responsible for all asset in their area of responsibility. The decision-making process is clearly defined. A capital plan is developed and managed by the Capital Improvement Plan (CIP) committee. CIP committee evaluate business cases and risks associated and then forward onto division heads for approval or clarification. Each business case has a description of problem statement, prepared solutions, alternative solutions, and risk score which is a scale of up to 25 of the condition and consequences all together numerical value for each project. Public surveys for performance management are conducted every two years and received very favorable results.

INTEGRATION HIGHLIGHTS
- Collaborative effort of investment decision-making.
- Alignment of asset and risk management.
- Asset managed by each division.
- Use of customer satisfaction survey.

DATA NEEDS

Data sets are standard per group per asset within GCWW and all data sets are managed internally. Technicians and maintenance supervisors manage and utilize the detailed source data in their system. Though some data is still managed manually, most of the data sets are in electronic format and GCWW is improving the data management approach.

Each division is responsible for their data sources and CIP committee use the dame data to make project decisions. There is a well-established process to evaluate capital projects, whether needing replacement or new assets. Data analysis is also performed to determine strategy. GCWW is currently hiring an asset management director and working to improve the organization and documentation of processes and procedures.

GCWW developed a risk score tool and has been using it for over 5 years to support decision-making. The tool takes into consideration the asset condition, probability of failure, urgency, criticality, etc. The risk score can be a key differentiator when there are multiple projects with the same cost.

DATA HIGHLIGHTS
- Data is owned and managed by each division responsible for the assets; data is shared across the agency.
- Robust data-driven risk analysis supports decision-making.

PERSONNEL & SKILLS

GCWW primarily performs technical practices and decision-making in house and uses external services only as a supporting option if needed. GCWW appreciates staff with utility background who know about the assets they are responsible for. At the same time, GCWW notices the increasing usage of computers and mobile devices especially in the distribution areas. The agency recognizes that the new generations is more IT oriented and GCWW is transitioning to hire more business analysts or analytical type of people.

It is also important to GCWW to hire and train staff with skills in the utility space. There is a rotation program for new hire to immerse in different divisions in the first couple of days before they settle into any specific division.

GCWW has experienced some challenges with staff retention and knowledge transfer.

KEY SKILLS TO SUPPORT INTEGRATION

- Business analytics
- Industry knowledge

POLICY & AGENCY STRUCTURE
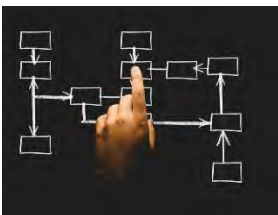
GCWW has established a steering committee which is formed with the heads and directors from all divisions. There is also a very new department for business architect to push new strategic business plan.

GWCC has developed and implemented a risk-based asset management practice with performance management processes managed by each division. The departments have the expertise to take care of their assets. Ad-hoc analysis of all of the performance reviews showed a reduction of leak and break on the operations and maintenance side. Around 90% of the work orders are currently non-reactive and only 10% of the work orders are reactive.

Though there is no one specifically responsible for asset management, the agency has identified in the 5-year strategic business plan that it is critical to have an asset management director on board. With the addition of the asset management department, GCWW will be able to improve the agency structure and asset management line of sight to better achieve their organizational objectives.

AGENCY HIGHLIGHTS

- ☐ The agency has identified an integration champion
- ☒ **Agency structure has been modified to support management area integration**
- ☐ Agency policy has been modified to support management area integration
- ☐ Innovation in management practices has been identified as a priority for agency leadership

RESOURCE REQUIREMENTS

Within GCWW, the funding and staffing for each management areas are not separate. Prioritization and decision-making is performed across the board to achieve highest benefit or return.

GCWW recognizes that some improvements are needed in this area. Human resource is one of the highest priorities to address the challenges. With limited revenue budget, the agency manages to balance the various critical projects. With limited staffing resources, the agency is looking to perform business process reengineering to improve efficiency and effectiveness.

RESOURCE ALLOCATION HIGHLIGHTS

- ☒ **The budgets for asset, performance, and risk management are combined**
- ☐ The agency has established funding specifically to support management area integration
- ☒ **The agency has developed flexible programming plans to account for variations in available funding**
- ☐ The agency has established support from executive leadership and/or legislators for integration

NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Highways England	AMP Date:	2017
Location:	England, United Kingdom	PMP Date:	NA
Sector:	Transportation	RMP Date:	NA
Contact Title/Dept.:	Consultant (Jacobs), Asset Management		

OVERVIEW

Highways England is the government-owned company in charge of operating, maintaining, and improving the motorways and major A roads of England, known as the strategic road network (SRN). The SRN includes over 4,000 miles of paved roadways as well as a broad variety of structures and ancillary assets. The roads of the SRN make up only approximately 2% of England's total roadway network, however they carry about one third of all of England's motor vehicle traffic.

LEVEL OF INTEGRATION

☐ High
☑ **Moderate**
☐ Low
☐ None

INTEGRATED PRACTICES

☑ **Asset Management**
☑ **Performance Mgmt.**
☑ **Risk Management**

APPROACHES TO INTEGRATION

Within Highways England, the Asset Management division oversees major projects, maintenance, and support activities and planning. The division includes a cross-functional group which intentionally incorporates cross-discipline considerations into decision-making. Additionally, they have developed a Road Investment Strategy, monitoring key performance indicators such as safe journeys, customer satisfaction, environmental performance, and network condition. In this manner, asset management serves as an umbrella, with risk and performance management practices being fed into the larger operations of the team. The ISO 55000 standard is used to support these practices.

Highways England recognizes that risk is ubiquitous and needs to be considered, mitigated, and acted upon in all levels of asset management, and have therefore are working to fully deploy a risk-based approach to asset management on the national level.

INTEGRATION HIGHLIGHTS

- Development of Road Investment Strategy Document.
- Full alignment of asset and risk management.
- Application of ISO 55000 standard.
- Use of a broad variety of KPIs, including environmental impact and customer satisfaction and safety.

DATA NEEDS

Different practices within Highways England are responsible for a variety of data sources, however most are housed in a common repository. Though some elements are more actively maintained and monitored than others, there are standards for common referencing which are well-established, improving compatibility. Though there is no overarching data management system, the agency is exploring options for achieving this.

Robust data and information systems are a major requirement for the effective integration of management practices. This has at times been a challenge for Highways England due to limitations in available data and modeling procedures for determining asset deterioration and financial forecasting. This is important to support dynamic, forward-looking decision-making. Additionally, for agencies such as Highways England which are working to modernize their asset management practices, inconsistent or incomplete historic data can be a challenge as data acquisition and management practices catch-up with the asset management program.

KEY DATA NEEDS

- Institutionalized data governance practices are key to maintaining consistent, quality data.
- Asset condition and other modeling methods are beneficial for dynamic decision-making.

PERSONNEL & SKILLS

Highways England primarily insources their technical practices and decision-making, though previously they commonly used external services to support this. This has been decided to create a smarter agency with more comprehensive skills and insights to provide a more sustainable practice. This change has presented challenges along the way, though it is expected to pay-off in the long-term.

It is also important to Highways England to hire and train multi-skilled staff to allow for cross-cutting practices for improved efficiency and effectiveness of asset management programs. Specifically, staff with experience in both engineering and finance, as well as modern technology and autonomous and connected vehicle systems will be important moving forward.

The agency has experienced some staff retention, recruiting, and training difficulties due to resource scarcity and competition with other organizations.

KEY TAKEAWAYS
- Internal technical experts support sustainable practices without the need for outsourcing.
- Multi-skilled staff improve effectiveness of asset management programs.

KEY SKILLS TO SUPPORT INTEGRATION
- The marriage of engineering and finance.
- Data management, visualization.
- Modern technology systems.

POLICY & AGENCY STRUCTURE

Highways England has established common objectives across different departments which cascade throughout the organization. They have worked to develop a platform which encourages and incentivizes their staff to think and behave creatively, and to break through walls between practices to serve the greater good of their road users and the general public. This structure of constructive challenge is largely cultural, stemming from effective leadership throughout the organization working to create a cohesive, innovative, and cooperative environment.

Due to a number of contributing factors, Highways England has encountered some difficulty in establishing a system-based, forward-looking mindset among some specific practices, within their asset management group and adjacent groups. As they work to address these factors and pursue the guidance outlined in their Road Investment Strategy, they hope to expand the vision of their agency for longer-term planning and consideration, allowing for greater efficiency and improved customer experience.

AGENCY HIGHLIGHTS
- ☐ The agency has identified an integration champion
- ☐ Agency structure has been modified to support management area integration
- ☑ **Agency policy has been modified to support management area integration**
- ☑ **Innovation in management practices has been identified as a priority for agency leadership**

RESOURCE REQUIREMENTS

With risk and performance considerations being fed into the existing asset management group, Highways England is able to achieve efficiencies in use of resources which would be difficult for less holistically-thinking agencies. However, as with all comparable agencies, scarcity of resources at times limits the capability and capacity of the agency to pursue systemic changes. Because they are such a large company, they face many competing interests and initiatives. This can sometimes limit the level of resources that they are able to acquire to support integration efforts. Additionally, the size of their network can mean that efforts to develop data can be financially cumbersome, and that implementation of new policies and initiatives can take a great deal of time. In order to address such issues, Highways England hopes to more broadly implement modern technology to monitor assets, automate data collection, and produce dynamic interfaces to improve agency efficiency with asset management practices, making room for more innovative approaches and strategies.

RESOURCE ALLOCATION HIGHLIGHTS
- ☑ **The budgets for asset, performance, and risk management are combined**
- ☐ The agency has established funding specifically to support management area integration
- ☑ **The agency has developed flexible programming plans to account for variations in available funding**
- ☑ **The agency has established support from executive leadership and/or legislators for integration**
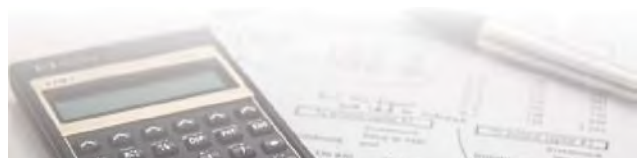
NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Minnesota DOT (MnDOT)	**AMP Date:**	2014
Location:	Minnesota, United States	**PMP Date:**	2017
Sector:	Transportation	**RMP Date:**	NA
Contact Title/Dept.:	Assistant Commissioner, Modal Planning and Program Management		

OVERVIEW

Made a formal part of the business process in 2003, the Minnesota Department of Transportation (MnDOT) has been managing its transportation assets using a performance-based approach since the mid-1990s.

This approach relies on performance measures to assess system performance, identify needs and develop investment priorities.

LEVEL OF INTEGRATION
- ☐ High
- ☒ **Moderate**
- ☐ Low
- ☐ None

INTEGRATED PRACTICES
- ☒ **Asset Management**
- ☒ **Performance Mgmt.**
- ☐ Risk Management

APPROACHES TO INTEGRATION

Based on the understanding of transportation as a means to other ends, and not an end itself, MNDOT launched the Minnesota GO visioning process. This has allowed the department to better align their transportation system with what residents expect for their quality of natural environment, economy, and life.

MnDOT's approach to developing the Transportation Asset Management Plan as part of a family of investment plans has been its most complete integration of performance, risk and asset management. MnDOT has been incorporating risk into the agency's functional areas, including capital and highway operations planning and business planning, aided by their understanding of the value of accounting for and managing risk. The Minnesota 20-year State Highway Investment Plan, published in 2013, fully incorporated risk assessment and played a prominent role during its development. MnDOT also produced an Enterprise Risk Management Framework and Guidance document in 2013, which "establishes the standards, processes and accountability structure used to identify, assess, prioritize and manage key risk exposures across the agency." Risk also factors into the most recent Statewide Highway Systems Operation Plan (HSOP), where it influences tradeoff discussions and funding prioritization.

MnDOT has struggled is to think about risks globally, and think about cross-asset risk. It has been easier to think about risks within a single asset class, but broader risks are not well addressed. For example, MnDOT has been challenged to think about risks to operations, public health and broader outcomes.

That said, MnDOT is moving in the right direction. Performance targets may be thought of as an "acceptable" level of risk. As part of the development of MnDOT's 10 year plan, central office has been asking districts about risks they aren't able to mitigate, and rebalancing funding in response.

MnDOT's web-based performance dashboard communicates risks to meeting performance targets. With this information, staff are able to tie risk back to MnDOT's decision making process. Right now MnDOT often looks at risk while considering cross-asset tradeoff levels (e.g., what level of performance will MnDOT see in various assets—informed by risk-informed targets).

MnDOT has not yet integrated in an clear documented way how risk can be integrated into the project selection process. MnDOT thinks about risk management in planning and project development process, but to the same extent in programming.

INTEGRATION HIGHLIGHTS

- Transportation Asset Management Plan, State Highway Investment Plan, and Highway System Operations Plan together incorporate risk into capital and operations planning

- Cross-program tradeoffs are another point of integration in multiple plans

INTEGRATION MEASURES

The Minnesota 20-year State Highway Investment Plan (MnSHIP) identifies key capital investment risks, one of which is "misalignment with Vision and Statewide Multimodal Transportation Plan." The risk assessment considers how well the risks are mitigated via the strategies outlined in the plan. Other risk measures address loss of public trust in the agency and the ability of MnDOT's investments to support local economic development and quality of life opportunities.

DATA NEEDS

MnDOT fairly recently acquired data that will be used to monitor performance across a broad range of measures. The agency will need some time to look at trends in data, and the intelligence gained from that analysis will influence decisions.

MnDOT has been involved in the question of how to use data to implement performance management for more than 15 years. MnDOT's first Data Business Plan gave the agency focus, addressing structure, process, and overall understanding of what information the agency has and what MnDOT needs to make better decisions. The Data Business Plan and data governance in general have given MnDOT structure to ensure focused data management. MnDOT views data as an asset. Today, MnDOT's data governance structure includes data stewards, and there is are lead.

Nevertheless, MnDOT has a long way to go in understanding what data exist and what data are needed. Data needs should be driven by performance, and include risk management/risk assessment considerations.

KEY DATA FINDINGS
- Data Business Plan address structure and decision-making process.
- Recent advances in analytical capabilities will help improve business intelligence.

PERSONNEL & SKILLS

MnDOT is moving away from job descriptions such as "technician." To support data governance MnDOT has started to look at more tailored job descriptions such as "data librarians" and "data stewards."

That said, replicating a position in 8 districs is difficult. MnDOT faces challenges identifying staff in all 8 districts that fill common needs related to data management, risk management and performance management.

KEY PERSONNEL TO SUPPORT INTEGRATION
- Data librarians
- Data stewards
- Senior staff

KEY SKILLS TO SUPPORT INTEGRATION
- Data modeling
- Familiarity with analysis tools
- Expertise in GIS and geospatial analysis

POLICY & AGENCY STRUCTURE
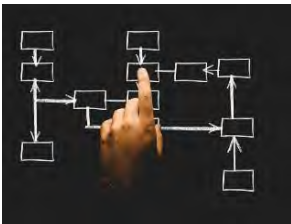
MnDOT has an Asset Management Office to lead development of the Transportation Asset Management Plan (TAMP). The Asset Management Office is responsible for coordianting across MnDOT, including District Offices, to compile data needed to complete the TAMP, including data to support risk assessments.

Increasingly, MnDOT is moving toward shared services within District offices. By sharing resouces across silos and making job descriptions more flexible, MnDOT is able to find people with the skill sets needed to manage a combination of performance, assets, and risk.

AGENCY HIGHLIGHTS
☐ The agency has identified an integration champion

☒ **Agency structure has been modified to support management area integration**

☐ Agency policy has been modified to support management area integration

☒ **Innovation in management practices has been identified as a priority for agency leadership**

RESOURCE REQUIREMENTS

MnDOT has been implementing performance management for decades. Thus, there are not discrete resources allocated to performance, risk, and asset management. MnDOT has not identified specific resource requirements for integrating performance, risk, and asset management, other than the general need to hire staff who can understand the relationships between the three concepts.

RESOURCE ALLOCATION HIGHLIGHTS

☐ The budgets for asset, performance, and risk management are combined

☐ The agency has established funding specifically to support management area integration

☑ **The agency has developed flexible programming plans to account for variations in available funding**

☑ **The agency has established support from executive leadership and/or legislators for integration**
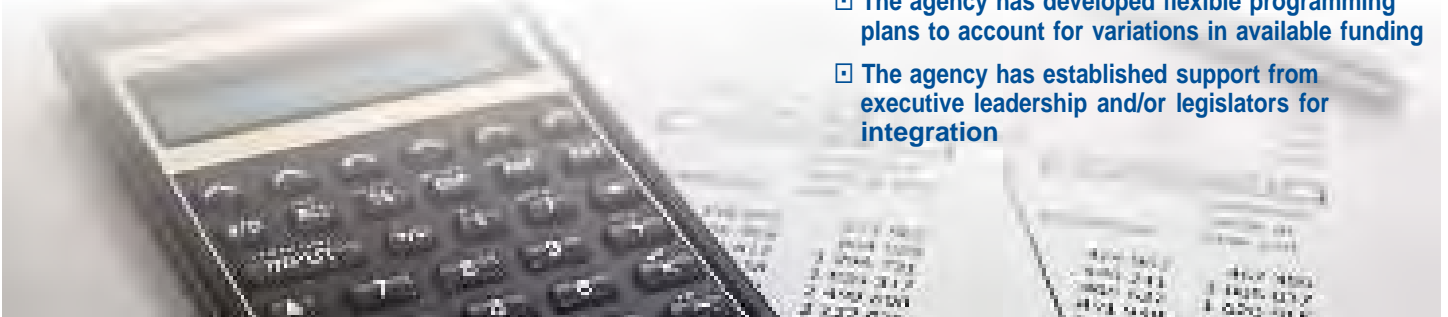
NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	SDOT	**AMP Date:**	NA
Location:	Seattle, WA	**PMP Date:**	NA
Sector:	Transportation	**RMP Date:**	NA
Contact Title/Dept.:	Asset Management Program Manager		

OVERVIEW

The Seattle Department of Transportation (SDOT) is a municipal government agency in Seattle, Washington that is responsible for the maintenance of the city's transportation systems, including roads, bridges, and public transportation. The agency is funded primarily by taxes that are supplemented by voter-approved levies from other sources.

LEVEL OF INTEGRATION

- ☒ **High**
- ☐ Moderate
- ☐ Low
- ☐ None

INTEGRATED PRACTICES

- ☒ **Asset Management**
- ☒ **Performance Mgmt.**
- ☐ Risk Management

APPROACHES TO INTEGRATION

Within SDOT, asset management and performance management teams reside in the same office directed by the Asset Management Program Manager. With the combined team, SDOT has been collecting comprehensive data for new projects, and conducted asset condition assessment for current assets. The visualized asset and performance dashboards help improve political and public support in allocating budget to where needed. Asset management team has also been acting as an internal consultant team to help other divisions with a long-term strategic view.

SDOT is looking forward to setting up a risk management team in the near future. Currently, a series of workshops with senior management teams to discuss risks from all departments, and enterprise risk, corporate risk and asset risk are the three main risks SDOT is facing.

INTEGRATION HIGHLIGHTS

- Highly collaborated asset and performance teams.
- Less number but more relevant measurements to stay focused.
- Condition assessment for current asset to help allocating budget.
- Served as internal consultant for other divisions to integrate the department.

DATA NEEDS

SDOT has an asset data repository to centralize data including new assets built, but different tools are used for different functions and different types of assets for better performance. Each asset owners are responsible to maintain the relevant data. SDOT recognizes the challenge to establish a centralized way to manage data in all assets. Five out of the 47 asset classes represent 95% of the overall value and resources are directed to maintain high competency of these five classes. These five high-value asset classes include arterial and non-arterial pavements, bridges, sidewalks and retaining walls.

A transparent public database which is regularly updated is available on the city website to monitor performance. SDOT has been using the datasets to develop prioritization tools which serve as reference guide to help engineers picking the right projects to invest in.

With a lot of achievement on data utilization within the department, risk data as well as cost data have been expected to be gathered in the future.

KEY DATA NEEDS

- Decentralized approach of gathering data.
- Different tools are used for different functions.
- Risk and financial cost data are going to be the next revolution.

PERSONNEL & SKILLS

The type of talents for Asset Management team needs are is the group of people with the knowledge of finance, economics and engineering together. The current Asset Management team is composed economists, engineers and an IT employee, while Performance Management team has data scientists and project managers.

Since SDOT is working on data collection, analysis and visualization, people with data analysis, data visualization and IT skills are in great needs. However, there is a challenge of getting and keeping young people with data and IT skills due to the competition with so many IT companies which dominate the market in Seattle.

KEY TAKEAWAYS
- Additional support from interns could be helpful for massive condition assessment.

KEY SKILLS TO SUPPORT INTEGRATION
- The marriage of engineering, finance and economics.
- Data management, visualization.
- Modern technology systems.

POLICY & AGENCY STRUCTURE

SDOT has both Asset Management and Performance Management teams managed by the same office and there is about 60% to 70% overlap between the two teams. Yet there is no real strategic direction on integrating the two areas of management with risk management. There is not a specific risk management team in the organization, but there is a legal group mainly responsible for legal risks.

The agency worked under the MAP-21 focused regulation and mandate to make sure compliance is achieved with improvements in the asset and performance management program. Transportation is general in a slow rolling industry, but this also force the agencies to grow asset management practice with federal support. Within SDOT, the asset management and performance management practices are been rolled out gradually in a business practice type of way.

AGENCY HIGHLIGHTS
- ☐ The agency has identified an integration champion
- ☐ Agency structure has been modified to support management area integration
- ☐ Agency policy has been modified to support management area integration
- ☐ Innovation in management practices has been identified as a priority for agency leadership

RESOURCE REQUIREMENTS

Within SDOT, there is sufficient budget for each management areas and SDOT believes there is still room for improvements. They have the privilege to accomplish a lot in the asset and performance management areas that their peer cities don't have a chance to do.

The agency recognizes the need for more people with IT skills and people understand economics and finance support better integration of the management areas. However, in the current economy and competitive market in Seattle, it is challenging to attract the top talent that the agency desires.

SDOT has also been pushing trainings throughout the team and would like to see if any higher education institutions would offer asset management degree in the future. In the meantime, Institute of Asset Management training and certificate is considered as a good resource.

While federal has pushed various peer exchange at state level, SDOT would like to have more formalized opportunities for local agency to communicate and collaborate.

RESOURCE ALLOCATION HIGHLIGHTS
- ☐ The budgets for asset, performance, and risk management are combined
- ☐ The agency has established funding specifically to support management area integration
- ☒ **The agency has developed flexible programming plans to account for variations in available funding**
- ☐ The agency has established support from executive leadership and/or legislators for integration

NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Transport Scotland	AMP Date:	2018
Location:	Scotland, United Kingdom	PMP Date:	NA
Sector:	Transportation	RMP Date:	NA
Contact Title/Dept.:	Consultant (Jacobs), Asset Management		

OVERVIEW

Transport Scotland is the national transportation agency for Scotland, formed in 2006. The agency, headquartered in Glasgow, oversees multiple sectors of transportation, including aviation, maritime, rail, and trunk roads. They are also responsible for managing Traffic Scotland, a service aimed to deliver safe and reliable trunk roads. As described in their 2018 Scottish Trunk Road Network Asset Management Strategy document, Transport Scotland maintains a variety of assets, including over 3,000 kilometers of roadways, 2,000 bridges, and many ancillary assets.

LEVEL OF INTEGRATION

☐ High
☒ **Moderate**
☐ Low
☐ None

INTEGRATED PRACTICES

☒ **Asset Management**
☒ **Performance Mgmt.**
☒ **Risk Management**

APPROACHES TO INTEGRATION

Since 2010, Transport Scotland has been working to integrate performance and risk management practices into their Asset Management branch, moving towards the ISO 55000 standard. Internal policy and documentation are being developed to institutionalize this effort and to create a structure to support their innovative vision. The agency uses a variety of key performance indicators to support their data-driven methods and employs asset condition models to perform financial forecasts. Over time, evaluations are conducted to ensure that such forecasts are producing expected results. Transport Scotland also utilize a complex risk register, which is reviewed annually, to inform their auditing processes.

Integration is currently most effective on higher-level assets, and, as policies and programming continue to evolve, it will begin permeating lower-level assets more completely as well.

INTEGRATION HIGHLIGHTS

- Moving towards ISO 55000.
- Use of financial forecasting with asset condition models.
- Use of annually reviewed risk register.
- Integration is primarily employed for high-level assets, working towards employment for all classes.

DATA NEEDS

Effective integration requires access to comprehensive, reliable, and up-to-date data sources for all asset classes. Transport Scotland performs its own pavement surveys to ensure quality data, though data on some ancillary assets is limited. Information on the performance of their roadways is sourced through Traffic Scotland, a service under the management of the agency.

Currently, Transport Scotland does not employ a robust data governance structure, with most data being managed by the branch responsible for collecting the data. This results in some inefficiencies and duplication of efforts, and will be a focus of the agency in the future, as they work to reform the system to achieve better data management and analytics through modern software tools and methods.

Transport Scotland has found great benefits in monitoring and reporting on the direct financial benefits of their innovative integrated management approaches, helping to bolster further evolution of their branch's practices.

KEY DATA NEEDS

- Condition data on all asset classes.
- Roadway performance metrics (traffic disruption, travel time reliability, etc.).
- Financial benefits of integration.

PERSONNEL & SKILLS

The Transport Scotland asset management branch makes extensive use of consultants to support their day-to-day efforts as well as to bring in specific packages of expertise and technical abilities to support management practices. The agency however works to ensure knowledge transfer takes place to support the development of such skills within their own agency staff, reducing the need to expedite certain tasks. There is no formal process in place to ensure that this takes place, however staff regularly achieve this through informal means.

Transport Scotland recognizes the importance of acquiring the right level of staff, ensuring a quality workforce which can support existing practices as well as the evolution of their practice. Not doing so can result in long-term negative impacts on the agency's performance and stagnation of program development.

KEY PERSONNEL TO SUPPORT INTEGRATION
- Consultants can provide valuable expertise.
- It is important to ensure knowledge transfer when outsourcing.
- Agencies must focus on quality of staff as opposed to quantity.

KEY SKILLS TO SUPPORT INTEGRATION
- Data analysis and visualization.
- Identify consultancies with diverse competencies.

POLICY & AGENCY STRUCTURE

Transport Scotland's asset management branch has taken ownership of their integration efforts, and with the support of the branch manager have established a distinct vision and plan. This has brought in a variety of leaders within the organization and has helped to cut across the largely siloed nature of the agency. In this way, the asset management branch manager has established herself as a champion for the integration effort, playing an invaluable role in the branch's evolution.

As the agency pushes towards a more integrated approach to asset management, they are working to draft policy which will directly support this. Because integration is complex and requires buy-in from a broad variety of agency roles, and because integration must be conducted over a long period of time, it is important that such efforts be formalized through policy. This ensures that practices remain consistent and effective despite periodic changes in leadership, staffing, and resources.

AGENCY HIGHLIGHTS
- ☑ **The agency has identified an integration champion**
- ☐ Agency structure has been modified to support management area integration
- ☑ **Agency policy has been modified to support management area integration**
- ☑ **Innovation in management practices has been identified as a priority for agency leadership**

RESOURCE REQUIREMENTS

Asset management budgets are largely broken down by asset classes within Transport Scotland. Structures and pavements tend to have the most stable, best protected budgets, while ancillary assets are often substantially underfunded.

Current budgeting is largely based on historic funding patterns and is only partially influenced by agency data. However, as the asset management branch continues to evolve its program, they have been able to demonstrate financial savings as a result of the integration of risk and performance management into their asset management practices. This ability to exhibit improvements in financial efficiency and the quantitative value-add that such an innovative approach offers has been valuable to the branch, however it is remained a challenge to move this upwards beyond the branch. However, the economic benefits of the approach has been noticed by many staff and has been able to bolster ongoing efforts to achieve a robustly integrated system.

RESOURCE ALLOCATION HIGHLIGHTS
- ☑ **The budgets for asset, performance, and risk management are combined**
- ☐ The agency has established funding specifically to support management area integration
- ☐ The agency has developed flexible programming plans to account for variations in available funding
- ☑ **The agency has established support from executive leadership and/or legislators for integration**

NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	TriMet	AMP Date:	2018
Location:	Oregon, United States	PMP Date:	20XX
Sector:	Transit	RMP Date:	20XX
Contact Title/Dept.:	Director of Business Planning & Asset Management		

OVERVIEW

The Tri-County Metropolitan Transportation District of Oregon (TriMet) is a public agency that provides light rail, commuter rail, bus, and other mass transit services to an urban region spanning most of the Portland metropolitan area. The agency averages over 300,000 rides per weekday, and operated with an annual budget of approximately $526 million in 2018. TriMet owns $2 billion of capital assets, including buses, trains, and right of way. Because of this, it is essential that the agency continuously invest in the maintenance and replacement of critical assets using cost-effective, multidisciplinary means.

LEVEL OF INTEGRATION
- ☐ High
- ☑ **Moderate**
- ☐ Low
- ☐ None

INTEGRATED PRACTICES
- ☑ **Asset Management**
- ☑ **Performance Mgmt.**
- ☑ **Risk Management**

APPROACHES TO INTEGRATION

TriMet is currently making a coordinated effort to develop an integrated management approach, bringing together the practices of asset, performance, and risk management. They have modified their agency structure to support this integration and have developed a guiding 2019-2023 Business Plan, which will be updated annually with a five-year horizon. This plan is intended to provide a holistic outline for managing operations and capital budgets through contemporary, integrated business practices. The agency's efforts have led to increased coordination and cooperation among the Business Planning & Asset Management, Performance Management, and Risk Management groups. This has improved efficiency and customer experience, and has helped the agency make more effective decisions in the face of scarcity, where there are consistently more projects than the agency can regularly fund. TriMet's integration effort is still young, however it is evolving quickly through the help of agency leadership and culture.

INTEGRATION HIGHLIGHTS
- New 5-Year Business Plan serves to align management areas and focus agency vision.
- Reconfiguration of management structure has supported integration efforts, leading to increased cooperation among complementary staff.
- Integration supports more efficient, robust decision-making processes.

DATA NEEDS

TriMet collects and maintains a broad variety of asset data, with a lot contained and managed through a central database system, and some in unconnected environments. Because disbursed data requires additional effort to access and maintain, the agency is continuously working to further develop their data governance systems to improve efficiency.

With recent developments, operational and maintenance data are now being used internally to support TriMet's asset management program, feeding into their developed multiple-objective decision analysis approach.

TriMet is constantly collecting data through the operation of their fleet, pushing user-friendly, customer-side results to provide for customer needs and to help with trip planning. Because of the massive size of their data operations, it can be challenging to effectively parse the information as it is collected, distilling it and visualizing it to support the needs of their management practices. Additionally, the agency has focused on pursuing high-quality data in order to support high-quality analysis.

KEY DATA NEEDS
- Constant collection of robust data through normal operations; much data provides opportunities but requires much effort.
- Use of a multiple-objective decision analysis approach in asset management.
- High quality analysis requires high quality data.

PERSONNEL & SKILLS

TriMet is lightly staffed relative to comparable agencies across the West Coast. This requires them to be highly focused and intentional as they pursue integrated management practices, necessitating agency-wide buy-in to lead the effort to completion. This also means that staff must be organized around needs and projects as they come up, leading to more effective cooperation and cross-discipline partnership. Additionally, having low staffing numbers leaves them susceptible to staff turnover, making knowledge retention a key goal as the agency continues to develop its practices.

As an agency providing public services, TriMet looks to hire new staff whose vision is aligned with their goals of providing excellent services to the general public through safe, reliable transit systems. The agency has also highlighted the value of diversity of backgrounds, emotional intelligence and collaborative skills in hiring key staff.

KEY TAKEAWAYS
- TriMet is lightly staffed compared to similar agencies.
- Staff organize around needs and projects, leading to cross-discipline partnerships.
- Low staffing numbers leaves TriMet susceptible to turnover.

KEY SKILLS TO SUPPORT INTEGRATION
- Public service-oriented staff.
- Diverse backgrounds.
- Emotional intelligence, collaborative skills.

POLICY & AGENCY STRUCTURE

TriMet employs unique staff for the three areas of business planning and asset management, performance management, and risk management. The asset management group is made up of just a few dedicated staff, requiring them to work directly with other groups to perform operations, with maintenance staff addressing most day-to-day needs. The risk group deals primarily with insurance, claims, and more recently enterprise risk analysis. The performance group is staffed with analysis to support operations, security, database management, and more.

The agency puts a great deal of focus on the importance of developing effective workplace culture which is itself focused on developing progressive, integrated practices. TriMet's current General Manager and their Director of Business Planning & Asset Management have worked jointly to develop agency structure and policy that support integrated management approaches, while also fostering a culture where these practices are sustainable, self-motivated, and highly effective.

AGENCY HIGHLIGHTS
- ☑ **The agency has identified an integration champion**
- ☑ **Agency structure has been modified to support management area integration**
- ☑ **Agency policy has been modified to support management area integration**
- ☑ **Innovation in management practices has been identified as a priority for agency leadership**

RESOURCE REQUIREMENTS

TriMet has identified one of the key resource requirements for successful management area integration as team and executive level buy-in. With collective support of progressive management approaches and expectation- and culture-setting from the top down, integration can happen more effectively despite limitations in financial and other resources.

Currently, TriMet's budget doesn't line-up with their integrated approach to asset, performance, and risk management. Funds are allocated separately among the three divisions, with flexibility within each division, but not between divisions. This is largely defined by external factors such as state law however, and cannot directly be modified by the agency.

TriMet does not directly track returns on investments or other objective evaluations of their integrated approach, however executive leadership maintains the expectation that such integration will improve efficiency and the customer experience that the agency provides.

RESOURCE ALLOCATION HIGHLIGHTS
- ☐ The budgets for asset, performance, and risk management are combined
- ☐ The agency has established funding specifically to support management area integration
- ☐ The agency has developed flexible programming plans to account for variations in available funding
- ☑ **The agency has established support from executive leadership and/or legislators for integration**

NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Utah Department of Transportation	**AMP Date:**	2018
Location:	Utah, United States	**PMP Date:**	2018
Sector:	Transportation	**RMP Date:**	NA
Contact Title/Dept.:	Director of Transportation Performance and Program Engineer		

OVERVIEW

The Utah Department of Transportation (UDOT) 2018 Transportation Asset Management Plan's objectives involve using a data driven, performance-based approach with the incorporation of asset management and risk management in their decision-making processes for both planning and resource allocation. The 2018 TAMP outlines three asset management tiers; performance-based management, condition-based management, and reactive management. UDOT is currently working to establish a process to integrate asset, risk, and performance management into their Statewide Transportation Improvement Program (STIP). As a first step, they will complete a process to incorporate risk, asset, and performance management into their corridor planning process in 2019.

LEVEL OF INTEGRATION

- ☐ High
- ☑ **Moderate**
- ☐ Low
- ☐ None

INTEGRATED PRACTICES

- ☑ **Asset Management**
- ☑ **Performance Mgmt.**
- ☑ **Risk Management**

APPROACHES TO INTEGRATION

Currently, UDOT is working on a verification process for quantifying risk by obtaining 2017 data to compare how close their performance modeling is to actual data. Additionally, UDOT is moving forward with the development of a concept report process to better manage the life-cycle of assets and to bring together risk and asset management. UDOT is focused on performance metrics, with each metric having specific measures that are used to support UDOT strategic goals that are often evaluated to make sure that they are the correct measures to meet goals. UDOT is working to better understand the benefits of projects before they are developed at the project level to determine how these projects will help meet strategic goals. Along those lines, their current efforts to identify threats through a risk assessment and system resilience analysis for corridors is moving towards the goal of fully integrating asset management, risk management, into corridor planning to support system performance goals. Their innovative corridor planning process provides information on typical performance measures such as safety, operations, and mobility. Their current efforts will also provide information on physical threats to the corridor upstream of the project development process to ensure adequate resources can be allocated to address corridor needs.

INTEGRATION HIGHLIGHTS

- Process for Quantifying Risk.
- Performance Modeling.
- Concept Report Process.
- Corridor Planning Process.

DATA NEEDS

UDOT is a data rich agency that organizes around their data and has implemented data collection processes to understand asset location, and condition. In addition, their Performance Management Committee comprised of Division Managers who establish specific performance measures within each division to support the overall agency strategic goals. The PMC tracks progress towards these goals on a public facing dashboard: https://dashboard.udot.utah.gov/stories/s/stj7-tcak

UDOT has also heavily invested in their UPLAN data portal that serves as a foundation for multiple geo-referenced databases to support system management.

In addition, UDOT has employed a multi-objective optimization program to prioritize STIP projects to maximize performance outcomes for Safety, Preservation, and Mobilization measures. The project is still a work in progress as the agency is working to incorporate better data for better results catered specifically to UDOT.

KEY DATA NEEDS

- UPLAN for data, analytics, and mapping.
- Story Maps for Corridor Planning to begin to integrate asset, risk, and performance management.
- Multi-objective Optimization Methods being developed.

PERSONNEL & SKILLS

The maintenance program has standardized the process of data collection which is updated every time there is a life cycle event for an asset. This has helped with more consistent data as well as maintenance crew having more ownership over the process. In the future, this could be replicated in different programs. Of note, UDOT expressed that staffing for the management areas is not adequate but is moving to improve staffing needs with approval of a requested block grant in the 2020 budget.

KEY PERSONNEL TO SUPPORT INTEGRATION
- Maintenance for data improvement
- Leadership for process development

KEY SKILLS TO SUPPORT INTEGRATION
- Data Collection
- Process development and implementation

POLICY & AGENCY STRUCTURE

Recently, UDOT has integrated data analytics into the performance group and has organized it as a business unit. It is expanding across the department within all business units. In the future, UDOT is looking to use asset management in support of performance goals as it is believed that performance management is the way they do business and it needs to be a function of every group throughout the department. Also, a focus has been placed on Geographic Information Systems (GIS) by bringing the process into different regions, with some regions hiring their own GIS analysts.

In addition, the agency noted that coordination across the four UDOT regions to define process for meeting the needs of performance management is a need. The agency is working towards this but believes additional guidance would be helpful to expedite the development of such a process.

AGENCY HIGHLIGHTS

☐ The agency has identified an integration champion

☑ **Agency structure has been modified to support management area integration**

☑ **Agency policy has been modified to support management area integration**

☐ Innovation in management practices has been identified as a priority for agency leadership

RESOURCE REQUIREMENTS

UDOT has established a budget that is set aside for pavement, bridges, ATMS and signs, and the other assets rely on money that is set aside by the regions for "Transportation Solutions". Currently, the agency has requested a block grant that could improve the integration of asset management, performance management, and business systems.

Currently, UDOT has strategic goals and performance measures, but lacks a clearly defined process to support the agency in meeting these goals. The agency lacks standardization throughout the four regions, and without this it is difficult to implement new processes and tools with buy in from all of the separate regions.

RESOURCE ALLOCATION HIGHLIGHTS

☑ **The budgets for asset, performance, and risk management are combined**

☐ The agency has established funding specifically to support management area integration

☑ **The agency has developed flexible programming plans to account for variations in available funding**

☑ **The agency has established support from executive leadership and/or legislators for integration**

NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Vermont Agency of Transportation	AMP Date:	2018
Location:	Vermont, United States	PMP Date:	2018
Sector:	Transportation	RMP Date:	NA
Contact Title/Dept.:	Manager, Asset Management & Performance Bureau		

OVERVIEW

Vermont Agency of Transportation (VTrans) has long-standing measures that guide funding and investment decisions for congestion, safety, bridge, pavement, and congestion-related projects. The agency has connected performance to asset management, but risk is just starting to be integrated into business processes and information systems. Vermont's key question is "What stands in the way of achieving a certain goal?" The agency is challenged with helping staff understand that daily tasks are important to meeting longer-term performance targets.

LEVEL OF INTEGRATION
- ☐ High
- ☑ **Moderate**
- ☐ Low
- ☐ None

INTEGRATED PRACTICES
- ☑ **Asset Management**
- ☑ **Performance Mgmt.**
- ☐ Risk Management

APPROACHES TO INTEGRATION

Vermont views risk management as a tool to help understand how it can achieve performance goals. Asset management is a "tactile" planning process, with activities that are undertaken on a daily basis. Staff of VTrans mitigate risks in their daily jobs without explicitly acknowledging that they are practicing risk management.

Vermont views risk management from bottom-up and top-down perspectives. Management sets broad policies (for example, explicitly addressing risk in the state's Asset Management Plan), and is starting to communicate how everyone in the organization can help VTrans meet its performance and asset management targets just by making small changes in their day-to-day job performance. Staff implement risk mitigation strategies every day, but don't view it as "risk management." Management's goal is to help people prioritize and rethink their assignments based on risk to meeting the agency's performance goals.

According to VTrans, the journey is still ongoing in developing an agency-wide risk registry to "enhance its decision-making processes by documenting internal and external risks that may affect its performance objectives." These risks are identified at the enterprise level and across VTrans programs, projects, and activities. To achieve the Agency's strategic goals, performance and risk management play integral roles supporting asset management activities.

VTrans has begun to emphasize asset management policy and incorporate business processes, brought on by the risks and challenges of managing transportation infrastructure assets in a sustainable and fiscally responsible manner. This ensures quality decisions are based on accurate analysis and data, while also mitigating the identified risks.

INTEGRATION HIGHLIGHTS
- VTrans has established an Asset Management and Performance Bureau.
- Asset management is and has always been tightly woven into VTrans' culture.

INTEGRATION MEASURES
VTrans' **Asset Management Policy Statement** has four goals, two of which explicitly address integration between performance, risk, and asset management (as indicated in **bold**):

- Meet the minimum federal and state legislative requirements regarding asset management implementation.
- **Develop factual, risk-based, and data-driven asset management processes.**
- **Use asset management to manage the Agency's physical infrastructure, drive the budget development process, and support the Agency's Strategic Plan.**
- Integrate asset management principles into VTrans culture.

DATA NEEDS

VTrans has a robust process to consider key performance indicators (KPIs) in funding and investment decisions at a program level. The agency considers how various levels of funding might impact performance, under "business as usual" conditions. VTrans is less certain about its ability to consider what risks stand in the way of achieving a performance target or outcome when circumstances vary from historical trends and conditions.

One specific data need is related to damage assessments, in terms of extent and cost of damage from unpredictable events like extreme weather events and the economic disruption resulting from the damage (which, in turn, is a key input to benefit-cost analysis for repair and replacement projects). VTrans is looking at operational data from emergency management agencies so that the agency can use historical information to help inform decision about discrete adaptation projects and systematic design changes to prepare for future extreme weather events.

KEY DATA NEEDS

- VTransparency provides online, public access to a range of contents such as bridge inspection reports and how pavement segments are deteriorating. It complements the VTrans Fact Book.

PERSONNEL & SKILLS

VTrans employees practice some form of risk management in their daily jobs, but it isn't clear that this is consistently applied and done in a way that benefits the entire agency's performance. VTrans is working to develop training and resources to educate people and give them tools to better integrate performance, risk, and asset management.

VTrans' organization is a key obstacle to integrating performance, risk, and asset management. "Risk" is a scary term to many people. When the concept is explained in terms of threat, vulnerability, and consequence, people can better understand how to consider risk in their day-to-day decisions.

KEY PERSONNEL TO SUPPORT INTEGRATION

- Management.
- Data stewards and managers.
- Maintenance and operations staff.

KEY SKILLS TO SUPPORT INTEGRATION

- Data management and analytics.
- Strategic planning and holistic view of transportation impacts.
- Vulnerability and risk assessment and mitigation.

POLICY & AGENCY STRUCTURE
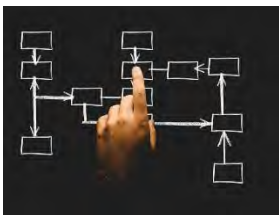
According to VTrans, "The VTrans' Asset Management and Performance Bureau (AMPB) coordinates the management of effective and realistic schedules for these activities. The AMPB is committed to providing these services at an acceptable level of risk to the Agency and within current forecasted revenue projections while delivering customer service levels that the public expects and decision makers require. VTrans utilizes asset management, performance management and risk management principles to effectively manage both the physical and financial condition of its assets to achieve its strategic objectives. This renewed commitment and focus on asset management complements the Agency's customer service focus."

VTrans has found it challenging to integrate performance and risk management in its transportation system management and operations (TSMO) and transit divisions, as those programs are more independent and siloed in the organization.

develop agency structure and policy that support integrated management approaches, while also fostering a culture where these practices are sustainable, self-motivated, and highly effective.

AGENCY HIGHLIGHTS

- ☐ The agency has identified an integration champion
- ☐ Agency structure has been modified to support management area integration
- ☑ **Agency policy has been modified to support management area integration**
- ☑ **Innovation in management practices has been identified as a priority for agency leadership**

RESOURCE REQUIREMENTS

By establishing an Asset Management and Performance Bureau, VTrans has taken a large step toward integration those two areas. According to the Vermont Agency of Transportation, "The VTrans' AMPB coordinates the management of effective and realistic scopes, accurate cost estimates, and reliable schedules for these activities. The AMPB is committed to providing these services at an acceptable level of risk to the Agency and within current forecasted revenue projections while delivering customer service levels that the public expects and decision makers require."

RESOURCE ALLOCATION HIGHLIGHTS

- ☐ The budgets for asset, performance, and risk management are combined
- ☐ The agency has established funding specifically to support management area integration
- ☑ **The agency has developed flexible programming plans to account for variations in available funding**
- ☑ **The agency has established support from executive leadership and/or legislators for integration**

NCHRP 08-113: QUICK SCAN SUMMARY

Agency/Organization:	Main Roads Western Australia	AMP Date:	2018
Location:	West Australia, Australia	PMP Date:	NA
Sector:	Transportation	RMP Date:	NA
Contact Title/Dept.:	Director of South West Operations		

OVERVIEW

Main Roads West Australia (MRWA) is the transportation agency of the state of Western Australia which is responsible for managing, maintaining, and improving more than 18,500 kilometers of roads, as well as implementing state policies regarding network operations and compliance. The public highways and main roads under MRWA's purview make up much of the Australian state's arterial roadway network, providing statewide connectivity. These roads complement the networks managed and maintained by local agencies throughout the state and are an essential element of Western Australia's economy.

LEVEL OF INTEGRATION
- ☐ High
- ☒ **Moderate**
- ☐ Low
- ☐ None

INTEGRATED PRACTICES
- ☒ **Asset Management**
- ☒ **Performance Mgmt.**
- ☒ **Risk Management**

APPROACHES TO INTEGRATION

MRWA has identified the integration of asset, performance, and risk management as an important objective of their agency. Though integration is still developing, they currently employ a number of practices to implement a more modern, holistic approach to managing their network. For MRWA, this is largely top-down, with a corporate risk process which reaches through each branch of the agency, across regional and divisional divides. Additionally, they have a performance management system which looks at cost-benefit of capital projects, driver exposure and safety, high-level congestion management, and more, requiring these measures to be reported up the management structure to be reviewed at the corporate level. This helps to centralize management efforts across the geographically vast jurisdiction of the agency, and relies largely on cross-coordination between branches and interactions of branch managers. However, this high-level approach can be difficult to reflect in low-level asset management decision-making.

INTEGRATION HIGHLIGHTS

- Corporate-level risk process which reaches across agency branches.

- Performance measures are reported upwards, being assessed at the corporate level; this is difficult to turn into low-level practices.

- Consider measures of economic benefits, driver exposure, congestion, and more.

DATA NEEDS

MRWA maintains a corporate database which contains geometric data on all roads as well as deterioration data, crash data, and more. Additionally, they have implemented a maintenance management system which helps prioritize maintenance projects and supports economic analyses. Additionally, traffic and similar data are collected internally by performance management staff. In recent years, MRWA has made strong pushes to verify their data, especially geometric data, which largely rely on human updates. Though this is a large effort, the data has been improving over time, with broad staff effort and understanding of the importance of data validation. The agency also maintains a risk management database which includes information which cascades throughout the enterprise.

MRWA has implemented software programs such as Microsoft Power BI and Tableau to help with data visualization and to support decision-making processes, and hope to implement more advanced data analysis techniques, such as machine learning, to bring additional efficiencies strengths to their analysis programs.

KEY DATA NEEDS

- It is vital to validate data, ensuring quality and accuracy of information on which decisions are being made.

- Data visualization using tools such as Power BI and Tableau help with decision-making.

- Modern data analysis methods such as machine learning may play a role in the future.

PERSONNEL & SKILLS

MRWA includes about 1,000 staff, making it fairly large though still small enough that people across the agency know each other. This helps to support collaboration between agency divisions and regions, which is essential for the integration of management practices within such a geographically wide and diverse agency.

In recent years, MRWA has faced difficulties due to losses in institutional knowledge related to region-specific maintenance and operations practices. In response to this, the agency is working to provide diverse experiences for staff to achieve more well-rounded skillsets, giving staff the opportunity to work in various regions and divisions. This helps to achieve cross-pollination, professional network building, and knowledge transfer among regions and divisions, providing insurance against staff turnover. Additionally, they are working to improve documentation of agency methods and practices to avoid productivity loss during staffing changes.

KEY PERSONNEL TO SUPPORT INTEGRATION

- Interpersonal relationships across regional and divisional boundaries are important to support collaboration.
- Rotational programs for younger staff help achieve cross-pollination, network-building, and knowledge transfer.

KEY SKILLS TO SUPPORT INTEGRATION

- Documentation of basic agency practices and diverse staff experiences help to ensure productivity during staff turnover.

POLICY & AGENCY STRUCTURE

Currently, MRWA has a siloed structure, with separate divisions responsible for different management areas. Despite this separation of operations, there is a good deal of collaboration and cooperation between divisions, due in large part to partnerships between branch managers. In particular, the agency's risk management group works primarily as a provider, facilitating practices of risk management for other areas of practices, regularly crossing boundaries and collaborating with outside staff. MRWA is also working on developing a more complex internal reporting system to further support the integration of practices through agency policy.

MRWA has a strong structure for process risk management, however it is working on expanding this to better cover risks related to their network assets themselves. This would include considerations of risks related to asset failure and environmental impacts. Due to the diversity of regional experiences, it is possible that this would need to be managed separately among regions.

AGENCY HIGHLIGHTS

- ☑ **The agency has identified an integration champion**
- ☐ Agency structure has been modified to support management area integration
- ☐ Agency policy has been modified to support management area integration
- ☑ **Innovation in management practices has been identified as a priority for agency leadership**

RESOURCE REQUIREMENTS

With MRWA's current structure, budgets for different branches remain separate. This requires that staff work intentionally on all collaboration efforts, identifying means to circumvent the limitations to budget fluidity. This can be a barrier to some efforts for integration, limiting the degree to which branches work together on various tasks.

MRWA have been pushing to focus on longer term views of funding in order to achieve greater effectiveness and improved efficiency in use of limited resources. To support this, the agency has been working on developing data visualization techniques which can be presented to executives and government officials, demonstrating the needs related to their assets, their backlog of ongoing efforts, and the economic benefits of more robust maintenance measures and an integrated management approach. A Strategic Asset Plan is developed annually to capture this information and to add justification to the agency's efforts and funding allocations.

RESOURCE ALLOCATION HIGHLIGHTS

- ☐ The budgets for asset, performance, and risk management are combined
- ☐ The agency has established funding specifically to support management area integration
- ☑ **The agency has developed flexible programming plans to account for variations in available funding**
- ☑ **The agency has established support from executive leadership and/or legislators for integration**

APPENDIX B
Deep Dive Case Studies

NCHRP

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

JUNE 28, 2019

DEEP DIVE CASE STUDY
S U M M A R Y

DEEP DIVE CASE STUDY
S U M M A R Y

INTRODUCTION

This document summarizes the deep-dive interviews conducted with the Atlanta Airlines Terminal Company LLC (AATC), in support of Task 5 of NCHRP Project 08-113. One in-person interview was conducted in the AATC headquarter office at the airport with four representatives from different areas of the company, led by Chenchen Liu of Jacobs on May 29, 2019. The interview topics included: *Agency Overview, Approaches to Integration, Data Needs, Personnel and Skills, Policy and Agency Structure,* and *Resource Requirements,* which are discussed in the following sections.

AGENCY OVERVIEW

AATC is a privately-held airport operation and maintenance company, officially formed in September 1979 by several major airlines, namely American, Delta, Frontier, Southwest, and United Airlines, with the principle being Delta Air Lines. AATC, which is owned and controlled by its founding airlines, is based in Atlanta, Georgia and located within Domestic Terminal above Concourse T at the Hartsfield-Jackson Atlanta International Airport (ATL). AATC was established for the primary purpose of operating and maintaining the Central Passenger Terminal Complex (CPTC) at ATL, which measures approximately 7 million square feet or 160 acres.

BASIC INFORMATION

According to the ATL Department of Aviation Fiscal Year 2017 Budget Book, "ATL occupies a 4,750-acre site in Clayton and Fulton counties about 10 miles south of downtown Atlanta. It is classified as a large hub by the Federal Aviation Administration (FAA) and is the principal air carrier airport serving Georgia and the southeastern United States. ATL serves as a primary transfer point in the national air transportation system. In Calendar Year 2015, ATL handled more than 101 million passengers and just over 882,000 aircraft operations, making it the world's busiest passenger airport." ATL's location and design has enabled its handling of some of the most significant volumes of passengers and aircraft operations ever since the CPTC complex was opened in 1980. Since that time, several airlines have used ATL as a major hub.

KEY FINDINGS

- AATC has successfully integrated their performance, risk, and asset management practices. The integration effort has largely benefited from the ISO 55001 certification process.
- The quality standard ISO 9001 helps AATC setup solid foundation for performance, risk, and asset management by organizing processes, improving efficiency and continually improving quality.
- Executive support is a key factor in AATC's successful integration.
- A significant part of effective leadership is building an organization with a healthy and strong culture.
- Culture is a foundation of good management system for asset heavy organizations, and a key ingredient of its success.
- The development and initial implementation of the integrated management system is a journey that spans over several years. The journey doesn't stop after the initial system and processes are setup. AATC keeps refining the standards and processes and commits to continuous improvements.

According to the ATL Department of Aviation, the Central Passenger Terminal Complex includes a "Domestic Terminal and an International Terminal that houses airline check-in facilities, security checkpoints, ground transportation facilities, administrative offices, access to parking facilities, and concessions, as well as an award-winning art program, a wide selection of high-quality restaurants, and retail offerings, in addition to security checkpoints. The Domestic Terminal includes five domestic concourses (T, A, B, C, and D) and a three-story atrium. The International Terminal includes two international concourses (E and F), with concourse F serving as the primary originating and destination terminal for international flights."

AATC offers structural and system maintenance services that include:

- Fire alarm and fire prevention
- Two Central Utility Plants
- Electrical distribution
- Plumbing
- Heating, ventilation, and air conditioning (HVAC)
- Vertical transportation
- Public address
- Operation and maintenance of Building/ Baggage Management System (BMS)
- De-icing system containment and operation
- Ramp sweeping and striping
- Roof management
- North Terminal Baggage Handling System

The company also offers facility services such as custodial services, waste removal and recycling, pest control and abatement, window washing, pressure washing, snow removal, airport lost and found, airport paging system, cargo truck pass operation, and employee parking and transportation.

CONTEXT AND GOVERNANCE

AATC was originated to establish "an airline-owned and controlled management team that could provide the most efficient and cost-effective airport operation and maintenance services in the industry. This concept was formalized in 1979 through the contracting airlines' lease agreement, officially announcing what is now AATC." Currently, the company provides services to approximately 55,000 employees and more than 100 million airline passengers annually. They currently have 91 team members who oversee more than 40 contracts and more than 1,100

contract partners. The strategic focus of AATC is to "continuously maximize their potential as a world-class provider of outstanding value to their members, partners, and our customers by cultivating a team focused on their people." AATC stands on four pillars:

AATC PILLARS

PILLAR 1
CUSTOMER SERVICE
Deliver industry leading customer service through employee empowerment, training, and technology.

PILLAR 2
OPERATIONS
Maintain industry leading passenger safety protocols and practices.

PILLAR 3
PEOPLE
Promote the AATC mission, vision and values as the basis of AATC's culture.

PILLAR 4
FINANCE
Achieve financial operational targets annually while completing projects on time and within budget.

To better achieve the company's objectives, AATC has gone through several reorganizations over the past decade. To meet the requirements for the integration, AATC has modified the scope of roles and added some new positions corresponding to the new processes. The following sections describe AATC's experiences around integration approach, data needs, personnel and skills, policy and agency structure, and resource requirements.

APPROACHES TO INTEGRATION

STATE OF MANAGEMENT PRACTICE INTEGRATION

AATC's goal is to deliver world class performance in airport facility maintenance and operations. They provide outstanding value to their shareholders and customers through their passion for innovation, responsiveness, and excellence in industry best practices. AATC's management integration efforts make ATL the first international airport in the United States and the third organization in North America to receive asset management system certification. To that end, AATC plans to remain at the forefront of emerging operational trends. In the busy, day-to-day world of the airport that never sleeps, higher-level strategy and responses can get lost. Working to maintain ISO 55001 certification gives AATC the tools to be proactive, rather than reactive, so they can maintain ATL's world-wide reputation as one of the best-maintained passenger terminal complexes.
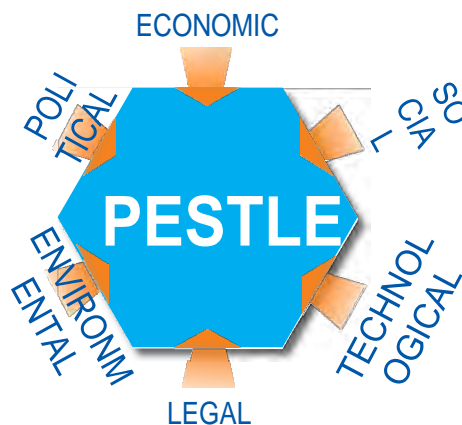
Figure 1. SWOT and PESTLE

ASSET MANAGEMENT FRAMEWORKS

Integration started at a conceptual level by examining interactions between the management processes of the company. AATC has consultants on board to support the integration and certification and they did series of interviews with each person to discover lessons learned and identify roles in the business process. There were 26 business processes after the initial audit and eventually AATC condensed to seven improved business processes.

The seven core processes include the different areas of AATC's business management and daily operations. These processes are:

- Business performance
- Training
- Business administration
- Asset performance management
- Asset integrity and risk management
- Project delivery
- Maintenance and operations

The overarching asset management framework and integrated processes focus on asset management, performance management, and risk management.

Performance

Business performance is the first core process, which focuses on asset management; strategic planning; Strengths, Weaknesses, Opportunities, and Threats (SWOT); the Political, Economic, Social, Technological, Legal, and Environmental (PESTLE) framework; executive level risks; and high-level performance management. This business performance process also focuses on organization-wide management.

Along with the strategic planning analysis, a SWOT assessment was conducted to identify what external and internal factors can affect the future direction and success of AATC's business. PESTLE framework, which is complementary to SWOT, analyzed and screened the external marketing environment of the company in support of the integration effort by gauging these macro environmental factors. The PESTLE analysis helped identify strength and weaknesses for the SWOT analysis. It was also used to precisely explore the external opportunities and threats that affect the chances of a business strategy being successful. SWOT, PESTLE, and the four pillars provide strategic guidance and direction of AATC's business operation and management integration (Figure 1).

Asset performance is conducted through maintenance and monitoring. They make sure legislative and standard compliance mandates are met (for example, the emissions from the boilers must comply with industry requirement).

On the organizational performance side, AATC holds staff competency meetings and send emails to managers to assess staffing needs as well as the needs for additional employee training, as needed. This is an ongoing effort as part of daily work. People will need to present proof of completed work on time and within budget. To ensure efficient work completion, internal audits are conducted at AATC.

Showing continuous improvements, AATC communicates the results or programming of management practices to stakeholders and AATC leadership through several channels including Quarterly Business Reports (QBRs). The QBR describes the measurements of 20 key performance indicators (KPIs) and reports the effectiveness measurements of these KPIs to inform and/or directly impact funding decisions and staff allocation. KPIs are measured on a monthly basis and reported quarterly.

Risk

AATC manages both asset risk and enterprise risk. They have created a business continuity and risk role to support the integration of risk management. They have developed checklists and procedures for risk management, and they manage the execution and follow up of the risk impacts. On the organizational side, AATC has been conducting various trainings around risk readiness. Examples are safety training and active shooter training. A business continuity plan was also developed in May 2018 (Figure 2).

Risk management within AATC involves a collection of processes supported by a series of techniques. It is iterative and encompasses many planning horizons. Within the asset management landscape, risk assessment and management describe policies and processes for identification, assessment, analysis, and treatment of risks and opportunities. Risk assessment and management is integral to asset management overall (the overall process is the asset health relates to asset failure, which relates to asset risk).

One of AATC's seven processes has a technical risk taskforce. AATC has a strategic risk committee comprised of the CEO and VPs. They meet regularly to assign the risk owner to develop a mitigation strategy with a focus on the risks with highest priority. Risk management is a part of everyone's responsibility at AATC.

AATC also uses a risk register to support risk management decision making. A 5-by-5 risk assessment matrix is applied to assess the risks and consider the problems. (Figure 3)

After AATC completed the ISO 55001 certification process, within one year the risk ratings shifted from Almost Certain to Rare, showing significant reduction in the likelihood and consequences.

Business Continuity Plan

Prepared for
Jacobs Engineering Team at the
Atlanta Airlines Terminal Corporation (AATC)

FOR OFFICIAL USE ONLY
May 2018

Figure 2. AATC Business Continuity Plan

LESSONS OF INTEGRATION

AATC improved their asset management system, establishing a best practice approach to decision-making and managing assets with risk-based and information-driven planning across the lifecycle of the asset. The keys to success were understanding every employee has a stake in its management system and must strive for continual improvement of processes and improved relations with service partners. Achieving ISO 55001 is now the foundation for AATC's future. AATC can now efficiently and effectively improve asset, risk, and performance management; plan for successful expansion; and further pursue recognitions and certifications with ISO 55001 ingrained into their work culture.

AATC has identified coordination and consensus at the executive level of the company as a key requirement for successful management integration. Because integration causes some overlap of responsibilities, it is important that leadership recognize opportunities for expanding roles to benefi t the efforts of the company through its ongoing evolution. For similar companies and organizations to be successful in integration, it is crucial to establish initial buy-in from the leadership and retain the momentum throughout daily work activities.

The integration and ISO certifi cation effort is a long-term, time-consuming commitment. AATC has identifi ed ISO champions to own the processes internally and to manage employee participation in the roles identifi ed in the integration roadmap and implementation action plan. Sometimes the executives delegate to the integration champions to develop documents for review and approval, adding to the responsibilities of the champions. AATC believes in the management approach and the processes. The ISO certifi cation really requires top level executive buy-in and each process owner needs to show continuous commitment through completion.

Figure 3. A 5-by-5 Risk Assessment Matrix

DATA NEEDS

AATC collects and maintains data sources that are critical for processes related to asset performance management, asset integrity, and operation and maintenance (O&M). Through data analytics, AATC can conduct performance management planning for assets, manage asset operating ranges, and manage how assets are performing. They use data to inform decision-making. During the certification and integration effort, AATC decided to focus on the two central utility plants, which is approximately 300 assets. These assets represent high visible areas, high value, and criticality. They would have major impact on customer experience while the scope is still manageable.

During the asset integrity processes, AATC has risk assessment meetings with the Program Manager, Facilities Manager, and VP Facility to assess likelihood and consequences of each of the 300 facilities. All the information is synthesized into the enterprise asset management (EAM) system. Frontline staff use their engineering judgment to assess the asset condition and record the likelihood of failure and a matrix is created to show the consequences of the risk using 5 category risk registries. Asset information is then used to inform asset contingency planning and life-cycle planning in the maintenance and operations processes.

Assets around mechanical, electrical, and plumbing facilities are managed by AATC who act as the superintendents of the airport. However, the Department of Aviation (DOA) owns the ATL airport and has the responsibility of life-cycle management.

DATA GOVERNANCE

AATC has a formalized data governance structure with a vision for a smart airport and becoming more connected to transform the traveler experience and generate new revenue. Strong data governance would be a strong foundation for future developments. AATC uses proprietary software INFOR to support their data governance practices.

AATC focuses on the direction where they have to navigate and found the key factors to be IT and Finance, which are both data-heavy areas. The business model is contract management and almost everything is outsourced. There is tremendous financial data, which are deeply connected with work orders and asset information through complex IT systems.

While most of the data governance model is automated, there are still manual processes. For example, front-line staff use hand-hold devices to record asset type, location, and failure type data into the software and the information then gets uploaded and integrated into the centralized data management center.

DATA APPLICATIONS

AATC uses predictive modeling methods to support their asset, performance, or risk management practices. The executives have a vision for introducing the use of Artificial Intelligence (AI). AATC also collects real-time data from the facilities including customer satisfaction surveys conducted by public devices installed in targeted locations in the terminals. They are working towards building real-time dashboards for executives and below to communicate results and execute informed decision-making.

AATC uses the data collected to forecast project needs and recommend capital requirements or changes in project timelines to the DOA.

For O&M, AATC uses a computerized maintenance management system (CMMS), which is linked to the centralized database and can help effectively execute an asset management strategy. Two examples are:

- **Winterization Plan** – AATC and their facility management consultant team developed a Winterization Plan, which uses the capabilities of the INFOR CMMS system and industry best practices to establish a schedule of proactive, seasonal preventive maintenance plans to prepare

critical assets for cold weather operations. This plan's development was a result of the 2013/2014 winter in which HJAIA experienced sustained temperatures in the single digits over several storm events. This extreme weather caused loss of major mechanical assets affecting HVAC, central utility plants (due to curtailment of natural gas by GA Natural Gas), fire protection and glycol dispensing. By combining routine PMs with seasonal preventive maintenance requirements, the staff successfully executed more than 800 work orders in 4 months preceding Winter 2014/2015 and Winter 2015/2016. Since the institution of this CMMS based preventive maintenance plan, there has been zero instances of major asset failure attributable to cold weather through January 2017.

- **Implementation of Planning/Scheduling for CMMS** – Since implementation of a process work flow for preventive maintenance at HJAIA, scheduling, and on time completion of all preventive maintenance work orders has increased nearly 80 percent, resulting in fewer corrective maintenance work orders associated with equipment failure. This brings lower capital costs for new equipment and use of outside contractors for unplanned repair/replacement of assets. The increased ability for technicians to perform project-related (long-term planned work) work orders.

PERSONNEL AND SKILLS

STAFFING AND COMPETENCY

AATC uses consultants to support the management areas and the integration of management areas. The current level of staffing is adequate to support the AATC's journey for management area integration. Their staffing for the asset, performance, and risk management areas is managed collectively with a primary focus on ISO 55001 standards. To optimize the delivery and performance of AATC's assets, seven competencies are identified in alignment with ISO framework. These seven key roles and competencies are:

- **Policy development:** staff in this role can analyze policy requirement and develop company's asset, risk, and performance management policy.
- **Strategy development:** staff in this role can analyze strategy requirements, they are skilled to forecast and analyze future user requirements and

demands, they are familiar with the development of the management strategy, and they also plan the implementation of the management strategy.

- **Asset management planning:** staff in this role can apply whole life costing principles, they have the skills to appraise investment options, they can produce business case for creation or acquisition of new assets, plan for contingencies, and develop and communicate management plans.

- **Implementing management plans:** staff in this role should be able to create and acquire assets, control operations, maintain assets, optimize and rationalize assets, review and dispose of assets.

- **Asset management capability development:** staff in this role can develop and deploy asset management teams, develop and deploy suppliers, develop and manage organizational changes, and share the integrated management culture.

- **Risk management and performance improvement:** appraise and manage risks, assure the quality of asset management processes, monitor and review processes and performances, review and audit compliance with legal, regularity, ethical and social requirements, and learn from mistakes.

- **Asset knowledge management:** staff in this role define asset information and data standards, specify, select and integrate information systems, and they know how to make appropriate data available for decision-making.

KNOWLEDGE AND SKILL RETENTION

Some agencies may face challenges of staff turnover over the course of a management area integration process. At AATC, the scope of the transition was established to be manageable to avoid such challenges, and continuous modifications have been made to keep the company structure up-to-date as roles have evolved throughout the integration process. However, AATC notes that some areas have experienced some turnover over the course of the integration, with one manager leaving the company and two other employees retiring.

AATC has identified integration representatives for each department. For example, there are three champions, namely the Three Angels, one for facility maintenance, one for project and programs, and one for contract management.

Typically, there are formal communications coming from the executives, and then the information flows to the departmental representatives, and then to the sub departments within the departments.

AATC has knowledge management structures in place to mitigate the impacts of staff turnover and retirement. When new staff come on board, they are required to think about a succession plan for their current role starting from their first day and more than one successor must be identified, if possible. Exiting employees document what happened, when and why, have formalized the processes, and developed metrics for travel knowledge.

TRAINING AND DEVELOPMENT

On one hand, AATC invests in training for their own staff and business administration. On the other hand, AATC recognizes the importance of consultants and the consultants to forward AATC's objectives and strategies.

Training is managed by HR and business continuity at AATC. They provide opportunities for staff rotation or other cross-pollination programs to support staff development and manage practice integration. AATC has a formal training program for new staff in the business processes following ISO 55001 standards, and the asset, performance, or risk management practices. They also use external training resources or services to support staff development. Training has taken place at various levels to educate internal people as well as external parties including consultants and vendors regarding the management systems and the use of data management tools including INFOR. In return, AATC also has access to a much broader range of trainings through their consultant knowledge base. An example is that they use consultant's NCCER for facility management training.

The business administration processes also guide and support staff and skill development. These processes focus on staff management including staff resourcing, competences, and service partners. Outsourcing and procurement is a key area of AATC's business operation. They hire external auditors and develop internal auditing capabilities to audit AATC on their asset management system. Currently, the auditing results are not directly associated with staff performance review yet. AATC put more emphasize on the monitoring and control of major KPIs and how to track maintenance and service issues.

AATC continuously evaluates personnel and/or skillsets and created a new role for a materials control specialist to oversee new stock acquired during the completion of new projects in addition to inventory management.

POLICY AND AGENCY STRUCTURE

INTEGRATION LEADERSHIP

AATC has successfully integrated three management areas of asset, risk, and performance management through the certification process of ISO 55001. They have strong support at the executive level starting from the CEO and they take a top-down approach for the integration. Any ISO implementation first and foremost requires total commitment from executive leadership. The CEO acts as their head coach and makes the program a top priority. The company specifically created a role for a continuous improvement industrial engineer to support the integration. AATC identified a key integration champion or an executive person who has explicitly led integration efforts. They have also identified additional integration champions in the company and representatives in each sub-department. The management system is integrated into everyone's responsibility including lower-level staff as well as leadership staff. Quoted from the CEO, on a daily basis, the AATC team members hold themselves accountable to AATC's tagline – *Delivering Excellence and Exceeding Expectations.*

Through the use of a single, centralized office, with staff and consultants all working within their core facilities within the ATL complex, AATC has been able to achieve effective communication and efficient management practices. Additionally, the company is a fairly flat organization, being led by a leadership team comprised of the president and CEO along with four vice presidents overseeing the four core areas of operations, finance, facilities, and business administration. While focused on individual areas of responsibility, the leadership team strives to perform as a creative, cohesive unit, taking pride in presenting AATC's core values through effective company practices.

Currently, integration processes at AATC are not yet fully developed and implemented, and the company is focusing on the conceptual level of setting up the processes rather than the operational, day-to-day tasks. AATC believes in the power of small steps and has commitments for continuous improvements throughout the coming years.

ORGANIZATION POLICY

As defined in ISO 55002: 2014, an asset management policy is a *"statement that sets out the principles by which the organization intends to apply asset management to achieve its organizational objectives. The policy should set out the organization's commitments and expectations for decisions, activities and behavior concerning asset management and should be aligned to and demonstrate support for the organizational objectives."* Policy-making involves deciding on a definitive course or method of action, selected from alternatives, to guide and, often, to determine present and future asset management decisions.

AATC's vision is to attain long-term success by building on proven processes to achieve world-class performance in all areas of responsibility. The foundation for achieving success rests on AATC's four pillars of customer service, operations, people, and finance. The policy of AATC has been explicitly modified to better support the integration of management areas and AATC is committed to the principles outlined within their policy. They believe in RACI: responsible, accountable, consulted, and informed.

During the integration process, AATC published their policy directives related to the management areas or integration. The policy is communicated and made available to stakeholders and shareholders. It is reviewed in conjunction with updating the strategic asset management plan. Leadership is committed to provide sufficient information, training, and resources to enable achieving the policy. They recognize the value of developing and portraying a clear message regarding taking a modern, integrated approach to asset, performance, and risk management. One example is the communication materials in the hallway of their office for Asset Management System Improvement Plan ISO 55001. Also, several flyers with interesting facts have been created, shared throughout the company, and posted in the office.

Communication materials for *Asset Management System Improvement Plan ISO 55001.*

Culture plays an important role in the development and support of integrated management practices at AATC. They are committed to building strategic relationships and put customer satisfactory at a high priority. They focus on teamwork rooted in a spirit of collaboration. They thrive to get recognized as a leader in the industry. This culture helps shape a great environment for everyone in the company to work toward the same goal and partner with each other to better achieve AATC's objectives. This culture helps keep the momentum at various level to push AATC to the frontier of the industry. A lot of this goes back to the culture and it is crucial to have a successor.

The culture of AATC around integration is top-driven, being established through the buy-in of the CEO and other executive-level staff. The intent of the president of the company is to validate their work, to feed growth, and to improve sustainability. AATC strives to manage by fact and fairness, with facilitation and participation from company consultant and vender partners. For example, AATC carries out annual vendor appreciation events during which they invite venders to dinner and tell them how much they've done and show appreciation. Culture is very strong at AATC and that's been a huge success and has driven the entire company as well as the strong relationship with vendors and the expanded team.

RESOURCE REQUIREMENTS

BUDGET AND ALLOCATION

To AATC, investing in ISO 55001 and the new management system is also budgeting for the future. Financial commitment is required for at least the next 3 or 4 years. There would be 1-year for application of certificate at the initial stage. There should also be budget for a disengagement strategy and training to plan for knowledge transfer. It could be a plan over the course of 5 years and setup internal employees to conduct internal audits. the system will fail if constricted to a short-term agenda rather than longer-term (such as 5 years).

ECONOMIC AND OTHER BENEFITS

AATC has performed various routine evaluations on KPIs and are currently planning to quantify economic benefits of ISO 55001 moving forward. They are planning to evaluate the financial benefits and potentially measure true cost by dollar amount per passenger. Standardization is also an important benefit, which is usually overlooked so it is difficult to quantify.

As mentioned in earlier sections, measurements are demonstrated in the QBR on a regular basis. Return on investment is reflected through reduction of risk, decrease of consequences of risks, and other measures that drives their bottom line and reduce operation costs. The last four figures on the next page are for demonstration purpose.

BMS Status
FY 2018 YTD = 72% total reduction in offlines

Ramp Light Initiative
87.5% Improvement

Comfort Calls
2016 -2018: > 50% Reduction

Ramp Light Initiative Data: FY2018
Reduction from 25.83% to 3.24% in FY2018
(87% Improvement)

OTHER RESOURCES

AATC has identified a core process around projects, including asset management project delivery and asset valuation. They are looking to strengthen the commissioning process. The nature of AATC is a not-for-profit private company and AATC has a long-term lease with DOA to provide oversight services for each airport terminal. Frequent communication and collaboration are required among the airline, DOA, and AATC. AATC has a program management office with contractor liaison and project managers to oversee the effort since a stronger partnership will enhance program effectiveness and efficiency of the airport system.

JUNE 28, 2019

DEEP DIVE CASE STUDY

S U M M A R Y

INTRODUCTION

This document summarizes the deep-dive interview conducted with the California Department of Transportation (Caltrans), in support of Task 5 of NCHRP Project 08-113. One extended phone interview was held with Caltrans' State Asset Management Engineer on April 24, 2019. This engagement was a follow up to a previous interview held to develop the Quick Scan Case Studies. The interview covered the topics of Agency Overview, Approaches to Integration, Data Needs, Personnel and Skills, Policy and Agency Structure, and Resource Requirements, that are discussed in the following sections and is augmented with information from recent relevant publications by Caltrans.

AGENCY OVERVIEW

California was one of the first states to create a Bureau of Highways Commission, over 100 years ago, that eventually evolved into what we now know as Caltrans. The California Department of Transportation (Caltrans) is a large agency, managing approximately 51,280 lane miles of interstate freeways and State Routes, also known as the State Highway System (SHS). In addition, Caltrans coordinates with regional and local governments who operate and maintain over 335,000 lane miles of public roads and streets. Caltrans also funds and manages three intercity rail routes, five light rail systems, and commuter rail service such as the BART system in large metropolitan areas. Additionally, Caltrans manages more than 400 public use airports and hospital heliports.

State level oversight is provided by the California State Legislature, the California State Transportation Agency

KEY FINDINGS

- Caltrans conducted an extensive business process mapping exercise to determine how the agency would implement a performance-based allocation program.
- The passage of Senate Bill 1 (SB 1): *Road Repair and Accountability Act* (2017) – is anticipated to generate over $5 billion annually through increased motor fuel taxes.
- Caltrans is currently working within its 12 districts to meet 34 performance objectives based on the State Highway Operation and Protection Program (SHOPP).
- For each project in the SHOPP a "Project Initiation Document" (PID) is developed to convey the intended needs and goals of each project that provides transparency in "plain language" to the legislature and the public on how the proposed SHOPP projects will work towards the goals of the TAMP.
- Each of the 12 Caltrans Districts has an asset manager that meet with the central asset management team through monthly calls and a few statewide meetings held annually.

(CalSTA), the California Transportation Commission (CTC) that consists of 11 appointed voting members and two non-voting ex-officio members, and Caltrans. Caltrans coordinates with multiple tribal, planning organizations, and local governments to move toward its overall agency mission to "Provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability." The agency seeks opportunities to support the mission with the

Transportation Funding Sources

User Taxes and Fees	Property Related Charges	Subsidies
• Federal and State gasoline or diesel taxes • Vehicle weight fees (debt service) • Tolls • Public transit fare	• Property taxes • Benefits assessment districts • Developer fees	• Sales taxes • General Funds provided by federal, State, and local governments • Externalized Costs

Source: The Santa Clara Valley Transportation Authority: Introduction to Transportation Funding

approximately 109 federally recognized tribal nations; 18 Metropolitan Planning Organizations (MPOs); 26 Regional Transportation Planning Agencies (RTPAs); 482 incorporated cities, and 58 counties in the state.

The agency includes 12 districts, with over 18,000 employees and is funded through federal, state and local taxes, as well as fees and assessments and private investments as shown in the table above.

Before a recently instituted gas tax increase, the state base excise tax had not been increased since 1994 and studies revealed to keep up with inflation, the base tax needed to be increased by 12 cents to achieve the same purchasing power as 1994. Caltrans' Division of Budget estimates for Fiscal Year (FY) 2018-2019, motor vehicle fees and taxes alone will generate nearly $16 billion in revenue. In addition, the recently passed Senate Bill 1 - Road Repair and Accountability Act (2017) - is anticipated to generate over $5 billion annually through increased motor fuel taxes. The State's base excise tax was raised to 30 cents/gallon until 2020 as outlined in Senate Bill 1 and will adjust with inflation beyond that with an estimated 36 percent of the revenue raised being utilized by cities and counties for transportation purposes. In addition, a price-based excise tax of 11.7 cents per gallon was instituted that will increase to 17.3 cents a gallon July 1, 2019 and be adjusted annually for inflation beginning in 2020. This portion of tax is slated to address loan repayments with the remaining funds to be allocated largely to local roadways, new construction, and highway maintenance and operations (State Highway Operation and Protection Program (SHOPP)). Diesel excise taxes were also raised to 36 cents per gallon and sales tax on diesel fuel by 4 percent in SB 1 with rates adjusting in 2020 for inflation. SB 1 also mandates the agency streamline environmental processes, identify specific performance measures, and improve

reporting accuracy to track the return on investment for the public which is in line with the agency's vision statement.

Caltrans' vision statement refers to the desire of the agency to focus on performance, transparency, and partnerships to address transportation challenges: "A performance-driven, transparent and accountable organization that values its people, resources and partners, and meets new challenges through leadership, innovation and teamwork." This vision statement is carried through the agency's integrated asset and performance management program.

AGENCY CONTEXT AND GOVERNANCE

In 2017, Caltrans developed the State Highway System Management Plan (SHSMP) to fulfill the requirements of the Streets and Highways Code section 164.6 that addresses requirements for SHOPP and federal asset management requirements. The plan included a Needs Assessment to identify funding requirements to address performance targets and an investment plan to address management of the SHS. Historically, Caltrans has used an asset-based approach that centers around more asset centric investments, however, through the SHSMP, this approach has been replaced with a performance-based approach which focuses on optimization of performance across assets. This provides the flexibility to ensure that multiple objectives can be met within a single project.

Caltrans works to preserve the condition of the SHS through three primary means: (1) field maintenance, (2) Highway Maintenance (HM) projects, and (3) SHOPP projects. Field maintenance encompasses day to day activities including pothole repair, cleaning of drains, servicing lights and signs, and structural painting. HM projects entail typically contracted corrective maintenance such as thin pavement overlays, culvert repairs, and bridge joint seals. The goal of

HM projects being to extend the life of assets through preservation activities. SHOPP projects typically initiate when HM projects are no longer cost-effective and

involve more elaborate projects including rehabilitation projects for pavements, bridges, culverts, buildings, signs, lighting, etc. As shown below, the benefits of preventative maintenance allow Caltrans to preserve their SHS in the most fiscally responsible way possible.

The 2017 SHSMP addressed financial needs to ensure the

agency can achieve performance targets as well as an Investment Plan to guide funding for the SHS. The needs assessment consisted of five steps (Figure 1).

The table below includes the 34 focus areas of the needs assessment that covers a 10-yr period.

STEP 1 Asset Inventory

STEP 2 Baseline and Projected Condition

STEP 3 Target Condition

STEP 4 Performance Gaps

STEP 5 Cost to Close Performance Gaps
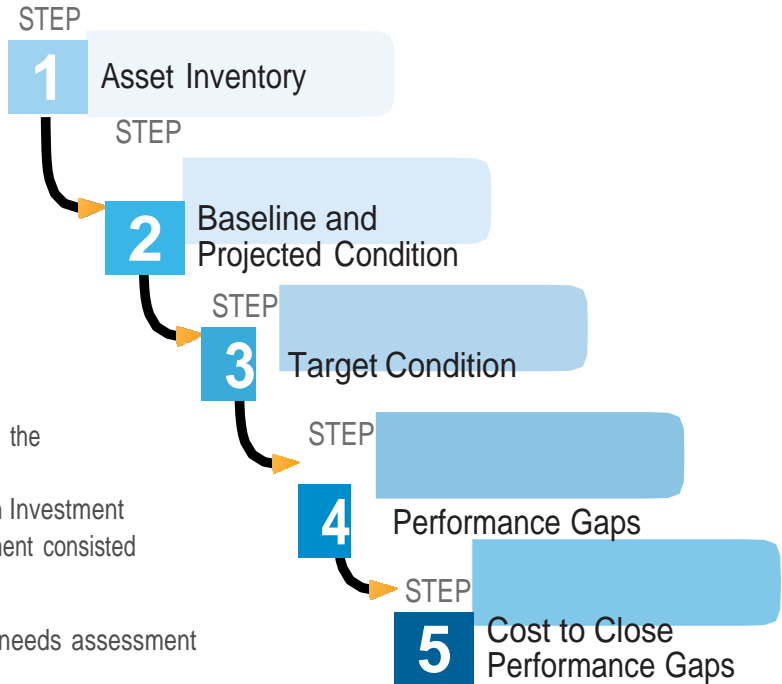
Figure 1. Five Steps Assessment

Objectives	Capital Outlay (in millions)	Capital Outlay Support (in millions)	Sum* (in millions)
SAFETY	**$9,400**	**$3,933**	**$13,333**
Bridge Rail Replacement and Upgrade	$4,426	$1,771	$6,197
Collision Severity Reduction	$895	$430	$1,324
Roadside Safety Improvements	$1,072	$530	$1,602
Safety Improvements	$3,007	$1,203	$4,210
STEWARDSHIP	**$27,223**	**$8,305**	**$35,529**
Bridge Health	$4,160	$1,325	$5,485
Drainage Pump Plants	$110	$55	$165
Drainage System Restoration	$1,668	$898	$2,567
Lighting Rehabilitation	$401	$201	$602
Major Damage (Emergency Opening)	$919	$606	$1,525
Major Damage (Permanent Restoration)	$982	$353	$1,335
Office Buildings	$491	$0	$491
Overhead Sign Structures Rehabilitation	$301	$180	$481
Pavement Class I	$10,648	$1,904	$12,552
Pavement Class II	$4,171	$800	$4,970
Pavement Class III	$989	$197	$1,185
Relinquishments	$22	$7	$29
Roadway Protective Betterments	$316	$151	$467
Safety Roadside Rest Area (SRRA) Rehabilitation	$646	$546	$1,192
Transportation Related Facilities	$1,341	$1,046	$2,387
Water and Wastewater Treatment at SRRAs	$60	$36	$96

Objectives	Capital Outlay *(in millions)*	Capital Outlay Support *(in millions)*	Sum* *(in millions)*
SUSTAINABILITY	$7,167	$3,531	$10,698
ADA Pedestrian Infrastructure	$486	$486	$972
Advance Mitigation	$231	$69	$300
Bridge Scour Mitigation	$580	$267	$847
Bridge Seismic Restoration	$2,160	$929	$3,089
Hazardous Waste Mitigation	$3	$2	$5
Roadside Rehabilitation	$1,368	$657	$2,025
Storm Water Mitigation	$2,327	$1,117	$3,444
Zero Emission Vehicle Infrastructure	$11	$4	$15
PERFORMANCE	$7,000	$2,859	$9,859
Commercial Vehicle Enforcement Facilities	$65	$65	$129
Operational Improvements	$666	$267	$933
Sign Panel Replacement	$539	$162	$700
Transportation Management Systems	$1,321	$489	$1,810
Bridge Goods Movement Upgrades	$4,219	$1,688	$5,907
Weigh-In-Motion Scales	$189	$189	$379
SUBTOTAL	$50,790	$18,628	$69,418
Asset Management Pilot Program	-	-	$82
Minor Program	-	-	$1,500
PID Program Support	-	-	$1,379
TOTAL			**$72,379**
ESCALATED TOTAL			**$85,771**

The SHOPP program will begin to close part of that gap and provide the capability to begin to meet established performance goals. For each of the identified focus areas in the Needs Assessment, a performance measure and target has been identified to help track progress toward closing the gap between needs and performance goals. A few example performance goals are included here:

Drainage System Performance Goal		
GOOD	**FAIR**	**POOR**
80%	10%	10%
16,219,598 Linear Feet	2,027,451 Linear Feet	2,027,451 Linear Feet

Performance Management Components	Basis
Effective Annual Deterioration Rate	N/A (Not a condition-based objective)
Average Unit Cost and Support Ratio	Historic cost data
Target Condition (in 2027)	The goal is to have no scour critical bridges, but due to additional scour identification after significant storm events and due to the length of the project development process, the target has been set to eliminating 90% of scour critical bridges.

Performance Management Components	Basis
Effective Annual Deterioration Rate	Service life criteria
Average Unit Cost and Support Ratio	Historic cost data
Target Condition (in 2027)	The target is to replace all sign panels with retroreflective backgrounds.

In addition, four asset classes have established performance targets to ensure accountability of SHOPP funding that were established in SB 1 and the TAMP including:

- **Pavement** – Not less than 98 percent of pavement to be in good or fair condition by 2027
- **Pavement** – Achieve a pavement pothole and cracking Level of Service of 90 percent or higher by 2027
- **Bridges** – Not less than 98.5 percent of bridge area to be in good or fair condition by 2027
- **Bridges** – Fix not less than an additional 500 bridges by 2027
- **Culverts** – Not less than 90 percent of culvert length to be in good or fair condition by 2027
- **TMS Elements** – Not less than 90 percent of TMS element to be in good condition by 2027

Caltrans is currently working within its 12 districts to meet 34 performance objectives based on the SHOPP. The current version includes fiscal years 2018-2019 to 2021-2022. The guide serves as the state's "fix-it-first" program, that funds the repair and preservation of the SHS. The SHOPP is updated every two years by Caltrans to track progress towards performance goals for funded projects in the previous 2-year SHOPP assessment. SHOPP builds on the performance-based asset management framework set forth in the SHSMP and the TAMP. On Page 6 of this case study provides additional information on funding allocation.

The California Transportation Asset Management Plan (TAMP) was developed in accordance with FHWA TAMP guidelines and provides a statewide view of the system to ensure that each district and Caltrans is meeting national and state performance goals. The SHOPP program builds on this plan and introduces vulnerabilities to achieving goals. While the TAMP only covers physical assets, SHOPP furthers the ideas of the TAMP and includes operational vulnerabilities and environmental risks. Such vulnerabilities include extreme weather and climate change stressors as well as seismic threats to infrastructure health and ratings.

APPROACHES TO INTEGRATION

HOW IT BEGAN

Caltrans conducted an extensive business process mapping exercise to determine how the agency would implement a performance-based allocation program. The exercise was supported by the State of California and allowed the agency to understand the methods and processes used to allocate funding in the past and how those methods and processes may need to change to move towards a performance-based allocation program. The business process mapping effort took approximately 6 months to complete by the Lean Six Sigma group who have been trained to complete this sort of analysis for various divisions of Caltrans. The result was a dramatic change in how the agency funds asset management. Prior to the exercise, funds went to 34 different people at Caltrans headquarters for determining projects to fund. The effort was arduous to build consensus for project selection given the need for agreement from a majority of the reviewers of the proposed projects. Caltrans reduced the project approval process and moved more decision-making regarding funding and development of projects to address agency needs and goals to the district level. The table below contains an overview of the difference between funding levels by asset class and project objectives between the previous and current programs.

Program Categories	2018 SHOPP Projects & Reservations *(in millions)*	40% of 10-yr Constrained 2017 SHSMP* *(in millions)*
PRIMARY ASSETS		
Pavements*	$4,827	$7,458
Bridge	$3,103	$2,889
Culverts	$928	$927
TMS	$798	$698
Supplementary Assets	$748	$632
PROJECT OBJECTIVES		
Major Damage Restoration	$1,451	$1,082
Collision Reduction	$4,087	$2,027
Mandates	$643	$451
Mobility	$367	$156
Roadside Preservation	$107	$129
Protective Betterments	$125	$57
Multiple Objective	$136	$6
Minor Program	$600	$600
Long Lead (New)	$40	
TOTAL	**$17,960**	**$17,114**

Caltrans is working on documenting this effort but has not yet published the overall effort for public consumption.

In 2015, Caltrans published a four-phased approach to their performance-based asset management plan. The four phases called out included:

PHASE 1:
TAMP Prior to 2015

- Establish Asset Classes
- CTC Approval of Asset Classes
- Implement SHOPP Management Tool
- Pilot the SHOPP Prioritization Method
- Baseline Inventory
- Baseline Condition
- Establish draft Performance Measures
- CTC Approval of Draft Performance Measures
- Develop target performance levels.

PHASE II:
TAMP PRIOR TO JANUARY 2017

- Establish new fiscal target setting method
- Finalize Performance Measures
- CTC Approval of final Performance Measures
- Move Prioritization to PID (Project Initiation Document) Stage
- Business process changes
- Software Development

PHASE III:
TAMP PRIOR TO JANUARY 2018

- Multi-Asset Pilot Projects in SHOPP
- Fund allocation business changes
- Asset Management
- Software Development

PHASE IV:
TAMP COMPLETE JANUARY 2020

- Software complete
- TAMP Implemented

With the identified approach to meeting new performance-based asset management requirements, the state legislature moved on a bill to support the agency's identified needs to meet established performance goals.

HOW IT CAUGHT ON

As noted previously, the passage of SB 1 moved Caltrans forward on their path to move towards a performance-based, transparent, accountable agency. Through their asset management plans and SHOPP, Caltrans has successfully integrated performance and asset management in their 2018 TAMP and are working towards more quantitative risk assessment and integration of this information into their performance management goals. They are currently working with 12 districts to meet 34 performance objectives based on the SHOPP. The current version includes fiscal years 2018-2019 to 2021-2022 and identifies approximately 1,000 projects with approximately 450 of the projects addressing specific performance goals for four primary asset classes (pavement, bridges, culverts, and traffic management systems). The SHOPP programming cycle is made up as four steps as follows:

1. The SHSMP is updated every two years to show what has been done in the last period and what needs to be done in the next ten-year period.

2. The TAMP presents current Caltrans inventory and conditions of assets, SHS, performance objectives, risk mitigation, and life-cycle to identify areas of improvement.

3. Caltrans develops a fiscal capacity for this cycle, which is then approved by the Commission.

4. Identifying projects that fit within the 4-year program that directly respond to the needs of the SHSMP.

Caltrans has built a custom trade off tool to ensure that each of the 12 districts equity funding to meet statewide goals including safety, structural deficiencies, vulnerabilities from external stressors, performance, etc. Instead of funding individual asset classes, Caltrans funds districts in a manner that allows for project development in support of the agency's overall objectives. As projects are developed and executed, four performance snapshots are taken to track performance objectives against agency goals pre-planning, post-planning, award of the project, and construction close out.

For each project in the SHOPP a project a "Project Initiation Document" (PID) is developed to convey the intended needs and goals of each project that provides transparency in "plain language" to the legislature and the public on how the proposed SHOPP projects will work towards the goals of the TAMP. When possible, a projection of the improvements in performance goals is noted in the project description, such as the anticipated reduction in crashes as a benefit of the proposed project. An example project description is provided on the right.

To track these performance objectives, projects are tracked in a four-phase system:

1. **Pre-planning**
2. **Post-planning**
3. **Award of the project**
4. **Construction close out**

Caltrans has other funding mechanisms that help to address the additional SHS needs. In addition to maintenance and rehabilitation of the SHS, there are also needs such as increased freight movement, economic growth, population increase, and environmental changes. These needs are often addressed through funding provided by recent legislation, the State Transportation Improvement Program (STIP), as well as state and local taxes. With the increase in these types of projects, it is imperative that life-cycle planning is taken into consideration. This will not only help with maintenance projects in the future, but also in the beginning project stages for new projects.

CHALLENGES OF INTEGRATION

Through SHOPP, Caltrans has worked to integrate existing and forecasted performance goals with asset management and project development. The next area of integration Caltrans is working towards is fully integrating risk and climate change into their asset management program. Recognizing risks come in many forms including faster than anticipated deterioration rates of assets, higher project costs than anticipated, to climate change and extreme weather and natural disaster events, Caltrans is initiating several activities to work towards incorporating these risks into their performance metrics and goals.

In 2017, Caltrans developed a Risk Register through a series of workshops with staff led by a consultant team. The exercise resulted in a list of prioritized perceived risks, strategies, and potential actions to take to mitigate identified risks. The risks were classified into several categories including:

- Asset Performance
- Highway Safety
- External Threats
- Finances
- Information and Decision Making
- Business Operations
- Project and Program Management

These risks were further scored against a risk matrix that reflects the likelihood and impact of any of the identified risks qualitatively to the Caltrans system. Those threats that were score as being "very high" or "ultra-high" included external threats such as extreme weather events and threats related to information and decisions in which succession planning and lack of accurate performance models for assets were noted as being of concern to meeting asset management needs.

Caltrans is working to integrate risk into other management areas by looking at vulnerabilities that have been developed over the years, including seismic, rockfall/slide, bridge scour, high load vehicle hits to bridges, etc. As noted in the 2018 TAMP, multiple bridges have been struck by high load vehicles and several landslide areas have experienced events that have resulted in emergency projects. Caltrans is also working towards development of mitigation plans for these types of risks that result in emergency projects.

Additionally, an extensive climate change vulnerability assessment is being executed that takes sea level rise and climate change into account. As of the spring of 2019, five districts have been mapped to understand how climate change may affect highway assets. Looking into the future, it was noted that how climate change will affect the agency is still an unknown, it could easily cost the agency billions and take away from other areas of investment. Currently, the agency is grappling with funding to deal with a whole new set of vulnerabilities brought on by climate change, such as sea- level rise, extreme weather patterns, and fire damages. Balancing the needs of the system across multiple demands such as safety, asset condition, and operations is something still up for debate in the agency. One change that has occurred due to the past few substantial fire seasons is a move towards steel only guardrail systems to avoid losses from fires. Another change related to design is the requirement that new bridges be built to 2100 sea level rise elevations, typically 8 feet higher in elevation that current standards.

A goal of the agency is to provide quantitative risk assessment data at the asset level to their districts through a GIS portal to allow for information related to physical threats to infrastructure such as flooding, to be added into consideration of projects developed for SHOPP. The agency also wants to develop mechanisms to consider the life cycle of assets when considering risks, for example, recognize the remaining service of an asset and identify opportune points in that life cycle to make appropriate investments to harden assets from external stressors that optimize investment and remaining service life when possible.

DATA NEEDS

To meet new performance goals, Caltrans has implemented an in-house developed spreadsheet tool to act as a management system for monitoring assets. In addition, the agency is working with subject matter experts to develop models for deterioration of pavement and bridges. Currently, pavement is the only asset that can utilize future forecasting of pavement condition. In addition, Caltrans is working with GIS specialists to assemble a portal on the agency's internal website which would allow asset managers to access information on more assets. This program will include lane by lane pavement conditions gathered from in-field data collection techniques, as well as spatial information for all assets.

To be able to see the big picture, Caltrans is working to create a "three-dimensional risk assessment", that will consider the impact to the system, safety, and asset condition. This will enable Caltrans to analyze vulnerabilities on a common scale. To achieve this, Caltrans is looking to bring in consultants to design asset management software that will take these concerns into account.

Caltrans is working to secure funding and consultants to map their data, prepare their document landscape, and implement data governance. The end goal is to have a heavy GIS based program that will connect project assets directly to needs. The product would establish a baseline, allow asset managers to asses if goals were met and look at the asset into the next ten years. To achieve this, Caltrans is collecting data, more than required by the federal government (bridges and pavements), to compare how assets are currently performing as compared to asset forecasted conditions.

PERSONNEL AND SKILLS

PERSONNEL

Caltrans conducted an extensive business process mapping exercise to determine how the agency would implement a performance-based allocation program. The exercise was supported by the State of California and allowed the agency to understand the methods and processes used to allocate funding in the past and how those methods and processes may need to change to move towards a performance-based allocation program. The review also revealed the need for additional staff to meet the changing needs of the agency.

Caltrans is made up of 12 districts who report to the central agency. Across the 12 districts, Caltrans has seen an increase in staffing. To increase the asset management program, each district now has an asset manager that meet with the central asset management team through monthly calls and a few statewide meetings held annually. These asset managers are responsible for overseeing budget and allocating funds as well as reporting to the central asset management team. On-going efforts are underway to provide additional training and guidance to support the new staff.

Each district has a set budget that is allocated for five years and updated every other year. Every other year, there is a goal constrained needs assessment that is used to create a report for the governor and legislature to show the unfunded liability. Caltrans uses transportation system equity to make sure that

all districts are meeting their required performance targets. This pushes responsibilities to district directors, who then must address how many of the 34 metrics have improved between each period. Each district is provided a lump sum to fund any number of projects that district sees fit that works towards the overall statewide performance goals. District directors are then responsible for how their district performs across the identified 34 metrics.

SKILLS AND TRAINING

Caltrans is working on an asset management framework and guidance to document what each district asset manager should collect, track, and report as well as how to incorporate life cycle information into their project selection process. The agency is focusing on documentation to help asset managers understand what can and cannot be funded through the new state laws.

To ensure the accuracy of Caltrans data, there has been extensive training as well as staff and program expansion. Caltrans employs many employees and is committed to investing in these employees to meet future challenges and embrace new skills. With the inclusion of new policies, the agency has had to expand their skill set and add additional staff and employ new training to existing staff. Policy and Agency Structure

RESOURCE REQUIREMENTS

To increase funding to the agency, California passed a gas tax that was based on recommendations from Caltrans. The value of the gas tax was based on Caltrans' own performance-based analysis. It is noted that SB 1 provides the first significant, on-going, and stable investment in the SHS in more than two decades. The efforts put forth in the planning stages of multi-year effort that identified the rehabilitation needs and priorities of the SHS that identified financial needs while recognizing fiscal constraints. Through this effort, Caltrans was able to begin to address established performance goals and short-falls of existing budgets to meet the identified financial needs and demonstrate the impact to potential future conditions. The two-year rolling cycle of updating performance goals against programmed and executed projects will provide the insight needed to track the return on investment to meet the agency's goals from SHOPP over the anticipated ten-year program.

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NCHRP
**NATIONAL
COOPERATIVE
HIGHWAY
RESEARCH
PROGRAM**

JUNE 28, 2019

DEEP DIVE CASE STUDY

S U M M A R Y

DEEP DIVE CASE STUDY

INTRODUCTION

This document summarizes the deep-dive interviews conducted with the United Kingdom transportation agency, Highways England, in support of Task 5 of NCHRP Project 08-113. Two extended phone interviews were held with a representative of the government-owned company, led by Tariq Shihadah and John Turpin of Jacobs, on Wednesday, May 15 and Monday, May 20, 2019. The interviews covered the topics of Agency Overview, Approaches to Integration, Data Needs, Personnel and Skills, Policy and Agency Structure, and Resource Requirements, which are discussed in the following sections.

AGENCY OVERVIEW

The primary responsibility of the government-owned company Highway England is to provide a safe and serviceable network for their road users and stakeholders. The agency constructs, renews, maintains, and operates the Strategic Road Network (SRN) infrastructure, which encompasses over 20,000 miles of roads and an extensive portfolio of ancillary roadside assets such as bridges, structures, drainage, geotechnical, lighting, vehicle restraint systems, technology, signage and road markings. The SRN carries over four million vehicle journeys every day, moving more freight than all other transportation modes put together and acting as the backbone of the national economy.

AGENCY CONTEXT AND GOVERNANCE

The agency, previously known as England's Highways Agency, transformed into Highways England in 2015, creating a new governance structure and new management mechanisms

KEY FINDINGS

- Highways England underwent a major restructuring in 2015, impacting leadership, objectives, and culture; changes include the implementation of 5-year road investment periods under the supervision of a regulatory monitor and the development of strategic documents for achieving their performance specification.

- Their asset management program is being designed to be consistent with ISO 55000, drawing lessons and practices from the airport and water sectors.

- Several key performance indicators cover both quantitative metrics, such as safety performance or pavement surface condition, as well as qualitative metrics, such as customer satisfaction.

- Executive-level buy-in, cultural change, collaboration across practices, and continuous improvement are necessary to support effective integrated management.

- It is important to take a sophisticated approach to utilizing available data and modeling for uncertainties and unknowns, while constantly striving towards improved data.

- Longer-term investment periods aid in finding efficiencies and effective solutions, however it is important to maintain complete records of spending and budgets to support such decision-making.

- Moving towards in-sourcing technical activities related to asset management can be challenging and may take time, however it may provide long-term benefits through expanded agency competencies and experience.

that enable the business to plan and deliver work more effectively. Because of this, there have been and continue to be significant organizational changes associated with leadership, objectives, culture and priorities. Not least, the evolving relationship with the Office for Road and Rail (ORR), who are Highways England's regulatory monitor. Central to this new structure is the requirement to measure delivery as well as performance and, in turn, to better understand the relationship between investments and outcomes. The hierarchy of top-level strategic documentation that underpins Highways England's obligations is:

- **Highways England License.** Contains Secretary of State for Transport statutory directions and guidance to the strategic highways company.

- **Road Investment Strategy (RIS).** Sets out the government's vision for the strategic road network and a 5-year investment plan, including a Statement of Funds Available (SoFA) and a Performance Specification for the Road Period.

- **Highways England Strategic Business Plan (SBP).** Highways England's response to the RIS sets out the company's main activities and strategic outcomes and describes how it will go about delivering the Investment Plan and meeting the Performance Specification.

- **Highways England Delivery Plan.** Building on the SBP, the Delivery Plan sets out in detail how Highways England will meet its strategic outcomes including the maintenance output volumes to be delivered.

During the first 5-year road period (2015 to 2020), the ORR has been monitoring how well Highways England is delivering against the Performance Specification, Investment Plan, and aspects of its Operating License. A suite of performance metrics has been developed and data collected to enable Highways England to gain a fuller understanding of performance level and investment choice relationships. As a result, Highways England now holds a significant amount of information upon which to make business choices going forwards. It follows that there is both an opportunity and expectation to produce an SBP that raises the bar in terms of efficiency, performance level and certainty of outcomes.

In line with other UK sectors, there is a direction of travel towards regulated bodies becoming self-assured whereby the emphasis is on them to perform a level of internal governance and to provide accurate well-evidenced performance information. Investment plans also require strong evidence demonstrating that needs identification, optioneering, and costing is robust. In the case of Highways England, there are opportunities to learn from other more established regulated sectors and a key aspect of this is to identify assurance practices that meet the needs of your organization within the timescales for the SBP. Coupled with this there is also an opportunity to support the wider objectives of the technical assurance services and there is a significant potential benefit of reviewing the strategic asset management approach.

Highways England is now approaching the end its first 5-year Road Period and is presently working on the SBP that will define the investment choices and set the level of performance for the second Road Investment Strategy (RIS2) period, 2020-2025. This will set out the ambition for RIS2, which is divided into 6 strategies that have been developed collaboratively across the business, covering:

These strategies inform the SBP which, in turn, shape the investment portfolio and the performance metrics that will incentivize and govern the next Road Period. The settlement for the RIS2 investment period will be c. £25.3 Bn TOTEX.

ROLES AND ACCOUNTABILITIES

Through RIS1, Highways England responded to the challenges of moving from an annualized funding to a five-year budget, which has impacted planning horizons and governance. There is an evolving view of the respective roles of the Directorates through the different time horizons of the business planning cycle for capital renewals. The schematic shown in Figure 2.1 provides an indicative illustration of the future state, where:

Figure 2.1. Planning Horizon Schematic
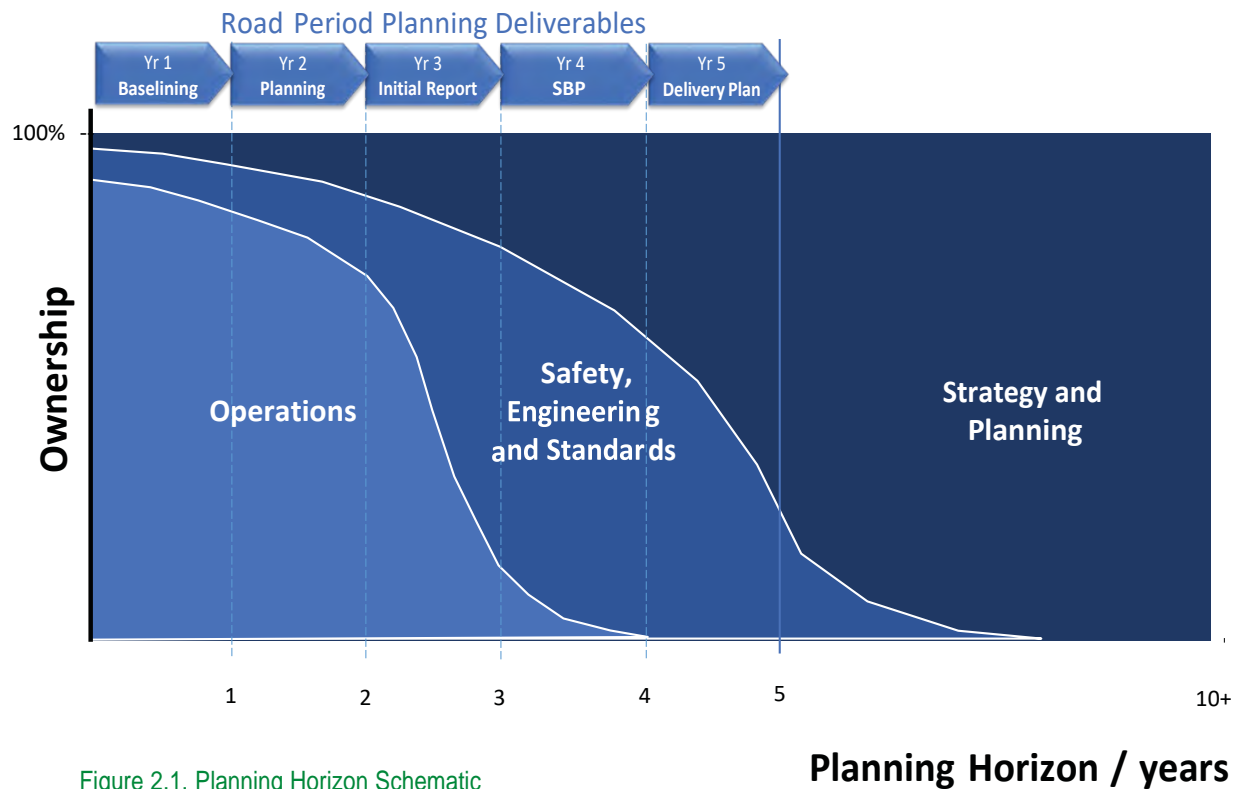
- **Strategy and Planning** set out the long-term vision and negotiate strategic outcomes with Government (ORR/DfT);

- **Safety, Engineering, and Standards** define the *envelop of need* through the application of asset lifecycle modeling and defining the technical asset specific policies; and

- **Operations** develop and deliver the detailed plans, at scheme level, that achieve the strategic outcomes that comply with policy and within the negotiated budget.

APPROACHES TO INTEGRATION

ASSET MANAGEMENT FRAMEWORK

In support of the business transformation, Highways England embarked on a newly reconfigured asset management program with the ambition of embedding an integrated asset decision making framework consistent with ISO 55000. This has presented significant challenges in terms of:

- The sheer scale and geographical distribution of the asset portfolio;

- Incentivizing the change from *old world practices*, engrained by *old world processes;*

- Providing a suitably adaptable solution to cater for its many different contract delivery models;

- Managing extensive, complex and sometimes conflicting stakeholder expectations; and

- Consolidating inconsistent approaches from across several service providers, each working under different decision-making assumptions.

The asset management transformation program is enabling Highways England to redesign its approach and consider more the whole-life cost and benefits of investment decision making. One of the critical enablers for success was to gain leadership buy-in. To address this, an Asset Management Policy has been endorsed by the agency's CEO and a cross-directorate Asset Management Steering Committee has been established to provide top-level governance, consistent decision making, collaborative working, alignment of objectives and coordinated communications.

The Asset Management Framework was adapted from an ISO 55000 compliant solution that had been successfully implemented in the Airport sector. This blueprint has been successfully re-configured for several other clients from

Remove End of Life Assets

Process 5 & 18:
Update I-AMP and Project
and Scheme Development

ACT:
Update the Asset
Investment Strategy &
Asset Management Plans

Process 1:
New Assets

PLAN:
Identify Asset Groups &
Priorities Based on
Business Risk

Legacy Asset Reviews
(Risk Based)

Assets In-Service or
Being Developed
@Highways
England

Proces19:
Executive Governance
Reviews

CHECK:
Value Improvement
Meetings &
Asset Governance
Reviews

DO:
Set-up Whole Life
Operational &
Maintenance Profile
for Assets

Process 2-9:
Identify Assets
Assess Criticality
Set Performance Requirements
Develop Whole Life Plans
Set Operating Protocols
Develop Contingency Plans
Assign Resources

Process 10, 11 & 17:
Measure Performance
Check Maintenance Work Completion
Asset Governance/Value Improvement

Figure 3.1. Continuous Improvement Cycle Schematic

across different sectors. The blueprint is underpinned by 19 core asset management processes, which are based on a *plan-do-check-act* continuous improvement cycle (Figure 3.1)and aligning strategic objectives with regional and lifecycle asset management plans.

These processes were developed to create a bespoke Asset Management system that aligns to the context of the specific organization. For Highways England, the majority of these processes were already present in some form but were adhered to inconsistently across the business. The blueprint was used to build on existing good practices and to seek to address the gaps and inconsistencies across the processes and departments, rather than wholesale process re-engineering or re-branding.

Highways England is still on its asset management journey; however, the following benefits and outcomes are starting to be realized:

- More expedient, consistent and transparent

decision making and the ability to demonstrate value for money to stakeholders such as ORR;

- Extension of the planning horizon and, in turn, identification of opportunities for cross-asset and programmatic efficiency savings;

- More mature understanding of the risk/cost relationship between capital renewal and routine inspection frequencies;

- Prioritization of capital renewal interventions closely aligned to business KPIs;

- More transparent adherence to Highways England's Operating License obligations, specifically with regards to the adoption of a whole-life-cost approach to managing the assets; and

- Cost efficiencies through better alignment, integration, and timing of major projects and capital renewals.

INTEGRATION OUTCOMES

Under their new asset management framework, Highways England has been able to successfully integrate elements of performance and risk management into their asset management practices. This integration is exemplified in their identification of several key performance indicators (KPIs), such as those shown in Figure 3.2. Some KPIs are quantitative, such as safety performance or pavement surface condition, which feed into an enterprise database which tracks these performance measures and more. These measures may trigger interventions for maintenance and capital improvement and will commonly influence decision-making in concrete manners. Others are qualitative and bottom-up, such as customer satisfaction and focus group response, which often have tenuous linkages with decision-making due to their subjective nature and being difficult to act upon. Some KPIs may also have goals which are in competition, such as roadway availability and roadway condition. Roadway availability concerns the agency's intention to make key routes available

to road users at all times, conflicting with the agency's goal of providing continuous maintenance and improvement to roads which may result in lane and road closures due to construction and inspections.

Despite the broad adoption of these KPIs at higher levels of the agency, Highways England has remarked at the challenge of achieving full infiltration of such considerations at lower levels, where behaviors are more commonly driven by individual, local targets. The agency is working on bridging such gaps, improving the line of sight from the executive level where KPIs are established and lower levels where the KPIs can be implemented in daily applications. It is important that insights behind KPIs are understood, so that levels of achievement and reasons behind achievements can be documented and can ultimately influence goal-setting and decision-making.
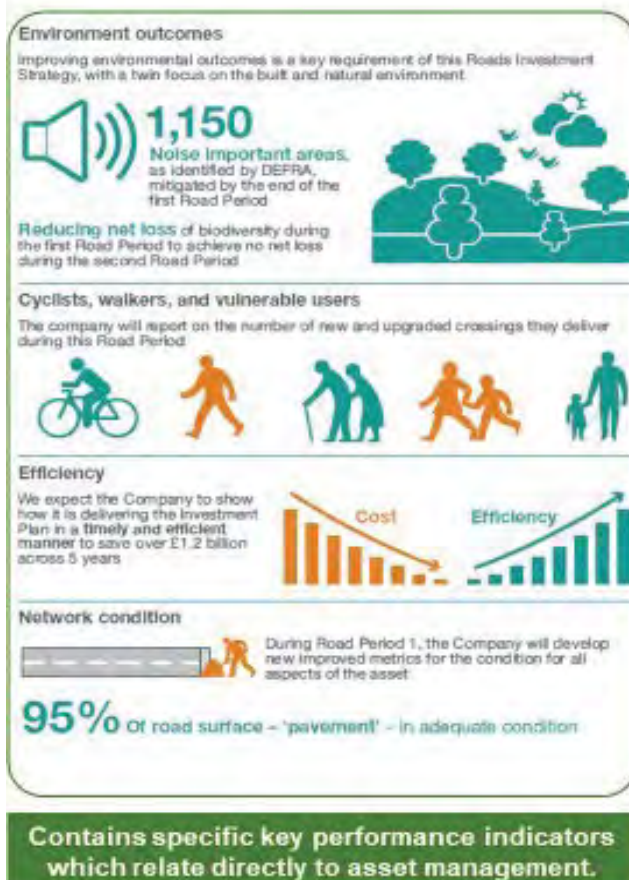
Figure 3.2. Road Investment Strategy Performance Specification

LESSONS OF INTEGRATION

As Highways England continues to work towards developing a more integrated and progressive approach to asset, performance, and risk management, they have noted several key lessons. Firstly, they discuss the importance of buy-in from the executive level. Because structural change is initiated from the top, it is important that leadership identify integrated management practices as a priority to help ensure success at all levels. This feeds into a cultural change within an agency and allows for the alignment of practices to a new set of goals. Such goals include cooperation and collaboration, where practices are able and encouraged to breach the traditional silos which are commonly in place in government agencies. This leads to greater efficiencies, newfound synergies, and more effective day-to-day performance.

Highways England also highlights the importance of continuous improvement through their informal implementation of ISO 55000, guiding the agency by its principles of effective and flexible asset management. Because of the unique context of each transportation agency as well as their unique asset portfolio, it is imperative that an agency produce an asset management program which is appropriate and efficient for their needs. Along with this, it is important that the program is dynamic, able to evolve over time to better suit and adapt to any and all needs that arise. Because Highways England is working to advance an already established asset management program, they recognize the importance of providing consistency and reliability over the course of their evolution. It is important to understand the individual goals of the transition, taking steps to achieve a steady evolution, knowing that many challenges will be encountered along the way and that being prepared to deal with them is essential for long-term success.

It is also important that agencies are aware of the data needs associated with such progressive approaches to management practice integration. Data quality and availability can often be a limiting factor for agencies who are looking to expand their methodologies. This can relate to data about existing assets or asset deterioration models in addition to historic finances related to maintenance and capital improvement, which may impact an agency's ability to perform accurate and effective long-term investment planning which is a key element of effective management. However, because of the time it often takes to collect and refine data, it is important that agency staff work to optimize the use of what data is available in the meantime instead of only waiting for improved data.

DATA NEEDS

DATA GOVERNANCE

As the agency has evolved over time, Highways England has highlighted data governance as a key area for improvement. Because data consistency and accessibility are valuable for effective data-driven asset management programming, it is important to have some structure in place. Currently, Highways England has established general data standards through an asset data manual which is helping drive some consistency throughout data management groups. However, systems are still fairly disparate, and the agency has struggled to establish uniformity through formal solutions. Each asset management group currently owns and maintains their own databases, separating information on pavements, structures, and more across the agency. This can inhibit growth of strong data-driven techniques due to the level of effort needed to bridge gaps for cross-asset applications. Additionally, it can reduce the efficiency of the performance of some regular tasks, impacting the overall effectiveness of the asset management practice. Moving forward, Highways England is putting together plans to improve data governance during the next 5-year period, providing greater accessibility to data, improved data compatibility, and more comprehensive documentation.

MODELING AND PREDICTIVE ANALYSIS

As Highways England continues to advance its data management approach, the agency hopes to provide support for the implementation of more sophisticated data analysis methods as well as modeling. They plan to accomplish this through more robust data sets and improved uniformity and accessibility of data in time for the next 5-year period. For such advancements, they are taking cues from England's water sector, which has been through five regulatory cycles over their history. Through these cycles, the sector has been able to achieve significant advancements and further refinement of data governance methods and analysis approaches. This has allowed them to access more modern and technologically and statistically advanced, data-driven techniques, which Highways England hopes to emulate.

A key advanced data process which Highways England will implement is the use of data modeling to adjust for the uncertainties of data which is incomplete or unreliable. This is an important application due to the current state of the agency's data and the time and cost of gathering and preparing new data. Such modeling will allow the

agency to optimize its use of what is available, opening new opportunities to advance its current practices without waiting for newer data to become available. This is particularly relevant for information related to asset condition, where continuous data collection on all elements of a vast network may not be possible, as well as for financial data, where historic data, which is valuable for use in long-term financial planning, may be lacking.

PERSONNEL AND SKILLS

STAFFING

Highways England includes more than 4000 staff, covering a broad range of responsibilities. In recent years they have faced some staffing challenges due to the competitiveness of the private sector which can be more popular among new engineers entering the field. This makes it difficult for the agency's practices to acquire the levels of staffing and expertise that they need to find the greatest success with the current evolution of their asset management program. Additionally, since its conversion from an executive agency to a government-owned company in 2015, they have faced some turnover related to the transition.

COMPETENCIES

Highways England is working to grow internal competencies by insourcing more operations and maintenance work, moving away from common use of consultants to support regular, long-term, and some specialized processes. Previously, the agency had 12 service providers with 5-year contracts, however this is now being reduced under their new asset management program. The agency has identified this is a long-term goal as it increases their capacity to perform various key asset management activities that were previously outsourced and removes commercial boundaries. This is helpful in preparing the agency for further advancements to their management program, building efficiencies and greater levels of creativity into their staff, improving sustainability. Similarly, it puts responsibility on Highways England to be the innovators, driving intentionality and modernization and leading them towards more intelligence-led asset management.

The push towards insourcing also will lead to a stronger focus on the goals of the agency. Due to the profit-driven nature of private entities, too much use of consultants may skew operations and investments away from the purposes of serving the public and more towards the supply chain. However, too much reduction in consultant partnerships may disincentivize private firms from supplying the most effective services due to the less profitable nature of smaller contracts. Because of this, the agency notes that it is important to strike a balance of internal and external competencies to provide the most effective results for the public.

In their push towards greater levels of insourcing for operations and maintenance tasks, Highways England has encountered some stresses to staffing. This move requires training and on-the-job learning for existing staff as they begin to take on additional responsibilities for tasks that were previously outsourced, putting additional experiential burdens on staff as well as financial burdens on the agency at large. Similarly, the move requires the acquisition of some new staff to address new competency needs which can be challenging and may take time.

TRAINING AND DEVELOPMENT

Currently, Highways England offers standard minimum training for new staff entering the agency as well as some topical, one-time training events when necessary as new tasks arise and as new methods are piloted. However, the agency has not established a formal training structure around integrated management processes for new or existing staff which invests time into the furthering of their ongoing evolution. This is primarily due to the sheer amount of changes currently ongoing at the agency which have affected many aspects of their operations. As agency structure and processes continue to develop and become formalized, they hope to begin providing more structured training opportunities for staff to continue to invest in their workforce's role in the new agency model.

Additionally, the agency notes the importance of mentorship among staff, supporting informal training structures and relationships in regular, day-to-day operations. This is valuable for developing a culture which actively supports agency management approaches. This is important and reflects a key goal of the agency to foster creativity and collaboration within the ranks of their staff, building successful practices into the low-level structure which reflect the key performance indicators established at the executive level. Similarly, mentorship and culture-building leads to more effective succession planning, promoting longer-term success within the agency.

POLICY AND AGENCY STRUCTURE

STRUCTURE OF MANAGEMENT AREAS

Within Highways England, asset management has intentionally been established as a cross-directorate practice. This requires intentional collaboration and communication among various levels and areas of staff within the agency to achieve effective results. This is counter to the way that many agencies are set up, with each practice largely operating separately with minimal cross-pollination or cooperation. Additionally, in recent years the asset management practice has become more customer-facing, leading to a greater focus on customer service and systems through key performance indicators (KPIs) related to customer experience and satisfaction. This gets enabled through the practice's autonomy to operate in a manner which best serves its goals as well as through its accountability to the goals of the broader agency. Because of this, it is essential that there is cross-talk among directorates and a breaking down of silos to allow for internal collaboration and synergies. Establishing effective internal teamwork among disparate practices takes a great deal of effort and time, and interruptions can occur as the agency continues to evolve and there are many barriers to this along the way. However, Highways England is resolved to continue pursuing this structure, leading to KPIs filtering through the entirety of the agency to achieve greater results.

As Highway's England's asset management practice is building on the existing structure that was previously in place prior to its transition in 2015, it is able to advance incrementally. The practice selects the best examples and practices from within the agency as well as from adjacent agencies in the water and air travel sectors to help formulate a structure that offers the greatest results for their context as well as flexibility to allow for continued growth and change. As they look forward to more full-scale advances of their agency in the future, they recognize the importance of a steady evolutionary process, which provides consistency for staff, executives and road users, avoiding overexertion of staff and introducing stresses which may distract from the agency's goals and KPIs.

INTEGRATION LEADERSHIP

Within their new agency structure, the Highways England asset management division is lead by a director of asset management. This person serves as a central point across the whole business for all operations related to asset management and is the primary one driving the program through its ongoing changes. The director holds a senior role, acting as a leader and guiding advancements to the agency's asset management approach. Though the agency hasn't explicitly identified a champion for their effort to integrate management approaches, this director largely serves this role through the responsibilities of the position.

AGENCY POLICY

Highways England has established common objectives across different departments which cascade throughout the organization. They have worked to develop a platform which encourages and incentivizes their staff to think and behave creatively, and to break through walls between practices to serve the greater good of their road users and the general public. This structure of constructive challenge is largely cultural, stemming from effective leadership throughout the organization as they work to create a cohesive, innovative, and cooperative environment.

Due to a number of contributing factors, Highways England has encountered some difficulty in establishing a system-based, forward-looking mindset among some specific practices, within their asset management group and adjacent groups. As they work to address these factors and pursue the guidance outlined in their Road Investment Strategy, they hope to expand the vision of their agency for longer-term planning and consideration, allowing for greater efficiency and improved customer experience.

RESOURCE REQUIREMENTS

BUDGET AND ALLOCATION

With risk and performance considerations being fed into the existing asset management group, Highways England is able to achieve efficiencies in their use of resources which would be difficult for less holistically-thinking agencies. However, as with all comparable agencies, scarcity of resources at times limits the capability and capacity of the agency to pursue systemic changes. Because they are such a large company, they face many competing interests and initiatives. This can limit the level of resources that they are able to acquire to support integration efforts. Additionally, the vast size of their network can mean that efforts to develop and expand infrastructure data can be financially cumbersome, and that implementation of new policies and initiatives can take a great deal of time. In order to address such issues,

Highways England hopes to more broadly implement modern technology to monitor assets, automate data collection, and produce dynamic interfaces to improve agency efficiency with asset management practices, making room for more innovative approaches and strategies.

FINANCIAL PLANNING

To achieve a stable and effective budget, Highways England has found it is important to study and to understand the full life cycle of the each road investment period. In the course of an investment period, plans are presented to the government, capturing the full picture of asset needs and funding strategies which will be implemented over the course of the next five-year plan. Discussions are held as to the way finances will need to be allocated to best achieve agency goals and determinations are made to prioritize outcomes for the investment period. Such longer-term views allow for more stability and efficiency of finances. However, because budgets are always in flux within Highways England as is the case for many comparable agencies, it is important that they remain flexible and prepared to modify financial plans as needed.

Highways England ran into some difficulty during the first road investment period due to lack of data and information about historic budgeting and expenditures, limiting their ability to accurately forecast expenses and estimate returns. This resulted from much of their project work expenses being lumped and documented together, leading to uncertainty of how finances have historically been allocated and used. Additionally, due to the unpredictable and non-linear ways that some asset classes deteriorate, the agency has found it challenging to effectively measure all asset conditions, data which is essential for effective asset budgeting decisions. These have proved to be major challenges in their planning cycle as they have limited the agency's understanding of budgeting needs as well as their ability to plan according to historic finances, where future decisions could be informed by the effectiveness of decisions made in the past. Moving into the second investment period, the agency hopes to mitigate these limitations as best as possible, utilizing uncertainty modeling and more robust planning methods to achieve greater accuracy and confidence. Additionally, they are working to improve documentation methods and data collection to better serve future planning efforts.
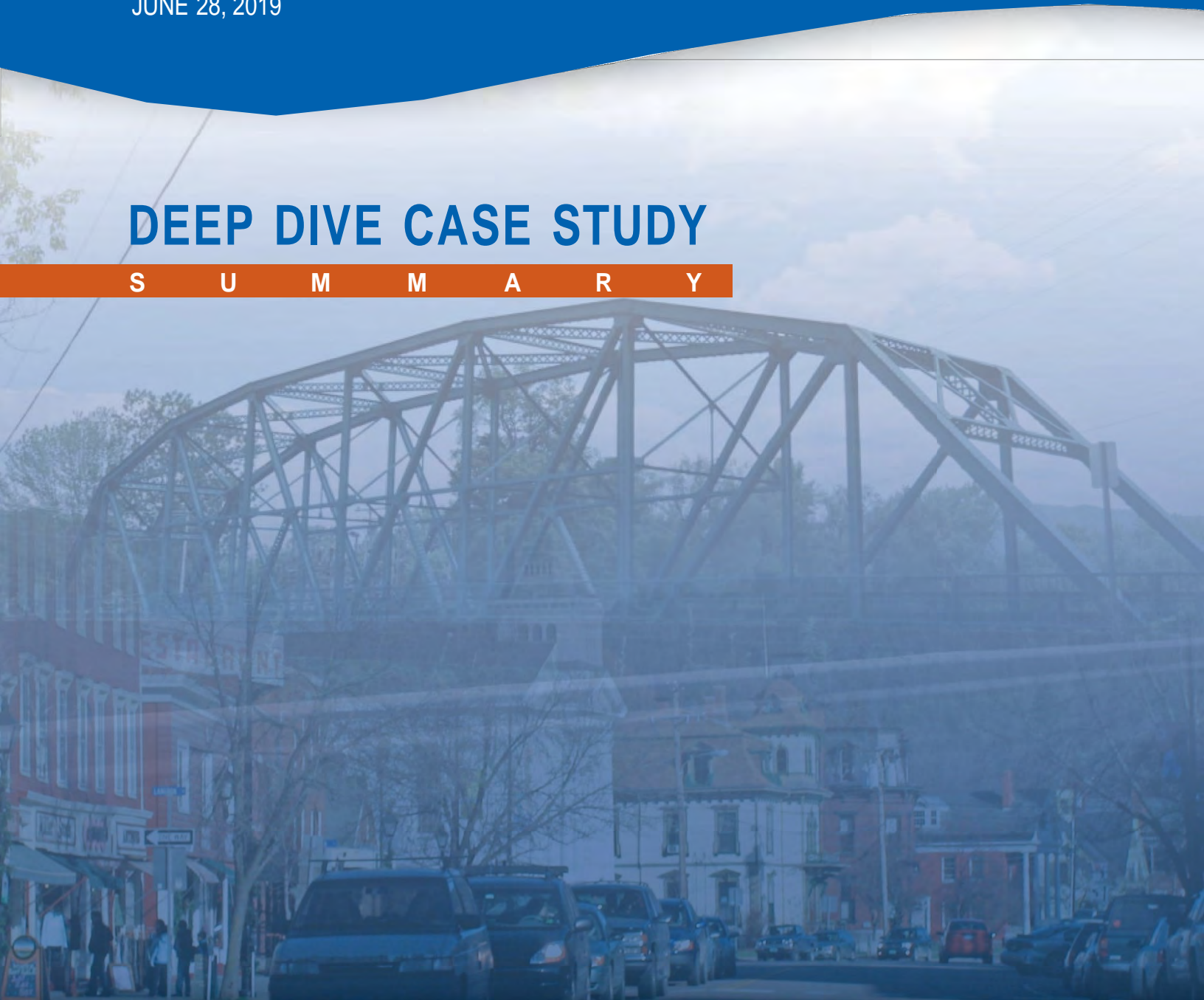
NCHRP

NATIONAL
COOPERATIVE
HIGHWAY
RESEARCH
PROGRAM

JUNE 28, 2019

DEEP DIVE CASE STUDY

S U M M A R Y

INTRODUCTION

This document summarizes the deep-dive interviews conducted with the Vermont Agency of Transportation (VTrans), in support of Task 5 of NCHRP Project 08-113. Brian ten Siethoff and Nathan Higgins of Cambridge Systematics traveled to VTrans' offices in Montpelier, VT, for two days of in-person interviews with VTrans staff on May 13-14, 2019. The interviews covered the topics of Agency Overview, Approaches to Integration, Data Needs, Personnel and Skills, Policy and Agency Structure, and Resource Requirements, which are discussed in the following sections

AGENCY OVERVIEW

VTrans, headquartered in Montpelier, Vermont, is a relatively small agency, with 1300 employees and a $620 million annual budget. The agency is responsible for planning, constructing, and maintaining state-owned transportation facilities across the state of Vermont, including roadway networks, airports, bicycle and pedestrian facilities, and public transportation systems. VTrans has established a mission which focuses on providing safe and efficient movement of people and goods while delivering excellent and effective service to all customers, with a vision of "a safe, reliable and multimodal transportation system that grows the economy, is affordable, and protects the vulne able "

KEY FINDINGS

- VTrans cites improved communication, collaboration, and trust among staff as among the chief benefits of their efforts to integrate performance, risk, and asset management.

- Exposing the data and improving transparency inside and outside the agency was a key to making asset management effective and making risk- and performance-based decisions. Data-driven processes require quality, accessible, consumable data.

- Being honest about performance has held VTrans accountable and has built credibility with the agency's external partners.

- VTrans' leadership at the highest levels is dedicated to performance management and understands the value of integrating risk and asset management with performance. The agency's culture of performance management is getting stronger, and they are spreading a culture of asset management and risk management.

AGENCY CONTEXT AND GOVERNANCE

In 2014, VTrans created the Asset and Performance Management (AMP) Bureau within their Highway Division. Through the creation process, AMP has established a three-part mission:

- **Preserve the state's assets and minimize their whole life cost**
- **Operate in a financially-sustainable manner; and**
- **Provide a framework to improve performance on a long-term basis**

There are three sections within APM:

- **Data Management** maintains VTrans' asset inventory and the agency's asset and performance management systems, which currently consist of a pavement management system and a bridge management system. VTrans is developing a more comprehensive Vermont Asset Management Information System (VAMIS). Vermont's state Office of Information Technology also manages various other performance information portals and management systems in coordination with VTrans;

- **Budget and Programming** provides resources to other VTrans offices to improve budget development and tracking, capital project development, resource allocation, and project prioritization. This section also oversees bridge inspections; and

- **Performance** oversees and disseminates VTrans' project cost estimating resources, including historical project performance data, benchmaking data, and performance forecasting capabilities; oversees quality assurance processes; and provides guidance on implementation of risk management.

Finance and Administration Division	Contract Administration
	Audit
	Budget Operations
	Financial Operations
	Civil Rights & Labor Compliance
	Performance, Innovation, and Excellence
	VTrans Training Center (VTTC)
Highway Division (Chief Engineer)	Maintenance & Operations
	Project Delivery
	Construction and Materials
	Municipal Assistance
	Asset Management and Performance
	Office of Highway Safety
Policy, Planning and Intermodal Development Division	Policy, Planning and Research
	Development Review & Permitting Services
	Transportation Mapping
	Outreach
	Rail
	Public Transit
	Aviation
Department of Motor Vehicles	Support Services
	Operations
	Enforcement
	Special Programs

Figure 2.1. VTrans Organization, with Performance and Asset Management Functions Highlighted

A separate *Performance, Innovation, and Excellence* Section within VTrans' Finance and Administration Division promotes and supports performance management within VTrans by assisting in the development of performance monitoring tools and methods across all VTrans divisions, bureaus, and offices. The Performance Section also manages a Continuous Improvement Program, providing training in Lean, a management concept centered around delivering value, eliminating waste, and continuous improvement, as well as overseeing implementation of the program in collaboration with the VTrans Training Center (VTTC).

ROLES AND ACCOUNTABILITIES

As part of Vermont's statewide Results-Based Accountability initiative, VTrans developed a new agency-specific Strategic Plan in 2015 with an agency mission and vision, strategic transportation goals, agency-wide objectives, and performance measures tied to "population-level outcomes" for the entire state (e.g., "Vermont is a safe place to live."). VTrans prepares an annual performance report with three years of history and two years of targets associated with key measures (several per program area), as well as an annual Fact Book and Annual Report that is delivered to the Legislature and posted for public review. Information for the various performance reports is compiled by every division. The AMP Bureau in the Highway Division and the Performance, Innovation, and Excellence Section of the Finance and Administration Division do the bulk of the work to pull information together for the reports, but most of VTrans' offices are actively engaged.

VTrans leadership has been successful at establishing a culture of performance, asset, and risk management among senior staff. Through training programs led by VTTC, the Agency is spreading knowledge and providing resources for personnel throughout the organization, from top to bottom. In addition, having trained 30 "Green Belts" who are able to oversee continuous improvement initiatives, VTrans is making a commitment to ingrain the culture of performance and continuous improvement in staff.

To help build consensus and facilitate decision making around asset management specifically, VTrans is forming cross-office and cross-division working groups for asset and performance management. VTrans convened the original Transportation Asset Management Plan Working Group (TAMP-WG) in 2014. The 27 members are drawn from materials, design, construction, asset management, and planning offices. Six asset management task forces deal with asset management business processes, customer service levels, financial planning for asset management, risk management, data management, and life cycle planning.

APPROACHES TO INTEGRATION

ASSET MANAGEMENT FRAMEWORK

VTrans has established a well-integrated performance and asset management process, for example using the Results-Based Accountability framework and the annual Fact Book to show connections between asset performance and broader strategic goals. Currently, integration of risk into asset management is not as developed. Project delivery and resilience (both facility-level and network-level) are two areas where risk is being integrated into asset and performance management.

State of Management Practice Integration

VTrans' efforts to improve and link asset and performance management date back to the initial acquisition of a pavement management system in 1995. VTrans adopted its first Asset Management Vision and Work Plan in 2002. Then, in 2006, Vermont Governor James Douglas and Transportation Secretary Neale Lunderville advanced the "Road to Affordability" initiative in light of the increasing cost of maintenance as well as a recognition that proactive preservation interventions could result in long-term savings on reconstruction projects. As detailed in the "Policy and Agency Structure," the initiative set into motion changes in VTrans' agency culture that persist today, most notably by linking asset management tools and processes more strongly to the VTrans' project prioritization and capital program development process, and by emphasizing a "Back to Basics" approach to project design and delivery.

Two discrete events put tremendous strain on the agency's resources, but also provided opportunities and momentum for integrating asset, performance, and risk management at VTrans. First, the funding made available through the American Recovery and Reinvestment Act of 2009, and the performance tracking requirements associated with the funds; and second, the enormous damage to the state's transportation system wrought by the remnants of Tropical Storm Irene in 2011.

In 2014, VTrans established its Asset and Performance Management (APM) Bureau within the Highway Division to focus on integrating asset, performance, and risk management for highways. There is a separate Performance section of the Finance and Administration Division with a broader mission of implementing Continuous Improvement throughout VTrans and supporting the specific data, management systems, process improvement, and staffing needs of individual VTrans offices.

Project delivery is the first area where VTrans focused efforts to improve management systems to improve performance outcomes. Very quickly, VTrans realized that if they were not delivering projects on time and on budget, they could not provide effective asset management. VTrans looked closely at various risks related to project delivery and opportunities to mitigate those risks by providing better information to planners and project managers. VTrans inaugurated scope collaboration meetings to review draft scoping reports. Now, 5-10 people from archaeological, hydraulic, historic

preservation, structures management, construction, and district planning offices regularly conduct online meetings to review major projects with the goal of identifying and addressing all major project delivery risks. The design team receives an annotated risk register that not only lists potential risks but provides actionable information to inform the design process. A related training component similarly helps to improve adherence to best practices in project management over the course of the planning, designing, and implementation of these projects

Addressing damage to the state's transportation system due to extreme weather events has been another catalyst to better integrate asset, performance, and risk management. VTrans assigns a flood vulnerability index to all bridges, culverts, and road segments, and assigns risk scores to each roadway segment based on vulnerability and criticality. The flood vulnerability metric is being incorporated into an updated project selection and prioritization process so that VTrans can identify and address high risk locations before flood damage

Mission:	Provide for the safe and efficient movement of people and goods.
Vision:	A safe, reliable and multimodal transportation system that promote Vermont's quality of life and economic wellbeing.

2040 Draft LRTP Goal 2. Preserve Vermont's multimodal transportation system and optimize its performance. This will be done through, "strategic investments to preserve and improve conditions…", utilizing, "asset management systems to inform transportation infrastructure investment priorities."

Strategic Goal 2: Preserve, maintain and operate the transportation system in a cost-effective and environmentally-friendly manner.

Right investment on the right asset at the right time.

Transportation Program, State Transportation Improvement Program (STIP), Maintenance Work Program, and other funding programs. These programs are coordinated to complete priority projects and activities effectively and efficiently.

Figure 3.1 Alignment of VTrans Policies, Strategies, and Programs
Source: VTrans Tranportation Asset Management Plan, 2018

Figure 3.2. VTrans Asset Management Framework
Source: VTrans Transportation Asset Management Plan, 2018

occurs. Over time, VTrans hopes to use a new, web-based Transportation Resilience Planning Tool (TRPT) in conjunction with better data on impacts of extreme precipitation events, better understanding of river science and watershed-scale hydrology, and more information about the relative cost and performance of various mitigation measures to improve project scoping and overall hazard mitigation planning.

VTrans is developing and testing a number of measures that integrate asset, risk, and performance management. For example, an asset sustainability index calculates the ratio of funding budgeted for asset management vs. funding needed to maintain assets in a state of good repair. VTrans also calculates a separate bridge sustainability index and pavement sustainability index based on the same concept. These measures help communicate the connection between funding levels and performance outcomes over time, and they help VTrans understand the implications of program-level tradeoffs during annual budget discussions and longer term capital planning.

VTrans' Performance section and Continuous Improvement manager are continuing to train staff in the principles of continuous improvement, the VTTC is providing guidance and training on performance, risk, and asset management, and VTrans' human resources staff are defining and refining core competencies and tailored job descriptions that include elements of performance, risk, and asset management, including specific responsibilities for coordination across the agency.

Management Frameworks

Figure 3.1, from VTrans' Transportation Asset Management Plan (TAMP), shows how VTrans has linked its performance-based plans and the capital investment program, and Figure 3.2, also from the TAMP, shows the current asset management framework, with relationships between strategy, analysis, implementation, and programming.

VTrans' challenges in implementation and integration have included:

- Uneven implementation of asset, performance, and risk management across offices and divisions;
- Limited staffing and resources;
- "Innovation saturation" (a competition for focus in light of other agency priorities and initiatives);
- A continued need to negotiate (and renegotiate) roles and responsibilities for asset, performance, and risk management as staff rotate in and out of key positions. Even though VTrans' culture has changed, some individuals continue to resist change; and
- Risk is not well-understood by VTrans employees, nor by the public. Importantly, the public's understanding of risk (and the value they assign to specific interventions and mitigation actions) is not congruent with asset management practices and principles.

Implementation of asset management, and integration with performance and risk management, have yielded several key benefits. VTrans is now more transparent about its performance with respect to the state's overall desired outcomes and VTrans' specific goals, helping with communication with the Governor, the Legislature, and the public. Additionally, the agency's staff are more comfortable speaking about performance because the agency has consistently messaged around organizational performance and not individual performance. Fears that performance data would be used to hold individuals (e.g., bridge inspectors) responsible for poor or declining performance have been allayed by helping people understand how better performance data can help them in their daily jobs and help the organization meet its performance targets and advance toward broader strategic goals. Additionally, VTrans' unique *VTransparency* tool allows anyone to independently access asset data and other types of performance data, engaging more staff in the broader performance discussion.

These benefits have better-equipped VTrans to communicate their story, showing how improving asset management and incorporating better risk management is tied to better performance outcomes across a variety of measures.

INTEGRATION OUTCOMES

Figure 3.3 shows a screen shot of VTrans' Results-Based Accountability scorecard, which ties performance measures to strategic objectives and statewide desired outcomes. This scorecard and VTrans' Fact Book and Annual Report are among the mechanisms VTrans uses to track the success of its initiatives.

VTrans cites improved communication, collaboration, and trust among staff as among the chief benefits of their efforts to integrate performance, risk, and asset management. VTrans has been able to break down institutional barriers and get people to share data and knowledge more readily. People see that VTrans is using the data they're collecting and the analyses they're conducting to make better investments and other decisions. There also are fewer "fire drills" to collect redundant information for ad hoc performance reports.

Being able to see the impacts of investment decisions on spending levels has improved VTrans' predictive capabilities and helped them set more realistic and achievable performance targets. VTrans is beginning to experiment with

"efficiency frontiers," an analytical tool to help determine the optimal level of investment for a given program area or project type.

Specifically:

- VTrans now delivers 80 to 90 percent of projects on-time and on-budget.
- The percentage of structurally deficient highway bridges has declined from 18.4 percent in 2008 to 4.8 percent in 2018. With 2.8 percent of bridges rated poor (compared to a national average of 7.7 percent), Vermont ranks 6th in the nation.
- Pavement rated very poor reduced from 28 percent in 2010 to 13 percent in 2018. Pavement rated good increased from 28 percent in 2010 to 49 percent in 2018.

LESSONS OF INTEGRATION

VTrans learned a number of lessons as it implemented asset management and integrated asset management with performance and risk management. In particular, they've noted how becoming more proactive and managing risks to improve performance requires a shift in leadership and a shift in an emphasis on what is important. It may require policy or cultural changes. Exposing the data and improving transparency inside and outside the agency was a key to making asset management effective and making risk- and performance-based decisions. Data-driven processes require quality, accessible, consumable data. Sharing data was one key way to engage staff in the performance discussion, and open sourcing certain data has allowed for improved data quality, opening the door for other asset stewards to add their data to VTrans' emerging information systems.

Additionally, being honest about performance has held VTrans accountable and has built credibility with various external partners. In the early years of asset and performance management, VTrans Executive Leadership owned the fact that the agency's performance lagged others in the U.S. To address this, they delivered a consistent, annual message to the Legislature and have shown significant improvement over the years. Though VTrans initially had limited success with implementing change management for asset management, the agency has found great improvements in recent years through consistent and concerted efforts. At first, lack of resources and a focused vision established at the executive level hampered grassroots efforts to implement change

Population-Level Outcomes	Related VTrans Strategic Plan Goals, Objectives and Measures								

VTrans Goal: Provide a safe and resilient transportation system that supports the Vermont economy

Objective: Reduce the number of major crashes

Vermont is a safe place to live.

Safety & Traffic Operations Program

Type of Measure	Indicator	Year	ACTUALS			TARGETS		Target	Trend
			2016	2017	2018	2019	2020		
How much did you do?	Reduce Major crashes at intersections (5 year rolling average) by 10% relative to the 2017-2021 period.	CY	-11%	-2%	TBD	-2%	-2%	🟢	⬆
How well did you do it?	% Of State Highway and Class 1 and 2 Town Highways that received refreshed pavement markings. Target is 100%	CY	100%	100%	100%	100%	100%	🟢	⬌
Is anyone better off?	Percent change in 5 -year rolling average number of major crashes relative to 2017-2021 period. Target is 10% reduction by 2021	CY	-3.1%	-4.1%	TBD	-2%	-2%	🟢	⬇

VTrans Goal: Cultivate and continually pursue innovation, excellence and quality customer service.

Vermont has open, effective, and inclusive government.

VTrans Objective: Staff are competent, fair, polite and sympathetic to customers' needs

Department of Motor Vehicles

Type of Measure	Indicator	Year	ACTUALS			TARGETS		Target	Trend
			2016	2017	2018	2019	2020		
How well did you do?	Percentage of customers that are waited on at DMV in 30 minutes or less.	FY	84%	88%	81%	90%	90%	🔴	⬆

VTrans Goal: Preserve, maintain and operate the transportation system in a cost effective and environmentally responsible manner.

Objective: Maintain pavement, structures and other transportation system assets in a state of good repair.

Vermont's State Infrastructure meets the needs of Vermonters, the economy and the environment.

Pavement Program

Type of Measure	Indicator	Year	ACTUALS			TARGETS		Target	Trend
			2016	2017	2018	2019	2020		
How well did you do?	Advertise for bid 80% of Pavement projects within 30 days of anticipated bid date.	CY	70.0%	91%	100%	≥80%	≥ 80%	🟢	⬆
Is anyone better off?	Less than 25% of all State-owned and maintained roadway pavement mileage is in very poor condition.	CY	14.0%	11.2%	13.0%	<25%	<25%	🟢	⬆
Is anyone better off?	Pavement condition shall achieve a Travel Weighted Average of 70% or greater.	CY	67.0%	69%	72%	≥70%	≥ 70%	🟢	⬆

Interstate Bridge Program

Type of Measure	Indicator	Year	ACTUALS			TARGETS		Target	Trend
			2016	2017	2018	2019	2020		
Is anyone better off?	Less than or equal to 6% of all Interstate Bridges are structurally deficient.	CY	1.9%	1.6%	1.6%	≤ 6%	≤ 6%	🟢	⬌
How well did you do it?	Advertise for bid 80% of Interstate Bridge projects within 30 days of anticipated bid date.	CY	100%	100%	67%	≥80%	≥ 80%	🔴	⬇
Is anyone better off?	Percentage of Structurally deficient deck area.	CY	5.1%	4.6%	3.8%	≤5%	≤ 5%	🟢	⬇

State Highway Bridge

Type of Measure	Indicator	Year	ACTUALS			TARGETS		Target	Trend
			2016	2017	2018	2019	2020		
Is anyone better off?	Less than or equal to 10% of all Interstate Bridges are structurally deficient.	CY	5.7%	5.1%	5.2%	≤ 10%	≤ 10%	🟢	⬆
How well did you do it?	Advertise for bid 80% of State Hwy Bridge projects within 30 days of anticipated bid date.	CY	53%	100%	67%	≥ 80%	≥ 80%	🔴	⬇
How much did we do?	Percentage of Structurally deficient deck area.	CY	5.4%	5.1%	5.7%	≤5%	≤ 5%	🔴	⬆

Town Highway Bridge Program

Type of Measure	Indicator	Year	ACTUALS			TARGETS		Target	Trend
			2016	2017	2018	2019	2020		
Is anyone better off?	Less than or equal to 12% of all Town Bridges are structurally deficient.	CY	5.9%	5.4%	5.2%	≤ 12%	≤ 12%	🟢	⬇
How well did you do it?	Advertise for bid 80% of TH Bridge projects within 30 days of anticipated bid date.	CY	100.0%	25%	71%	≥ 80%	≥ 80%	🔴	⬆
How much did we do?	Percentage of Structurally deficient deck area.	CY	5.6%	5.0%	4.6%	≤ 7%	≤ 7%	🟢	⬇

VTrans Goal: Provide Vermonters energy efficient, travel choices/options.

Objective: Increase use of walking, biking, transit, rail and Travel Demand Management

Public Transit Program

Type of Measure	Indicator	Year	ACTUALS			TARGETS		Target	Trend
			2016	2017	2018	2019	2020		
How much did you do?	Percent change in annual transit ridership	CY	-5%	-1.0%	1.0%	2%	2%	🔴	⬆
How well did you do it?	Cost per Transit Trip	CY	$6.09	$6.79	$7.22	$7.22	$7.22	🔴	⬆
Is anyone better off?	Total annual transit ridership	CY	4,711,693	4,687,076	4,742,202	4,739,624	4,837,520	🟢	⬆

Rail Program

Type of Measure	Indicator	Year	ACTUALS			TARGETS		Target	Trend
			2016	2017	2018	2019	2020		
How well did you do?	Percent change in Amtrak Ridership	CY	-8%	5%	1%	-1%	3%	🟢	⬆
How much did you do?	Bridge condition inspections	CY	100%	100%	100%	100%	100%	🟢	⬌

Target	🟢 meeting target	🔴 Not meeting target	
Trend	⬆ Positive Trend	⬆ Negative Trend	⬌ Flat Trend

Figure 3.3. VTrans Results Based Accountability Scorecard

management, causing confusion and frustration in early implementation and integration. However, as the agency has worked to address these challenges, they have found strong improvements in program efficiency and have better been able to achieve their goals of safe and effective transportation services.

DATA NEEDS

DATA SOURCES

VTrans recently undertook a comprehensive review of their data resources and management systems to support asset management as part of the development of the Vermont Asset Management Information System (VAMIS). A detailed internal document has been developed to define management systems to be included in an Enterprise Data Environment, as well as a detailed list of the categories of data, their functions in supporting VTrans' business processes, and individual staff roles in data stewardship and use.

VTrans pulls data needed to produce annual performance reports like VTransparency and the VTrans Fact Book from across the agency. VTrans is moving toward online information management systems that make data available and visible throughout the organization. Examples of key data sources and information systems include:

- Detailed Damage Inspection Reports System (DDIRS) with information about storm-related damage and other events that cause damage and disruption to the state's transportation system;
- Linear Reference System (LRS) with roadway inventory and cross section data;
- Vermont Asset Management Information System (VAMIS) and the legacy Pavement Management System and Bridge Management System for asset-level data and the asset inventory (location, condition, treatment history, and inspection reports);
- Construction Management System (CMS) for things like project cost and schedule information;
- Managing Assets for Transportation Systems (MATS) records most highway maintenance work by location. MATS is being expanded to include culverts, transportation buildings, and ancillary assets;

- Airport Information Management System (AIMS) identifies, prioritizes and tracks progress on aviation-related projects. The primary project driver at both the federal and state level is Aviation Safety; and
- Corridor Needs Tool, an online story map that combines and visualizes geospatial information about Asset Needs, Community Needs, Safety Needs, and Traffic Needs.

DATA GOVERNANCE

VTrans is incorporating actions related to Data Governance in its Asset Management Implementation Road map. As part of initial steps in development of a new Vermont Asset Management Information System (VAMIS), VTrans staff and staff from the Enterprise Project Management Office (EMPO, a division of the Agency of Digital Services) are connecting business needs with functional and technical requirements for the new system. The EMPO staff conducted interviews with VTrans staff which culminated in development of context diagram, which shows how information would flow into and out of the VAMIS in support of key functions of VTrans. While this effort was limited to a single information system, conversations around automating data validation, quality assurance improvement needs, and connecting data to processes and agency-level objectives will benefit future information technology development and deployment initiatives.

SYNERGIES

Two areas where VTrans is seeing synergies in use of data across multiple practices include damage assessment as well as weather and maintenance operations. Damage assessment data, which is used by planning, asset management, operations, and emergency management offices to help prioritize projects, implement Active Transportation Demand Management strategies around events, and proactively plan for emergency response and recovery operations given information on how previous events have disrupted the state's transportation system. Having broad access to the data and having people in place to analyze the data has improved VTrans' integration of performance, risk, and asset management.

Additionally, combining various weather data, roadway condition data during weather events, and real-time data on winter maintenance operations has given VTrans more insight into what treatment strategies, staffing levels, and resource

deployment decisions are most effective at keeping roadways open during winter storms. Operations, maintenance, and emergency management staff have better information to plan for and respond to events.

MODELING AND PREDICTIVE ANALYSIS

Like many transportation agencies, VTrans' pavement and bridge management systems have the most robust modeling and predictive analysis capabilities, although both are best used to generate specific treatment strategies and look at asset-level conditions vs. doing system-level predictive analysis. However, VTrans has been improving their asset deterioration curves, for example using traffic speed deflectometers to determine the condition of roadway pavement subbase and how that affects pavement deterioration.

VTrans' implementation of a Winter Severity Index that looks at real-time roadway conditions, salt/sand application rates from trucks, weather conditions, traffic volumes and speeds has helped improve the agency's performance during storms and helped plan for approaching storm events. VTrans is integrating its winter maintenance systems with ITS and transportation system management and operations capabilities, as well as public-facing traveler information systems. Similarly, the agency is using information on previous events to learn which roads are most likely to flood, empowering them to pre-position emergency response and recovery resources in strategic locations.

VTrans is a strong believer in applied research to test interventions and then using before and after analysis to predict how the same interventions might perform elsewhere given information on context. In corridor planning, VTrans is collecting information over time across a variety of performance indicators to help answer the question of which conditions identify a need for action. Additionally, VTrans is in the process of developing efficiency frontiers for different program areas or project types to determine what is the optimal level of investment in each program area, to support program-level tradeoff analysis.
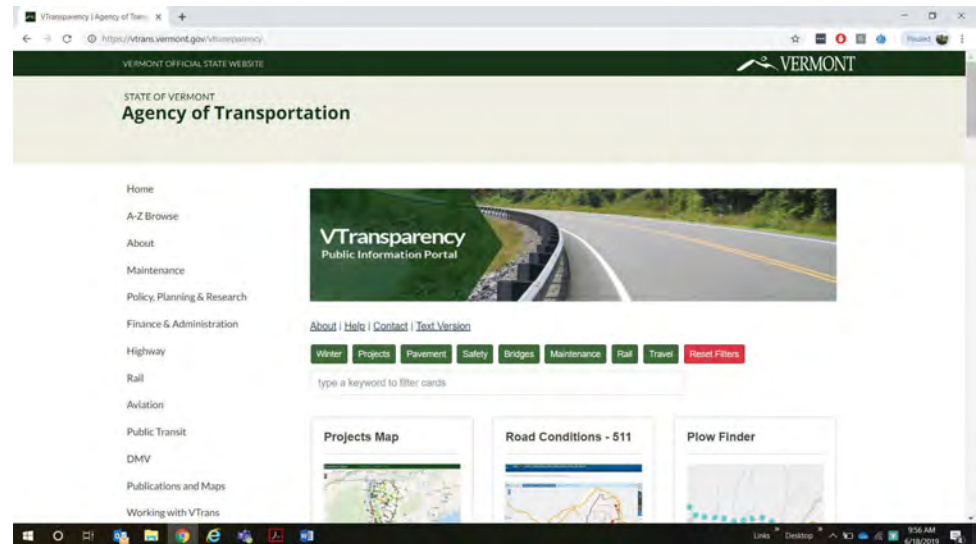
Figure 4.1 VTransparency Public Information Portal

SOFTWARE AND TECHNICAL TOOLS

The Vermont Asset Management Information System (VAMIS), currently under development by the agency, will provide VTrans with key data for program development and decision-making. This software system will give VTrans better insight into historical, current, and future conditions at an asset, asset class, corridor, and system level. It will be the source of performance information related to VTrans' assets and tie into state performance reports like VTransparency and the VTrans Fact Book and Annual Report.

Additionally, VTrans' Survey123 GIS tool is being used for post-disaster data collection. The system is similar to a crash data collection system in that it incorporates drop down menus and has simple user interfaces on tablets for field engineers to input data. The field data collection tool geo-references where people are entering assessment data. VAMIS will help connect Detailed Damage Inspection Reports (DDIRs) and project cost info to the Survey123 tool. VTrans' Construction Management System also is being linked to tie money down to the asset level. This tool will improve VTrans' risk management capabilities and make the state's transportation system more resilient. It will provide better insight into the causes and effects of damage for planning purposes, improving both long-term asset management and short-term operational decisions.

VISUALIZATION AND DELIVERY

VTrans has established three mechanisms for producing visualizations and summaries of performance data to VTrans' executive team, the Governor, and the Legislature:

- VTransparency is VTrans' public information portal (see Figure 4.1);
- VTrans publishes its VTrans Fact Book and Annual Report annually; and
- A Results Based Accountability summary sheet is delivered to the Legislature annually.

Pavements	Retaining Walls	Business Processes
Bridges	Public Outreach	Bike / Ped
Culverts	Maintenance	Safety
Rail	Fixed Asset Accounting	FHWA
Transit	Long Range Plan	IT
Aviation	Strategic Plan	Data Management
Signals	Performance Mgmt	Budget
Stormwater	Risk Management	Planning
Rock Slopes	Fleet Equipment	Capital Program

Table 5.1 TAMP Working Group Functions

PERSONNEL AND SKILLS

Along with the Asset and Performance Management Bureau in Highway Division and the Performance Section in Finance and Administration Division, VTrans has established a 27- member Transportation Asset Management Plan Working Group (TAMP WG) and six asset-class task forces. TAMP WG members represent the functions outlined in Table 5.1.

KNOWLEDGE AND SKILL RETENTION

VTrans is moving from a transactional, project delivery orientation to a government as a business orientation. VTrans is contracting more work to consultants, including data collection, management, and reporting for performance reports.

People no longer have long-term tenures at the agency. The promotional process is set to establish a more fluid organizations with people moving into and out of positions. Onboarding and training are very different. There are different styles of learning across generations of staff, and employee expectations for their jobs are changing. In the context of performance management, VTrans is adapting to changing requirements for skills and core competencies to support a new style of decision making.

The Finance and Administration division has produced a draft Strategic Workforce Plan, working with the Civil Rights Group on recruiting and onboarding and the VTrans Training Center on training.

COMPETENCIES

VTrans has used a Korn Ferry Card Sort to match skills to needs, leveraging strengths of individuals in support of the agency's mission. For example for a new Deputy position, leadership thought about what skills a person would need to fill that position and do a good job. They built interview questions around competencies, thinking beyond job duties.

VTrans is looking at a handful of core competencies that every VTrans employee should have, and then develop training around them. The agency has not determined how to identify competencies related to performance, risk, and asset management.

TRAINING AND DEVELOPMENT

VTrans Training Center (VTTC) is a well-established and successful part of the organization. VTTC has been nimble enough to adapt training and resource materials to the needs of the agency's workforce, including performance management.

VTrans' Maintenance and Operations Group is developing individual job development plans. What are competencies people need to have and tasks that everyone needs to do.

VTrans has found that things like safety and soft skills have been easier to train for and ingrain in the agency's culture. Technical training has been harder. Even maintenance equipment has much more technology on-board than previous equipment, making it harder for maintenance staff to keep in a state of good repair. VTrans is having to pay much higher salaries to get workers skilled in data science and people who can interpret data, communicate complex concepts, and collaborate with others.

VTrans' successful Transportation Leadership Institute acknowledges that there are different avenues for obtaining leadership skills. VTrans is providing staff guidance on what it means to be a leader in transportation. The institute is open to people at different levels who have a long-term, visionary bent.

VTrans also is opening up different pathways to supervision. Some people are great at what they do technically, but they are not good at managing people. Others are good staff managers, but they don't understand data or management systems. VTrans is loosening requirements that people have a Civil Engineering degree to be a manager, in recognition of the different types of skills that are needed in an agency more oriented toward management and operations.

POLICY AND AGENCY STRUCTURE

STRUCTURE OF MANAGEMENT AREAS

VTrans has a single Asset and Performance Management Bureau in the Highway Division and a Performance section of the Finance and Administration Division. Both offices work together closely, and they interface with many other parts of the organization, encouraging integration of performance, risk, and asset management. The current structure is regarded as a success.

INTEGRATION LEADERSHIP

VTrans' leadership at the highest levels is dedicated to performance management and understands the value of integrating risk and asset management with performance. VTrans is a small enough agency that Division, Bureau, and Section managers have strong relationships and communicate well. The agency's culture of performance management is getting stronger, and they are spreading a culture of asset management and risk management.

AGENCY POLICY

As part of the "Road to Affordability" initiative in 2006, VTrans adopted a new set of strategic parameters to guide day-to-day management:

- Realignment of priorities:
  » Future investment will be focused on traveler safety and the preservation of existing infrastructure.
  » Optimize financial resources by focusing attention on a practical number of large projects.
  » Set realistic timetables for large projects and new roadway segments, and balance funding within the Roadway Program to reflect priority on system preservation.

- Rethink project focus:
  » Back to Basics – Where design status allows, develop project scopes that limit the addition of project amenities not related to preservation and environmental protection. (Example: under-grounding of utilities, streetscapes)
  » Innovative Financing – Any proposed new roadway-segment project not presently in the Transportation Capital Program will require an innovative financing approach acceptable to the Agency prior to being considered for inclusion in the capital program.
  » Just-in-time delivery of design, right-of-way, and permitting.

In particular, "Back to Basics" continues to inform the agency's day-to-day decision making: VTrans has become more proactive, less reactive, and the agency manages risks to increase performance. Becoming more proactive has required a shift in leadership and a shift in an emphasis on what is important. It is requiring sustained effort to shift policy and culture.

RESOURCE REQUIREMENTS

Budget and Allocation

With specific staff dedicated to performance management in multiple divisions, VTrans has made a strong financial commitment to performance. Although some staff have specific responsibilities that may be weighted toward performance, risk, or asset management, budget allocations do not influence how they communicate and collaborate. Additional resources could enable the agency to make more rapid progress toward integration.

Economic and Other Benefits

VTrans has not yet begun to evaluate the efficiency or benefits of performance, risk, or asset management in a quantitative way, but qualitatively, the leadership, the Governor, and the Legislature have indicated they are pleased with the agency's management practices and progress toward goals.

Other Resources

Resources for additional staff that would be dedicated to data collection, management, and analysis, resources to acquire and improve management systems, and opportunities for staff from around the state to meet face-to-face were cited as opportunities to make more rapid progress toward integration of performance, risk, and asset management.

APPENDIX C

Integration Maturity
Assessment Framework Outline

NCHRP 08-113 INTEGRATION OF PERFORMANCE, RISK AND ASSET MANAGEMENT SELF-ASSESSMENT OUTLINE

Objective

The purpose of this outline is to present a framework for a Transportation Performance, Risk and Asset Management Integration, Self-Assessment – Capability Maturity Matrix. It is the basis for a tool which will be developed later that transportation agencies can use to assess how well they are integrating Performance, Risk and Asset Management within their organization. It will aid in evaluating the maturity of their integrated program, identifying areas where they can take steps to improve and expand their capabilities.

The Six Steps of Maturity

This section defines six unique levels of integrated management program maturity. Figures 1 and 2 outline these levels, describing an agency's increasing capability to deliver effective performance, asset and risk management practices. Agencies which have not yet begun the process of integrating their management practices or have not shown commitment to do so will not have reached the initial level and will fall under the pre-integration level. The work completed in NCHRP 08-113 is intended to demonstrate the value of a highly integrated asset management program. Efforts will be made to reinforce the value of such a program to motivate agencies to begin to seek methods to move towards an integrated performance, asset, and risk management program, understanding the values and efforts associated with the integration of various areas at different levels.

Figure 1. The Six Levels of Integration Maturity

Level 0 – Pre-Integration. The agency has not yet begun the process of integrating their management practices or has not shown a commitment to do so.

Level 1 – Initial Stage. The agency has identified a need to integrate its risk, asset, and performance management programs and intends to undertake such work. At this stage the agency is identifying agency and leadership champions and determining the overall structure needed for establishing such an integrated program.

Level 2 – Defined Stage. The agency has established metrics for measuring the integration of risk, asset, and performance management. It has also established agency goals and has developed initial documentation for the intended integrated management system. The agency is also working towards measuring their current level of maturity and establishing a roadmap towards a highly integrated asset management program, including developing a timeline to put the program in place. The agency has undertaken work to integrate risk, asset, and performance management in at least one asset class. Processes have also been put into place that allow specific departments to further undertake such work on a small scale, which may primarily be reactive.

Level 3 – Expanded and Repeatable Stage. The agency has identified its approach to systematically and consistently achieving management area integration across asset classes and budgeting periods. However, management systems may not be fully coordinating among important assets and there may be discrepancies in approach, data management, and results across appropriate agency departments.

Level 4 – Managed Stage. The agency has worked to deploy an integrated management program across appropriate asset classes and departments. The agency is systematically measuring and monitoring its business, practices, and operations to

ensure documented processes are followed consistently. The agency is also insuring that coordination and integration occur across the organization. These processes are producing results as expected at the project and program levels.

Level 5 – Optimizing Stage. The agency is committed to continuous improvement, constantly optimizing and working toward a system with highly integrated performance, risk, and asset management practices, where they are needed to advance the organization's mission and achieve strategic goals.
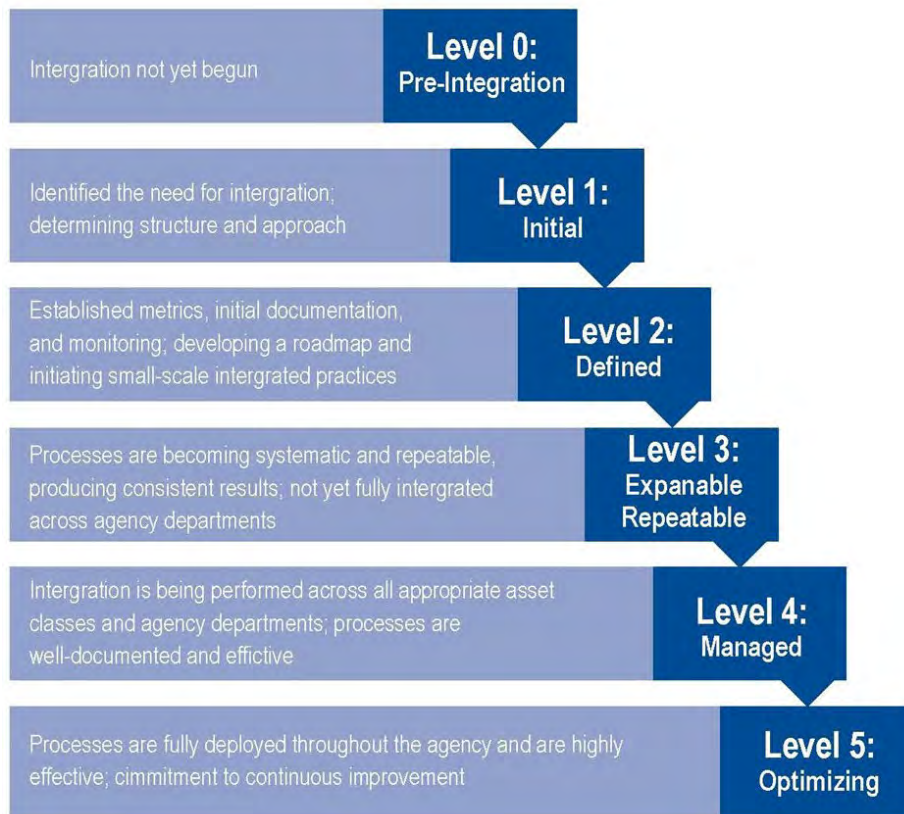
Figure 2. Integration Maturity Descriptions

Components of the Self-Assessment Capability Maturity Matrix

The Self-Assessment Capability Maturity Matrix will consist of four components as illustrated in Figure 3. Each of the components includes several subcomponents. Each of the subcomponents will be evaluated on its "Maturity Level" using a scale of zero to five (0 – 5). The following sections provide a brief description of each of the components and their respective subcomponents.
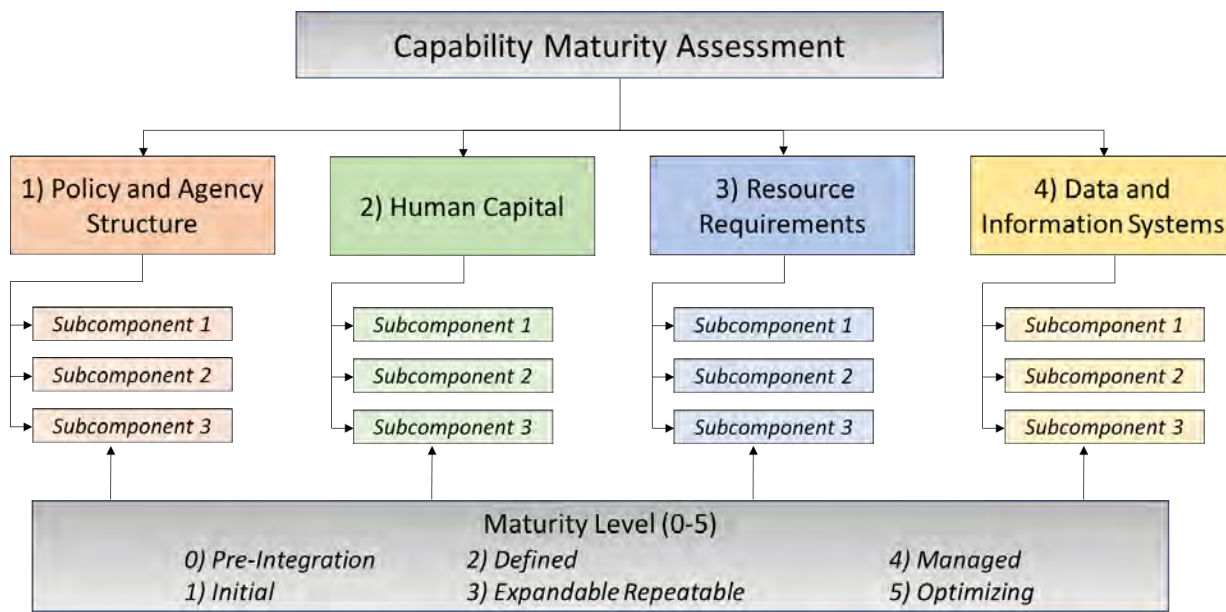
Figure 3. Capability Maturity Assessment Outline

Component 1: Policy and Agency Structure

The Policy and Agency Structure component considers the organizational structure of an organization and the level of policies in place that support the development and use of the integrated system. There are seven subcomponents.

Subcomponents

- The agency has identified an integration champion.
- The agency has modified its organizational structure to facilitate management area integration.
- The agency has modified its policies to support management area integration.
- The needs and goals of individual departments and functions are incorporated into agency strategy to ensure long-term success of integration.
- The Agency has identified innovation in management practices as a priority for agency leadership.
- Top management has authorized and bought-into a policy on innovation in management practices.
- The policy on innovation in management practices:
    - Provides a framework for development and implementation of a strategic management plan.
    - Sets out the agency's commitment to satisfy applicable requirements.
    - Sets forth a commitment to continual improvement.
    - Is effectively communicated to employees and stakeholders.
    - Is reviewed and updated on a regular basis to support continuous improvements.

Component 2: Human Capital (Capacity and Competency)

Human Capital refers to the people managing the work of the organization as well as the people doing the work of integration. There are five subcomponents that consider the people aspects of an integrated Performance, Risk and Asset Management system and measure.

Subcomponents

- Agency leadership shows strong support for integration and motivates staff to participate.
- Employees have skills and training needed to understand and support their roles in integration and cooperation.
- Expectations and incentives for employees and groups are tied to measures of integration.
- Knowledge retention tools and succession planning are integrated into agency policy and structure.

- Staffing needs are regularly evaluated to ensure that new roles are created, and existing roles are modified as needed to support evolving requirements over the course of integration and beyond.

Component 3. Resource Requirements

This section considers the agency's support for developing an integrated system through funding and other key resources. The six identified subcomponents are outlined below.

Subcomponents

- The need for the budgets for asset, performance, and risk management are combined or are highly flexible and funding can be moved to support changing asset needs.

- The agency has established funding specifically to support management area integration.

- The agency has developed flexible programming plans to account for variations in available funding consistent with asset needs, risk, and performance.

- The agency has established support for integration from executive leadership and/or legislators for integration and has an approved integration strategy.

- The top management demonstrate leadership and commitment to integration by ensuring related policy, strategic plan and integration objectives are established and aligned to organizational objectives.

- Top management ensures that resources for the integrated management system are available and actively directs and supports people to contribute to an effective program.

Component 4. Data and Information Systems

Component 4 considers the agency's work to develop and maintain data and information systems needed to support integrated systems. Nine subcomponents of this subject are outlined below.

Subcomponents

- Management systems support integration (e.g., performance assessment, cross-program tradeoff analysis and target setting)

- Good data governance is being implemented, with rules and procedures for acquiring, managing, analyzing, reporting, and disposing of data to support integration

- Historical, current, and projected future performance data and indicators support planning, programming, implementation, and other integrated decision making

- Internal and external factors are identified and recorded in the information system for the agency to forecast potential influence, demand, and required level of services

- Quantitative forecasting analysis and software are used to develop alternative planning scenarios and to address uncertainties in data and models

- The agency determines, obtains, and manages the financial, non-financial, and technical data and information that is necessary to enable the integrated management

- The agency reviews the data and information periodically in the light of developments in quantitative and qualitative analytical measures as well as the criticality and complexity of the decisions being made

- The agency implements changes to the measurement, collection and analysis of data and information that support integrated management where it is beneficial

- The agency has a process to identify, create, regularly review, update, and control the documented information

APPENDIX D

Agency-Specific
Implementation Plan

DISCLAIMER

Agency-specific implementation plans were primarily developed using materials, comments, and discussion from collaborative engagement workshops with each participating agency. Although originally intended to be conducted in person, these workshops (which took place over the Summer and Fall of 2020) were required to be held virtually due to travel and meeting constraints imposed by the COVID-19 pandemic. Although some workshop materials received from participants are pictures of sketches with less than optimal image quality (due to the unusual working situation) the content and resulting action plans reflect a diverse and impactful roadmap to management integration and should be considered on the basis of their merit to that effect.

Furthermore, the circumstances present a working case study of integration principles included in this guidance - elevating what is truly needed to initiate performance, risk and asset management integration. Each virtual workshop had agency executive participation and support, a diverse cast of managers from across the agency and the framework for assessing integration maturity and creating an action plan that is provided within this guidance. This occurrence therefore presents an opportunity to view not only a model for an integration action plan document, but also the flexibility and relatively minimal investment needed for an agency to initiate and/or asses their management integration development. It serves as an example of how to adapt in a difficult environment.

NCHRP 08-113

Integrating Effective Transportation Performance, Risk, and Asset Management Practices

NCHRP

NATIONAL
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Workshop Summary and Work Plan Outline

Vermont Agency of Transportation

November 2020

Introduction

The objective of this memorandum is to summarize the NCHRP 08-113 Workshop conducted at the Vermont Agency of Transportation (VTrans) and to outline the potential roadmap the project team can develop to better integrate performance, asset, and risk management at VTrans in a five year timeframe.

The NCHRP 08-113 team has engaged with VTrans at multiple points. In 2018, the agency served as a "quick scan case study" that reported a "moderate" level of overall integration as well as the integration of asset and performance management, but not of risk. In 2019, the research team returned to VTrans for "deep dive" interviews that produced a more detailed assessment of the agency's integration maturity in each of the team's five focus areas. The case study also included a history of management area integration, local catalysts for improvement, and next steps.

The 2020 workshop was intended to build on the past engagement by accomplishing the following:

- For the research project, the team intended to "test-drive the guidance". To accomplish this, it collected real-world detail and established best practices to support the focus areas and framework laid out in the Interim Report. The team also evaluated whether practitioners responded to that framework. In addition, the team hoped to collect anecdotes and descriptions that illustrated the benefits of integrating performance, risk, and asset management.

- For the hosting agency, the team intended to lay the groundwork for a roadmap for the next phase of management area integration at VTrans. This included prioritizing resource needs and tasks. The manager of AMB said that "this workshop is hopefully like the last person to push off of a bobsled and then jump on the back – we already have momentum, but we need that one last push to be off to the races."

The Workshop

The workshop was held at VTrans Headquarters in Barre, VT on March 4, 2020. It was split into morning and afternoon segments:

- Before lunch, the group explored some focus areas for integrating performance, asset, and risk management identified in the NCHRP 08-113 research. The goal for the morning was to collect, on

  sticky notes, the participants' thoughts on how VTrans could best address:

  - Approaches to Integration
  - Data and Software Needs
  - Personnel and Skills
  - Policy and Agency Structure

- After lunch, the group started to build a roadmap, beginning with an activity to prioritize the resources VTrans might require to better integrate the management disciplines. The group explored tasks that VTrans can undertake to further integration. Then, the group developed elevator pitches to highlight perceived benefits of management area integration, phrased to be delivered to the Governor or Secretary of Transportation. To conclude the day, the group piloted a maturity self-assessment honed for this project by the research team shown Figure 1.

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FIGURE 1   INTEGRATION MATURITY SELF-ASSESSMENT LEVELS

Agenda

The agenda for the workshop is provided in Figure 2.

FIGURE 2   AGENDA FOR THE WORKSHOP

8:00	8:15	Welcome
8:15	8:45	"Power-On" Activity
8:45	9:30	Approaches to Integration
9:30	9:45	Break
9:45	10:30	Data and Software Needs
10:30	11:15	Personnel and Skills
11:15	12:00	Policy and Agency Structure
12:00	1:00	Lunch
1:00	1:45	Resource Needs
1:45	2:30	Tasks
2:30	2:45	Break
2:45	3:30	Elevator Pitches
3:30	4:00	Maturity Self-Assessment

Participants

The participants where from various VTrans office's, offices having representation are listed below.

- ☐ Asset Management Bureau
- ☐ Highway Division
- ☐ Maintenance Bureau
- ☐ Performance Section
- ☐ Policy, Planning, and Research Bureau
- ☐ Project Delivery Bureau
- ☐ Training Center

Outcome

The workshop produced valuable insights, including:

- Key benefits of management area integration, as expressed in the elevator pitches:
  - Spending the agency budget more efficiently, with fewer surprises.
  - Building a shared, personalized vision across the agency that reflects the best intentions of staff.
  - Raising morale by spreading positive connotations for terms like "performance" and "risk".
  - Thinking long-term to build a sustainable network and avoid always having an emergency response mentality.
- Strategies for better management area integration, including:
  - An illustration of the value of strong champions with broad buy-in (as exist at VTrans).
    - Setting clear priorities, aligned with an agency-wide strategy, for what staff should be focusing their time on and why.
    - Actively sharing knowledge across silos by (for instance) inviting maintenance staff on inspections, exchanging or rotating junior staff, setting and funding "coffee dates" to intentionally facilitate cross-functional discussions, or simply remembering to follow up on conversations or ask for advice.
  - Using agency-wide training as an opportunity to hear each other and build necessary skills.
  - Establishing an agency-wide performance report card that includes all measures critical for decision-making and that is endorsed/valorized by leadership.

These insights are the basis for the VTrans roadmap outline laid out in the remainder of this document.

Outline for a Roadmap

This roadmap outline includes detail gathered in the workshop but does not include detailed plans for implementation (e.g., names, due dates, etc.). It consists of a vision, strategies, and the beginning of an action plan. VTrans can build on this outline with a detailed, time-bound action plan, with actions assigned to specific people and a commitment to follow-up and measure progress.

Relationship to the Focus Areas

As described in the above sections, the workshop and roadmap are based upon the five focus areas described in NCHRP 08-113. Through discussion sessions based on each focus area in turn, the VTrans participants generated strategy statements that added detail to the universal concepts in the focus areas, highlighting VTrans' specific potential areas of growth. By following this road map, VTrans will address each focus area as follows:

- *Approaches to Integration* by embracing VTrans existing champions and influencers.

- *Data and Software Needs* by discussing the collection of data for pavement, bridge, and other assets, the identification and publicization of the most useful data sources, condition forecasting, and long- term work planning.

- *Personnel and Skills* by discussing the role of training and "essential skills".

- *Policy and Agency Structure* by discussing the role of working groups in continuing to enhance the agency's practices and cross-silo communication.

- *Resource Needs* by discussing the need to tie budgeting and project selection to performance metrics.

Vision

VTrans will achieve integrated performance, asset, and risk management across its full portfolio of assets and its full range of performance outcomes, focusing on aspirations for a better transportation system for all users — now and in the long-term — an opportunity and responsibility shared amongst all of the agency's leaders and staff.

Foundation

This roadmap recognizes the significant progress that VTrans has made toward integration of these management areas over the past decade, and in particular over the past five years. Major accomplishments include:

- Creation of an *Asset Management Bureau* within VTrans to centralize the performance-based asset management practice and considerations of risk and vulnerability.

- Creation of a Performance Section within the Finance and Administration Division to support performance management within the Agency and foster continuous improvement.

- Implementation of training for organizational change management through the VTrans' Transportation Training Center (VTTC).

- Implementation of centralized GIS-based data systems, principally including VAMIS.

- Development of an integrated performance and asset-based VTrans' Project Selection and Prioritization Process (VPSP2) based upon criteria including safety, asset condition, mobility/connectivity, economic access, resiliency, environment, health access, and community.

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Strategies

VTrans could continue on this growth trajectory by pursuing several measurable goals. Over the next five years, VTrans could:

- *Complete the implementation of VAMIS.*

- *Broaden the performance focus,* strengthening measurement of asset condition while actively considering risk and non-condition-based performance measures.

- *Focusing budget and time resources* on projects and activities that directly and explicitly support the agency's stated mission, goals, objectives, and measures.

- *Identify and publicize the most useful data sources* to support key functions.

- *Ensure that raw data can be effectively converted into information* that supports VTrans operations and decision-making.

- *Building a team strong in "essential skills":* communication, collaboration, empathy, and transparency.

Action Plan

To achieve the strategies, VTrans should develop an action plan that assigns actions like the ones below to individuals or groups, with deadlines and accountability.

- To *complete the implementation of VAMIS*, VTrans could:

  - Upload and update inventory and condition data for Phase 1 (0 – 24-month implementation period) assets.
  - Develop an implementation plan for Phase 2 (24 to 48-month implementation period) assets.
  - Support the implementation and integration of the work order and asset inspection processes to ensure that asset deficiencies are addressed in a timely manner and in accordance with VTrans' risk pyramid.
  - Support work processes to identify, report, and monitor damage sites as part of emergency declarations while complying with the intent of federal legislation related to repeat damage sites (23 CFR Part 667).

    - Verify and validate bridge and pavement deterioration models. Perform network level trade-off analyses.

    - Establish simplified benefit-cost models for all assets to enable effective network level optimization of remaining (post bridge and pavement analyses) budget across ancillary assets.

  - Use the VAMIS to provide data support and analysis to inform the VPSP2 project selection and prioritization processes on an annual basis.
  -

- To *broaden the performance focus*, VTrans could:

- Establish a small "risk leadership working group" to bring performance, asset, and risk management under one roof and generate discussions/insights. This group will consider whether a separate job description is necessary for an agency "Risk Manager".

- Build on the success of the Pavement Working Group by establishing similar groups for other assets (e.g., bridges and signs) and potentially also for non-asset-based areas of focus (e.g., safety and system performance).

- Develop an agency-wide performance report card and conduct quarterly reviews of all Agency- wide performance measures with shifting multidisciplinary discussion groups to broaden awareness and understanding of what "performance measurement" means and which measures truly do influence decisions and resource allocation for capital, maintenance, and staffing.

- Ensure that performance measures not reflecting asset condition are used to identify and inform strategic goals and objectives, to set Agency priorities and to prioritize projects. These include Statewide priorities of economic development, environmental protection, and public health; the Federal target measures of system reliability and safety; and the criteria identified by VPSP2.

- Improving collection of multimodal traffic volume data to support project development, prioritization, selection, and harmonization.

- To *focus budget and time resources*, VTrans could:

  - Update the 10-year pavement plan, create a 10-year bridge plan, and explore a plan to identify, prioritize, and manage small culverts, pavement markings, signs, drainage structures, safety assets, ITS equipment, and other unnamed, ancillary assets.

  - Document business processes that support life cycle planning (inspection, condition, treatment scheduling/projection, work plan development, project development, work tracking, and overall statewide condition forecasts) for bridges, pavement, and possibly other assets.

  - Collaboratively develop job descriptions for all functions that touch performance, asset, and risk management, reviewing daily activities and prioritizing those that best fulfill VTrans mission and support its shared aspirations. By involving Human Resources and VTTC staff in this effort, technical managers can ensure that improvements are persistent and embraced in the hiring process.

  - Integrate the concepts of transportation value and cost effectiveness ratios as derived from the Agency's VPSP2 efforts to optimize the Agency's annual capital investment portfolio (capital program) while maintaining focus on safety, service, and asset conditions.

  - Support continued implementation of VPS2, while developing project harmonization efforts to more effectively distribute investment funds among assets in a project area and to identify maintenance activities that can be deferred due to planned capital work.

  - Use and strengthen VTrans' existing Risk Pyramid to prioritize projects, investments, and activities. ▪ To

identify and publicize the most useful data sources, VTrans could document its data sources with the intent of identifying their maturity (value, availability, reliability, security, trustworthiness, clarity, efficiency (lack of duplication), and accountability). To ensure long-term success with utilizing "big data", the Agency could establish enterprise-wide data governance, as well as education and training that ensures the proper documentation and integration of the Agency's data. Data governance should establish common definitions and data architecture while promoting data usability, accessibility, and proper storage. Specifically, VTrans should identify the following for each data source:

  - Contents and system-of-record – what is this dataset the best source for if anything?

    - Metadata – field definitions, units/glossary, and update schedule (against either the calendar or a project lifecycle).

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- Use cases and thence value – why VTrans should be paying to collect or purchase this data and to maintain it, in terms of both time and money. How do the data support VTrans' mission?

- Data owner – who is responsible for collecting and maintaining each dataset?

- Consumers – could this data be leveraged outside the group that owns it? Is there a level-of-service (in terms of quality and accessibility) that customers should expect?

This documentation process could allow VTrans to prioritize data sources, promote high-quality data with wide but unrealized applicability, and eliminate duplication of effort. In addition, VTrans could pursue the larger goal by:

- Completing a map of its data and enterprise architecture, including repositories, connections, and applications.

- Clearly documenting all software and tools with their value and use cases – ensuring that useful tools are widely available, and staff and managers are adequately trained. ▪

To *ensure that raw data can be effectively converted into information*, VTrans could:

- Ensure that communication channels within the Agency allow staff to notify each other of emerging risks quickly and efficiently up, down, and side-to-side. This may involve continued maturation of VTrans' Microsoft Teams chat platform. Beyond this, ensure that risks can be rapidly assessed and prioritized, and mitigation identified where necessary using the Agency's existing Risk Pyramid.

- Document unstructured data in documents and forms as datasets by asking offices to consider which forms, they collect in hard or digital copy. If the data proves substantial and valuable, VTrans could explore data mining (through natural language processing/machine learning) or stripping solutions.

- Build skills among current staff and managers in visualization tools (e.g., PowerBI or JavaScript), advanced GIS scripting and analysis (e.g., ArcGIS, QGIS, or Python), and statistical analysis and data science (e.g., Python, R, SAS, SPSS, Stata, or simply advanced Excel). Beyond these technical skills, VTrans can also place value on analytical thinking and problem-solving skills, encourage and train current staff in developing them, and seek them in new employees.

▪ To *build a team strong in "essential skills"*, VTrans could:

- Engage Human Resources and Training staff in the development of job descriptions for performance, asset, and risk management functions. As noted above, this makes the improvements "sticky" and ensures efficient and successful workforce development.

- Seek opportunities to personalize performance, asset, and risk management for employees across the agency – look for "hooks" that can bring people into the effort by appealing to shared aspirations for Vermont and the transportation system.

- Seek opportunities to recognize and valorize staff and managers who collaborate and ask for advice, data, or help from outside of their silos.

- Actively pursue opportunities to "reach out" up, down, and side-to-side in the organization. For example, VTrans could invite maintenance staff on inspections, exchange or rotate junior staff, or sponsor "coffee dates" for pairs or small groups of employees whose responsibilities touch but who may not prioritize interacting in the usual course-of-business.

- Recognize the value of being a "risk taker" while also acknowledging that innovation adds some uncertainty to operations. However, VTrans can capture value from this risk by fully documenting lessons learned from failure in trial-and-error efforts and celebrating the end accomplishments.

NCHRP 08-113

Integrating Effective Transportation Performance, Risk, and Asset Management Practices

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Workshop Summary and Work Plan Outline

California Department of Transportation

November 2020

Introduction

The objective of this memorandum is to summarize the NCHRP 08-113 Workshop conducted with the California Department of Transportation (Caltrans) and to outline the potential roadmap the project team can develop to better integrate performance, asset, and risk management at Caltrans in a five-year timeframe.

The NCHRP 08-113 team has engaged with Caltrans at multiple points. In 2018, the agency served as a "quick scan case study" that reported a "high" level of overall integration as well as the integration of asset and performance management, but not of risk.

The 2020 workshop was intended to build on the quick scan by accomplishing the following:

- For the research project, the team intended to "test-drive the guidance." To accomplish this, it collected real-world detail and established best practices to support the focus areas and framework laid out in the Interim Report. The team also evaluated whether practitioners responded to that framework. In addition, the team hoped to collect anecdotes and descriptions that illustrated the benefits of integrating performance, risk, and asset management.

- For Caltrans, the team intended to lay the groundwork for a roadmap for the next phase of management area integration, including prioritizing resource needs and tasks. Specifically, the State Asset Management Engineer has called out upcoming efforts to scope and procure a Transportation Asset Management System (TAMS) as a central hub and rallying point for integration, as well as the upcoming 2022 update to the California Transportation Asset Management Plan (TAMP).

The Workshop

The workshop was held virtually on September 17, 2020. It was split into several modules:

- First, the group explored some focus areas for integrating performance, asset, and risk management identified in the NCHRP 08-113 research. The goal was to collect, on virtual "sticky notes" in a shared PowerPoint whiteboard, the participants' thoughts on how Caltrans could best address:

  - Approaches to Integration
  - Data and Software Needs
  - Personnel and Skills

- Then, the group started to build a roadmap, beginning with an activity to prioritize the resources Caltrans might require to better integrate the management disciplines. The group then explored ways that Caltrans has successfully implemented performance, asset, and risk management in its policy and agency structure, as well as possible additional enhancements or initiatives to do so.

- The group pulled these discussions together by identifying tasks that leaders, managers and staff could undertake to further integration, sorted into "low-hanging fruit" and "major, but necessary initiatives." Finally, the group developed elevator pitches to highlight perceived benefits of management area integration, phrased to be delivered to the Governor or Director, and completed a maturity self-assessment honed for this project by the research team shown in Figure 1.

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Participants

The participants in the workshop were from various CalTrans office's, offices having representation in the workshop are listed below.

- ☐ District Asset Manager Offices
- ☐ HQ Asset Management Office
- ☐ HQ Program Office - Drainage
- ☐ Office of Risk Management

Outcome

The workshop produced valuable insights, including (in brief):

- Key benefits of management area integration, as expressed in the elevator pitches:
  - Clearly communicating the benefits of investment, building on Caltrans's strength in doing so. – Coordinating Headquarters and District-level messaging and programming.
  - Ensuring that decisions are influenced by high-quality data.
  - Facilitating the inclusion of climate vulnerability and resiliency in investment planning.

These insights are the basis for the roadmap outline laid out in the remainder of this document.

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FIGURE 1   INTEGRATION MATURITY SELF-ASSESSMENT LEVELS

Integration not yet begun — **Level 0: Pre-Integration**

Identified the need for integration; determining structure and approach — **Level 1: Initial**

Established metrics, initial documentation, and monitoring; developing a roadmap and initiating small-scale integrated practices — **Level 2: Defined**

Processes are becoming systematic and repeatable, producing consistent results; not yet fully integrated across agency departments — **Level 3: Expandable Repeatable**

Integration is being performed across all appropriate asset classes and agency departments; processes are well-documented and effective — **Level 4: Managed**

Processes are fully deployed throughout the agency and are highly effective; commitment to continuous improvement — **Level 5: Optimizing**

FIGURE 2   INTEGRATION MATURITY SELF-ASSESSMENT - RESULTS

Legend:
- Level 0: Pre-Integration
- Level 1: Initial
- Level 2: Defined
- Level 3: Expandable and Repeatable
- Level 4: Managed
- Level 5: Optimizing

Outline for a Roadmap

This roadmap outline includes detail gathered in the workshop but does not include detailed plans for implementation (e.g., names, due dates, etc.). It consists of a vision, strategies, and the beginning of an action plan. Caltrans can build on this outline with a detailed, time-bound action plan, with actions assigned to specific people and a commitment to follow-up and measure progress.

Relationship to the Focus Areas

As described in the above sections, the workshop and roadmap are based upon the five focus areas described in NCHRP 08-113. Through discussion sessions based on each focus area in turn, the Caltrans participants generated strategy statements that added detail to the universal concepts in the focus areas, highlighting Caltrans' specific potential areas of growth. By following this roadmap, Caltrans' will address each focus area as follows:

- *Approaches to Integration |* Through its business process mapping exercise and development of the State Highway Operation and Protection Program (SHOPP), Caltrans has gone above and beyond Federal requirements for performance-based investment and life cycle planning. Better integrating risk management into these national best practices will improve the network's resiliency in the face of agency, program, asset, and activity-level risk.

- *Data and Software Needs |* Like many DOTs, Caltrans has high quality datasets for pavement and bridge assets but not for others. The Department will continue to mature datasets for its other assets (culverts, signs, sign structures, retaining walls, etc.) while uniformly establishing, educating, and enforcing data governance procedures. TAMS will provide Caltrans with a unified software and data framework for performance, asset, and risk management.

- *Personnel and Skills |* Caltrans has a highly competent workforce with a consistent commitment to maintaining a safe and effective transportation system. To serve them, the Department could establish formal training in skills such as geospatial information systems (GIS), data visualization, and dashboard development and ensure access across Headquarters and the Districts.

- *Policy and Agency Structure |* Caltrans has a significant operational and cultural divide between Headquarters and District staff. Asset management has been emphasized at both levels, with dedicated engineers both Statewide and in each District. However, ensuring consistent communication and coordinated decision-making and messaging across the Department remains an ongoing effort.

- *Resource Needs |* Caltrans identified some key resource needs for better integration: data, people, money, tools, and training. These will be woven throughout the remainder of the outline.

Vision

Integrated performance, asset, and risk management provides an objective, data-driven framework to make Caltrans's strategic goals a reality. The Department will pursue integrating these disciplines in order to better defend and communicate the reasoning behind its decisions (including unpopular ones) and their expected benefits, as well as to ensure that investment at each stage of an asset's life is made on the basis of high-quality data and with an awareness of uncertainty and vulnerability. Doing so will ensure a safe, efficient, cost-effective, and resilient transportation network for all Californians.

Foundation

This roadmap recognizes the significant progress that Caltrans has made toward integration of these management areas over the past decade, and in particular over the past five years. Major accomplishments include:

- Caltrans conducted an extensive **business process mapping exercise** to determine how the Department would implement a performance-based allocation program. The effort led to a dramatic change in how the Department funds asset management.

- Caltrans established the **SHOPP process** to tie investments to multi-dimensional performance benefits. Projects are evaluated on 34 performance objectives, and the needs and goals of each project are required to be assessed in "plain language" for SHOPP consideration.

- Caltrans completed the final two **district vulnerability assessments** in July 2020. Together the assessments provide a comprehensive evaluation of climate change effects on the State Highway system.

- Caltrans completed a **risk-based TAMP** that includes a discussion of objectives and measures and life cycle planning, as well as a prioritized risk register.

- Caltrans hired an **asset management engineer** for each of its districts and has established coordination for those District efforts at Headquarters through the State Asset Management Engineer and his team, as well as monthly calls and meetings.

- Caltrans began the procurement process for **TAMS** as a clearinghouse for asset management data hub for performance, asset, and risk management activities.

Strategies

Caltrans could continue on this growth trajectory by pursuing several measurable goals. Over the next five years, Caltrans could:

- **Complete the implementation of TAMS.**

- Further integrate vulnerabilities to an increasing range of natural threats and **pursue a resilient transportation system.**

- **Establish clear standards for data governance, promote best practice data quality** and ensure that all staff have appropriate training on management of systems-of-record.

- Continue to **develop risk-aware business practices** for funding allocation, project selection, and project delivery.

- **Ensure that all staff have the skills, instructions, empowerment, and information to perform integrated performance, asset, and risk management.** This includes ensuring that Headquarters and the Districts communicate often and collaborate effectively on performance, asset, and risk management, and that the technical and non-technical skills necessary for integrated performance, asset, and risk management are taught throughout the Department.

Action Plan

To achieve the strategies, Caltrans should develop an action plan that assigns actions like the ones below to individuals or groups, with deadlines and accountability.

- To **complete the implementation of TAMS**, Caltrans should proceed with the development and oversight of the planned TAMS system.

- To **establish clear standards for data governance and promote best practice data quality**, Caltrans could document its data sources with the intent of identifying their maturity (value, availability, reliability, security, trustworthiness, clarity, efficiency (lack of duplication), and accountability). The Data Governance Group could establish common definitions and data architecture while promoting data usability, accessibility and proper storage. Specifically, the Data Governance Group (with assistance from across Caltrans) should identify the following for each data source:

  - Contents and system-of-record — what is this dataset the best source for, if anything?

    - Metadata — field definitions, units/glossary, and update schedule (against either the calendar or a project lifecycle).

    - Use cases and thence value — why Caltrans should be paying to collect or purchase this data and to maintain it, in terms of both time and money. How do the data support the Department's mission?

  - Data owner — who is responsible for collecting and maintaining each dataset?

  - Consumers — could this data be leveraged outside the group that owns it? Is there a level-of-service (in terms of quality and accessibility) that customers should expect?

    This documentation process could allow Caltrans to prioritize data sources, promote high-quality data with wide but unrealized applicability, and eliminate duplication of effort. In addition, Caltrans could pursue the larger strategy by:

    - Completing a map of its data and enterprise architecture, including repositories, connections, and applications.

  - Clearly documenting all software and tools with their value and use cases — ensuring that useful tools are widely available, and staff and managers are adequately trained.

  - Completing the implementation of Esri Roads and Highways in 2020 and the All Roads Linear Referencing System (LRS) project in 2022 as scheduled.

  - Continuing to improve inventories for assets other than pavement and bridge.

  - Documenting unstructured data in documents and forms as datasets by asking offices to consider which forms they collect in hard or digital copy. If the data proves substantial and valuable, Caltrans could explore data mining (through natural language processing/machine learning) or stripping solutions.

  Once data governance documentation exists, it should be promoted and provided to Headquarters and District staff alike at an easily-accessed online location. It may be desirable for the Data Governance Group to develop training materials (e.g., webinars, presentations, handbooks, checklists, fact sheets) to ensure that the protocols and definitions are used and followed consistently throughout the Department, and that known issues in some datasets (e.g., AM Tool, PRSM, CTIPS) are addressed.

- To **continue to develop risk-aware business practices**, Caltrans could embrace risk management as an everyday tenet of planning and operations. The Department has recognized the vulnerability to its

assets to natural risk (i.e., climate change, sea level rise, and seismic events, as well as consequent damage from landslides, wildfires, etc.).

Beyond these physical risks, however, Caltrans must also consider risks to conducting its business. Funding from Senate Bill 1 fuel and excise taxes will fluctuate, as will prices for materials and contracted labor. Succession planning could be insufficient to maintain program effectiveness after retirements. Caltrans has placed both a statewide and District emphasis on maximizing the life cycle of assets by taking full advantage of field maintenance, but failure to direct proper resources to these preventive tasks could result in unexpected surges of capital needs.

To address these needs, Caltrans could:

– Implement the findings of district vulnerability assessments in design standards and business practices, and build on them to study the full range of agency, program, asset, and activity-level uncertainty, including fiscal risks, data quality risks, administrative risks.
– Collaboratively develop job descriptions for all functions that touch performance, asset, and risk management, reviewing daily activities and prioritizing those that best fulfill Caltrans's mission and support its shared aspirations in the most cost-effective way, making proper heavy use of field maintenance and other preventive tasks.
– Develop new documented business processes for portfolio development.
    – Continue to evolve business processes related to project delivery to ensure that the focus is placed on productivity and network performance.
– Recognize the value of being a "risk taker" and the potential unintended consequences and incentives of enforcing performance-based "success" and "failure" (e.g., enforcing 95% on-time project delivery could lead project managers to subconsciously extend their schedules during the planning stage even when unnecessary). Document lessons learned from failure in trial-and-error efforts and celebrate end accomplishments.

▪ To **ensure that all staff have the skills, instructions, empowerment, and information to perform integrated performance, asset, and risk management**, Caltrans could:

– Consider establishing a formal "Asset Management Academy" with technical and non-technical training materials. These could include visualization tools (e.g., Tableau, PowerBI or JavaScript), GIS mapping, analysis, and scripting (e.g., ArcGIS, QGIS, or Python), and statistical analysis and data science (e.g., Python, R, SAS, SPSS, Stata, or simply advanced Excel). Non-technical skills could include risk management, management/leadership, analytical thinking, and problem solving. Encourage and train current staff in developing these skills and seek them in new employees.
– Ensure that communication channels within the Department allow staff to notify each other of emerging risks quickly and efficiently up, down, and side-to-side. Ensure that risks can be rapidly assessed, prioritized and mitigated through regular communication between Headquarters and the Districts. Consider adopting a collaboration platform such as Microsoft Teams for common use.
    – Seek opportunities to personalize performance, asset, and risk management for employees across the agency – look for "hooks" that can bring people into the effort by appealing to shared aspirations for California and the transportation system. Consider in-person silo-breaking opportunities such as virtual (or in-person, post-COVID) "coffee dates", cycling of junior employees among responsibilities, or inviting staff from other areas on inspections or ride-along.
– Engage Human Resources and Training staff in the development of job descriptions for performance, asset, and risk management functions. This makes the improvements "sticky" and ensures efficient and successful workforce development.
– Seek opportunities to recognize and valorize staff and managers who collaborate and ask for advice, data, or help from outside of their silos.

APPENDIX

Workshop Collaboration Boards
Elevator Pitches

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Appendix | Workshop Collaboration Boards (Sample)

What can you get out of integrating performance, asset, and risk management?

Planning projects and targets timely to address the right treatment at the right time based on asset performance life cycle, risk associated by Not addressing Fixing first the asset to defer major investment need (stretching available dollars effectively)

Effectively planning and prioritizing projects for the present and future Calculating Cost-effectiveness Integrating resources for project evaluation

Consolidation of decision-making factors Performance/ efficiency Cost and time saving Better prioritization/re-prioritization Minimize duplication of efforts

- Better portflo management

- Manage the Assets more effectively
- Create forecast scenarios
- Prioritize projects
- Identify the treatments that are repetitive or not effective for a specific asset/location
- Review the impacts of projects on the assets
- Maximize cost/benefit

Better informed decisions in project portfolio management.
Risk as a communication tool to decision makers.
Better ability to manage impacts of changes made at a project level.

More performance and less waste. Better reasoning for why we include work and when we don't include wishlist work from various divisions

Do the right work at the right time maximizing available funding. Avoid rework on our aging highway system

how best to invest limited funding

We do literature scans and surveys of other DOTs to get best practices.

manage my portafolio better.
Bring the right project at the right time.
Prepare better for the future with the given funds..

Better investing in projects such as combining two projects into once to save money.

Intelligence Efficiency/effectiveness Shared decision-making aiding/communication tool

Prioritize projects Improve investments in infrastructure Address risks strategically, considering consequences

Strike the proper investment balance across physical assets, risk mitigation and performance

Get the best possible system for the people of CA

Allows for providing background to district management on high level planning effort

- Better Decision Making, including consideration of other factors that should be considered
- More accurate reflection of the Costs and Benefits of the work performance we are achieving
- Open information
- Sharing of Data across functions
- Competitions
- Modernizing of Tools

What can be done in your office to integrate performance, asset, and risk management?

Separate performance that can be achieved by field Maintenance, Maintenance Engineering, local measure projects, toll roads versus Major SHOPP. Focus on High risk assets

- the development of new tools.
- Evaluate projects in the current and past fiscal years

Develop a greater willingness to accept risk

- Need to standardize a risk framework; quantify risk in a way to enable decision-making and prioritization

- quantify risk
- historical data analysis
- Increase the data ownership responsibility

Manage risk in the project portfolio while maintaining performance. Reserve funding based on overall TYP risk.

Create a prioritized wish list with realistic cost data so that when we have money, we start checking off the list and delivering these items. Planners don't want to look at cost and Engineers are too conservative in their estimates

Educate every division on it.

Our office leads literature scans and surveys of other DOTs to find best practices for integration. We also lead research projects with universities

Set goals and expectations Update business process

Allow lifecycle analysis earlier in the Project Development phase, allow value analysis earlier prior to programming the project. Consider various factors to prioritize work such as route importance, equity, climate change etc.

- Implement TAMS
- Implement Risk scores to prioritize Needs that should be addressed in projects
- Identify proactive measures to address risk

Reflect current process and improve educate and increase awareness

These tradeoff decisions are made largely based on experience without tools to help evaluate the benefits and costs objectively

Develop analytical tools and a standardized risk framework for asset management

priority projects in each program. Which project make sense funding first.

Reorg, bring in staff with more analytical/economic expertise

What do you see as the greatest risks in your office?

Project delivery schedule concerns, scope creep of nice to do versus required to do, and integrating complete street features early in the PID development

- Data Integration
- Not having a proactive risk processes
- Need risk prioritization processes

Promoting managers that are risk adverse. Silver Tsunami is creating a vacuum of people comfortable making tough decisions. It took us a 100 years to create the system and people want change now

Not being able to consider risks in projects.

Missing risks such as effects on disadvantaged communities, homelessness

- Buy-in, support
- Complexity of implementation

It is very complex to implement the trade-offs between these three perspectives of asset management

lack of adequate funding. The current rules regarding programming SHOPP projects

Schedule

Training, buy-in

-Educating new users of future tools
- data quality

-data management

Resistance to change

loss of expertise due to retirees,

Data integrity
Policy/Reg change

District not taking ownership of risks to performance plan. Investment in inventory data maintenance.

What important data does your office control? Who benefits from it? Can they get it?

Feeding district real life asset condition on TMS (Component versus system), Drainage, and Mobility (Delays). System users benefits. Yes

Culvert and pump plants, All districts
Yes

Everyone else's data along with funding levels and commitments. Lots of people benefit but I'm not sure that all decision makers have knowledge or accessible

the System Info side of DRISI manages the Linear Referencing System and also the TASAS (traffic accident) database

Examination of the same data in multiple systems

TYP portofolio, asset info, project specific info (cost, scope, schedule), various other CT data,

Project level performance data
Project Portfolio Coordination/monitoring of District owned asset data sets

District own the data that we plan to deliver, internal and external stakeholders. Internal has access

Performance Data (projects, activities, assets); data used by Districts & HQ Programs; data available through the Asset Management Tool

Project performance information

Needs and investment analysis

- Data in AM tool to manage performance and cost
- HQ and Districts benefits

Performance Data
Project list
Project location

Culvert
ADA
TMS
Hq's and District Division

- Performance Summaries.
  - Pipeline projects
  - Funding used and available.

- TAM data in the AM Tool (SHOPP, HM & Minor Project with associated performance)
- Developing TAMS to integrate data across the organization

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Does your office need data that is currently inaccessible? Who controls those data?

The data is there but just the speed to get it and the link to get the real time asset condition as soon as condition changes. From Permit, from Field maintenance, etc

Right of Way data statewide

Project status and milestone COS

Data from other prgrams such has STIP, local funded projects. Projects that are going to Relinquished. Most current data from programs to effectively capture performance.

The lack of data quality control makes even data that is available suspect

Lack of an official list of varous authoratve data sources for easy access

Prioritized complete streets
Environmental risks – GIS
Maintenance Station condition

There is a lack of data about local projects, and planning data (climate change, complete streets, etc), but I do not know who controls or even if data is available.

Environmental Studies, Reason for risks, Design Exception database searchable by exception type, Prioritized Complete Streets list with estimated costs, Survey Data

Most data exists it's just not in central locations making it tedious to track down. Assets imporved by local funds via permits are not adequately tracked and captured.
Equity needs will be a big lift to determine past ahrm andwhat can we do to make things right.

IMMS- Maintenance Surveying Data (R/W)- Design and R/W

More specific project info from the locals, upcoming workload for contractors

data from other CA agencies such as CalFire, Energy Commission, Air Resources Board, etc.

While much of the core data exists, a major challenge is accessibility, software interoperability, redundancy, errors from insufficient chain-of-custody controls, and standardization (e.g., location data)

GIS inventories data for:
- ADA
- Culvert,
- TMS
- Bridge

Safety and system congestion data is not very accessible

Our LRS needs more reliability

- Integrated Asset Data
- Environmental data
- External data including Socio-economic, public health, climate data
- Local projects, inventory, and condition, performance and risk

What datasets at Caltrans are the most mature? Which most need to improve?

Mature: Pavement, Bridge, performance dashboard.
Improve: TMS component level tracking, GIS visualization of multiple asset needs, ADA compliant/ non-compliant

proj mgt/prsm, bridge, pavement, CS

GIS, disadvantaged communities, barriers/end treatments,

Needs improvement- Culverts and Transportation Management Systems (TMS), ADA, Facilites, Complete Streets
Mature- Pavement, Bridge, Roadside Safety

Mature: bridge

Improve:Culvert condtion, pavement condition

How we locate assets needs improvement

Most:Bridge/Pavement inventory
Least:
Complete street/ADA/Signs

Pavement, and Bridge are the most mature
TMS and Drainage need some improvements
GIS data
Complete Streets, signage, ADA, and many others need more improvements

Need work with Environmental Studies, Complete Streets gaps, traffic operation improvements, climate vulnerability priorities,

Bridge, pavement

Improvement needed ADA, culvert, TMS, operational needs, complete street elements

Mature- Pavement, Culvert and Bridge.
Improvement- TMS, ADA and Complete Streets, GIS, and Lighting

Culverts moderate
TMS needs improvement

Mature: Pavement, Bridge
Improve: Transportation Related Facilities, Protective Betterments, Multi-Modal Facilities, Complete Streets priorities

Most mature:
- Pavement
- Bridge
Needs improvement:
- Bike, pedestrian, and ADA infrastructure

need to improve Intelligent Transportation Systems aka Transportation Management Systems:

Most Mature – Pavement and bridge

Least – LRS, Facilities, smaller highway assets (lights, signs etc), bike and ped assets

- Mature: Bridge and Pavement
- Moderate: Culvert and TMS
- Most others need improvement including inventory, location, condition, processes, modeling, needs recommendations,

Which skills do you have in your office that could help integrate performance, asset, and risk management?

Skills: Asset Management understanding, project development. Need: GIS capabilities centralized in District and HQ. Process to report real time asset condition as they happen. Support staffing dedicated to Asset Management	Experience as District Risk Coordinator Project Programming Knowledge Previous ADA coordinator works in office. Good relationships with data owners	Flexibility to adjust to changing priorities and funding levels. Dashboard have been great to quickly see and address issues Learning to accept risk rather than avoid it	Understanding the risk of combining projects from design background. Need: GIS skill. Hoping our new staff will fulfill this missing pieces in our office.	We have been working hard to get an enterprise asset management software for Caltrans
Risk management experience Project delivery exp. Asset management exp. Data management exp. Performance management exp.	expand involvement/staffing for our RM expert, Data/intelligence mining; visualization training/education	Have – project experience, diverse experience Need – District funding for asset management efforts including data stewards and GIS. Need better risk understanding	• Data analysis, visualization, and reporting • Performance modeling, projections • Asset management principles and concepts; aligning plan with federal/state requirements	We have been working with visualization through dashboards Cross asset prioritization efforts
communication and training Data analysis and Visualization. Dashboards, communication, understanding project development.	Data evaluation GIS dan data reports Integration of data between different offices Strong analytical skills	Construction Programming (coding) GIS Innovation Communication ADA	need for being open to implement innovation. Have knowledge of silos within Caltrans	Have: • Asset Management • Performance management • Visualization • Communication

September 17, 2020   NCHRP 08-113 | Caltrans Workshop   7

Which skills would you be excited to undergo training on? For others?

We: Bridging data over multiple databases. (IMMS, PRSM) Others: Data governance Data management/visualization	technical skills such as data usage in HQ and districts for multiple modes.	How to influence others to accept more risk and reduce support requests. How to inspire others to influence their staff to accept risk. How to influence R/W department at a statewide level	various databases, understanding which would be beneficial to our needs linking those databases, funding,	
More Leadership - Managing Teams trainings GIS/Survey 1-2-3 More Asset Specific Trainings (I.e. Storm Water) Portfolio Level Risk	General busssiness environment; Prgm/Project implementation	District Program Managers need training on data stewardship. Risk analysis,	Methods/tools for cross-objective optimization, prioritization, risk	Analysis tools to evaluate program and project decision making
On going Dashboard training. Understanding data integrity for diffrent tools. Data Reporting analysis.	- data governance - Everyone needs data analysis/integration training	Local grants information Different funding types	GIS data. sustainability	• more analytics, BI, and Modeling • Risk analysis, • GIS • Team building and tools

September 17, 2020   NCHRP 08-113 | Caltrans Workshop   8

12

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What are the 3 most important resources Caltrans needs more of to integrate performance, asset, and risk management? (WORD CLOUD shared here after survey complete)

technology   knowledge transfer

training

expertise
reporting tools   staffing
                                    storage apace
data ownership   staffs   data tools
accurate budget data   user friendly
positions   data analyst
software   people money
              gis   succession
data management   software improvements
staff   tams   communication portals
                            data quality
gis data   knowledge

How To Submit
- http://www.menti.com
- Use code: 70 24 33 1
- Submit three responses (one-word answers only)

What do you think Caltrans *has done successfully* to push integration in the organization?

Excellent TAM policies, guidance, change control process and integration. TAMS ultimately will close the missing loop. Started District Portfolio Management office

Talk about breaking out of the funding silos

Development of Data Management and data governance
Develop OAM
TAMP
SHSMP integration of 5 yr Mtce Plan and 10 yr SHOPP

Coordination between Headquarters ad District Asset Mangement team. Implementation of policy and procedures. Strong leadership.

Thorough implementation (buy in) of Asset management at District and statewide level

Creating a Statewide collaboration for implementation of asset management

Strong senior executive support; e.g., 10-Y Project Book, AMT, TAMS, statewide data governance efforts,; increaing engagement at all org. Levels (HQ programs/divisions/districts)

Implementation of the AM Tool, monitoring data and project changes, increased collaboration between District and HQ through the Project Book
Leadership from Mike

Exec Mgmt support of Asset Mgmt. Putting Asst Mgmt under Prog/Project Mgmt to share the responsibility. Mingling SHOPP funding. Direct tie between SHSMP and funding. Supporting Mike and team. Adopting AMT for performance tracking

District Asset managers, AMT, pursuing TAMS, allowing multi asset projects, PaveM (not perfect but a great tool). Communication between districts as well as btwn district and HQ

Embrace Asset Management
Data Collection
Sharing of information
Expand Communication
District Management of funding

data 1. data governance office and Geospatial Information Officer (GIO) directly under the Caltrans director.
2.Executive Board with HQ Deputies and District Directors

- Established new organizational structures at HQ and Districts over last few years to better align Caltrans asset management efforts.
- State Highway System Management Plan, 10-yr Project Book – tools/products that are driving department decisions

established AMs, promoted more communication between HQ/Dist, development of various policies, constant evolution/improvements being made

Creation of Asset Management unit in the Directors Office and District Asset Managers
Openness to change business processes to facilitate asset management implementation

- Create a State Asset Manager
- Implement District Asset Managers
- Engage TAM in Executive discussions and steering
- Ensure Asset Mgt is at top levels of HQ and Dst
- Improved Communication w/HQ & Dst
- Shift decisions on projects to Districts

What do you think Caltrans could do *next* to push integration in the organization?

Caltrans significantly progressed from Silo projects to multi-asset project packaging. Caltrans can champion Integrating areas where locals can plan work around where the state is investing in to minimize public impact

Cross function rotational assignments

Business process review L6S Collaboration and then new policy directives

Understanding the Distrcits prespective and challenges to create more policies and procedures at the HQ level. Development of tools to ensure data quality. District to educate all staff on new implementations.

Fund asset management in Districts

Take another look at Contract for Delivery — how it can inhibit intelligent risk taking, and impact project portfolios

ensure funding/resources for essential building blocks. e.g. data collection and management; Enhance cross-functioning coordination and communication

increase data importance Increase data standards Improve planning steps Evaluate better the needs of the system (risk, long term/short term treatments impacts in future plans)

Reduce the size of HQ Programs / Advisor offices. Program size has direct correlation to maintaining silos and ability to intergrate HQ into project decisions

Dedicate a division in Districts for asset management with resources and funding. Ditto Darron. Develop "scoring" system to priorize work consider route importance, equity, climate change, local economy, etc

Reduce support cost Reduce duplication of efforts Communication among divisions both HQ's and District Data quality Data Storage

look at existing proj dev process and see if there's change needed.

1. avoid duplication of data collection between divisions - figure out how to collect, store and use more efficiently. 2.Corridor planning to look at all modes — what's best option

- Address challenges with data integrity, integration, standardization, availability.
- Expand availability of tools and products to assist Districts and HQ decision-makers.

Provide training to the Project development team to buy-in on our goals and visions.

Many competing policy objectives are still being evaluated without always fully considering trade-offs in asset management

Implement a software rally point for integration (TAMS)

- Implement TAMS
- More comprehensive inventory, condition and processes and policy
- Identify Needs that we can prioritize with Risk
- Data Governance
- Integration with locals

What do you think Caltrans could do *next* to push integration in the organization?

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Provide training to the Project development team to buy-in on our goals and visions.

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What are 5 things you OR *leaders could do* to integrate performance, asset, and risk management?

Available Funding versus needs 2) Risk acceptance 3) GIS layering of multiple needs 4) All needs communication versus specific funding color 5) If I can achieve performance cheaper move funds across

1. Training/Learning
2. Prioritizing (identifying gap/needs first)
3. Road-mapping
4. Process documentation and continual improvement

Track and manage risk globally
More flexibility in reacting to change

- Identify vulnerable segments on the State Highway System
- Prioritize Assets in Vulnerable Areas
- Create a framework to make decisions to move forward to make the SHS more resilient

Educate self and others
Develop a common goal
Identify pros and cons
Benchmark other DOTs
Develop a Pilot and test out in a couple of districts

monthly AM/Proj Dev mtgs
Estab new District processes/procedures
Continue developing docs for Dist partners
Provide more resources

Exec Team can force R/W at all levels to embrace change, risk, performance delivery. Exec Team can truly prioritize maintenance versus expansion of the system. Reallocate support resources from HQ Programs to streamline. I need to offer more District training

Me: Outreach, communication, elicit feedback, evolve and innovate business processes.
Leaders: Champion asset mgmt efforts

Leaders: Rely more on the products of asset management.

Support needed business process changes to gain better asset management

Self: Implement TAMS, continue collaboration, continuous improvement

Self: 1)Become more educated and attend training. 2) Help to share and educate others.
Leaders: 3) Provide support by addressing staff regularly on the progress of this vision. 4) support data governance.

1. leaders: use existing structure (Executive Board) to discuss how best to integrate - possibly create subgroups with HQ deputies and District Directors. 2. Me: monitor research projects for overlapping issues

1.Bring on stff to manage data. 2.Take on a more robust role in project development after project initiation. Leadership: 1. promote and provide more flexibility post programming, 2. promote and embrace intelligent risk taking, 3. Fund more asset managment postions in the district

Develop Risk Registers for District Performance Plans/Ten-Year Plans, and a State-level Managed Risk Register. Assign $ to those risks – especially the competing funding/commitment issues.

- More AM Training
- Provide innovative ideas (smart transportation system)
- Expand more resource during the PID-Phase to identify all the risks & scopes for the project.

1. Understanding the perspective between District & HQ 2. Educate and train one another on areas on expertise. Defining challenges to come up with potential solutions. Working and utilizing resources

Me: Analyze data and compare different data systems; Communications; data cleaning
Leaders: emphasize the importance of good data; make sure to communicate that we are not competing with other offices, but aiming to improve the data and processes

Self: Educate everyone
Data integration
Promote AM with Local Gov't
Leadership: Provide resources
Communication among Division and Districts

Better data governance and accessible shared data systems in which people know what to look for and where.

1. Me-Implement TAMS
2. Me-Improve org. process gaps
3. Leaders-Advocate TAM/TAMS Change Management
4. Leaders-Engage in TAM decisions, policy, process and support training

TASKS – "Low Hanging Fruit"

More communication out on Data Governance group progress and status

Create Processes for Portfolio Management

Educate everyone – District coordination with local governments

Continue Collaboration across the state – Monthly meetings HQ/Dist, Quarterly cross program meetings

Create Processes for Visualization, Dashboards and Reports needed for TAM and TAMS

Updated data governance document

Creating data standards with data governance

Continue working w/ HQ/Dist partners in developing processes/procedures

Continue development of interim tools until TAMS is implemented

Change business processes for: Needs, life cycle processes, and update project development

Correct the known data issues in asset inventories (in source HQ and District data systems) and project records (in HQ systems, e.g., AM Tool, PRSM, CTIPS, etc.)

Create District Ten-Year Plan Risk Register

GIS Layering of needs and where we are compared to SB-1 target by District

Establish a standard for inventory data management for secondary assets

Pros and Cons

Business process review

Implement TAMS – not an easy task but will be a big leap forward for CT

Begin discussions at Executive Board between district directors and HQ deputies

List of priorities projects for each program.

1. Grab a post-it note from stack
2. Drag to an open space
3. Double click to add text

District Monthly meeting to review Variance and future needs

Dedicate funding and positions in the districts to address AM.

- 15 -

TASKS – Major Initiatives, but worth it

Incorporate risks such as how transportation projects including operational improvements affect air quality, disadvantaged communities and fire hazards

Provide more transparency of funding sources and going projects

Data Software to integrate all data sources (TAMS)

Implement TAMS

Asset Management Academy

Developing staff that has the data management skills needed.

GIS survey Data for all program's inventories. And to keep those GIS data update every year.

Explain that "doing the right thing" was decided before the PDT gets the project initiation

Rethink how SHOPP projects are programmed and combining funding sources

Sea level Rise, Mobility needs, TAMS

Force Env & R/W Divisions to embrace project delivery over process security

Create database to track Env. Studies with the ability to sort by type and searchable on GIS layer and Excel layer

Reduce HQ Program resourcing based on current decision authority structure

Funding/structuring District Maintenance staff to maintain inventory data sets

Developing new data governance effort, incorporating SLR/wildfire mitigation, developing new expertise/classifications

Implement TAMS – I know it's on both lists.... It's that important

Ensure resouces for esentential data collection and management

TAMS – ensure long-term resources and support are available to continually improve and expand capability

1. Grab a post-it note from stack
2. Drag to an open space
3. Double click to add text

NCHRP

Appendix | Elevator Pitches

- "The transportation system is vital to California's economy and quality of life for our population. An asset management approach that integrates performance, assets, and risk is fundamental to smart investment decisions that will ensure that we leave the future generation with a sustainable system."

- "Integrating performance, asset and risk management is how we become open and transparent to communicate what we are doing/performance, what are the benefits/accomplishments of our decisions and how we will address risk. This will help us integrate our assets and integrate with local partners. This is core to integrate decision making across Caltrans and helps executives lead the organization to the right things at the right time."

- "Integrating performance, asset and risk management provides a platform for better communicating District-level and State-level priorities and impacts of new policies on the maintaining the highway system."

- "Several Divisions are still focused on maintaining old processes rather than delivering performance. Integrating Risk and Performance will allow us to spend more resources on your latest Complete Streets initiatives, but we need you to break the silos and refocus them on finding ways to deliver projects rather than protect Division pyramids. The more we risk, the more we can deliver while you are in your position."

- "Integrating performance, asset and risk management we can better address the needs of California's aging infrastructure with the limited funds available. We need dedicated funding for this effort."

- "Asset Management provides an objective data driven framework to make the departments strategic goals a reality."

- "We need to make sure that our decisions are made on good data to make sure we are spending the public money wisely. For that we need to integrate performance, asset, and risk management."

- "We need to integrate the three components because to it helps the organization have a 360 view of managing our assets."

- "Toks, if you'd like to leave a great legacy, integrating performance, risk and asset management would make Caltrans a leader in efficiency and assist with decision making into the next century."

- "In order to be the nation leader in transportation, we need to change our structure to integrate perf, asset, risk mgt."

- "Best bang for your buck. Increase efficiencies. Reduce Cost and be innovative."

- "Our vision and goals should integrate statewide Asset, performance, and risk management to Caltrans achieve success."

NCHRP 08-113

Integrating Effective Transportation Performance, Risk, and Asset Management Practices

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Workshop Summary and Work Plan Outline

Minnesota Department of Transportation

November 2020

Introduction

The objective of this memorandum is to summarize the NCHRP 08-113 Integrating Effective Transportation Performance, Risk, and Asset Management Practices Workshop conducted with the Minnesota Department of Transportation (MnDOT) and to outline the potential roadmap the MnDOT team can use to better integrate performance, asset, and risk management at MnDOT within a five-year timeframe.

The NCHRP 08-113 team (Jacobs, AEM Corporation and Cambridge Systematics) engaged with MnDOT prior to the workshop. In 2018, the agency served as a "quick scan case study" for this research project and through that quick scan, it appeared MnDOT had a "moderate" level of overall integration as well as a more advanced integration of asset and performance management programs.

The August 2020 workshop was intended to build on the past engagement by accomplishing the following: ▪ For

the research project, the team intended to "test-drive the guidance". To accomplish this, the team

- collected real-world detail and established best practices to support the focus areas and framework laid out in the Interim Report. The team also evaluated whether practitioners would be able to fully utilize the framework. In addition, the team sought to collect anecdotes and descriptions that illustrated the benefits of integrating performance, risk, and asset management from transportation agencies.

- As part of the process, the Research Team would provide the groundwork for a roadmap for the next phase of integration at MnDOT. This included building on MnDOT's culture of innovation to shift the working dynamic.

The Workshop

Due to the COVID-19 Pandemic, the workshop was held utilizing a virtual format through Microsoft Team's on August 19, 2020. The workshop was split into morning and afternoon segments:

- Before lunch, the group explored some focus areas for integrating performance, asset, and risk management identified in the NCHRP 08-113 research. The goal for the morning was to collect, through a facilitated process using Google Documents as a virtual collaboration tool, the participants' thoughts on how MnDOT could best address:
    - Approaches to Integration
    - Data and Software Needs
    - Personnel and Skills
- After lunch, the participants would continue with their thoughts with:
    - Policy and Agency Structure
    - Resource Needs
- The group would then get started to build a roadmap, beginning with a discussion on approaches to integration as well as the data and software needs to enable the level of process integration that MnDOT is seeking to build. The group explored tasks that MnDOT can undertake to further integration. Then, the group developed elevator pitches to highlight perceived benefits of management area integration, phrased to be delivered to the agency Director or Governor. To conclude the day, the group piloted a maturity self-assessment honed for this project by the research team shown in Figure 2.

Agenda

The agenda for the workshop is provided in Figure 1.

FIGURE 1   AGENDA FOR THE WORKSHOP

8:30	8:45	Welcome - Introductions - Today's Virtual Workshop
8:45	8:55	MnDOT's Leadership Welcome
8:55	9:15	"Power-On" Activity
9:15	10:00	Approaches to Integration (15 min break)
10:00	10:30	Data and Software Needs
10:30	11:00	Personnel and Skills
11:00	11:30	Break for Lunch (30 min break)
11:30	12:00	Policy and Agency Structure
12:00	12:30	Resource Needs
12:30	1:10	Tasks (10 min break)
1:10	1:25	Elevator Pitch
1:25	1:30	Maturity Self-Assessment

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Participants

The participants in the workshop were from various MnDOT's office's, offices having representation in the workshop are listed below.

- District ADE Program Support Office
- District Planning Director Offices
- Office of Asset Management
- Office of Bridge Construction and Maintenance
- Office of Bridge Planning and Hydraulics
- Office of Maintenance and Operations
- Office of Modal Planning and Program Management
- Office of Pavement Management
- Office of Performance and Risk Management
- Office of Policy and Planning
- Office of Project Selection Planning Program

Outcome

The workshop produced valuable insights, including:

- Key benefits of area integration, as expressed in the elevator pitches:

  - Leveraging good leadership and investment for a more comprehensive approach to monitoring performance and identifying risk to support best practices in asset, risk and performance management.
  - More effective management of transportation assets and resources, critical to empowering Minnesota's economy and quality of life.
    - Empower more informed decision making through an integrated management approach that details project prioritization and communicates a more comprehensive impact to the public.
  - Greater accountability and management of limited resources.
    - Making sure the right things are fixed at the right time to maintain the States assets in good condition.

- Strategies for better management integration include:

  - Work across different areas (different asset classes) to meet overall goals. More effective handoffs between planning/programming/project development.
  - In addition to Capital, focus on integrating risk into Maintenance and Operations.

- Integrate risk registers into management of the construction program.
- Ensure at the planning level, projects are selected based on performance, then they are managed against this performance. If there are deviations due to risk, respond to ensure that the highest priorities needs are being met regardless of budget.
- Identify potential asset needs early in the project development process (e.g. when the Planning Section develops the Project Charter). How to deal with unexpected asset issues? Culvert blowouts due to torrential rains, etc.?
- Use risk, performance data, and TAMS/TAMP data/info to make programming decisions and processes.
- Use risk to evaluate performance targets and set green/yellow/red thresholds.
- Implement recommendations from our TAMP and the current AM Strategic Implementation Plan initiative.
- Develop enterprise risk register to tie risk management more clearly back to strategy. Evaluate risks to performance targets.

- A shared perception from attendees that management area integration has been initiated in most areas but still has ample room for further development (see levels of integration below). The combined scoring from the Maturity Self-Assessment conducted during the workshop is displayed in Figure 3.

FIGURE 2   INTEGRATION MATURITY SELF-ASSESSMENT LEVELS

Integration not yet begun — **Level 0: Pre-Integration**

Identified the need for integration; determining structure and approach — **Level 1: Initial**

Established metrics, initial documentation, and monitoring; developing a roadmap and initiating small-scale integrated practices — **Level 2: Defined**

Processes are becoming systematic and repeatable, producing consistent results; not yet fully integrated across agency departments — **Level 3: Expandable Repeatable**

Integration is being performed across all appropriate asset classes and agency departments; processes are well-documented and effective — **Level 4: Managed**

Processes are fully deployed throughout the agency and are highly effective; commitment to continuous improvement — **Level 5: Optimizing**
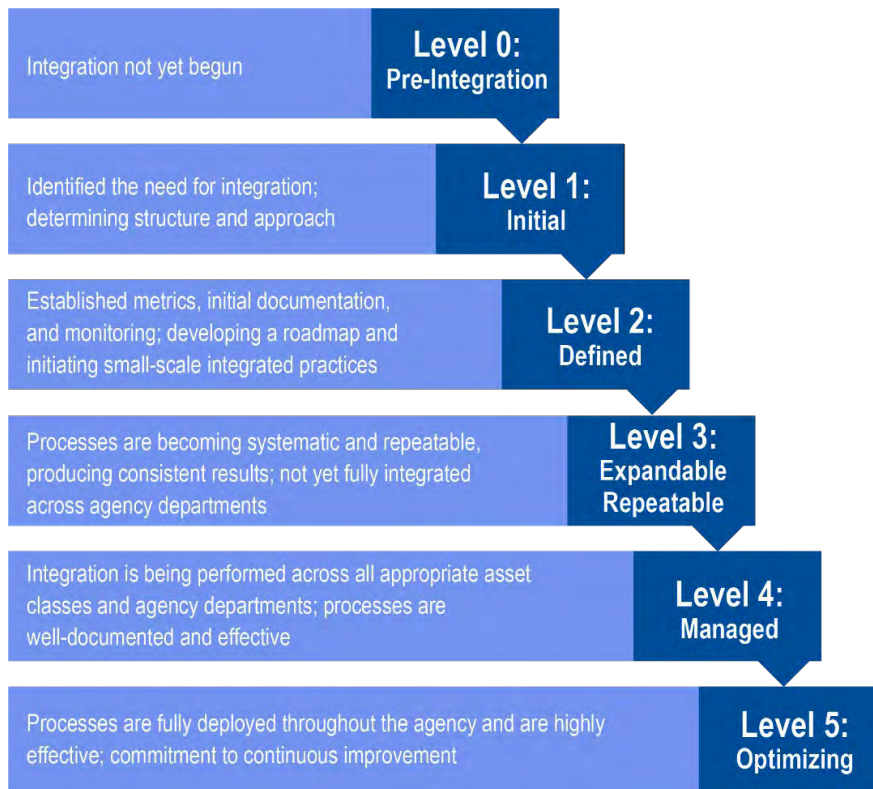
FIGURE 3   INTEGRATION MATURITY SELF-ASSESSMENT - RESULTS
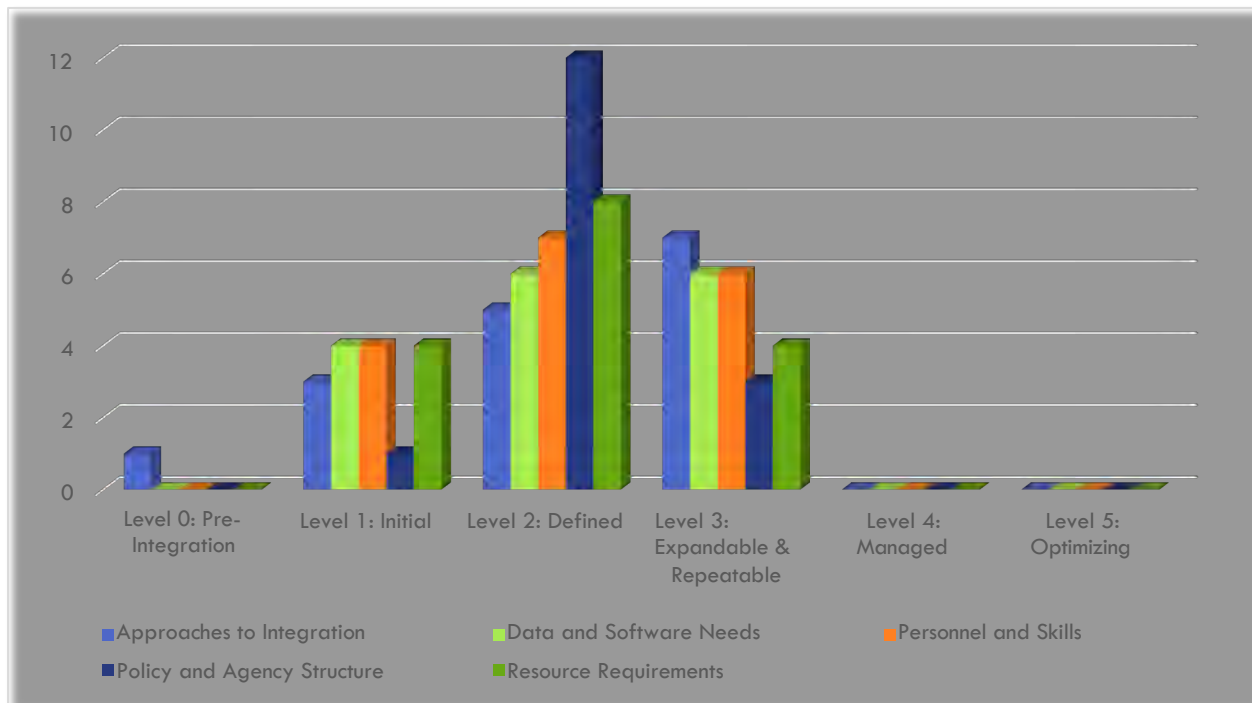
These insights are the basis for the MnDOT roadmap outline laid out in the remainder of this document.

Outline for Integration Roadmap

This roadmap outline includes details gathered in the workshop but does not include detailed plans for implementation (e.g., names, due dates, etc.). It consists of a vision, strategies, and the beginning of an action plan that MnDOT can build upon with a detailed, time-bound action plan, with actions assigned to specific people and a commitment to follow-up and measure progress.

Relationship to the Focus Areas

As described in the above sections, the workshop and roadmap are based upon the five focus areas described in NCHRP 08-113. Through discussion sessions based on each focus area in turn, MnDOT participants generated strategy statements that added detail to the universal concepts in the focus areas, highlighting MnDOT' specific potential areas of growth. By following this roadmap, MnDOT will address each focus area as follows:

- *Approaches to Integration* by having consistent communication across offices.

- *Data and Software Needs* by having consistent information generated from quality data (e.g., project cost estimates).

- *Personnel and Skills* by discussing the role of training and "essential skills".

- *Policy and Agency Structure* by integrating TAMP into project development.

- *Resource Needs* by discussing the need to tie budgeting and project selection to performance metrics.

When participants were asked to state the three resources most needed by MnDOT to integrate asset, performance, and risk management, participants provided a range of needs as depicted in Figure 4.

FIGURE 4   RESOURCE NEEDS IDENTIFICATION ACTIVITY - RESULTS

Vision

MnDOT will achieve integrated performance, asset, and risk management across its full portfolio of assets and its full range of performance outcomes, focusing on aspirations for a better transportation system for all users — now and in the long-term — an opportunity and responsibility shared amongst all of the agency's leaders and staff.

Foundation

This roadmap recognizes the significant progress that MnDOT has made toward integration of these management areas over the past decade, and in particular over the past five years. Major accomplishments include:

- Continuing with Minnesota GO visioning process, which primary goal is to better align the transportation system with what Minnesotans expect for their quality of life, economy, and natural environment.

- Creation of the Statewide Performance Program and the District Risk Management Program, these programs help the agency effectively reallocate funding and address changes.

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- Creation of the Asset Management Project Office, which is responsible for the development, update, and monitoring of the enhancements outlined in the TAMP, and oversight of Transportation Asset Management System development and other asset management initiatives.

Strategies

MnDOT could continue on this growth trajectory by pursuing several measurable goals. Over the next five years, MnDOT could:

- Continue to *refine and focus budget and time resources* that provide the framework for integration and collaborative activities such as standardizing terminology and defining job descriptions and workflows. Short-term investments that lay the foundation to more effective process and tool integration going forward.

- *Broaden the performance focus,* strengthening measurement of asset condition while actively considering risk and non-condition-based performance measures.

- *Target increased TAMP utilization* though integrated performance, asset and risk management processes and a unified group of champions with executive support.

- *Establish clear standards for data governance,* utilize tools such as the asset management strategic implementation plan to identify data sources and promote best practice data management and use. -

    Continue to *build a culture strong in essential skills to integration* including standardized communication processes, a collaborative and inclusive work environment, visibility and engagement from top to bottom and understood responsibilities.

- *Establish system of training that ensures skills, tools, processes and data are shared with all staff in order to instruct and empower them to integrate performance, asset and risk management.* This should include data managers and analysts, visualization specialists, district and central office asset managers, agency executives and managers, and operations and maintenance staff at every experience level.

Action Plan

To achieve the strategies, MnDOT should develop an action plan that assigns actions like the ones below to individuals or groups, with deadlines and accountability.

- To continue to *refine and focus budget and time resources*, MnDOT could:

    - Task a group of experienced managers to identify and define job descriptions for all functions involved in performance, asset and risk management.
        - o Review current organization structure within the Central Office and in the Districts and determine what changes, if any, should be made to increase process integration efficiency and effective communication.
            - o Prioritize position changes by intended impact to overall integration of performance, risk and asset management activities.
        - o Involve integration champions as well as junior staff in structure definition and revision conversations to provide integration development opportunity and reinforce top-down collaboration.

- Task process leaders with standardizing terminology within performance, asset and risk environments both in central office as well as within district functions.

- Ensure recent investment in life-cycle tools is understood throughout relevant departments and included in training activities to reinforce use and comprehension.

- To *broaden the performance focus*, MnDOT could:

  - Increase and standardize, as much as possible, continuous internal and external communications; ensure discussions with leadership on all decisions with asset, performance, and risk management. Example communication standards can include monthly/quarterly/annual communications to track performance metrics or standard visualization concepts to communicate condition targets. Reinforcing trackable and understandable communication on system and asset performance.

  - Knowing that MnDOT has previously identified non-asset performance metrics that are used to identify and inform progress on strategic goals, setting agency priorities and prioritizing projects, there may be a consideration to evaluate if they are being used effectively. Considerations such as:

    o Does the refining process of integrating performance, risk and asset management create opportunities for these metrics to be revised, discontinued or applied differently in order to be more impactful?

    o Are these metrics communicated and understood by staff involved in performance risk and asset management both in the Central Office as well as District offices?

    o Is there training material available to close existing understanding gaps, if any, as well as onboard new agency staff?

    o Do these metrics reference data that is shared and understood throughout performance, risk and asset managers and staff?

- To *target increased TAMP utilization.* MnDOT could:

  - Identify and communicate executive support, champion efforts and organizational structure enabling effective workflows in addressing TAMP considerations.

  - Identify potential project-level considerations where TAMP can be applied to push utilization further through the system while increasing impact visibility from the big-picture. One example where this can be done is in the corridor planning process where life-cycle planning can enrich the long-range planning of specific assets and performance gaps can gain more visibility. Such a consideration will strengthen the business case for corridor improvement investment strategies and increase TAMP understanding agency-wide.

    - Utilize broadcasted support to ensure agency staff in the central office and within district offices have adequate training to understand their role and the avenues of communication to engage further in a more integrated function.

    - Ensure developing and incoming staff are properly onboarded to ongoing efforts and processes, data and responsibilities.

- To *establish clear standards for data governance*, MnDOT could work with agency data domain stewards to evaluate data maturity (value, availability, reliability, security, trustworthiness, clarity, efficiency (lack of duplication) and accountability). This effort should identify the following for each data source:

  - Contents and system-of-record – what is this dataset the best source for, if anything?

    - Metadata – field definitions, units/glossary, and update schedule (against either the calendar or a project lifecycle).

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- Use case – where and how is the data used and why MnDOT should be paying to collect or purchase this data and to use time and money resources to maintain it. Could this data be used in other ways within performance, risk or asset management functions?

This documentation process could allow MnDOT to prioritize data sources, promote high-quality data with wide but unrealized applicability, and eliminate duplication of effort. In addition, MnDOT could pursue the larger goal by:

- Task an integrated panel to review and revise, as necessary, the Data Business Plan and Business Data Catalog. This effort should complete a map of performance, asset and risk management data and enterprise architecture, including repositories, connections, and applications.
- Clearly documenting all software and tools with their value and use cases – ensuring that useful tools are widely available, and staff and managers are adequately trained.

- Build and share skills among current staff and managers in visualization tools (e.g., PowerBI or JavaScript), advanced GIS scripting and analysis (e.g., ArcGIS, QGIS, or Python), and statistical analysis and data science (e.g., Python, R, SAS, SPSS, Stata, or simply advanced Excel).

- To continue to *build a culture strong in essential skills to integration*, MnDOT could:

  - Ensure that communication channels within the agency allow staff to notify each other of emerging risks quickly and efficiently up, down, and side-to-side. Ensure that risks can be rapidly assessed and prioritized and mitigation identified where necessary through regular communication between the Central Office and the Districts.
  - Consider further training and utilization of Microsoft Teams as an accessible and effective collaboration platform. Identify "power users" who can be trained or have existing experience to manage team engagement. This can be more impactful as an assignment for a more junior staff member to be responsible for with support and participation from relevant team leads.

- To *establish system of training that ensures skills, tools, processes and data are shared with all staff in order to instruct and empower them to integrate performance, asset and risk management*, MnDOT could:

  - Consider establishing a formal asset management training system with technical and non-technical training materials. Identified as a "critical concern" in the workshop, staff in district offices can be highly specialized and create natural silos; however, shared understanding and continuous development increase integration effectiveness throughout the agency.
    - o Technical training materials should be relevant to the existing performance, asset and risk management workflow and could include visualization tools (e.g., Tableau, PowerBI or JavaScript), GIS mapping, analysis, and scripting (e.g., ArcGIS, QGIS, or Python), and statistical analysis and data science (e.g., Python, R, SAS, SPSS, Stata, or simply advanced Excel).
    - o Non-technical skills could include risk management, management/leadership, analytical thinking, and problem solving.
    - o Current staff should be encouraged, supported and trained in developing these skills and these skills should be sought after and trained, if necessary, in new employees.

- Continue to seek opportunities to personalize performance, asset, and risk management for employees across the agency – look for "hooks" that can bring people into the effort by appealing to shared aspirations for Minnesota and the transportation system.
- Seek opportunities to recognize and valorize staff and managers who collaborate and ask for advice, data, or help from outside of their silos.

APPENDIX

Workshop Collaboration Boards
Conceptual Organization Charts
Elevator Pitches

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Appendix | Workshop Collaboration Boards

What can be done in your office to integrate performance management, asset management, and risk management?

Use risk, performance data, and TAMS/TAMP data/info to make programming decisions and processes	Allocate resources to work in this area. Better communication/transparency in data, TAMP plan, educate staff on need and for doing this and how they work in their area to make AM to success	Get resources for digging in and getting the background work done (data). Work across different areas (different asset classes) to meet overall goals best. Better handoffs between planning/programming/project development	Use risk to evaluate performance targets and set green/yellow/red thresholds	Implement recommendations from our TAMP and our current AM Strategic Implementation Plan initiative
Participate in TAMP work group development of risk, pm, am. / Participate in TAMP work group development of risk, pm, am.	In addition to Capital, we should also focus on integrating risk into Maintenance and Operations.	Our office works to provide data and tools. We can help to facilitate determination of data needs.	How do you deal with unexpected asset issues? Culvert blowouts due to torrential rains, etc.? / Include risk when discussing goal for performance measures and risks associated with not meeting them.	Ensure at the planning level, projects are selected based on performance, then they are man aged against this performance. If there are deviations due to risk, we respond to ensure that our highest priorities needs are being met regardless of budget.
Identify potential asset needs early in the project development process (e.g. when the Planning Section develops the Project Charter). / Integrate risk registers into management of the construction program.	Consistent communication across offices, revisit main purpose of managing all that (alignment with plans, vision, goals, etc.).	Develop enterprise risk register to tie risk management more clearly back to strategy. Evaluate risks to performance targets	Trying to minimize scope creep in projects by getting all assets that need repair up front instead of last-minute changes	Increase use of data and outcomes of TAMP, etc. to improve decision making in long range planning

What do you see as the greatest risk in your office(s)?

Credibility and buy-in	Staffing, Inertia of change, software, staff expertise (rare skill set), bad data, network calibration to project decisions	Retirements/resources, time to do the pre-work or innovative work	People need to trust in the process. Need to resist funding projects with the loudest proponents. (this is MnDOT as a whole, not my office)	"We can't afford preventive maintenance" - we can't afford not to! Lack of current investment in following life cycle planning and risk mitigation
Inconsistent communications about risks associated with different performance levels		Funding or lack-there-of.		
Foster challenging policies and processes that provide innovation, added value in personnel that look for finding solutions, not going down the same traditional paths. personnel. Changing the culture, everyone buying in.	Climate change could dramatically change some maintenance operations. In the near term COVID is also a huge risk.	Not communicating enough, making sure to get right data to answer the most important questions for Districts, turning strategy into implementation	Having to respond to the politics of projects.	The ability to slow down and stop what we're doing and do what is right even though it may not be popular. All actions (good and bad) have their consequences.
			Effectively translating these management concepts to the public we serve	
The ability to keep the data updated; educating staff on where to find the data; changing habits	A small number of people, each with very unique and critical skill sets.	On the dash it is difficult to summarize the measures in plain language, don't want to oversimplify or over complicated/lose the meaning	Lack of communication between offices/departments/groups. Sometimes other areas are working on very interesting projects that we are not aware of that could be valuable to what you are working on	Data management, balance to family of measures and targets, siloed work and initiatives, transparency

What important data does your office control? Who benefits from it? Can they get it?

Information that influences each of the areas owned/stewarded by different offices and that needs to be communicated/shared. Who benefits? Offices/agency	Bridge data in BRIM, SIMS, BrM. Planners, scopers, FHWA, inspectors, operations/maintenance, project development staff. transparent access	Bridge Data, TAMS Hydraulic Infrastructure data – the overseers/not the collectors. Program and project data (CHIMES, P6, etc) Widely known and used Some other hydraulic data in an ArcGIS online application – not well known and used. Most data is pretty siloed, would be nice to have it in mainly one spot – i.e. Georilla, or similar that is easy to use and access.	Agency performance measures on MnDOT's Performance Dashboard; Benefits – public, stakeholders, leaders; open source, downloadable	Capitol & Operating Budgets Who Benefits – Taxpayer Can they get it - yes
Metro Maintenance AM – Traffic Barrier, pedestrian infrastructure, noise walls, earth retaining structures. AMPO stewards TAMS and Georilla (GIS Mash-up technology). Benefits include having data for planning, programming (scoping), design, Maintenance.	Snow and Ice data, Damage restitution, facilities. Districts, Operations and Maintenance benefit with mostly direct access.	Data on all MnDOT Public facing agency measures. MnDOT Performance Dashboard. Benefits all stakeholders, easy one stop shop for data.	District 10 Year Plan that can be accessed by staff .	Programming data related to projects in CHIMES; data used for project scoping that is pulled into GIS; and data from survey results (that is not currently available but could be).
We steward the TAMS system. We can produce all manner of reports on the data – a goal is to have potential users be aware of the possibilities so we could collaborate to provide information.	Performance measures. Internal staff, public, leadership, stakeholders.	Performance measures. Public/stakeholders on the dash. Corridors of commerce - speed, bottleneck, crash	Scoring and prioritization data. Most can be accessed on MnDOT's public website, but I don't think anyone is actually looking at it.	Linear Referencing System (in GIS),Planned and Programmed Projects over the next 10 years, traffic data, etc. Wildly available and very broadly used

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Does your office need data that are currently inaccessible? Who controls the data?

BI tools to understand/summarize the data for us	Construction As built data - project staff, materials/details/design innovation tracking and recommendations from districts. Don't get overweight permit truck data(where, weights, where can't go) need to make good bridge project decision	Chicken/egg issue – aligning bridge/pavement and other projects. Moving target. Data in similar formats (map/GIS/etc.)	I think we need depreciation curves for several assets, but these are under development?	Not necessarily "need" by our office, but there are several assets owned by MnDOT that have little/inconsistent data. Some data is stored in a mind rather than a useful system
Live vs Static Data.	Yes, there is/are data that we could use that is not currently collected. We are addressing much of this need in our TAMS Strategic Implementation Plan.	CHIMES data in SDW! Great comment by Deanna! I echo As-Built comment by Ed as well.	Yes, I would agree that some GIS data is not accessible and there also need to be coordination state-wide.	Data available: Programming data related to projects in CHIMES; data used for project scoping that is pulled into GIS; and data from survey results (that is not currently available but could be).
Our agency is committed to open data. sometimes the culture is stuck in the past and needs strong urging.	Complete system condition information for all pedestrian assets in Minnesota. Generated ad hoc by open source platforms	Consistent information generated from quality data (e.g., project cost estimates)	I have all the data I need. I wish I could have a better tool to manipulate than excel. It breaks too easily.	Greater access to spatial data, if we don't specifically ask for it we don't receive it

Datasets that are the most mature?

Pavement, bridge	Bridge data (last 50 years) Pontis, BrM, SIMS, BRIM - internal, culverts (hydr info to TAMS).	Bridge, pavement Hydraulic Infrastructure - culverts (about 15-20 years), but improvement needed for some other hydraulic infrastructure.	Workforce	Pavement
Bridge, pavement	Probably Pavement and Bridge-both internal. Culverts mature only with highway culverts, not entrance culverts, ponds, etc.	Pavement info	Pavement and Bridge (internal)	Pavement and Bridge (internal); traffic counts every 2 years not live; crash data.
Pavement and bridge	Pavement, bridge	Pavement/bridge	Bridge pavement culverts barriers its signs markings	Traffic Barrier (I), bridge (I), pavement (I), centerline culverts (I), signs (I), ITS (I), utilities (E)

Datasets that most need to improve?

Agree with the non-motorized data.	Non bridge/pavement assets , bridge modelling, budget forecasting, Asset Management tools although the bridge data is mature, it wasn't developed for the purpose we want to use it for. You can have all sorts of data but unless you have confidence, quality data it is wasting resources. accuracy, predictive.	Non-culvert hydraulic assets (spcds, ponds, etc.), bikes, walls?, forecasting, flooding and vulnerability (work in progress)	Lots of other assets data is improving. We could use way to report how we are doing with our overall system/asset condition. But index measures are not popular.	Freight data; multimodal data; guardrail (work in progress); tools to forecast pavement fix tradeoffs.
ADA, lights, signals, almost any transportation element, property assets, property uses like surplus R/W, Limited Use Permits, Leases, Permits, hydraulic, other multimodal data.	Fleet, entrance culverts, Greater Minnesota lights and signals. Many systems could be enhanced with additional data	Statewide non-motorized asset info. Complete system info	Bike facilities/ped.	All? Even mature systems have areas of improvement. Deterioration modeling. State legislation requiring geotechnical inventory (not complete)
Entrance Culverts, Bike Facilities, underground lighting and signal utilities including weigh station data (as-builts), storm sewer pipe and structures, maintenance agreement data is HUGE <all per AMSIP Team Matrix>	MnDOT is actively planning to determine this Strategic implementation plan "Asset Management Strategic Implantation Plan"	Budget (capital and operations).	ADA, pedestrian and bike facilities.	

Skills that MnDOT has?

Engineering, planning	Bridge Data management, advanced excel, business intelligence, macros, visual basic, collaboration, customer engagement, national leadership, .	Data scientists/storytellers, though not how we think of ourselves	GIS, storytelling, communication, facilitation	Communication and Marketing
GIS, data scientists with Advanced Excel, programmers (embedded IT), story maps; data domain governance	BI Skills, GIS, Excel	Asset expert Risk expert Performant expert	CHIMES; Excel; programming	An outstanding GIS Specialist that can work with a variety of datasets.
Leadership, communications, customer engagement	GIS, Data viz/storytelling, transportation research	Excel, GIS, tableau	Data visualization	Tableau, advanced excel

Skills that MnDOT needs?

Culture change expert	Data science with SME skills, risk assessment, culture change acceptance.	Data analyst	Risk assessment, allocation, and management.	Interdisciplinary thinking (get out of silos). Look at how individual work areas affect or contribute to another.
Dashboard development coupled with business needs, common data environment BIM/software integration experience	TAMS (Agile Assets) experts	Internal communication. How do we know who has these skills? Still hunting down someone to help me with the excel tool I am using. Also more access to tools beyond the MnDOT firewall.	I know we need data scientists, but this is a growth area. For now, there isn't an analysis I need done that I don't have.	Data scientists/storytellers; communication skills combined with analysis
Risk analysis for the masses.				

Which skills would you be excited for others to undergo training for?

Data science for leaders, know how to use the information that comes to you. Can never do too much plain communication training	Data science, GIS, collaboration/ communication, risk assessment.	Consent building, BIM, data science, GIS, life balance with COVID	One other skill I thought of is recognizing needs vs wants and balancing the two.	Same as we heard in the last question
Life cycle management for decision makers	Model building for life cycle analysis.	Mentorship or how to navigate your MnDOT career successfully.	Integrating GIS into programming	Data analysis and management; working with multiple types of data software platforms.
Probably risk management but an applied course, applied to MnDOT practices				

Which skills would you be excited to undergo training for?

Advanced life cycle planning, applied risk management, GIS and other technologies.	Helping foster change, developing change culture.	Performance, Asset and Risk Management Integration	Culture change, storytelling	Storytelling
Change management, turning risk strategy into implementation, best way to present data to make better decisions, facilitating ROI	More AGILE training, including report generation, better understanding of Risk in general	Culture change	GIS; Cultural change and equity	Change management
Data storytelling and more advanced excel	GIS and story maps & advanced excel			

What do you think MnDOT has done successfully to push integration in the org chart?

Communication!	Resources for TAMP, AMPO office, performance targets, going beyond FHWA requirements, software, data collection.	Collaboration between asset mgt office and planning, Asset Management Steering Committee	Early engagement, constant communication about investments; TAMP, performance measures policy	So much leadership support! MnSHIP + TAMP. AMPO. Great IT Partnership.
Management groups (PCMG, PMG, etc) and steering committees create valuable connections across groups in the organization	Creation of AMPO. I think Assets and performance are being integrated pretty well, Through regular meetings with MBMT. Are beginning to integrate through LOS approach	Revised PAR Integration Committee Structure	Created Asset Management Office	Held Asset Management Workshop that included departmentwide participation.
The CO staff for these disciplines are linked	Creating AMPO, AM Strategic Implementation Plan, Wide reach to aid in TAMP development	Collaboration between perf dashboard team and subject experts	Still ongoing but early outreach to locals to better schedule projects	

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What do you think MnDOT should do next to push integration in the org chart?

Stakeholders want to know what their role is in the bigger picture. Accountability

Integrating TAMP into project development, transparency, MnDOT to "silo" ed communication between districts and SME,

Org chart changes not needed. Continued leadership support and continued communication (yes! conscious effort to integrate)

Districts have lots on their plates so need to work together; define how other project elements are included in asset mgmt. (e.g.: equity).

Find Gaps, roadmap, prioritize around risk/am/pm. Align key stakeholders.

Clarity around leadership level bodies; allowing decision making at the right level – even when it involves abdicating control

Make a conscious effort to integrate Risk

steady pressure

Make it a priority because there is only so much time

Hold TAMS discussions at District/Office level; Hold workshops to better define risk management and performance management as they relate to District ops and how these areas can integrate better with asset management and vice versa.

It is all about people and skills and having a roadmap to guide our efforts....where do we want to be and when and who/what do we need to get there

Better communication with legislators/public officials to tell them we're not just spending their money willy-nilly.

What are 5 things leaders can do to integrate performance, asset, and risk management?

1. Define The Goal
2. Communicate Roles and Responsibilities
3. Prioritize
4. Plan
5. Implement
   Build a Strong and Sustainable Foundation

Resources, vision, accountability, communication, sustainability

Educate, prioritize, communicate.

Leadership needs to consider perf, asset and risk with all decisions/conversations.

Continue to add into leadership conversations. Say it is important, but mostly, WHY it is important. Think proactive rather than reactive. Participate in steering committees (risk & AM). Talk about these together rather than separately

Consistent, plan, communicate, set priorities/where does it fit, commitment

Educate, ensure development, Sell/market, encourage use, and sustain

Hire someone to put us on the appropriate path

Create a plan to implement integration; prioritize; communicate to internal and external; allocate resources; execute

1. Define problem (why) and what we are trying to solve;
2. Explain problem and seek shared understanding;
3. Seek input on what needs to be done and how to implement;
4. Educate, communicate and seek buy in;
5. Execute and implement.

Communicate clearly, provide adequate resources, hold the agency accountable, lead by example, make it a priority

Plan, communicate, feedback, review,

Educate, communicate.

Create a clear pathway for leaders to engage on perf/risk/asset in their decision making where appropriate AND leaders to see role as implementers of publicly-vetted plans that use perf/risk/asset

Communicate that fixing existing assets are as important as big expansion projects, education, clear data, customer buy in, sell the story of what we/they're going to get

Communicate continuously; ensure discussions on perf. Also include asset and risk, discussions on risk include asset and perf., etc.; organize to support integration.

What are 5 things you can do to integrate performance, asset, and risk management?

Communicate where/when integration makes sense in different projects/applications	BAM (Bridge Asset Management) position, advocate for AMPO, TAMP. Collaborate/communicate with other offices/Districts Performance target accountability	Provide Tools like dashboards that will help to deliver data, helping to communicate and facilitate development of PM/AM/Risk, seek input.	Communicate clear Vision, provide adequate resources, hold the agency accountable, lead by example, make integration a priority	- Develop more clear, plainly stated summary information on perf/risk/asset; - Communicate outside - Create more examples of how we are integrating
Mirror the things I said above. lead by example, consistent, sell, accountability walk the walk, be open to suggestions/flexible/adapt.	Complete development of an Asset/Performance/Risk matrix for Maintenance and Op's (currently underway), encourage it's use and sustain it.	Have more meaningful 1-on-1 conversations with key staff, send kayaks down several rivers (get initiatives flowing that others can sustain)	Bring this topic to next meeting of planners; learn more	1. Participate in problem identification; 2. Assist in plan development; 3. Communicate within my circles; 4. implement elements that I have control toward influencing; 5. Sharpen the saw on these areas.
Data only tells part of the story - we need to involve maintenance staff and local partners in project decisions; keep all functional groups in the loop; familiarize myself with available tools.	Re-review these areas to find connections, meet with staff for updates/new data, create new/clearer ways to display info across staff/public.	Continue to make perf measures more plain language, learn more about how diff areas of MnDOT are connected.	Help tell the story.	Communicate data and tools available.

Low-Hanging Fruit

Priority | critical need, level-of-impact

Difficulty | time, cost, regulatory process

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Major initiatives, but worth it

Priority | critical need, level-of-impact

Difficulty | time, cost, regulatory process

Create a plan to implement integration

Deanna – this idea from Mitch

Mitch: Complete and regular data collection

Ronda: I agree with Mitch

Educate, communicate and seek buy in

Development of Tools that provide Data to make better decisions

Evaluate effort and applications to ensure effective calibration and buy-in of integration

send kayaks down several rivers (get initiatives flowing that others can sustain)

Problem identification

Prioritize resources, create a collaborative vision with all stakeholders, accountability,

Map your answer from Slide 78/79
Copy (Ctrl+C) your post it note
Paste (Ctrl+V) on this slide
Drag it to location you think it fits

Enterprise Risk Management Tools at MnDOT

	Capital	Governance	Operating
Enterprise		**Who Acts:** Executive & Senior Leadership Teams **Risk Management Tool(s):** *Agency Risk Register (composite of Capital, Governance, and Operating risks)	
	Who Acts: Transportation Program Investment Committee (TPIC) **Risk Management Tool(s):** • Risk assessments in capital investment plans • Investment Opportunity Plan (IOP)	**Who Acts:** Governance Council **Risk Management Tool(s):** • Safeguarding MnDOT Risk Assessment Plan • MnDOT Policies	**Who Acts:** Resource Investment Council (RIC) **Risk Management Tool(s):** • Risk assessment of RIPs • *Operating Investment Opportunity Plan (OIOP)
Program / Products & Services	**Who Acts:** Management Groups (PMG, PCMG, District Engineers, etc.) **Risk Management Tool(s):** • MnSHIP risk assessment and other risk-based capital investment plans • Asset Management Risk Register • District Risk Management Plans (DRMP)	**Who Acts:** Control Environment Leads, Data Domain Stewards, Policy Owners **Risk Management Tool(s):** • CET Risk Assessments • MnDOT Policies	**Who Acts:** Management Groups (PCMG, District Engineers, Modal Office Directors, etc.) **Risk Management Tool(s):** • P & S Investment Impact Analysis • Asset Management Risk Register • Office & District Business Plans
Project / Activity	**Who Acts:** Office Directors, District Engineers, Project Managers, and MnDOT Staff **Risk Management Tool(s):** • Project Risk Registers	**Who Acts:** Office Directors, District Engineers, Office Managers, and MnDOT Staff **Risk Management Tool(s):** • MnDOT Policies • Office & District Business Plans	**Who Acts:** Office Directors, District Engineers, Office Managers, and MnDOT Staff **Risk Management Tool(s):** • Office & District Business Plans

*Proposed Tools to Address Gaps

RISK

LCC

AM
SHANNON
DAVE
TRISH
ET. AL.

PM
IPU

INPUT

INPUT

RM

DEANNA
CHRIS
ET AL.

EXPERT
OFFICES

INPUT

DIST
PLANNERS
+
MANAGERS

DECISIONS

NOT TO SCALE
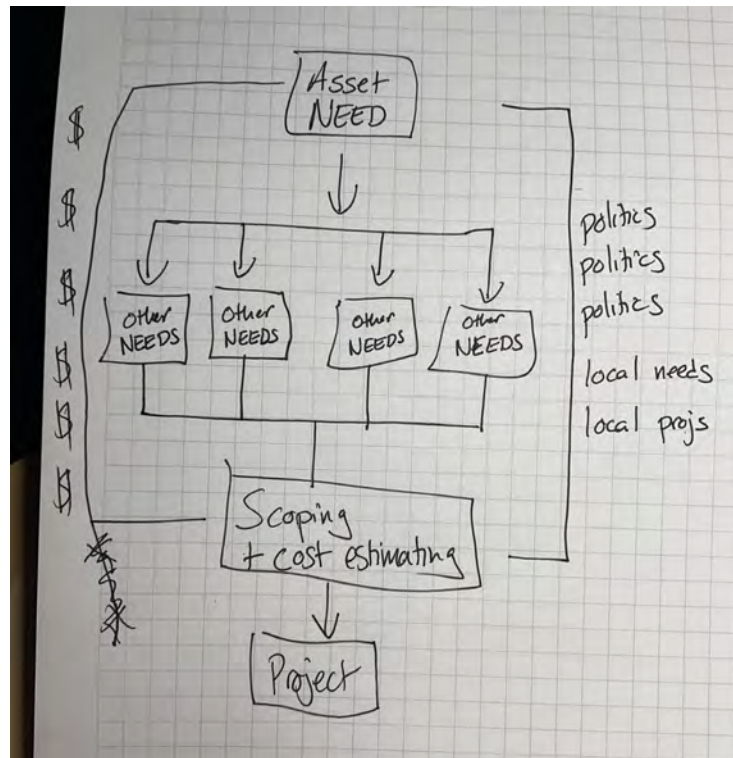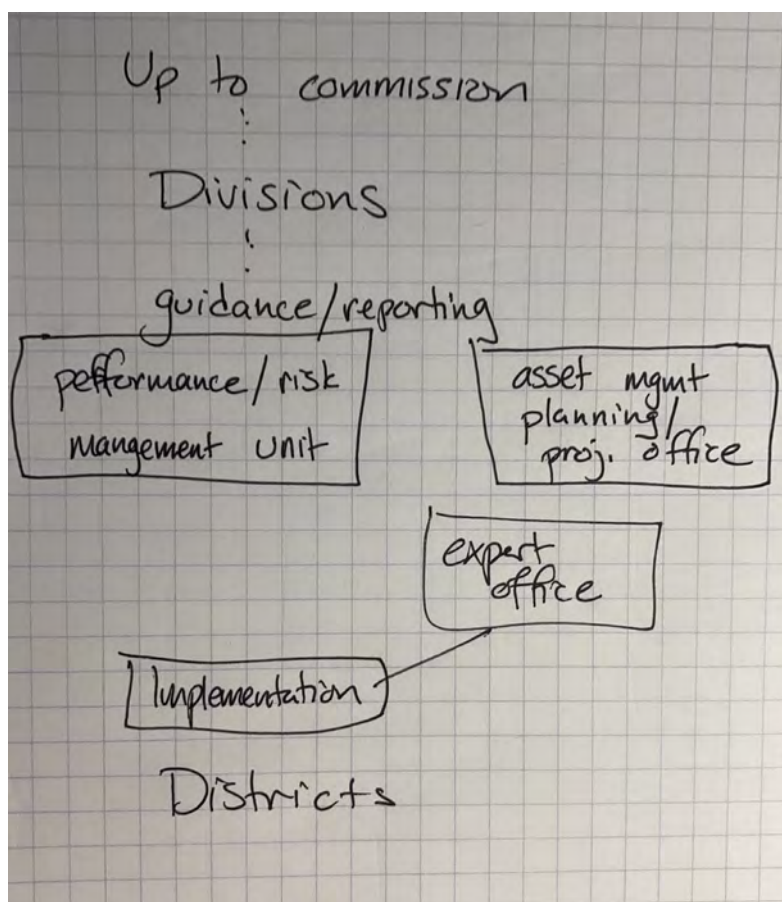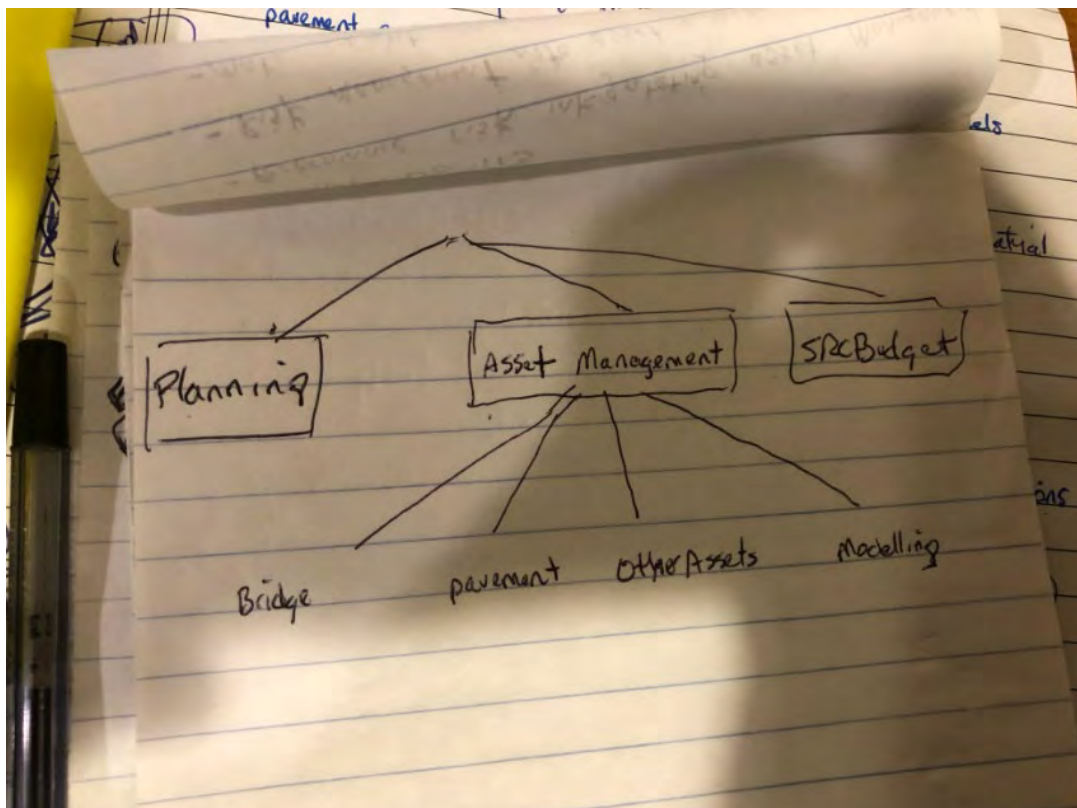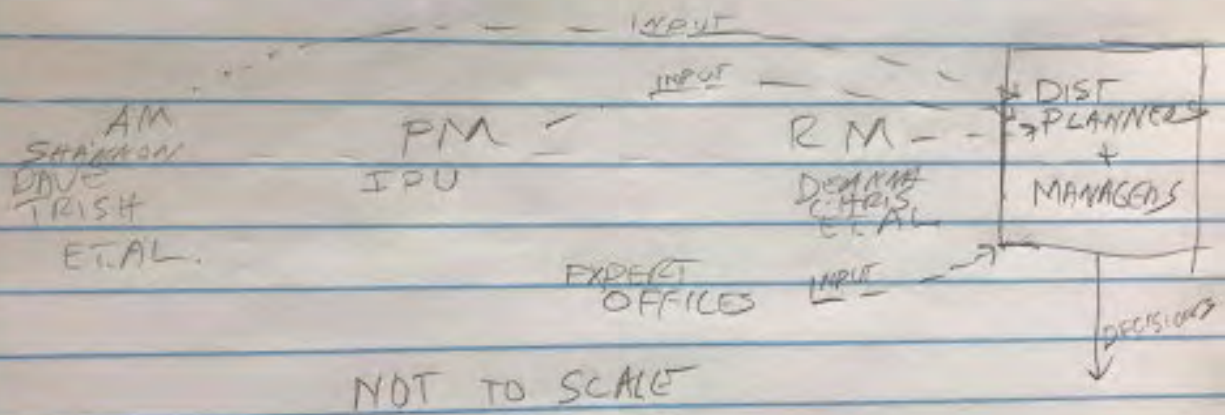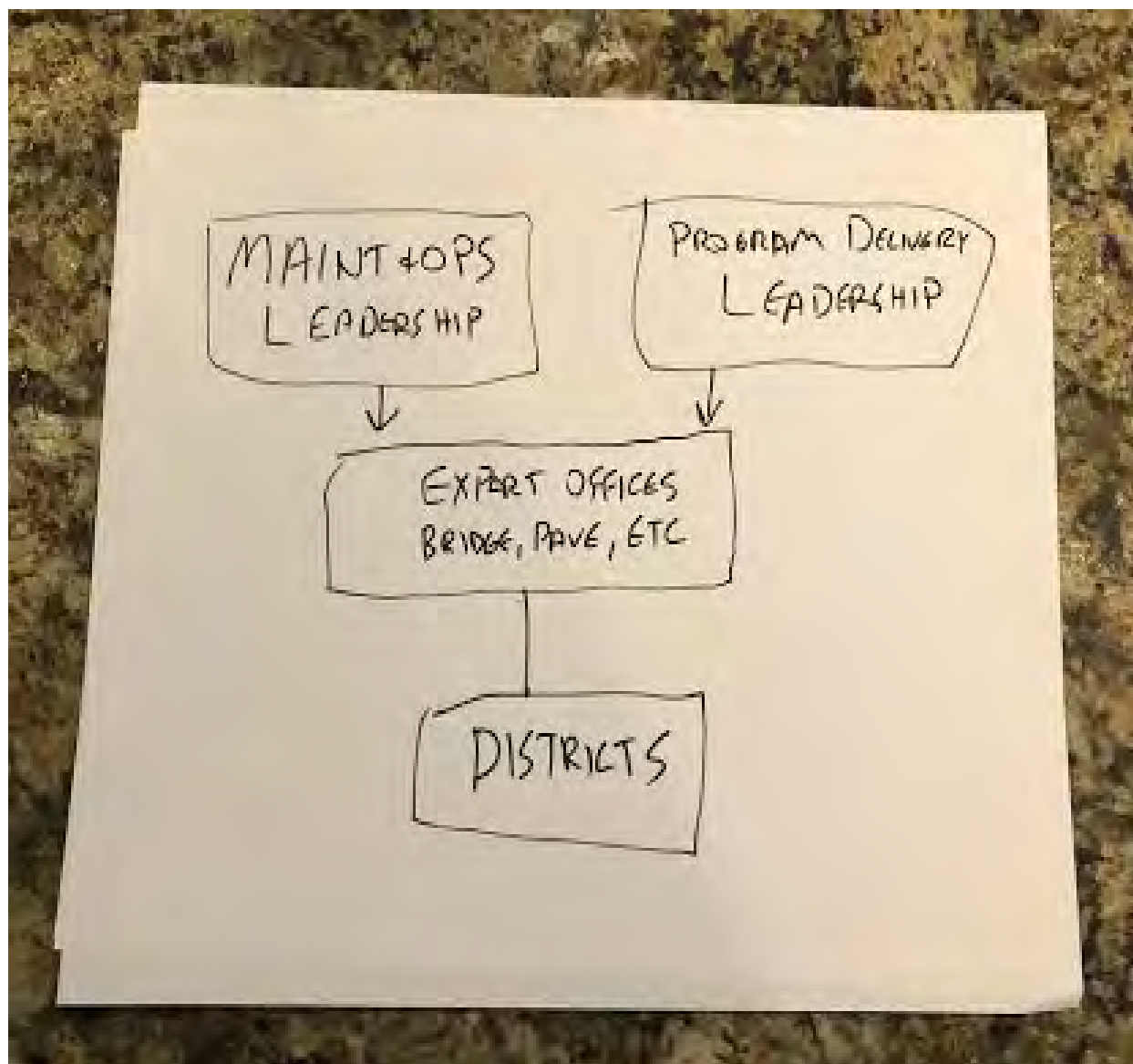
TAMP *

PM / RISK

Key technical Input

ah

OPPM

AMPO
• Am Strategy
• Am Tools
• PM Leadership

OTSM
• PM strategy
• PM tools
• PM Leadership
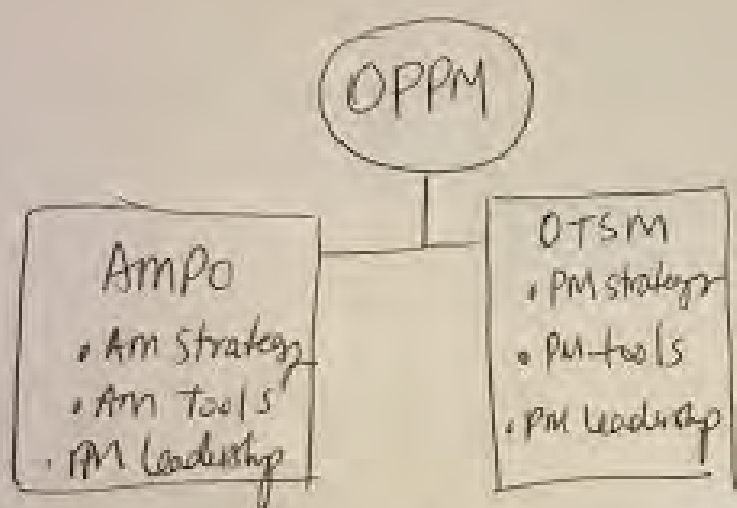
PM/AM
strategy
tool
Leadership
Bridge Office

maybe introd Lab

PM/AM
strategy
tool
Leadership

Districts

Specialty offices
• OTE
• Maint
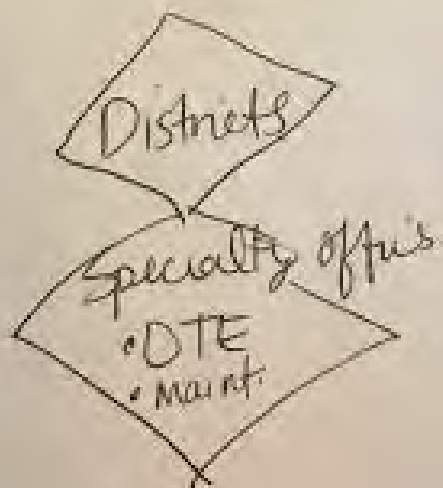
PM/AM/Risk
— implementation
— actions
— decisions

Appendix | Elevator Pitches

- "MN's infrastructure assets investment is billions and are critical to supporting our economy as well as what's important to MN families. To support good asset management, we need to continually monitor performance and identify and manage risks to meeting those performance objectives. To integrate this will take investment and leadership."

- "Effectively managing the State's transportation assets and resources is critical under all conditions 24/7. Our public expect this from us, and our economy and quality of life depends on it."

- "Customer (public and legislative) response and future financial effectiveness."

- "Formalizes the decision making you already have to make and allows you to communicate it back to the public"

- "PAR INTEGRATION – THERE IS NO SUBSTITUTE"

- "Given limited funding, integrating performance, asset, and risk management will help MnDOT better prioritize MnDOT projects."

- "As MnDOT budget fluctuates based on state priority, we need to embrace asset management principles to manage risk and maximize performance to give the accountability the public demands. Integrating performance, asset management and risk management will result in a better system for all users, help to plan for the needs and resources in the future and help MnDOT manage risks. In such a recourse constrained time, we need to clearly stretch and maximize taxpayer dollars. Integrating risk-based decision on such as level of service into performance management – with a strong asset management foundation will do just that!"

- "These three management disciplines are strong on their own but integrating then we could better achieve our multiple strategic objectives. Important with our limited resources."

- "It's a way to make sure we fix the right things at the right time to maintain the States assets in good condition."

- "I would start by illustrating the benefits like reduced life cycle costs and sound, real, and complete identification of needs. Then and provide a roadmap to implementation, including development costs."

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NCHRP 08-113

Integrating Effective Transportation Performance, Risk, and Asset Management Practices

NCHRP NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Workshop Summary and Work Plan Outline

TriMet
(Tri-County Metropolitan Transportation District of Oregon)

November 2020

Introduction

The objective of this memorandum is to summarize the NCHRP 08-113 Workshop conducted with the Tri- County Metropolitan Transportation District of Oregon (TriMet), and to outline a potential roadmap the TriMet team can use to better integrate performance, asset, and risk management at TriMet in a five-year timeframe.

The NCHRP 08-113 team engaged with TriMet prior to the workshop. During these preparation virtual meetings, they discussed the 2018 "quick scan case study" that was completed in the fall of 2018. The TriMet Quick Scan reported a "moderate" level of overall integration as well as integration of asset, risk and performance management programs. TriMet stated at the time that the vision in the new 5-Year Business Plan at the agency supports management alignment and that the resulting management reconfiguration has shown positive momentum in integration efforts.

The 2020 workshop was intended to build on the past engagement by accomplishing the following:

- For the research project, the team intended to "test-drive the guidance". To accomplish this, the team collected real-world detail and established best practices to support the focus areas and framework laid out in the Interim Report. The team also evaluated whether practitioners responded to that framework. In addition, the team sought to collect anecdotes and descriptions that illustrated the benefits of integrating performance, risk, and asset management efforts at the agency.

- The team intended to lay the groundwork for building a roadmap for the next phase of integration at TriMet. This included building on TriMet's current efforts in implementing a data-driven system that enables preventative maintenance. TriMet Executive Director of Maintenance Operations Roland Hoskins included the following as part of his opening remarks for the workshop: *"We're excited to get a system in place that helps to track work and manage workflow and productivity and definitely understand the state of [TriMet] assets. Our main goal is to do preventative versus corrective maintenance."*

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The Workshop

Due to the COVID-19 Pandemic, the workshop was held utilizing virtual collaboration technology through WebEx and utilizing a cloud-based collaborative PowerPoint deck on September 3, 2020. The workshop was split into several segments as follows:

- To start, the group explored some focus areas for integrating performance, asset, and risk management identified in the NCHRP 08-113 research. The goal for the initial portion of the workshop was to collect, through a collaborative, virtually-facilitated process, the participants' thoughts on how TriMet could best address:

    - Approaches   to   Integration
    - Data   and   Software   Needs
    - Personnel and Skills
    - Policy and Agency Structure

- After a short break, the group started to build a roadmap, beginning with a discussion of resource needs TriMet had in order to advance performance, asset, and risk management integration. A real-time polling tool, Mentimeter, was used to identify needs in addition to what constraints existed in TriMet accessing those resources. The group also explored personal and leadership tasks that TriMet can undertake to further integration. Then, the group developed elevator pitches to highlight perceived benefits of management area integration, phrased to be delivered to the agency General Manager. To conclude the workshop, the group piloted a maturity self-assessment honed for this project by the research team shown in Figure 2.

Agenda

The agenda for the workshop is provided in Figure 1.

FIGURE 1   AGENDA FOR THE WORKSHOP (SEPTEMBER 3, 2020)

8:00	8:15	Welcome - Introductions
8:15	8:30	TriMet Leadership Welcome
8:30	8:45	"Power-On" Activity
8:45	9:15	Approaches to Integration
9:25	9:55	Data and Software Needs
9:55	10:25	Personnel and Skills
10:25	10:55	Policy and Agency Structure
11:05	11:35	Resource Needs
11:35	12:05	Tasks
12:15	12:25	Elevator Pitches
12:25	12:30	Maturity Self-Assessment

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Participants

The participants in the workshop were from various TriMet office's, offices having representation in the workshop are listed below.

- Business Planning & Asset Management
- IT Operations & Infrastructure
- Business Planning & Asset Management
- Facilities Management
- Maintenance Operations
- Risk Management
- Service Performance and Analysis, Operations Planning and Development

Outcome

The workshop produced valuable insights, including:

- Key benefits of management area integration, as expressed in the elevator pitches:

  - Practice good stewardship over "incredible" infrastructure investment and public funds
  - Utilize long-term thinking to build intentional and desired future system
  - Align TriMet staff in purpose, expectations and direction
    - Provide agency understanding on how what people do every day can move TriMet forward

- Strategies for better management area integration, including:

  - An illustration of the value of strong champions with broad buy-in (as exist at TriMet).
  - Supported efforts behind shared space and language where the "gathering" part of the system and the "doing" part of the system can identify and close gaps
  - Develop format for standardizing and documenting processes without losing flexibility or constraining innovation
  - Advance agency-wide data sets to gain true view into whole life-cycle costing
    - Engage the developing Concept Report, Performance Management Committee, Transit Asset Management Plan (TAMP) and upgraded asset management system to define integrated discussion.

- A shared perception from attendees that management area integration has been initiated in most areas but still has ample room for further development (see levels of integration below). The combined scoring from the Maturity Self-Assessment conducted during the workshop is displayed in Figure 3.

FIGURE 2   **INTEGRATION MATURITY SELF-ASSESSMENT LEVELS**

Level 0:
Pre-Integration

Integration not yet begun

Level 1:
Initial

Identified the need for integration;
determining structure and approach

Level 2:
Defined

Established metrics, initial documentation,
and monitoring; developing a roadmap and
initiating small-scale integrated practices

Level 3:
Expandable
Repeatable

Processes are becoming systematic and repeatable,
producing consistent results; not yet fully integrated
across agency departments

Level 4:
Managed

Integration is being performed across all appropriate asset
classes and agency departments; processes are
well-documented and effective

Level 5:
Optimizing

Processes are fully deployed throughout the agency and are highly
effective; commitment to continuous improvement

FIGURE 3   **INTEGRATION MATURITY SELF-ASSESSMENT - RESULTS**

Legend:
- Approaches to Integration
- Data and Software Needs
- Personnel and Skills
- Policy and Agency Structure
- Resource Requirements

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These insights are the basis for the TriMet roadmap outline laid out in the remainder of this document.

Outline for Integration Roadmap

This roadmap outline includes details gathered in the workshop but does not include detailed plans for implementation (e.g., names, alternatives, schedules, due dates, etc.). It consists of a vision, strategies, and the beginning of an action plan that TriMet can build upon with a detailed, time-bound action plan, with goal-oriented actions assigned to specific people and a commitment to follow-up and measure progress.

Relationship to the Focus Areas

As described in the above sections, the workshop and roadmap are based upon the five focus areas described in NCHRP 08-113. Through discussion sessions based on each focus area in turn, TriMet participants generated strategy statements that added detail to the universal concepts in the focus areas, highlighting TriMet's specific potential areas of growth. By following this roadmap, TriMet will address each focus area as follows:

- *Approaches to Integration* by standardizing Key Performance Indicators (KPIs) that consider management integration (e.g., performance assessment metrics focused on enabling a predictive maintenance schedule) and communicating that through Business Plan updates, that may address budget constraints, staff training, etc.

- *Data and Software Needs* by establishing a terminology standardization process for TriMet, despite a lack of such standards industry-wide, to be able to speak with one voice concerning data management efforts.

- *Personnel and Skills* by discussing training that retains legacy industry knowledge at an agency level.

- *Policy and Agency Structure* by rolling out EAMS and using it to engage regular communications.

- *Resource Needs* by aligning training to the bigger picture of agency decision-making and filling the gaps between groups with common language and shared understanding.

When participants were asked to state the three resources most needed by TriMet to integrate asset, performance, and risk management, participants provided a range of needs as depicted in Figure 4.

Figure 4 **Resource Needs Identification Activity - results**

Vision for Integration of Performance, Asset, and Risk Management

Based on discussions with TriMet staff and for the purpose of dictating a guiding principle for this resulting roadmap, the research team offers the following recommended vision statement:

In order to achieve its mission to connect people with valued mobility options that are safe, convenient, reliable, accessible, and welcoming for all, TriMet will achieve integrated performance, asset, and risk management across its full portfolio of assets and its full range of performance outcomes – now and in the long-term – an opportunity and responsibility shared amongst all agency leadership and staff.

Foundation

This roadmap recognizes the significant progress that TriMet has made toward integration of these management areas over the past decade, and in particular over the past five years. Major accomplishments include:

- Inclusion of integrated working culture in vision of 2019-2023 Business Plan

- Management structure reconfiguration to support integration activities and drive a collaborative workspace (impacts data visibility, staff training, integration process champion, etc.).

- The organization of cross-divisional committees such as CPC, TCRC and VLT that can act as a process and resources bridge between functions.

- Procurement and ongoing implementation of an enterprise asset management system (EAMS).

Strategies

TriMet could continue this growth trajectory by pursuing several measurable goals. For example, over the next five years, TriMet could:

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- **Target EAMS implementation** that can act as a driver (or catalyst) for integration management processes.

- **Define a standardized process** for communicating process and performance that is understood amongst the seasoned veterans as well as newer staff.

- **Implement an agency-wide training system** that closes knowledge gaps and sets up TriMet for long-term success.

- **Develop an agency-wide communications program** aimed at raising awareness, gaining buy-in and informing stakeholders of agency-wide efforts to integrate performance, risk and asset management efforts.

Action Plan

To achieve the strategies, TriMet should develop an action plan that assigns actions like the ones below to individuals or groups, with deadlines and accountability.

- To **target EAMS implementation**, TriMet could:

    – Include cross-functional development resources from crafting the business case to identifying a champion to implementation so that the new EAMS reflects the diverse agency backgrounds it can impact. Challenge the group to identify where EAMS will impact agency functions and what processes, KPIs or staff positions need to be in place to reach the highest agency utilization scenario.

    – Garner more than a champion but executive support to lean on integration culture in Business Plan

    – Utilize EAMS development and implementation to broadcast and engage larger-picture integration of performance, risk and asset management within TriMet. This can include other primary roadmap objectives such as cross-functional training on developing system and standardized terminology, KPIs and data governance processes.

- To **define a standardization process**, TriMet should lean heavily on pairing agency expertise with innovative tools to create a space for process communication and standards in an evolving format. This approach can assist in resource sharing and cross-collaboration without inhibiting innovation and continued growth. Pushing for administrative, operations and maintenance staff alike to be trained and given access to this process will enable efficiencies in communication and greater retention in legacy experience and knowledge from senior staff.

    The use of cloud-based tools or other tools that ensure broad, yet secure, access from multiple locations and via varied platforms (e.g. desktops, laptops, tablets, and phones) to enhance access across the large system TriMet operates and maintains. This should be a priority in order to accomplish the vision of integrated management.

    A process to accomplish this pairing could look like the following:

    1. Select a steering committee that can identify and classify processes in an informal, shared space.

2. Define a unified terminology base within agency structure as well as in connection with industry best-practices. This could take the form of a complete data dictionary, with terms for assets, KPIs, procedures, processes, and other related terminology in a centralized repository that is created and maintained by a cross-functional group and available to all staff. This should address the inconsistency in industry terminology and identify a methodology (i.e.., training/mentorship program, process/document review, leadership endorsement) to address those inconsistencies prior to being replicated within TriMet.

3. Identify applicable toolset to enable process collaboration and standardization procedure where processes that would benefit form a unified approach across operations can be elevated to the steering committee.

4. Workshop a standard methodology on KPI creation and function.

5. In an ongoing function, the steering committee would be tasked to work with involved staff to identify software, key metrics or outputs or other process elements that can be standardized while allowing continued process flexibility for self-improvement and future evaluation of standardized elements if necessary.

- To *implement an agency-wide training system*, TriMet should first leverage the actions called for in the Operations Training Strategy (underway at the time of this writing) to emphasize steps that support integration of performance, asset, and risk management. Aligned with that, or in addition, TriMet could:

  - Implement a training management tool that can act as a unifying, comprehensive information source on available training and track training compliance to ensure momentum throughout the impacted groups.

  - Consider creating a training plan that specifically targets ongoing and planned training activities and could serve the following functions:
    o Confirms that training activities are aligned toward agency vision and goals
      o Assesses value of training activity toward meeting big-picture thinking and provides methods to pivot existing training practices to a more integrated-agency perspective
      o Identify opportunities to connect integrated management more directly to daily activities

    - Task a cross-functional team to be engaged in the execution of the training program and provide for the following needs:
      o Engage training creators to ensure content and delivery will both meaningfully apply to the intended audience and encourage purposeful integration of process between performance, risk and asset management functions.
      o Champion the rollout of the training to intended groups to drive collaborative culture, demonstrate managerial support and increase training utilization.
    o Be visible agency resources readily available for follow up and execution.

  - Supplement mentorship programs in capturing historical knowledge and legacy process understanding from senior staff. With TriMet being "lightly staffed relative to comparable agencies across the West Coast" (from 2018 agency quick scan), TriMet is even more susceptible to the industry-wide concern of the rate of retirement within critical senior staff and the staffing shortfall in replacing that expertise if not intentionally planned for.

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Agencies across the country have taken on this concern in different ways, some increasing staffing resources to development/mentorship cycle programs that can "onboard" expertise in an expedited process.

An additional tactic that could be applied to an agency-wide training program could be a consolidated resource or tool that holds historical expertise captured from a workshop or program that engaged the most experienced staff at TriMet. The retirement concern is one that is critical and can be answered by a unified, comprehensive training program in addition to providing an essential opportunity for agency leaders to reflect on process management and how an integrated approach to performance, risk and asset management can ensure success for the TriMet system going forward.

- To *develop a communications program*, TriMet could:

  - Begin defining all the elements needed for a robust communications program, specifically the target audiences (internally and externally) so messages can be aimed to effectively deliver the right information to the right stakeholders.
  - Identify communication objectives:
    - In alignment with TriMet's vision and goals
      - Enable cross-functional engagement with accessibility and buy-in from administrative, operations and maintenance backgrounds
      - Serve as a catalyst for future process integration activities (i.e. Cross-functional training, resource needs identification and roll-out, feedback collection)
  - Identification of media available (e.g., existing forums or reports, email system, creation of a new digital bulletin, etc.)
  - Identification of key staff in each group (risk, performance, and asset management) capable of creating content that can be used to report recent integration activities, training programs, success stories or plans and activities to be implemented.
  - Establish a timeline to deliver periodical reports informing on integration efforts progress.

The NCHRP 08-113 team recommends that the above-defined actions be coordinated under an overall five-year strategy or set of interlinked strategies. The following procedural steps would support the effective implementation of these strategies:

- Organize a cross-functional steering committee that can define roles, set yearly objectives and receive and review regular updates on integration activity progress. Work with steering committee to develop the following functional elements for implementation:
  - o Develop a complete matrix of activities, including clearly assigned roles and responsibilities for work in integration efforts
  - o Develop a five-year timeline for integration activities that lays out logical process for implementation and aligns with resource availability. This timeline should recognize and coordinate with efforts dedicated to the implementation of the new EAMS.
  - o Define measures of success and progress checks for each activity and a tracking methodology that will be used to track progress

- Set up a periodic schedule of reporting progress to the Steering Committee as well as general agency leadership (General Manager and Chief Operating Officer).

- Incorporate these actions into the TriMet Business Plan for each year implementation continues.

APPENDIX

Workshop Collaboration Boards
Conceptual Organization Charts
Elevator Pitches

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Appendix | Workshop Collaboration Boards

What can you get out of integrating performance, asset, and risk management?

Lifecycle planning budget forecasting Asset Management	Track failure trends.	Real time condition assessments that can inform budget forecasting and life cycle costs.	I get workgroup (department) efficiencies, data driven budget information and ability to understand trends that can assist in decision making processes
Making more connections; improved understanding of the activities of other agency stakeholders, the driving factors for their activities, and additional potential synergies.	1) Better information about future year spends to guide forecast work; 2) (2) clearer information about what purchases/replacements need to be made YoY. Data exists in some silos, but needs to be consistent across the agency	Cost information for service disruptions from incident, repair, and future prevention.	Improved process efficiency and cross-departmental integration
		Support for strategic Business Plan through performance in asset management/investment decisions and in maintenance performance	Clearer asset identification and faster cost/disruption estimates to pursue against liable parties.
	Inventory optimization, less chance of excess items. Improved cycle count process		Lifecycle planning for revenue vehicles and their components.

What can be done in your office to integrate performance, asset, and risk management?

Process Standardization and Key Performance Indicators	More consistency between 3 garages Have clear KPI goals	Work towards consistent asset naming conventions, validation across all divisions. Line out divisional asset responsibility.	Educate current management staff in all three areas. Develop consistent base knowledge that integrates common ideas and processes throughout department.
Support a robust implementation of the Enterprise Asset Management System. Build structures to ensure consistency and optimal leveraging of the EAMS...example, update/add relevant policies and training to assist agency staff.	(1) Continue to improvement connections between TAM data & CIP; (2) analysis & communication of higher-risk assets that need to be addressed; (3) what John said!!	1) Standardize on KPIs and measurement methodology 2) Change specificity level of asset tracking 3) Update repair documentation to capture more detailed tasks and condition assessments. 4) Use industry best practices to move the agency towards preventive maintenance and less reactive maintenance.	Develop KPIs as a team, promote a continuous improvement culture
			Build understanding around how efforts in our department affect other departments objectives.
	Identify cross-departmental processes with opportunities to streamline communication/ coordination between maintenance and asset management divisions		Use of date to plan maintenance and overhaul activities to increase performance and prevent failures causing service delays. If budget allowed, go to predictive maintenance. Budget.
			Review and update performance measures in Business Plan with focus on risk. Long-term- sponsor risk assessments for assets

What obstacles might be in the way of additional successful integration at TriMet?

Inadequate training, turnover during implementation, resistance to change.	Resistance to change. Lack of technical ability.	Competing and silo-ed data and processes.	Silos, education and knowledge, change, and complacency
All so busy doing daily work, it's hard to slow down and ask the right questions. Funding and resources will be especially challenging next few years.	(1) funding limitations [wherever funding is needed]; (2) Resistance to change	1) Technical limitations with staff and systems 2) Unfamiliarity with KPI measurements and how to apply 3) Over emphasis on metrics vs performance.	Funding limitations (impacts data tools, cross-functional staff positions, training, etc.). Staff turnover, especially in the key roles with higher cross-functional and system-level exposure/experiences...staff in these roles can be valuable integration resource. Tactical priorities/urgencies that can delay/impede organizational-wide implementation of strategic priorities. Existence or resourcing of cross-functional agency Departments.
Difficulties in adopting and learning something new; falling into the rut of "this is the way we've always done it"	Silos, employees working at home and frontline workers (communication, interaction)		

Does your office have definitions for data items (assets, work types, symptom codes, etc.)?

We have definitions in place, but they do not match other departments definitions. We could really benefit from sharing the same definitions, and adequate training on what each one means.	Yes, MMIS has defined codes.	To a degree but is not formalized any varies greatly between divisions.	MMIS has its defined codes. Mining data from MMIS is ever evolving and requires a genius analyst. We have discovered SCADA provides a wealth of data points to view equipment performance	
Assets are done in spreadsheets and in management systems like our MDM (Mobile Device Manager) or Microsoft SMS	There are some roughly defined definitions, but they are not consistently implemented and vary greatly in both nomenclature and functionality between maintenance departments (i.e. Bus vs Facilities)	Yes and No. It depends on the discipline and who is physically in the office that day.	Most definitions controlled in our department are finance related (i.e. we don't control many asset-related definitions), but there definitely has been inconsistent use of definitions in those we do manage.	We have definitions, but we have different definitions in several cases. We have numerous different offices/staff who work with the same assets, but often use different terminology. What's been interesting to me is finding how this same loose approach to terminology exists at the FTA level (e.g., NTD policy documentation).
We have component codes and symptom codes for all tracked items and work types.	Not that I know of	Generally no. But as part of EAMS procurement and implementation, we are beginning definition of an asset hierarchy and expect to tackle definitions as well.		

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What important data does your department control? Who benefits from it? Can they get it?

Asset value information, open claims information, disruption values, and limited risk assessment data for assets.	Internal data, vehicle history	Repair history	Internal data from MMIS is shared via performance dashboard. A large amount of data is in excel files..:(
Asset value Asset performance Replacement Cycle	(1) Budget, summary of Actual Spend, & Forecast; (2) Yes, EVERYONE benefits & must help with management; (3) Accessible to all through various systems & communications on TriNet.	Transportation data for all modes (except WES); All maintenance data; Customer Complaints, Incident Data, HR, some financial stuff; Benefits – internal and external customers. You can get it but it comes with many caveats.	Asset maintenance & transportation data is controlled via PM scheduling & maintenance personnel logged work order details. Used directly by SP&A team that then push actionable information to numerous departments.
External condition assessments of assets. Asset owners certainly benefit...more could if we had a robust reporting capability...the EAMS we are acquiring soon should significantly improve this.	Min/max points, and other inventory data in oracle. Benefits inventory, stores, and purchasing	We don't directly control any data, but instead compile it from other sources. We work with asset owners and others to bring data together.	We have all maintenance records, procedures, modifications and maintenance updates. The data is internal to the department.

What important data does your department need? Who controls the data?

Assets that directly support our systems. example. HVAC, Generators for our Data Centers	Component failure rates Accurate PM forecasting	Validated location data.	Ops Analyst controls the data. Integrating facilities and MOW data could prove beneficial.
More specificity on useful life information and decay curves for TriMet Assets. Better cost estimates for assets.	Planned expenditures for Budget & Forecast; controlled by Directors & Managers shared directly or through Budget Coordinators	1) Component Level maintenance data 2) Component or system level failure data "technically" my group controls the data but we actually control the input form. Others create the data.	While we have lots of good data, I believe we need a better way to restructure and organize how the data is used/updated/created across the agency for consistency
Repair and maintenance cost data, additional asset value information, downtime information, failure rates, estimates on assets useful life.	Estimated ridership/ LRV and Buses in service, hours of service- operations analyst (we received this data recently)		We need employee performance and mean time data.

Which datasets at TriMet are the most mature? Which most need to improve?

Risk and condition assessment information on specific assets is a weak spot.

MMIS is the most mature.

MMIS is the most mature, how we track item usage needs to improve

Accounting's fixed asset database seems fairly robust. Condition assessment and life cycle data is lacking.

MMIS is mature. SCADA data requires more work to determine what is useful to monitor equipment performance.

Most mature: Monthly performance report data (boarding's, ridership, cost per boarding, etc.)

Need to improve: Asset inventory data…more attributes and consistent and characterizing terminology to assist asset owners.

Yet, most mature doesn't necessarily equate to most effective/efficient.

TAM data is maturing nicely (continuing to get more detail each year), but still lots of detail & relationship data for it that needs to be augmented (planned with EAMS)

MMIS is the most mature, but also need the most improvement. At least for REM.

Bus position and service data is most mature. All other systems need a different input/data collection form.
No system lookup tables exist to neatly tie data together.

Asset management is the most mature. But needs improved

Operations data (ridership, vehicle movements, etc.) is most mature.
Maturation of how to incorporate risk in understanding data would be good.
Also, need more maturation in linking measures to assessment of condition.

The datasets between purchasing capital assets (buildings, buses, LRVs, etc.) and maintaining those assets were never connected. A MoW signal house with a HVAC on it requires Facilities and MoW maintenance; those are not only 2 separate assets in the maintenance dataset, but a third asset in another dataset for Finance to follow its depreciation. It's 1 building in 3 disconnected datasets.

Which skills do you have in your department that could help integrate performance, asset, and risk management?

Data analysis, identifying trends, risk-based assessments, detailed inventory and values of agency assets.

High level of Bus maintenance background, ability to identify trends.

Historical knowledge

High level of technical skills, lack of analysis and ways to retain historical knowledge. All MOW Management could retire within the next year...

Historical Knowledge

Analysis, Budgeting, and Forecasting methods; data management using various tools (Excel & other MS tools, Oracle, Hyperion)

Data analysis, collection; Identifying best practices, A/B testing for experiments; Life Cycle costing; Future Component forecasting, Budgets.

Strong tech skills by some and not by others. Low soft skills by some.

Have: lots of experienced staff with an intimate understanding of the last 20+ years of Public Transportation evolution. Need: this institutional knowledge to be documented and accessible so it can persist beyond the individual.

Planning/strategic planning, program/project management, interpersonal/team building/collaboration, analysis, transit asset management.

Project management, data analysis, forecasting, communication, subject matter experts

background in project risk assessments; performance analysis

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Which skills would you be excited to undergo training for? Which skills would you be excited for others to undergo training for?

More on interplay between asset condition/risk assessment/performance, visualization/dash boarding for performance tracking/reporting, data management, EAMS. Agency could leverage WebEx more for training of Department processes. An example is Mark Ashcraft's excellent training of the CIP process...how best to leverage WebEx for those who don't' attend real-time. WebEx recordings could probably be leveraged more for onboarding/training new employees.

Budget planning, computer skills, data mining.

Self/Team: Agency Electronic Data management system; Others: MS Product familiarity (especially Excel); Accounting processes familiarity (understanding expense coding).

Business process re-engineering;
Risk analysis for operations/ maintenance ongoing activities
More project management tools/skills
Broader BI skills

Document and information management across the entire org.

Basic computer skills and statistics. Advanced analysis techniques, visualization design, communicating through reports and visuals.

Data analysis, cross functional training, computer skills training, training related to online portals like smartsheets

Report writing skills.

Computer and budgeting

Me: I'd be interested to learn R programming.

Others: SQL & sustainable data reporting methodologies

Data visualization and other technical skills, Microsoft Project, Power BI

What do you think TriMet has done successfully to push integration in the org chart?

Andrew: Cross divisional committees are definitely being added to recently, (CPC, TCRC, VLT, etc.). The Directors
Exchanges occurring with more regularity has helped as well.

There has been a focus on the SP&A team, increasing from 2 maintenance analysts to 5, which has greatly increased our ability to stay on top of data analysis and make informed decisions

E3 training and communication

CPC & CPC-related activities; GM communications

Town hall meetings

The first step is admitting you have a problem.

Budget accountability

I think we've seen some more recognition of the need for cross-divisional committees and representation (e.g., CPC evolving; IT committee)

BRRST Committee CPC...successful?

Consolidated training; maintenance and operations under a single Operational Training & Development Department.

What do you think TriMet should do next to push integration in the org chart?

Identify formally the roles responsible for and in support of performance/asset/risk management results. Seek more opportunities to consolidate/centralize/then disseminate how we assess/report asset performance and risk, policy, process improvement, and procedures awareness/adherence.

Difficult to recommend an org chart change directly; my thoughts are more in line with updating SOPs and communication processes between the org charts' siloed tiers

begin a formal process for rolling out the EAMS and identify resources/personnel to do the initial groundwork.

Move planning and policy into operations. Have a liaison department between Engineering and Construction and Operations

Analyze the effectiveness of the current committees.

Collaboration between maintenance departments

Streamline communication between orgs and standardize the process

Review needs and opportunities. More collaboration tools.

What are 5 things TriMet can do to integrate performance, asset, and risk management?
*HINT: Consider tasks YOU can do, as well as tasks LEADERSHIP can do

Encourage collaboration, promote constant review of current practices, record good practices (SOPs), Review KPIs, encourage (virtual) networking

(1) Asset risk assessments (2) Explore performance reporting that allows more drill-down from Business Plan. (3)Training and workshops with each functional group on how to integrate (4) EAMS (5)Integrate risk analysis into next TAM Plan

Bring silo-ed assets in individual databases closer into alignment. Document baseline labor hours of Preventative Maintenance EAMS. Cross-divisional collaboration.

Training/Education Add Staff to Alan's Team Prioritize initiative at GM level. Educate SSO in EAMS effort Create collaboration among departments

Org chart: Identify roles responsible for/in support of performance/asset/risk mgmt results.
 Communicate: knowledge on integration, success stories, progress (good & needs improvement). Seek opportunities to consolidate/standardize/communicate how we assess/report asset performance and risk, related policy, process/procedures. Build staff and staff knowledge on integration.
Make integration foundational element for strategy and planning.

1. Support more cross functional training
2. Begin the process of develop common definitions
3. Align performance goals with specific metrics based on data analysis
4. EAMS
5. Review performance metrics regularly throughout the year

(1) EAMS implementation; (2) enhanced use of TAM data/condition assessments to lead funding

Fund department staff and budgets.
Mentoring.
Training.
EAMS.
Increase communication.

1) define level of specificity for analysis
2) train all employees on performance **metrics** and how they are calculated
3) "right sizing"
4) Publicize agency successes to the public
5) Unlink metrics to compensation

1. Implement new EAMS
2. Establish sustainable KPIs/metrics that are applicable across all maintenance disciplines
3. Document maintenance SOPs
4. Document analysis/reporting SOPs
5. Document risk management protocols/SOPs

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Low-Hanging Fruit

Unlink Metrics from Compensation

EAMS
Right-sizing

Training

encourage collaboration- reach out to other departments

Develop common definitions

Enhanced use of TAM data/condition assessments to lead funding

promote constant review of current practices

Define Specificity Level

Cross-divisional collaboration

encourage (virtual) networking

Integrate risk analyses into next TAM Plan

record good practices (SOPs)

Review KPIs

Publicize agency successes to the public

Org chart (communicate): Identify roles responsible for/in support of integration results.

Celebrate successes

Priority | critical need, level-of-impact

Difficulty | time, cost, regulatory process

Map your answer from slide 61
- Copy (CTRL+C) your post-it
- Paste (CTRL+V) on this slide
- Drag to where you think it fits

Major initiatives, but worth it

Shared definitions across all departments

Fund department staff and budgets

EAMS ACID
EAMS SIP

EAMS - brings silo-ed assets in individual databases closer into alignment.

Asset risk assessments

Putting new systems in place to capture institutional knowledge of assets

Visualization/dashboard tool/site (communicate): knowledge on integration, success stories, progress (good & needs improvement).

Training and workshops with each functional group on how to integrate

Priority | critical need, level-of-impact

Difficulty | time, cost, regulatory process

Map your answer from slide 61
- Copy (CTRL+C) your post-it
- Paste (CTRL+V) on this slide
- Drag to where you think it fits

J. Douglas (Doug) Kelsey
General Manager

Samuel Desue
Chief Operating Officer

Bernie Bottomly
Executive Director
Public Affairs

Dee Brookshire
Executive Director
Finance & Administrative Services
(CFO)

Shelley Devine
Executive Director
Legal Services (General Counsel)

Kim Sewell
Executive Director
Labor Relations & Human Resources

Steve Witter
Executive Director
Engineering & Construction

Maria Blagg
Executive Director
Safety & Security

Roland Hoskins
Executive Director
Maintenance Operations

Aaron Deas
Manager
Governmental Affairs

John Gardner
Director
Transit Equity, Inclusion & Community Affairs

Thomas Markgraf
Director
Public Affairs

Tom Mills
Director
Mobility Policy & Planning

JC Vannatta
Managing Director
Communications, Marketing & Customer Experience

Cara Fitzpatrick
Director
Financial Services

Rhyan Schaub
Director
Fare Revenue & Administrative Services

Andrew Wilson
Director
Risk Management

Kevin Yin
Director
Procurement & Supply Chain Management

Nancy Young-Oliver
Director
Budget & Grants

Lance Erz
Director
Real Estate & Transit Oriented Development

Erik Van Hagen
Director
Legal Services

Angela Burns-Brown
Director
Talent Mgt,HR Business Partner

Laird Cusack
Director
Labor & Employee Relations

Ankur Doshi
Deputy General Counsel
Emp Law & Labor Relations

Cedar Rupp
HR Business Partner

Heidi Vass
Manager
Benefits & HRIS

Rosalinda Wells
Manager
Compensation

Robert Barnard
Managing Director
Design & Construction

Amy Fandrich
Director
Program Management

Leah Robbins
Director
SW Corridor

Michael Kiser
Manager
Division Transit Project

David Unsworth
Director
Project Devl. & Permitting

Sean Batty
Director
Station Projects

Jason Groins
Manager
Engineering & Construction Vehicles

Kai Loojonga
Manager
Engineering & Construction Rail Systems

John McBride
Manager
CADD

Paige Schlupp
Director
Civil Construction

Daniel Sosnovske
Director
Building Projects

Alan Lehto
Director
Business Planning and Asset Management

Frank Castellon
Director
Safety Mgmt, Sys & Env. Svcs.

Patrick Williams
Director
Security & Emergency Management

Edmond Bennett
Director
Bus Maintenance

Daniel Blair
Director
Rail Equipment Maintenance

Richard Kiedig
Director
MOW Operations

Young Park
Project Manager
Bus Electrification

Karen Powell
Director
Facilities Management

Brett Rogers
Director
Operations Planning & Development

Specifically more across division/ department - role to help bridge across silos; but only two staff people with a lot of responsibilities

Specifically more across operational/ maintenance divisions: Strong data and analysis orientation

Cross-division committees or working groups include:
Capital Projects Committee
IT Committee
Enterprise Architecture team (but only IT so far)
Executive Team
BRRST
EAMS committees
more - but more still needed

Many, many informal connections between staff at various levels based on previous contacts or specific projects they've worked on together, but less formal coordination

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Appendix | Elevator Pitches

☐ "Our agency has grown from a small agency, with divisions that grew their infrastructure and performance goals in silos, to a large agency which has more of a need to manage assets, performance and safety concerns together. As a large agency with increasing oversight, in order to guarantee our future success, we must develop a common system to communicate our enterprise risks and goals as we manage our assets collaboratively."

☐ "Developing a more mature integrated performance, asset, and risk management system is critical to ensuring the Agency is able to best focus its limited resources on key activities that augment rider & operator safety & satisfaction."

☐ "TriMet has untapped potential (relate $ if can estimate) if we significantly enhance how we integrate performance, asset, and risk management. We can begin leveraging integration by: implementing EAMS, add integration staffing, educate and then track and communicate integration progress (or pick what we decide to be top three items in charts)."

☐ "It is important due to the positive domino effect it would have across TriMet. This not only benefits us but also our riders."

☐ "If you want to appeal to our riders, fund the thing that improves reliability and on-time performance. Give the departments the people, tools and budget to make sure their experience was what they would expect. Doing projects like making our platform look pretty does not get them to work on time."

☐ "Integrating a new EAMS system will allow TriMet to organize all data pertinent to our assets in one, interconnected system. Having a singular point of connectivity will naturally facilitate inter- departmental communication and improve our overall ability to work together to accomplish the mission."

☐ "Singular assets that are shared across divisions allow for actual life cycle costing, analysis and staffing requirements."

☐ "We own $6 billion worth of assets and have to spend over $100 million every year on replacement. In order to do that smartly, we have to understand the risks related to each asset, the performance on each, and the best way to manage across the lifecycle. Or else we will be wasting a LOT of money."

NCHRP 08-113

Integrating Effective Transportation Performance, Risk, and Asset Management Practices

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Workshop Summary and Work Plan Outline

Utah Department of Transportation

November 2020

Introduction

The objective of this memorandum is to summarize the NCHRP 08-113 Workshop conducted with the Utah Department of Transportation (UDOT) and to outline a potential roadmap the UDOT team can use to better integrate performance, asset, and risk management at UDOT in a five-year timeframe.

The NCHRP 08-113 team has engaged with UDOT prior to the workshop, for example, in 2018, the agency served as a "quick scan case study" in the fall of 2018 that reported a "moderate" level of overall integration as well as integration of asset, risk and performance management programs. UDOT stated at the time that integration efforts included a process for quantifying risk, performance modeling, the ongoing development of a Concept Report process and the planned refinement of their corridor planning process.

The 2020 workshop was intended to build on the past engagement by accomplishing the following:

- For the research project, the team intended to "test-drive the guidance". To accomplish this, the team collected real-world detail and established best practices to support the focus areas and framework laid out in the Interim Report. The team also evaluated whether practitioners responded to that framework. In addition, the team sought to collect anecdotes and descriptions that illustrated the benefits of integrating performance, risk, and asset management from transportation agencies.

- For the hosting agency, the team intended to lay the groundwork for building a roadmap for the next phase of integration at UDOT. This included building on UDOT's culture of innovation to shift the working dynamic. UDOT Executive Director included the following as part of his opening remarks for the workshop: *"This is a culture of innovation. Never limit yourself by what you think the limitations are. We don't have a competitor to help us go faster, it would be easy to do what we did last year. But we need a culture to push ourselves to do new things every single day. Think about the last 90 days and what has been learned during quarantine (referencing the 2020 COVID 19 Pandemic). I guarantee that if you think about it you can think of 3 positives for every negative that will make our jobs more efficient."*

The Workshop

Due to COVID-19 Pandemic, the workshop was held utilizing a virtual webinar through GoToMeeting and utilizing Google Documents on May 19, 2020. The workshop was split into morning and afternoon segments:

- Before lunch, the group explored some focus areas for integrating performance, asset, and risk management identified in the NCHRP 08-113 research. The goal for the morning was to collect, through a facilitated process using Google Slides as a virtual collaboration tool, the participants' thoughts on how UDOT could best address:

  - Approaches to Integration
  - Resource Needs
  - Personnel and Skills
  - Policy and Agency Structure

- After lunch, the group started to build a roadmap, beginning with a discussion on data and software needs to enable the level of process integration that UDOT is seeking to build. The group explored tasks that UDOT can undertake to further integration. Then, the group developed elevator pitches to highlight perceived benefits of management area integration, phrased to be delivered to the agency Director or Governor. To conclude the day, the group piloted a maturity self-assessment honed for this project by the research team shown in Figure 2.

Agenda

The agenda for the workshop is provided in Figure 1.

FIGURE 1   AGENDA FOR THE WORKSHOP

9:00	9:15	Welcome
9:15	9:25	What's in it for ME?
9:25	9:40	"Power-On" Activity
9:40	10:10	Approaches to Integration
10:30	11:00	Data and Software Needs
11:00	11:30	Personnel and Skills
11:30	12:00	Policy and Agency Structure
12:00	1:00	Lunch Break
1:00	1:30	Resource Needs
1:30	2:00	Tasks
2:00	2:15	Elevator Pitches
2:15	2:30	Maturity Self-Assessment

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Participants

The participants were from various UDOT offices having representation in the workshop are listed below.

- ☐ Asset Management, Maintenance and Facilities
- ☐ Bridge Management
- ☐ Data Technology and Analytics
- ☐ Performance and Process Improvement
- ☐ Risk Management
- ☐ Traffic & Safety
- ☐ Construction
- ☐ District Engineer
- ☐ Pre-Construction
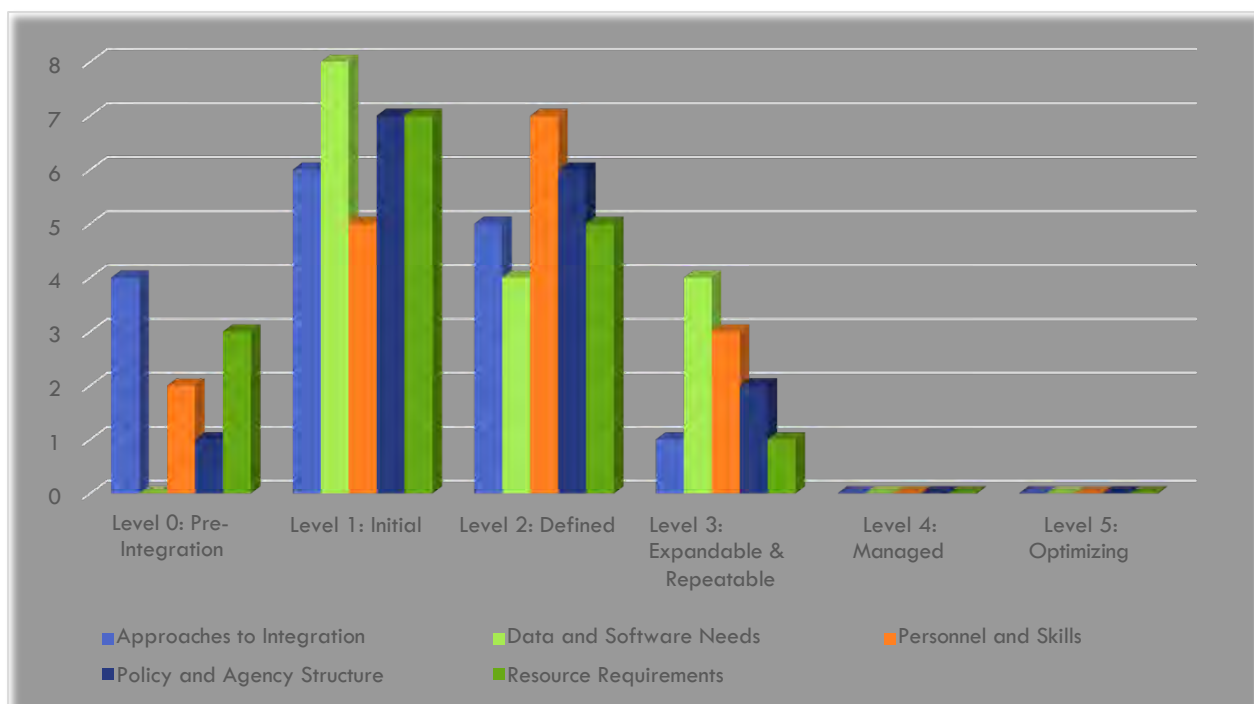- ☐ Project Managers

Outcome

The workshop produced valuable insights, including:

- Key benefits of management area integration, as expressed in the elevator pitches:

  - Practice good stewardship over "incredible" infrastructure investment and public funds
  - Utilize long-term thinking to build intentional and desired future system
  - Align UDOT staff in purpose, expectations and direction
  - Provide agency understanding on how what people do every day can move us forward

- Strategies for better management area integration, including:

  - An illustration of the value of strong champions with broad buy-in (as exist at UDOT).
    - Supported efforts behind shared space and language where the "gathering" part of the system and the "doing" part of the system can identify and close gaps
  - Develop format for standardizing and documenting processes without losing flexibility or constraining innovation
  - Advance agency-wide data sets to gain true view into life-cycle cost
  - Engage the developing Concept Report, Performance Management Committee, Transportation Asset Management Plan (TAMP) and recently upgraded asset management system to define integrated discussion.

- A shared perception from attendees that management area integration has been initiated in most areas but still has ample room for further development (see levels of integration below). The combined scoring from the Maturity Self-Assessment conducted during the workshop is displayed in Figure 3.

FIGURE 2   INTEGRATION MATURITY SELF-ASSESSMENT LEVELS

Level 0:
Pre-Integration
Integration not yet begun

Level 1:
Initial
Identified the need for integration; determining structure and approach

Level 2:
Defined
Established metrics, initial documentation, and monitoring; developing a roadmap and initiating small-scale integrated practices

Level 3:
Expandable Repeatable
Processes are becoming systematic and repeatable, producing consistent results; not yet fully integrated across agency departments

Level 4:
Managed
Integration is being performed across all appropriate asset classes and agency departments; processes are well-documented and effective

Level 5:
Optimizing
Processes are fully deployed throughout the agency and are highly effective; commitment to continuous improvement

FIGURE 3   INTEGRATION MATURITY SELF-ASSESSMENT - RESULTS

These insights are the basis for the UDOT roadmap outline laid out in the remainder of this document.

Outline for Integration Roadmap

This roadmap outline includes details gathered in the workshop but does not include detailed plans for implementation (e.g., names, due dates, etc.). It consists of a vision, strategies, and the beginning of an action plan that UDOT can build upon with a detailed, time-bound action plan, with actions assigned to specific people and a commitment to follow-up and measure progress.

Relationship to the Focus Areas

As described in the above sections, the workshop and roadmap are based upon the five focus areas described in NCHRP 08-113. Through discussion sessions based on each focus area in turn, UDOT participants generated strategy statements that added detail to the universal concepts in the focus areas, highlighting UDOT' specific potential areas of growth. By following this roadmap, UDOT will address each focus area as follows:

- *Approaches to Integration* by challenging the usage of the evolving corridor planning and developing toolset around life-cycle cost assessment to have a holistic inclusion of asset, risk **and** performance management, not simply tagged as "nice-to-haves".

- *Data and Software Needs* by viewing data training and standardized processes as a long-term investment, even when considering data with a relatively small shelf-life.

- *Personnel and Skills* by discussing the role of training and "essential skills" at an agency level.

- *Policy and Agency Structure* by refining usage of the TAMP in making performance and management decisions.

- *Resource Needs* by aligning training to the bigger picture of agency decision-making and filling the gaps between groups with common language and shared understanding of ultimate goal

When participants were asked to state the three resources most needed by UDOT to integrate asset, performance, and risk management, participants provided a range of needs as depicted in Figure 4.

FIGURE 4 **RESOURCE NEEDS IDENTIFICATION ACTIVITY - RESULTS**

Vision

UDOT will achieve integrated performance, asset, and risk management across its full portfolio of assets and its full range of performance outcomes, focusing on aspirations for a better transportation system for all users – now and in the long-term – an opportunity and responsibility shared amongst all of the agency's leaders and staff.

Foundation

This roadmap recognizes the significant progress that UDOT has made toward integration of these management areas over the past decade, and in particular over the past five years. Major accomplishments include:

- Investing in tool procurement to significantly improve asset management process.

- Creation of the data analytics group which is closely aligned with the performance management division.

- Creation of the Performance Management Committee to facilitate coordination across divisions and track progress in meeting performance metrics.

- Continuing investment in UPLAN, Story Maps and Concept Report development which will all have significant impact on process integration.

Strategies

UDOT could continue on this growth trajectory by pursuing several measurable goals, for example over the next five years, UDOT could:

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- **Target TAMP utilization** as a central process tool with actionable goals.

- **Focus budget and time resources** on projects and activities that directly and explicitly support the agency's stated mission, goals, objectives, and measures.

- **Define a standardization process** that enables continued process flexibility and supports innovation.

- **Provide training that closes the knowledge gaps.**

Action Plan

To achieve the strategies, UDOT should develop an action plan that assigns actions like the ones below to individuals or groups, with deadlines and accountability.

- To **target TAMP utilization**, UDOT could:

  - Drive TAMP recognition and understanding with leadership support and training at all levels in all relevant departments

  - Select working group representing all impacted departments and in particular those that supervise performance, risk and asset management activities to identify where TAMP can be revised to reach higher utilization scenario and meet integrated management goals

  - Set key metrics against a targeted adaptation timeline to track progress in higher utilization of TAMP in agency business.

  - Utilize Corridor Planning Process to highlight how risk, performance, and asset management can be integrated to support more holistic decision making. In the FY 2021 budget, UDOT has allocated $1 million for the Corridor Planning Program. UDOT intends to build upon the efforts made to date in their risk program to bring risk performance goals into the corridor planning process, similar to safety, operations, and mobility goals. Through the Corridor Planning Process, UDOT has an opportunity to elevate risk management into the long-range planning process. UDOT can build upon this investment to reinforce the agency's desire to optimize investments by capitalizing on identifying risk needs that may simultaneously benefit operational and asset management goals. An example from a recently completed FHWA Extreme Weather &
  Durability Grant Program demonstrates a potential approach to capturing risk and resilience metrics and performance goals within the Corridor Planning Process as shown in Figure 5.
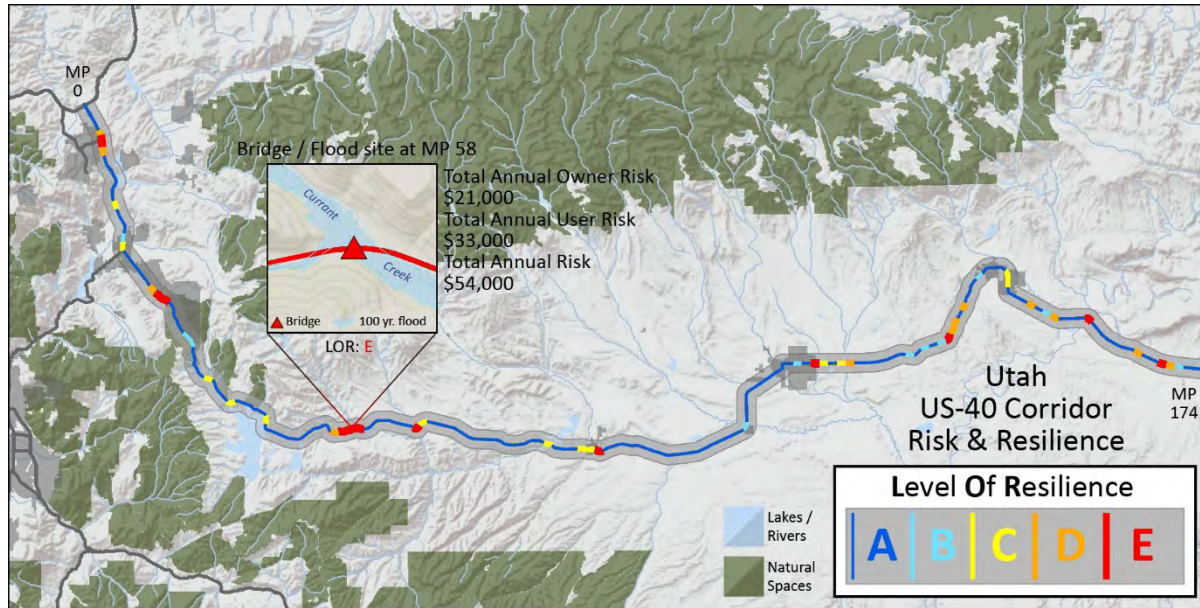
In this case, UDOT has sought to develop metrics of performance for risk from external natural threats to the US 40 corridor. Along this same corridor, UDOT has documented safety, operational, and mobility performance metrics. Ideally through the Corridor Planning Process, the agency can begin to integrate their decision-making processes by considering agency performance, asset, and risk management needs.

To *focus budget and time resources*, UDOT could:

- Ensure recent investment in life-cycle tools is understood throughout relevant departments and included in training activities whenever possible.

- Create and develop job descriptions for all functions that touch performance, asset, and risk management, by reviewing daily activities and prioritizing those that best support the vision of UDOT. By involving the Employee Development and staff in this effort, all levels of the organization will embrace the changes to ensure a successful implementation.

-

- To *define a standardization process*, UDOT should lean heavily on pairing agency expertise with innovative tools to create a space for process communication and standards in an evolving format. This approach can assist in resource sharing and cross-collaboration without inhibiting innovation and continued growth. A process to accomplish this pairing could look like the following:

   1. Select a steering committee that can identify and classify processes in an informal shared space.

   2. Identify applicable toolset to enable process collaboration and standardization procedure where processes that would benefit form a unified approach across operations can be elevated to the steering committee.

   3. In an ongoing function, the steering committee would be tasked to work with involved staff to identify software, key metrics or outputs or other process elements that can be standardized

while allowing continued process flexibility and future evaluation of standardized elements if necessary.

– Define how performance management process impacts the regions, creating a shared space for regional coordination and a bridge between management and implementation efforts.
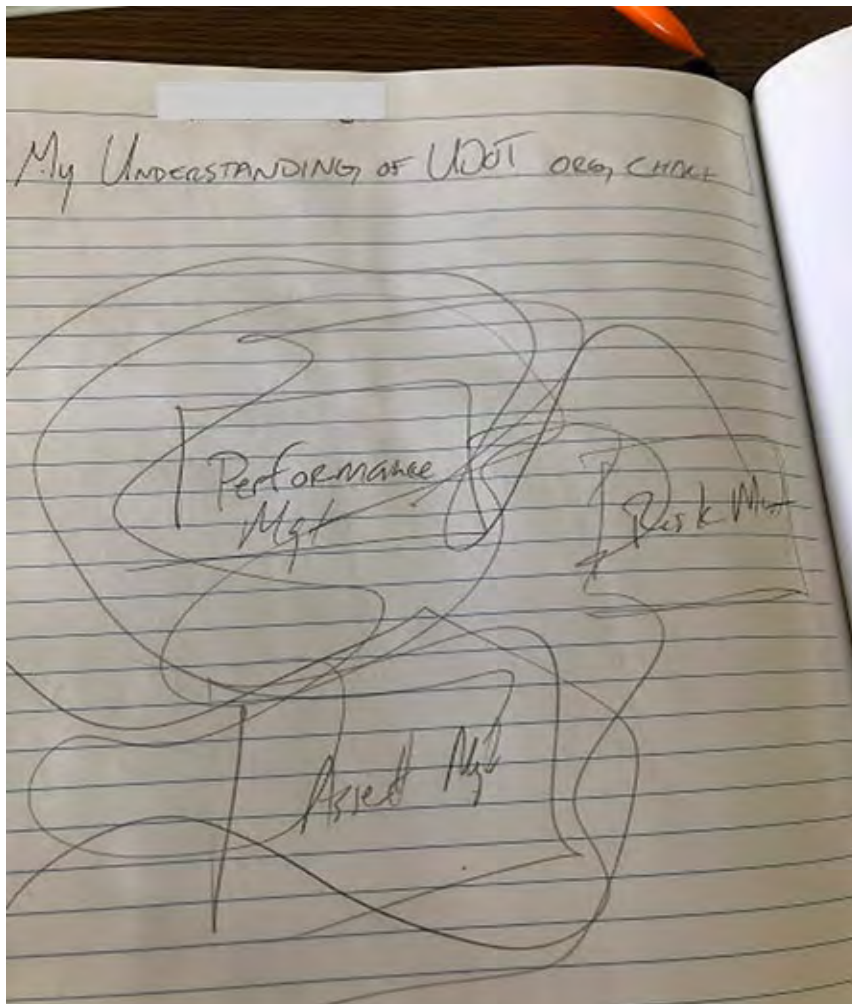
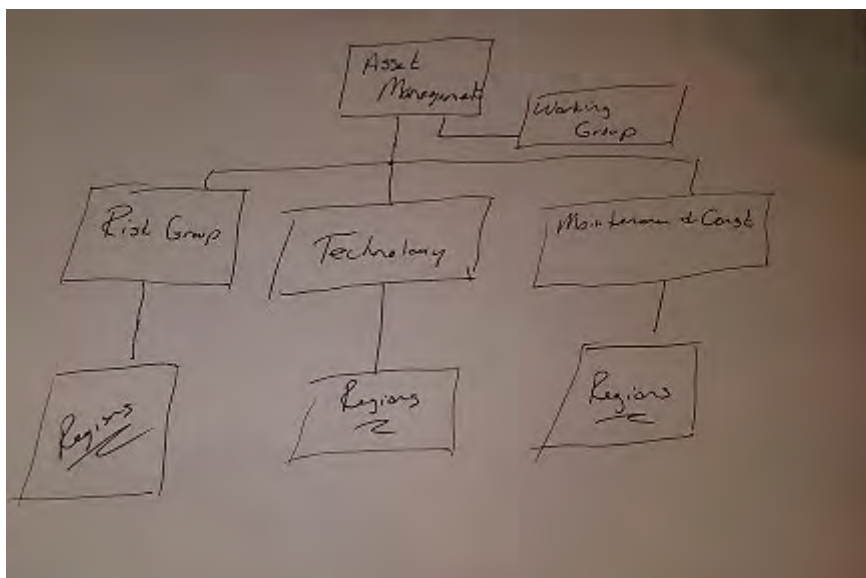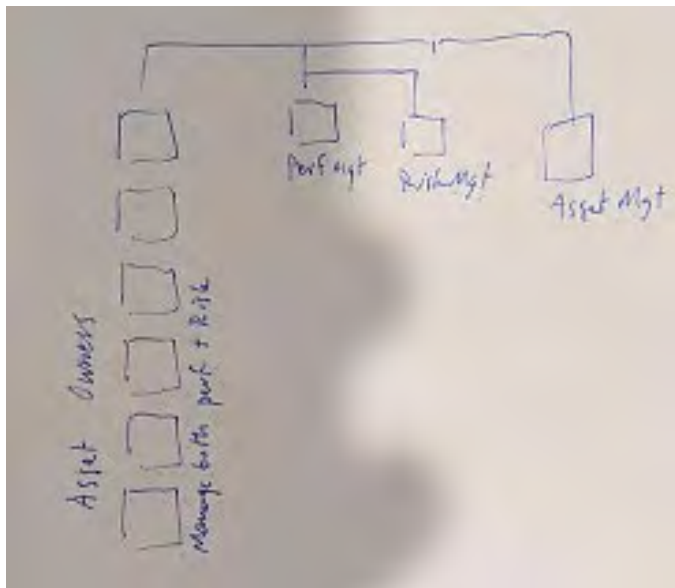- To *provide training that closes knowledge gaps,* UDOT could:

    – Establish a working group around UPLAN that connects the "gatherers" and the "doers" in a more formal group so that potential efficiencies in data usage can be identified as well as data becoming more of a shared resource that the "doers" understand the scope better.

    – Consider creating a training plan that specifically targets ongoing and planned training activities and could serve the following functions:

    – Confirms that training activities are aligned toward agency vision and goals

    – Assess value of training activity toward meeting big-picture thinking and provides methods to pivot existing training practices to a more integrated-agency perspective

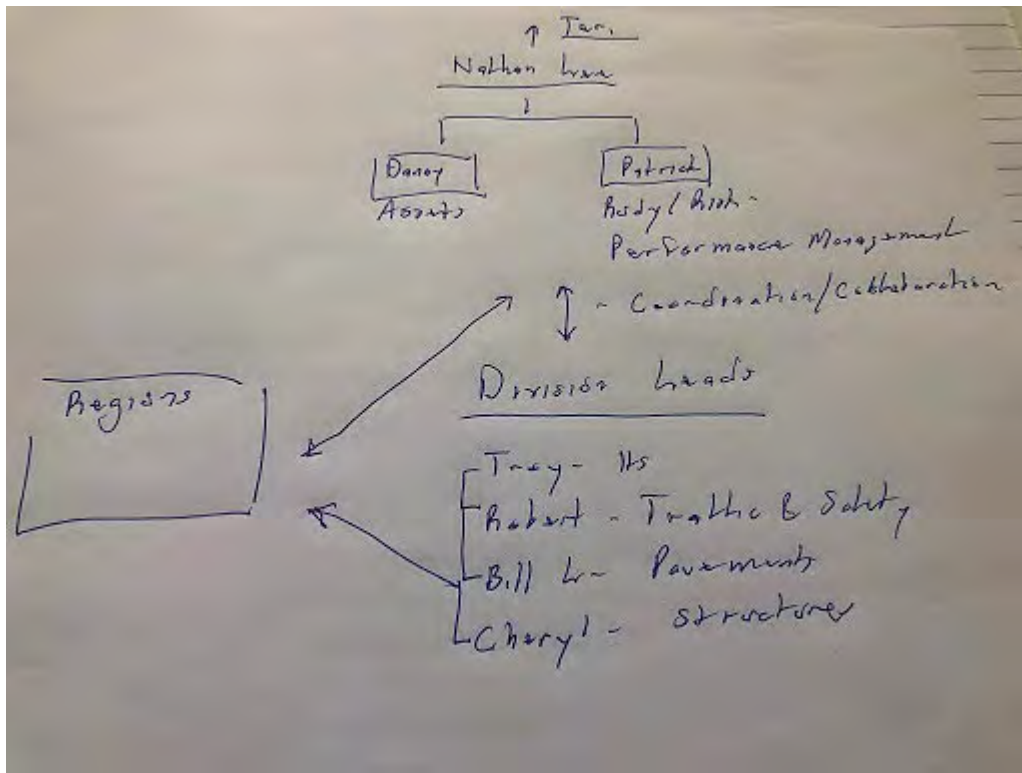   – Identify opportunities to connect integrated management more directly to daily activities

APPENDIX

Conceptual Organization Charts
Elevator Pitches

Appendix | Conceptual Organization Charts (Sample)

Ian,

Nathan Iron

Danny
Assets

Patrick
Ready / Risk -
Performance Management
- Coordination/Collaboration

Regions

Division Leads

Tracy - Its
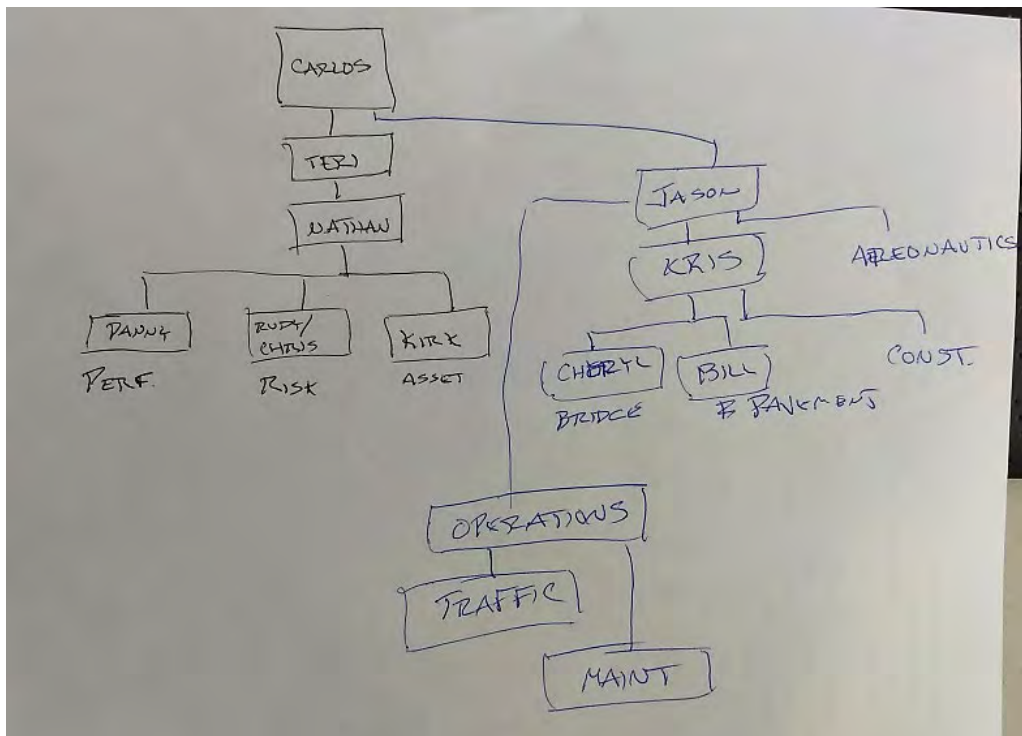Robert - Traffic & Safety
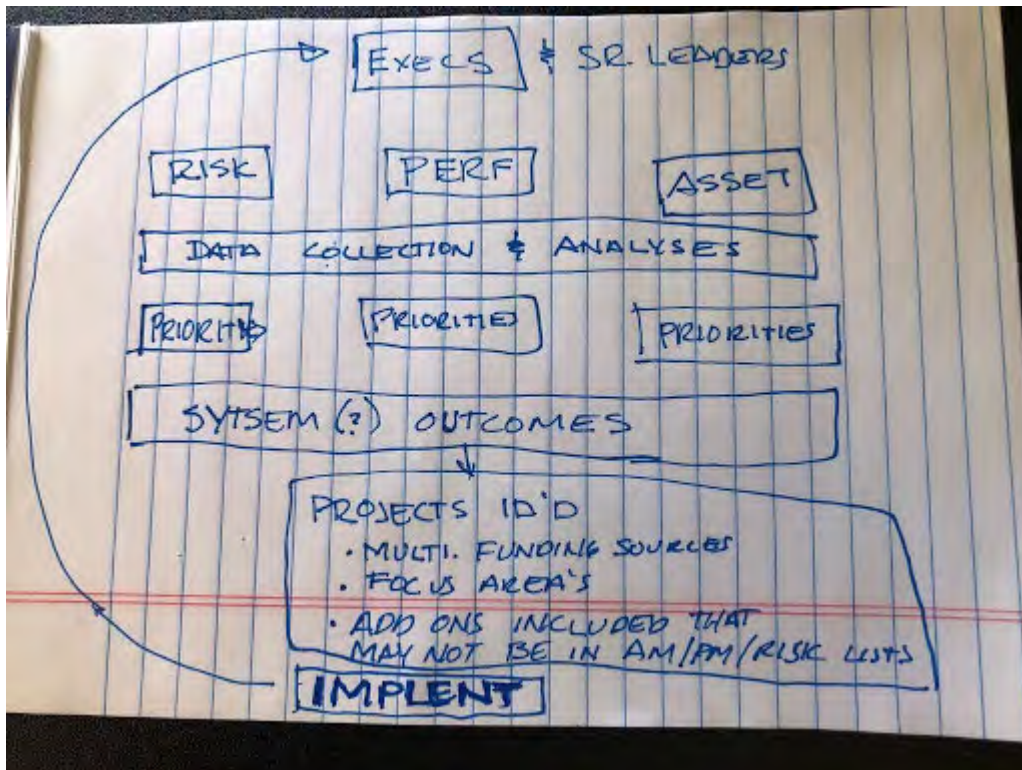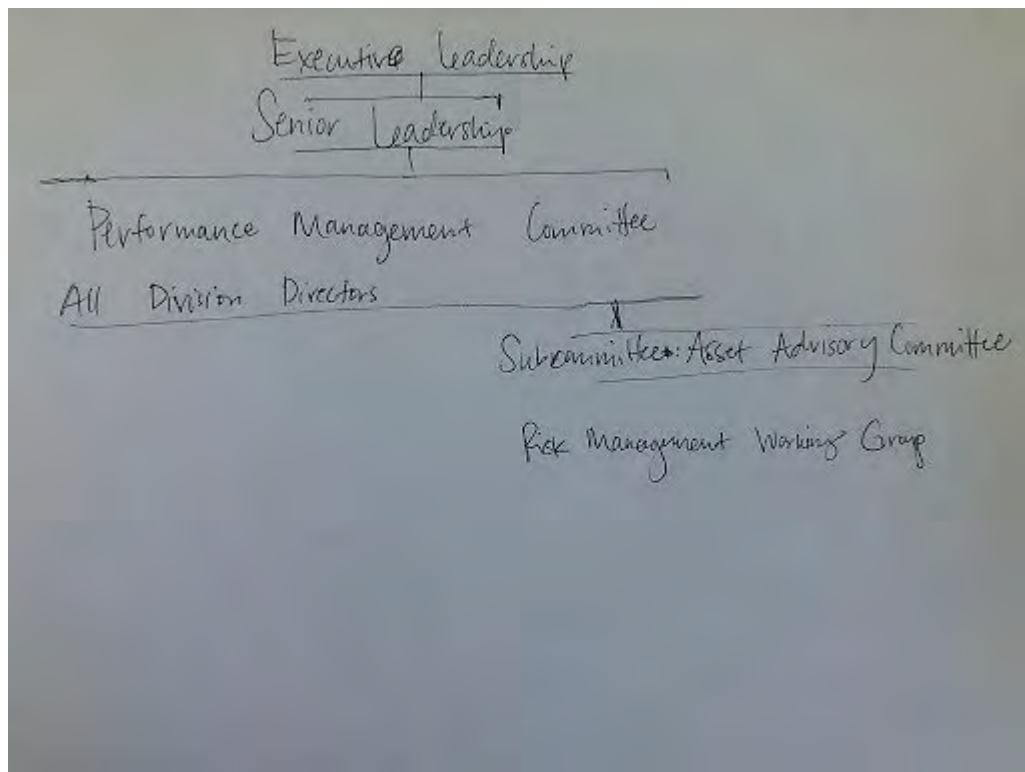Bill L - Pavements
Cheryl - Structures

Don't mean to be
Contrarian, but my understanding
is that we should be integrating
these concepts into our individual
organizations.

Support to do so is
being provided by

Patrick & Danny's groups.

Executive Leadership

Senior Leadership

Performance Management Committee

All Division Directors

Subcommittee: Asset Advisory Committee

Risk Management Working Group

Appendix | Elevator Pitches (Sample)

- "Transform our organization. Realize substantial benefits. Need Executive support to prioritize in organization."

- "The State has made an incredible investment in our transportation infrastructure. It is our responsibility to take care of that investment and make it last as long as we can. This includes all the infrastructure, not just pavement."

- "The integration of performance, asset, and risk management paints a clear picture of the place we will be in the future."

- "To advance the organization, it takes intentional, informed, and coordinated actions. The roadmap developed by this group will guide those actions."

- "If we want to be able to understand the true cost of doing our business, we have to have a complete asset management plan correct with [the] right data. This data can make us reach that goal!"

- "By understanding asset values, conditions, and deterioration/risk we are able to better assess the performance of our transportation system as a whole now and in the future. This will make us better able to efficiently allocate funds."

- "Enterprise level implementation of Performance, Asset and Risk management throughout our business will allow us to most efficiently utilize the public funds we have stewardship over. Better information = Better decisions."

- "Enterprise level implementation of Performance, Asset and Risk management throughout our business will facilitate the alignment, of the great employees of UDOT, in purpose, expectations and direction as they see how what they do every day moves us forward."

- "Performance measures tell us where we need to be. Performance management tells us how to get there. Risk management tells us the best place to invest our limited resources."

- "It is an integral part of our business at UDOT and needs to be engraved in UDOT's culture with clear vision and support."

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