NCHRP 08-36, Task 126

Development of a Risk Register Spreadsheet Tool

Requested by:

American Association of State Highway and Transportation Officials (AASHTO)
Standing Committee on Planning

Prepared by:

John Patrick (J.P.) O'Har, Ph.D. (WSP | Parsons Brinckerhoff)
Christopher Senesi (WSP | Parsons Brinckerhoff)
Keith R. Molenaar, Ph.D. (Independent Contractor)

WSP | Parsons Brinckerhoff (WSP | PB)
New York, NY

September 2016

The information contained in this report was prepared as part of NCHRP Project 08-36, Task 126, National Cooperative Highway Research Program (NCHRP).
Special Note: This report **IS NOT** an official publication of the NCHRP, the Transportation Research Board or the National Academies.

AASHTO
THE VOICE OF TRANSPORTATION

Acknowledgements

This study was conducted for the American Association of State Highway Transportation Officials (AASHTO) Standing Committee on Planning, with funding provided through the National Cooperative Highway Research Program (NCHRP) Project 08-36, Research for the AASHTO Standing Committee on Planning. The NCHRP is supported by annual voluntary contributions from the state departments of transportation. Project 08-36 is intended to fund quick response studies on behalf of the Standing Committee on Planning. The report was prepared by the project team members: John Patrick (J.P.) O'Har, Ph.D., Christopher Senesi (PB), and Keith R. Molenaar, Ph.D. The work was guided by a technical working group that included:

Joshua Bench-Bresher, South Dakota Department of Transportation
Daniel D'Angelo, New York State Department of Transportation
Timothy Henkel, Minnesota Department of Transportation
Joshua Johnson, Michael Baker International
Shital Thekdi, University of Richmond
Nastaran Saadatmand, Federal Highway Administration Liaison
Matthew Hardy, American Association of State Highway and Transportation Officials Liaison

The project was managed by Larry Goldstein, NCHRP Senior Program Officer.

Disclaimer

The opinions and conclusions expressed or implied are those of the research agency that performed the research and are not necessarily those of the Transportation Research Board or its sponsoring agencies. This report has not been reviewed or accepted by the Transportation Research Board Executive Committee or the Governing Board of the National Research Council.

TABLE OF CONTENTS

List of Figures and Tables ..... **iv**
Executive Summary ..... **v**
Chapter 1: Introduction **1**
Background 1
Research Objective 1
Reference Material 1
Chapter 2: Research Approach **2**
Task 1: Risk Register Survey 2
Task 2: Analyze Survey Results 2
Task 3: Develop Draft Risk Register Tool and User Guidance 3
Task 4: Prepare Final Spreadsheet-Based Risk Register Tool 3
Chapter 3: Results and Findings **4**
Risk Register Survey 4
Survey Results 4
Enterprise & Program-Level Risk Management 5
Enterprise & Program-Level Risk Register Tool 8
Risk Register Survey Summary 10
In-Depth Interviews 10
State Departments of Transportation In-Depth Interviews 11
International Transportation Agencies Interviews 12
Non-Transportation Organizations 12
Summary of Results and Findings 13
Chapter 4: Risk Register Tool **14**
Risk Register Tool Overview 14
Risk Register Tool Layout 15
Risk Categories & Rating Matrix 16
Risk Identification 18
Risk Analysis 18
Risk Management 19
Risk Register Outputs 19

Threats versus Opportunities 21
Chapter 5: Conclusions 22
Annotated Bibliography 23
Appendix A: Survey Questionnaire 26
Appendix B: In-Depth Interview Guide 32
Materials Request 32
Interview Agenda & Questions 32

LIST OF FIGURES AND TABLES

FIGURES

Figure 1: Overview of Project Approach 2
Figure 2: Risk Categories & Rating Matrix Screenshot 17
Figure 3: Risk Identification Screenshot 18
Figure 4: Risk Analysis Screenshot 18
Figure 5: Risk Management Screenshot 19
Figure 6: Comprehensive Risk Register Screenshot 20
Figure 7: Post-Treatment Heat Map Screenshot 20
Figure 8: Risk Summary Screenshot 21

TABLES

Table 1: Survey Responses 5
Table 2: Enterprise & Program-Level Risk Management 5
Table 3: State DOTs Implementing Enterprise & Program-Level Risk Management 7
Table 4: Tracking, Monitoring, and Managing Enterprise and/or Program-Level Risks 7
Table 5: Type of Risk Register Tools 8
Table 6: Reviewing & Updating the Risk Register Tool 9
Table 7: Risk Management Department 9
Table 8: Risk Register Tool Sheets 16

EXECUTIVE SUMMARY

The objective of this research project was to develop a risk register spreadsheet tool, applicable at the enterprise and program-levels that allows the user to identify risk events, define risk categories and assess the likelihood (probability) and consequence (impact) of an event occurring. The risk register tool complements Volume 2 of the American Association of State Highway Transportation Officials (AASHTO) Transportation Asset Management Guide, facilitates state department of transportation (DOT) compliance with Moving Ahead for Progress in the 21st Century (MAP-21)/Fixing America's Surface Transportation (FAST) Act requirements, and complements the research conducted for NCHRP Project 08-93: *Managing Risk Across the Enterprise: A Guidebook for State Departments of Transportation* (forthcoming).

Many state DOTs in the United States (U.S.) have implemented, or are beginning to develop, Enterprise Risk Management (ERM) programs. Federal legislation, MAP-21/FAST, provides an impetus for DOTs in the U.S. to further the maturity of their ERM programs. Each DOT must have a risk-based asset management plan in place to preserve the condition of its assets and improve the performance of the National Highway System.

A survey of the state-of-practice regarding the use of risk register tools to support enterprise and program-level risk management at state DOTs, international transportation agencies, and non-transportation organizations was conducted. The majority of respondents indicated that they engage in enterprise and program-level risk management activities. Nearly all organizations that reported to be tracking, monitoring, and managing enterprise and/or program-level risks reported the use of risk register tools.

Based on results of the survey, and to further inform development of the risk register tool, several organizations were selected for in-depth interviews to gather additional information on their risk management practices and use of risk register tools. Information from the interviews and examples provided by the participants are reflected in the risk register tool. The spreadsheet-based risk register is an editable template that does not use any macros or custom code. In addition to the editable template, two pre-populated examples, one for enterprise-level risk management and one for program-level risk management, were created. The enterprise and program-level examples are pre-populated to demonstrate how the tool can be used. The editable template is blank for the user to populate.

Successful and effective ERM practices involve many factors. A spreadsheet-based risk register tool can be valuable in facilitating ERM implementation. Population and use of this risk register tool does not guarantee compliance with MAP-21/FAST. An organization's risk management governance along with staff commitment, availability, and capability to support risk management activities are equally if not more important to effective risk management as the risk register tool itself. Although the spreadsheet-based risk register tool was developed to be a standalone product, it aligns with the materials and standards included in the bibliography of this report. In particular, users are encouraged to review *Managing Risk Across the Enterprise: A Guide for State Departments of Transportation* (NCHRP 08-93) for further ERM information.

CHAPTER 1: INTRODUCTION

BACKGROUND

To respond to an evolving environment of risk and under the impetus the requirement to consider risk in the Federal Government's Moving Ahead for Progress in the 21st Century (MAP-21), United States (U.S.) departments of transportation (DOTs) are developing and implementing Enterprise Risk Management (ERM) programs. The enactment of MAP-21, signed into law in July of 2012, requires that each state must have a risk-based asset management plan in place to preserve the condition of its assets and improve the performance of the National Highway System. Many provisions of MAP-21, including requirements for state DOTs to develop risk-based asset management plans and to establish performance-based planning processes, remain unchanged with the enactment of the Fixing America's Surface Transportation (FAST) Act, signed into law in December of 2015.

The development of a risk register is an industry best practice. It serves as a vital tool in the risk management process. Use of risk registers by DOTs will improve risk management practices and support MAP-21/FAST compliance.

RESEARCH OBJECTIVE

The primary objective of this research project was to develop a risk register spreadsheet tool, applicable at the enterprise and program-levels, that allows the user to:

1) Define risk categories; and
2) Assess the likelihood and consequence of an event occurring.

The risk register spreadsheet tool enables an organization to identify risk types, assess the consequences (impacts) and probabilities (likelihoods) of risks, and provides guidance on preparing risk statements. Organizations can modify the tool for their particular needs. Further, the risk register tool allows an organization to generate heat maps showing the results of risk response strategies (treatments) to support decision making. Results of this research also:

- Complement the AASHTO *Transportation Asset Management Guide: A Focus on Implementation* by preparing more detailed guidance on populating a risk register;
- Facilitate state DOT compliance with MAP-21/FAST requirements; and
- Complement the research conducted for the forthcoming NCHRP Project 08-93 *Managing Risk Across the Enterprise: A Guidebook for State Departments of Transportation*.

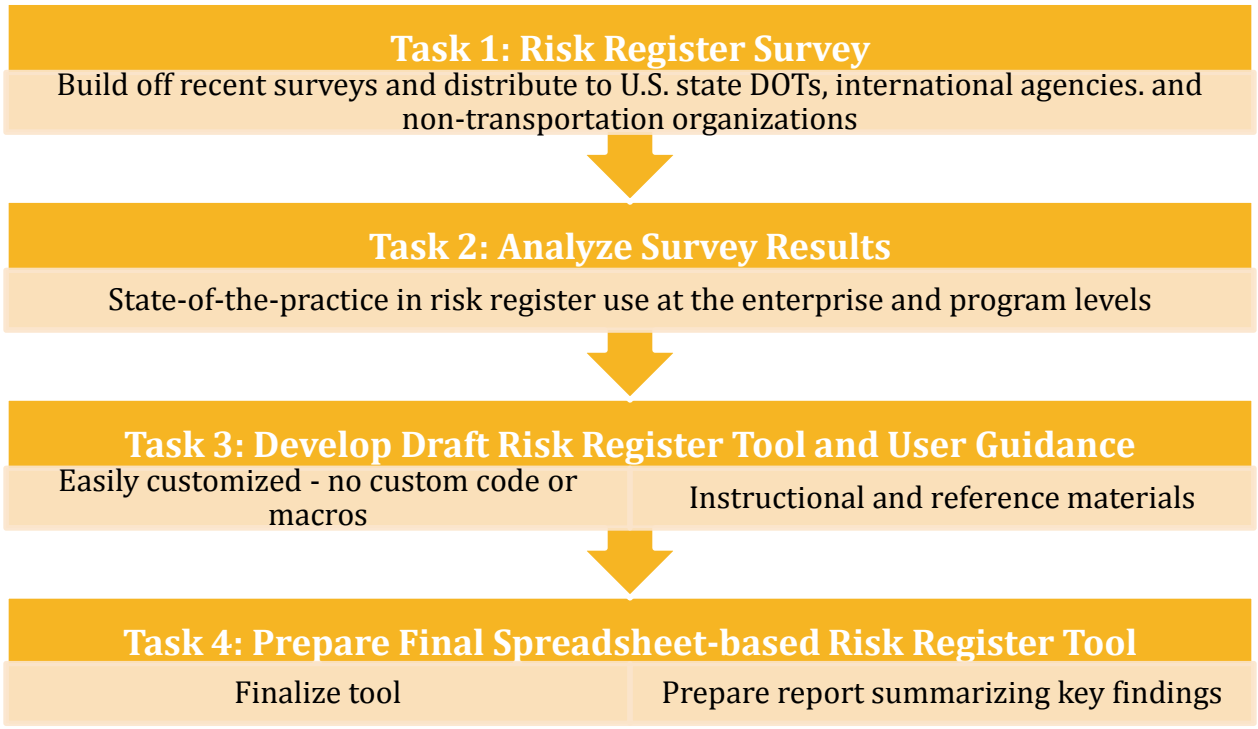
REFERENCE MATERIAL

The spreadsheet-based risk register tool was developed to function as a standalone tool, i.e., all required instructions and reference material is built into the spreadsheet. It should be noted that the tool was developed in alignment with industry standard reference materials and consistent with best practices. In particular, risk register tool users seeking additional information on ERM should consult *NCHRP 08-93: Managing Risk Across the Enterprise: A Guide for State Departments of Transportation*. The Annotated Bibliography section of this report provides brief descriptions of additional reference material.

CHAPTER 2: RESEARCH APPROACH

The research approach consisted of four primary tasks as outlined below in Figure 1. Each task is described in further detail in the subsections below.

Figure 1: Overview of Project Approach



TASK 1: RISK REGISTER SURVEY

The primary objective of Task 1 was to develop and distribute a state-of-practice survey regarding the use of risk register tools to support enterprise and program-level risk management at DOTs, international transportation agencies and non-transportation organizations. See Appendix A for the survey questionnaire.

TASK 2: ANALYZE SURVEY RESULTS

The research team distributed the survey to a broad audience that included all 52 DOTs (including the District of Columbia and Puerto). There were 27 responses. The survey was also distributed to a number of international transportation agencies through an email listserv of the Forum of European National Highway Research Laboratories (FEHRL), and to 190 selected non-transportation organizations. There were a total of 20 responses from these two groups. A technical memorandum summarized survey results describing how transportation and non-transportation organizations use risk registers. Based on results of the survey and with input from the Project Panel, several organizations were selected for in-depth interviews to gather additional information on their risk management practices and use of risk register tools.

TASK 3: DEVELOP DRAFT RISK REGISTER TOOL AND USER GUIDANCE

An initial draft spreadsheet-based risk register tool including user guidance was developed based on results of the risk register survey, input from the Project Panel, industry best practices, and the research team's expertise. As part of the initial draft spreadsheet-based risk register tool, an editable template was developed along with two pre-populated examples. One example is for enterprise-level risks and the other for program-level risks. The draft risk register tool was distributed to the Project Panel and follow-up interviewees for comment and feedback.

TASK 4: PREPARE FINAL SPREADSHEET-BASED RISK REGISTER TOOL

Based on comments and input received from the Project Panel and follow-up interviewees, the final spreadsheet-based risk register tool was updated. This included updates to the editable template, the pre-populated enterprise-level example, and the pre-populated program-level example.

CHAPTER 3: RESULTS AND FINDINGS

RISK REGISTER SURVEY

The research team distributed the survey to a broad audience that included all 52 DOTs (including the District of Columbia and Puerto Rico), selected international transportation agencies, and selected non-transportation organizations. Two versions of the survey, with minor differences for the audiences, were created (see Appendix A for the questionnaire):

- Transportation agencies (state DOTs and international transportation agencies); and
- Non-transportation organizations.

The transportation agency survey was distributed to all state DOTs. It was sent to a list of DOT contacts based on the previous survey conducted for NCHRP 08-36(121) – Successful Implementation of Enterprise Risk Management in State Transportation Agencies. These contacts originated from AASHTO standing committees and subcommittees as well as Transportation Research Board committees.

The target population for non-transportation organizations included organizations representing a variety of sectors including oil and gas, energy infrastructure, water and utilities industries – organizations that own, operate and maintain large physical infrastructure assets and face challenges and risks similar to those faced by transportation agencies. The research team targeted organizations through the Project Management Institute (PMI) and the Association for the Advancement of Cost Engineering International (AACEI).

Based on the successes and maturity level of ERM programs observed by an international scan team (see Curtis et al. in the Annotated Bibliography), the survey was also distributed to various transportation agencies outside the U.S. that have formal ERM programs and robust risk register tools in place. The international scan team consisted of highway agency and private sector representatives that studied risk management practices at transportation agencies in Australia and Europe. While the survey was open, the research team reached out directly to contacts at these international transportation agencies.

SURVEY RESULTS

Results of the survey are presented below in three categories that are based on the types of organizations that participated. These three categories are:

A. State Departments of Transportation;
B. International Transportation Agencies; and
C. Non-Transportation Organizations.

Within each of the three categories, results are further broken down into two groups: findings related to overall enterprise and program-level risk management, and those findings specific to enterprise and program-level risk registers.

Enterprise & Program-Level Risk Management

Overall, 47 organizations responded to the survey, representing state DOTs, international transportation agencies, as well as non-transportation organizations. Table 1 displays the number of responses. For DOTs, 27 out of 52 states participated, resulting in a response rate just over 50%.

Table 1: Survey Responses

Type of Organization	Number of Responses	Active Enterprise and/or Program-Level Risk Management
A. State Departments of Transportation	27	19
B. International Transportation Agencies	11	8
C. Non-Transportation Organizations	9	9

For the international transportation agencies, countries represented include: Denmark, Hungary, Latvia, South Africa, United Arab Emirates, Afghanistan, Brazil, Australia, and Canada. The non-transportation organizations represented various sectors including oil and gas, utilities, and process-related (refinery/chemical).

At the outset of the survey, organizations were asked whether they engage in enterprise or program-level risk management and whether or not they have formal policies and processes in place for their risk management practices. These results are presented in Table 2.

Table 2: Enterprise & Program-Level Risk Management

	Enterprise Risk Management Only		Program-Level Risk Management Only		Enterprise & Program-Level		Neither Enterprise or Program-Level	
Type of Organization	Engaging in RM Activities (#)	Formal RM Process (#)	Engaging in RM Activities (#)	Formal RM Process (#)	Engaging in RM Activities (#)	Formal RM Process (#)	Not Engaging in RM Activities (#)	No Formal RM Process (#)
A. State Departments of Transportation	3	3	7	3	9	2	8	19
B. International Transportation Agencies	2	2	2	2	4	4	3	3
C. Non-Transportation Organizations	4	4	2	2	3	1	0	2

As noted in Table 2, across all three categories of respondents, organizations are more likely to engage in enterprise and/or program-level risk management prior to having formal risk management processes in place. Typically, formal risk management processes are established after an organization engages in risk management activities. A notable exception to this was one international transportation agency that responded as having a formal ERM process in place but that it is not engaging in ERM activities. This was not the norm across the survey demographic.

State Departments of Transportation (State DOTs)

It was more evident that state DOTs were engaging in enterprise and program-level risk management activities but do not necessarily have a formal policy or process in place. For example, looking at agencies that engage in both enterprise and program-level risk management activities, nine state DOTs noted they engage in these types of risk management activities; however, only two agencies said they have formal policies and processes for both enterprise and program-level risk management. Table 3 lists the DOTs engaging in some type of enterprise or program-level risk management activities and whether the DOTs have formal risk management processes in place.

International Transportation Agencies

In most cases, a discrepancy between engaging in risk management activities and having formal processes for risk management is not present for the international transportation agencies. As evident in Table 2, the same number of agencies engage in risk management activities as those with a formal policy/directive.

Non-Transportation Organizations

Non-transportation organizations display similar response characteristics to the international transportation agencies. Organizations that are engaging in enterprise and program-level risk management activities also have formal risk management processes in place to guide the execution of risk management activities.

Table 3: State DOTs Implementing Enterprise & Program-Level Risk Management

State DOT	Engagement in RM Activities	Formal RM Processes
New York State DOT	Both Enterprise & Program	Yes (Enterprise & Program)
Washington State DOT	Both Enterprise & Program	Yes (Enterprise & Program)
North Dakota DOT	Both Enterprise & Program	Yes (Enterprise)
Tennessee DOT	Both Enterprise & Program	Yes (Enterprise)
Nevada DOT	Both Enterprise & Program	Yes (Program)
New Hampshire DOT	Both Enterprise & Program	No
South Dakota DOT	Both Enterprise & Program	No
Vermont DOT	Both Enterprise & Program	No
Massachusetts DOT	Both Enterprise & Program	No
California DOT	Enterprise-Level Only	Yes
Missouri DOT	Enterprise-Level Only	Yes
Texas DOT	Enterprise-Level Only	No
Pennsylvania DOT	Program-Level Only	Yes
Arkansas DOT	Program-Level Only	No
Idaho DOT	Program-Level Only	No
Kansas DOT	Program-Level Only	No
Minnesota DOT	Program-Level Only	No
Oklahoma DOT	Program-Level Only	No
Wyoming DOT	Program-Level Only	No

Of the organizations engaging in enterprise and/or program-level risk management activities, the survey then examined whether or not organizations are tracking, monitoring and managing these risks (illustrated in Table 4).

Table 4: Tracking, Monitoring, and Managing Enterprise and/or Program-Level Risks

Type of Organization	Tracking, Monitoring, and Managing Risks	
	Yes	No
A. State Departments of Transportation *(n=19)*	68%	32%
B. International Transportation Agencies *(n=8)*	100%	0%
C. Non-Transportation Organizations *(n=9)*	78%	22%

**n refers to the total number of organizations responding to this question*

In most cases, organizations that are engaging in enterprise or program-level risk management activities are tracking, monitoring, and managing their risks. Organizations that stated they are not tracking, monitoring, and managing risks typically are either: (a) in the process of developing a process to track, monitor and manage risks (such as a risk register); or (b) tracking risks through other means within the organization, such as through performance measures and regular staff meetings. In the latter instance,

risks can be documented through a range of methods, from inclusions in strategic/organizational plans or just tracked in meeting minutes.

Enterprise & Program-Level Risk Register Tool

Organizations stating that they track, monitor, and manage enterprise and/or program-level risks identified that they typically use a risk register tool for this activity. The type of risk register tool varied across the organizations, as illustrated in Table 5.

Table 5: Type of Risk Register Tools

Type of Organization	Database Risk Register Tool (Information System, etc.)	Spreadsheet Risk Register Tool (Excel, etc.)	Document Risk Register Tool (Word, etc.)	Other
A. State Departments of Transportation *(n=21)*	5%	57%	24%	14%
B. International Transportation Agencies *(n=3)*	33%	33%	33%	0%
C. Non-Transportation Organizations *(n=9)*	33%	33%	33%	0%

**n refers to total number of times all risk register types were selected – respondents could select more than one type of risk register*

The majority of state DOTs (57%) use a spreadsheet-based risk register tool, whereas only one used a database risk register tool. For the state DOTs selecting 'other', agencies noted that they have developed proprietary, in-house web-based tools to track, monitor, and manage risks. For both international transportation agencies and non-transportation organizations, the type of risk register tool in use was equally split across the organizations between database, spreadsheet and document-based risk register tools.

Organizations cited Microsoft Word and Excel as the most common software programs used for their risk registers. In addition to these two programs, organizations also noted risk management software programs including Microsoft InfoPath, RamRisk, and Active Risk Manager, or in a few instances, proprietary in-house software programs. To better understand the frequency of risk management activity review, respondents were asked how often their risk register tool is updated. Table 6 displays the frequency of risk register review and update.

Table 6: Reviewing & Updating the Risk Register Tool

Type of Organization	Monthly	Quarterly	Semiannually	Annually	Other
A. State Departments of Transportation *(n=13)*	15%	23%	8%	39%	15%
B. International Transportation Agencies *(n=3)*	0%	67%	0%	33%	0%
C. Non-Transportation Organizations *(n=6)*	20%	20%	0%	60%	0%

**n refers to the total number of organizations responding to this question*

Across all survey respondents, the most common frequencies to review/update the risk register were quarterly and annually. Two thirds of international transportation agencies review/update their risk register quarterly. Several DOTs noted that there is no set schedule for updating their risk register and the register can be updated at any time, based on various risk assessments or factors influencing operation.

In addition to asking organizations how often the risk register tool was updated, survey respondents were asked approximately when they adopted their risk register tool. For state DOTs, most agencies recently implemented their risk register tools, typically within the past several years. There are several state DOTs that have had a risk register and ERM program for more than ten years. For non-transportation organizations, risk registers have typically been in place for slightly longer than the state DOTs. Non-transportation organizations typically have had their risk registers in place for five to six years.

Survey respondents were also asked what department or group within the organization oversees and/or maintains the risk register. Table 7 identifies several common departments/groups responsible for the risk register.

Table 7: Risk Management Department

Type of Organization	Risk Management	Executive Staff	Audit	Planning	Other
A. State Departments of Transportation *(n=16)*	38%	19%	12%	6%	25%
B. International Transportation Agencies *(n=4)*	75%	0%	0%	25%	0%
C. Non-Transportation Organizations *(n=6)*	67%	0%	0%	0%	33%

**n refers to the total number of organizations responding to this question*

Two key takeaways are evident in Table 7. First, the majority of organizations surveyed have a risk management department/group. Second, in most cases, the risk register is maintained by the dedicated risk management department/group. In addition to a dedicated risk management group, several state DOTs noted that their executive staff oversee the register. In addition to the pre-populated list of departments/groups identified in the survey, organizations also noted that risk registers are maintained by

the performance departments, program management office (for program-level risks), or the treasury/finance department.

Risk Register Survey Summary

Across the survey respondent categories (state DOTs, international transportation agencies, and non-transportation organizations) the majority of respondents reported that they engage in enterprise and/or program-level risk management activities. Most of the international transportation agencies and non-transportation organizations also reported that formal risk management policies and procedures are in place. Among state DOT respondents that engage in enterprise and program-level risk management activities, the majority (58%) reported that formal risk management policies and procedures are not in place. This is typical of the earlier stages of risk management maturity; as risk management activities advance in maturity, formal risk management policies and procedures are typically put in place.

Most organizations that reported engaging in enterprise and program-level risk management activities also reported to have methods in place to track, monitor, and manage enterprise and/or program-level risks. Nearly all organizations that reported to be tracking, monitoring, and managing enterprise and/or program-level risks reported the use of risk register tools. The majority of state DOTs (57%) reported the use of spreadsheet-based risk register tools; international transportation agencies and non-transportation organizations reported an even split in the use of database, spreadsheet, and document-based risk register tools. Of note, several state DOTs reported the use proprietary, web-based risk register tools. Typically, across all survey respondent categories, risk register tools were reviewed and updated annually or quarterly. Many organizations reported that a dedicated risk management department/group is responsible for maintaining the risk register.

In-Depth Interviews

Based on the findings of the survey and input from the Project Panel, the research team identified organizations for in-depth discussions regarding their enterprise/program-level risk management activities and their use of risk register tools. In-depth interviews were conducted with the following organizations and included representation from all three categories of the risk register survey distribution (state departments of transportation, international transportation agencies, and non-transportation organizations):

- Caltrans
- NYSDOT
- VTrans
- WashDOT
- Danish Road Directorate
- Department of Transport and Main Roads (Queensland, Australia)
- A Fortune 500 Engineering and Construction Consulting Firm
- A Fortune 1000 Construction Firm
- A Small Management Consulting Firm Providing Risk Management Services

STATE DEPARTMENTS OF TRANSPORTATION IN-DEPTH INTERVIEWS

Several common themes emerged across the state DOTs that participated in the in-depth interviews. The majority of the DOTs interviewed maintained a small, i.e., two to three person, group of dedicated staff with responsibility and accountability for conducting enterprise and/or program-level risk management activities. Typically, the DOT's risk management team would provide training and technical assistance to facilitate improved population of the risk register tool by stakeholders. The resource commitments for the risk management teams to conduct training, facilitate workshops, update risk registers, and prepare reports appeared to require at least one, and in most cases two, full-time equivalent employees.

Having an established risk management process that is well-communicated and understood by staff appeared to be a greater factor in the success of a risk management program than the type, e.g., database, document, spreadsheet, of tool in use. One of the DOTs interviewed had more limited dedicated resources for ERM and was in the processing of soliciting bids for Commercial-Off-The-Shelf (COTS) risk management software. Two of the DOTs used in-house developed spreadsheets for enterprise and program-level risk management. Only one DOT interviewed used a database-based tool (SharePoint) for its risk register.

Initial risks identified by staff, or captured as the result of a workshop, required additional analysis by dedicated risk management staff. Typically, tens or even hundreds of risks are initially identified as a result of risk identification workshops. This often required effort on the part of the risk management staff to produce a consolidated listing of risks that eliminates duplicates and filters out risks that were not properly identified. In several instances, the state DOT was required to perform ERM activities to identify top risks to report to the DOT leadership on a regular basis. In some cases, the ERM reporting requirements are driven by state budget/finance departments.

Although our interviews with DOTs focused on enterprise-level risks, in most instances there was a linkage from project to program to enterprise-level risk management. Typically, establishing this link from project through to enterprise-level risk management was the duty of the DOT's risk management staff.

Common enterprise risk themes noted by the DOT interviewees included:

- Information Technology (IT) resource constraints
- Climate change adaptation
- Civil rights and ADA compliance
- Cybersecurity
- Retirements / succession planning

It was found to be good practice to link enterprise-level risks to an agency's strategic plan. Several DOTs linked enterprise-level risks to the goals/strategic objectives as defined in their strategic plans. In addition, the majority of the agencies rolled-up risks from the project and/or program-levels to the enterprise-level.

INTERNATIONAL TRANSPORTATION AGENCIES INTERVIEWS

Both international transportation agencies interviewed have been using risk register tools for approximately eight years. One agency continues to use spreadsheet-based software while another uses a COTS, database-based risk register tool. However, the agency that currently uses the COTS risk register tool initially used a spreadsheet-based risk register tool and moved to a COTS, database-based tool as the agency's risk management practices matured.

Both international agencies maintain strong risk management practices at the project, program, and enterprise-levels. There are also linkages from the project to the program to the enterprise-levels at both international agencies. The international agencies promote consistency in their risk management processes by conducting trainings and facilitating risk management workshops with their leadership and management teams at the strategic-level. Risk workshops are used for initial identification and analysis of risks. After this initial risk identification, the risk management staff generally conduct further risk analysis and evaluation to produce a final list of risks.

Providing some level of quality assurance and quality control through dedicated staff familiar with the risk management process appeared to be a success factor at the international transportation agencies. On some occasions, certain managers/individuals may be interested in seeing their identified risks advance through the full risk management process and ultimately onto the risk register. One of the agencies made use of risk checklists to assists facilitators with identifying risks, particularly at the project-level.

The international agencies interviewed both had strong risk governance structures in place. One of the agencies is subject to a legislative mandate for risk management. Although risk management is mandated, the legislation does not stipulate how to carry out risk management activities. However, this agency is required to maintain a risk register, risk response/treatment plans, and report quarterly on risks.

NON-TRANSPORTATION ORGANIZATIONS

As part of their duties and responsibilities to shareholders, many publicly-traded firms report to their boards regularly on the identification, analysis, and response to risks, both financial and enterprise risks. In this regard, traditional risk management for financial risk is related to insurance and claims management. Generally, ERM, i.e., focusing on risks that may impact an organization's achievement of its strategic objectives, is not as mature as traditional insurance and claims risk management at many private firms. Even so, many private firms do report to their board of directors on top enterprise risks that can result in operational failure and other catastrophic events.

The Fortune 500 Engineering and Construction Consulting Firm interviewed undertakes an annual ERM process as part of strategic planning efforts. They identify enterprise risks with potential impacts to operations as they relate to strategic goals and objectives. Then risk analysis and evaluation is conducted for these enterprise risks. Risk response/treatment plans are developed for each risk. Owners are assigned to risk response/treatment plans and report on the status of their risks at upper management and board of directors' meetings, particularly when risk status changes. A dedicated staff person is responsible for overall ERM.

The small management consulting firm that provides risk management services noted that while many private firms exhibit more mature project and program-level risk management, this is often disconnected from enterprise-level risk management. Enterprise risk management also does not tend to be strongly linked back to an organization's strategic plan. For this reason, the consulting firm stated that it is important to establish a risk governance structure that links an organization's ERM practices to its strategic planning processes.

The Fortune 1000 Construction Firm conducts an annual ERM survey with key leadership and management team members. This initial survey typically identifies a large list of over 100 risks that is narrowed down to a list of the "top", e.g., 20, 10, or 5, risks; these risks have the potential to severely impact the business and may include, but are not limited to: insufficient capital available; poor retention of key staff; poor project execution; misguided acquisitions; poor alignment to strategic objectives; etc. If these types of risks are not managed well they can pose a major threat to the company's success.

A web-based questionnaire tool is used to conduct the initial enterprise risk survey. These risks are then compiled and managed using a spreadsheet. The legal department is involved in scoring risks and preparing risk heat maps. Ultimately the executive team owns the enterprise risks and each executive team member is assigned a risk to manage. Each year the spreadsheet-based risk register is updated and it evolves over time.

In this Fortune 1000 Construction Firm, enterprise risk management principles outlined in the COSO framework (see Annotated Bibliography) are applied. Key success factors for this organization included establishing an ERM framework that fits the organization's culture and focusing on the people carrying out ERM. While there are several advanced COTS ERM tools available in the marketplace, this organization found that discussions surrounding ERM, increasing ERM awareness, and fostering a common language are more valuable than the tool used.

SUMMARY OF RESULTS AND FINDINGS

The survey and in-depth interviews set the boundaries and established best practices for the development of the risk register tool. The surveys and interviews confirmed that an editable spreadsheet was an appropriate tool for the risk register. The interviews also confirmed that the tool would provide a framework for conducting a formal risk management process and developing a risk management culture. Multiple interviewees from all three sectors stated that the process was more important than the tool itself. Therefore, the research team needed to emphasize the process in the tool. Finally, the example ERM policies and tools that were collected during the survey and interviews provided context to develop the spreadsheet tool and populate enterprise and program examples.

CHAPTER 4: RISK REGISTER TOOL

RISK REGISTER TOOL OVERVIEW

The spreadsheet-based risk register is designed around industry-standard risk management procedures. It incorporates best practices from the survey and interview findings. It provides a framework for a process that promotes risk-based decision making at the program and enterprise levels.

The risk register is an editable template that does not use any macros or custom code. To prevent users from unintentionally modifying the template, certain portions of the template are locked. However, users can unlock the template and advanced Excel users can configure and customize the tool.

In addition to the editable template, we prepared two pre-populated examples, one for enterprise-level risk management and one for program-level risk management. These files are labeled accordingly as the template version, the enterprise-level example version, and the program-level example version.

The editable template requires population by the user while the enterprise and program-level examples are pre-populated to demonstrate how the tool can be used. Further, these examples contain sample risk statements that are consistent with industry standards and best practices. The enterprise and program-level examples are intended to provide guidance and are not prescriptive. Each organization has unique needs and will need to adjust the risk register tool to suit its needs, but the tool provides a valid framework for ERM.

The sample risk categories for the enterprise and program-level examples are not exhaustive listings of potential categories but rather illustrative examples. Categories listed in the enterprise-level example are based in part on the example risk register tools received from the organizations that participated in the in-depth interviews; these categories are intentionally generic and are illustrative. Based the sample risk registers provided by the organizations that participated in the in-depth interviews, an illustrative listing of sample enterprise-level risk categories is provided below.

Illustrative Enterprise-level Risk Categories

- Asset Management/Assets
- Environmental & Cultural
- Financial/Budgeting & Programming
- Health & Safety
- Information Technology/Data Management
- Legal & Compliance
- Media & Reputation/Organizational Excellence
- System Performance/Business Performance & Capability
- Time or Schedule Delay

An illustrative listing of categories is also provided in the program-level example. However, it should be noted that how organizations define their programs tends to vary considerably from one organization to another. This was consistently seen in the in-depth interviews. The risk categories in the pre-populated program-level example were developed based on a generic asset management program as defined by the research team. In-depth interviews revealed a variety of areas considered programs that include but are not limited to:

- Administration
- Ancillary Assets
- Asset Management
- Bridges
- Engineering
- Legal Affairs
- Operations & Maintenance
- Pavements
- Policy & Planning
- System Performance/Optimization
- Traffic & Safety

RISK REGISTER TOOL LAYOUT

The risk register tool mirrors the core risk management steps within the ISO 31000 standard and *NCHRP 08-93 Managing Risk Across the Enterprise: A Guidebook for State Departments of Transportation*, including risk identification, risk analysis, risk evaluation, and risk management/treatment. The risk register is a standalone tool and includes detailed instructions to guide the user throughout the process. The tool is made up of various sheets, divided into one of three categories: reference (REF), input (INPUT), and output (OUTPUT). The user only needs to enter information on the input sheets. The reference sheets provide supporting information about the risk register and risk management. The output sheets include a comprehensive risk register as well as several graphics to help convey the risk landscape of the user's organization. The output sheets are automatically populated based on the information entered on the input sheets.

On the input sheets, the user enters data into each cell in one of three ways: 1) manually (users input information); 2) using a drop-down list (users select from a pre-populated list of choices); and 3) auto-population (users do not enter data in these cells, information is populated on the basis of data entered previously). Columns are marked with the input method for the cells in each column. Further, each input cell is denoted with cell-by-cell instructions, clearly explaining what the user should enter in that cell.

Table 8 provides a list of all the sheets in the risk register tool along with a brief description.

Table 8: Risk Register Tool Sheets

Title	Brief Description
REF - Instructions	Provides necessary instructions and definitions for the risk register tool. The sheet serves as a reference and requires no input.
INPUT – Risk Categories & Rating Matrix	Define the risk categories with corresponding impact and likelihood/probability definitions. Values are used later to calculate the risk rating and heat map outputs. Risk categories, impact ratings/definitions, and likelihood ratings/definitions are entered by the user.
INPUT - Identification	Identify the risks. Enter risks on this sheet, including date identified, risk description, and category of impact.
INPUT - Analysis	Analyze the risks. Rate the likelihood of occurrence and level of impact of the risks (pre-mitigated risk ranking). Reference the "Categories & Rating" sheet for guidance when rating risks.
INPUT - Management	Manage the risks. Identify response strategies, assign key individuals, and note potential trigger events. Re-rank the risks' likelihood and impact, based on the controls and response strategies (post-mitigated risk rating).
OUTPUT - Risk Register	Final risk register, based on the previous INPUT sheets.
OUTPUT - Heat Maps	Pre-mitigated and post-mitigated heat maps, identifying the number of risks in each impact/likelihood scenario.
OUTPUT - Risk Summary	Pre-mitigated and post-mitigated risk summary, identifying each risk and its resulting risk rating.
REF - Glossary	Collection of common risk management terms, including terms used in this tool.
REF – FAQs	List of Frequently Asked Questions related to the tool.

Risk Categories & Rating Matrix

The first input sheet of the risk register tool is the “Risk Categories & Rating Matrix” sheet. Here, the user defines risk categories at the enterprise or program-level and describes the level of impact (consequence), e.g., insignificant, minor, moderate, major, and severe, from potential risks in each category. In addition, the user defines the likelihood (probability) ranges, e.g., rare, unlikely, possible, likely, and almost certain, for risks. This tool uses a five-point risk rating system for both impact and likelihood. Finally, the user must also define the collective risk rating, which is based on the product of impact and likelihood. This tool has a four-level risk rating system: low, medium, high, and critical. Suggested definitions are provided. Figure 2 provides a screenshot of the “Risk Categories & Rating Matrix” sheet from the enterprise-level example.

Figure 2: Risk Categories & Rating Matrix Screenshot

RISK CATEGORIES & RATING MATRIX

Impact Levels	Risk Categories // Impact Areas: Reputation & Credibility	Transportation System Performance	Safety	Legal & Compliance	Workforce	Likelihood Ranges & Risk Ratings (Low, Medium, High, Critical): Rare	Unlikely	Possible	Likely	Almost Certain
						This event may have happened previously in our agency or similar organizations. However, in the absence of other information or exceptional circumstances, we would not expect it to happen in the foreseeable future. There is less than a 5% chance of the event happening in the next 12 months. It is likely to occur less than once in 15 years.	The event has occurred infrequently in our agency or similar organizations. Current controls and circumstances suggest the occurrence would be considered highly unusual. There is between a 5 to 30% chance of the event happening in the next 12 months. It is likely to occur once in 8 to 20 years.	This event may have occurred occasionally in our agency or similar organizations. Current controls or circumstances suggest there is a possibility of occurrence. There is between a 30 to 60% chance of the event happening in the next 12 month. It is likely to occur once in 5 to 7 years.	This event may have occurred in our agency or similar organizations on a regular basis. Current controls or circumstances suggest there is a distinct probability of occurrence. There is a 60 to 90% chance of the event happening in the next 12 months. It is likely to occur once in 1to 4 years.	This event occurs frequently within our agency, or with current controls or circumstances you expect an occurrence. There is a greater than 90% chance of the event happening in the next 12 months. It is likely to occur at least once over the next 12 months.
Severe	Constant extreme negative media for months; irreconcilable community loss of confidence; prolonged federal intervention; severe loss of trust from state and federal partners.	Permanent damage to multiple interstate systems cutting off lifelines.	Fatality, loss of limb; extensive damage to equipment or public services; involves members of the public.	Will result in significant litigation activities and fines; may involve class actions; will result in a severe breach (noncompliance) with regulation/legislation.	Agency's resource not available and a consultant/special service required at a prohibitive increase in time or money. Critical loss of staff that cannot be replaced.	Medium	Medium	High	Critical	Critical
Major	Prolonged community impact with dissatisfaction publicly expressed; community loss of confidence and negative media for weeks; level of trust impacted from state and federal partners.	Lifelines cut off for an extended time.	Extensive injuries requiring hospitalization; equipment damage extensive and insurance claim required; may involve members of the public.	May result in litigation, requiring significant dedicated time by legal counsel to address liability and consequences; will result in a major breach (noncompliance) with regulation/legislation.	Agency's resource not available and a consultant/special service required at a considerable increase in time or cost. Loss of staff that requires significant time to replace or rehire.	Low	Medium	High	Critical	Critical
Moderate	Regional community impacts and concerns publicly expressed with negative media for days.	Lifelines open but vulnerable.	Medical treatment required for injuries and lost time recorded; no hospitalization; equipment damage costs below insurance excess amount.	Would result in a serious issue requiring investigation and advice into legal liability; may require external counsel advice; will result in non-compliance with regulation or legislation.	Overtime is needed for more than 3 mo. or qualified staff not available requiring a consultant/special service at an increase in cost.	Low	Medium	Medium	High	High
Minor	Local community impacts and concerns; occasional single negative media report.	Short delays and operational slowdowns that go unnoticed.	First aid / casualty treatment; minor damage to equipment.	Would result in more complex legal issues but these are able to be managed by in-house legal staff; may result in minor non-compliance with regulation/legislation.	Overtime needed for a more than 3 mo. or a consultant/special service required.	Low	Low	Medium	Medium	Medium
Insignificant	Isolated local community or individuals issue-based concern; no media coverage.	Lifelines unaffected.	No injury; no damage to equipment; low financial loss.	Issues arise but are able to be managed by routine procedures; would not affect compliance with regulation or legislation.	Overtime needed for less than 3 months.	Low	Low	Low	Low	Medium

Key

Critical	Requires intervention from executive management; requires prompt action to implement new enteprise or program level controls to treat the risk.
High	Affects the ability of the agency to carry out its mission or strategic plan - existing controls may be effective but could require additional action and/or controls to be managed at the executive management level.
Medium	Impacts completion of a critical agency function - existing controls must be effective and possibile additional actions may need to be implemented.
Low	Managed with current practices and procedures - impacts are dealt with by routine operations which should be monitored for effectiveness.

Risk Identification

The second input sheet focuses on risk identification. Here, users identify their risks, including defining the risk ID, date identified and a risk description and statement. Further, the user should identify which category the risk will impact. If the risk impacts multiple categories, a new risk statement should be created and state a new risk impact. A screenshot of the "Risk Identification" sheet from the enterprise-level example is shown below in Figure 3.

Figure 3: Risk Identification Screenshot

RISK IDENTIFICATION				
ID	**Date Identified**	**Brief Risk Description**	**Detailed Risk Statement**	**Risk Category**
Manual	*Manual (MM/DD/YY)*	*Manual*	*Manual*	*Drop Down*
1	02/01/16	Delivering signature bridge construction project late	If the major projects division does not complete the signature bridge construction project on time, then the agency's ability to secure financial, political, and public support for future major projects may be impacted.	Reputation & Credibility
2	02/01/16	IT System breach resulting in limited TMC functionality	If the agency's information technology system is breached, then the functionality of the Transportation Management Center (TMC) may be limited, resulting in failure of variable message signs and requiring manual identification, recording and tracking of incidents that may increase response time for motorists in distress and may also increase congestion.	Transportation System Performance
3	02/01/16	Major workzone accident	If a workcrew on the new overpass does not comply with all safety protocols to speed up construction then a major workzone accident may occur resulting in injuries, fatalities, and/or fines along with a potential audit/investigation of safety protocols.	Safety

Risk Analysis

The "Risk Analysis" sheet includes a risk evaluation process as defined in ISO 31000. Here, the user identifies the appropriate impact and likelihood of a risk. The tool will automatically generate a risk rating, based on the inputs to the "Risk Categories & Rating Matrix" sheet. This is known as the pre-treatment risk rating. Figure 4 provides a screenshot of the "Risk Analysis" sheet from the enterprise-level example.

Figure 4: Risk Analysis Screenshot

RISK ANALYSIS					
ID	**Brief Risk Description**	**Risk Category**	**Impact**	**Likelihood**	**Risk Rating**
Auto	*Auto*	*Auto*	*Drop Down*	*Drop Down*	*Auto*
1	Delivering signature bridge construction project late	Reputation & Credibility	Severe	Likely	Critical
2	IT System breach resulting in limited TMC functionality	Transportation System Performance	Severe	Possible	High
3	Major workzone accident	Safety	Major	Possible	High

Risk Management

The final input sheet is the "Risk Management" sheet. Here, the user identifies specific response actions/strategies for the identified risks. The response options are consistent with *NCHRP 08-93: Managing Risk Across the Enterprise: A Guide for State Departments of Transportation* – take advantage, terminate, tolerate, transfer, and treat. After the user identifies appropriate monitoring and updating measures, the user then re-rates the impact and likelihood of the risk. A new risk rating, known as the post-treatment risk rating, is then calculated. A screenshot of the "Risk Management" sheet from the enterprise-level example is shown below in Figure 5.

Figure 5: Risk Management Screenshot

RISK MANAGEMENT										
ID	Brief Risk Description	Risk Category	Response Action/ Strategy	Responsible Individual	Monitoring & Updating			Post-Treatment Risk Rating		
					Trigger Event(s)	*Status*	*Risk Resolution Date*	*Impact*	*Likelihood*	*Risk Rating*
Auto	*Auto*	*Auto*	*Drop Down*	*Manual*	*Manual*	*Drop Down*	*Manual (MM/DD/YY)*	*Drop Down*	*Drop Down*	*Auto*
1	Delivering signature bridge construction project late	Reputation & Credibility	Treat	Tom Smith	Actual construction falls behind schedule	Active	07/01/16	Major	Possible	High
2	IT System breach resulting in limited TMC functionality	Transportation System Performance	Treat	Diane Wilson	Some vulnerabilities in IT systems are detected	Active	12/31/16	Severe	Unlikely	Medium
3	Major workzone accident	Safety	Terminate	Jerry Oscar	Actual construction falls behind schedule	Active	09/14/16	Major	Rare	Low

Risk Register Outputs

The risk register tool includes three output sheets.

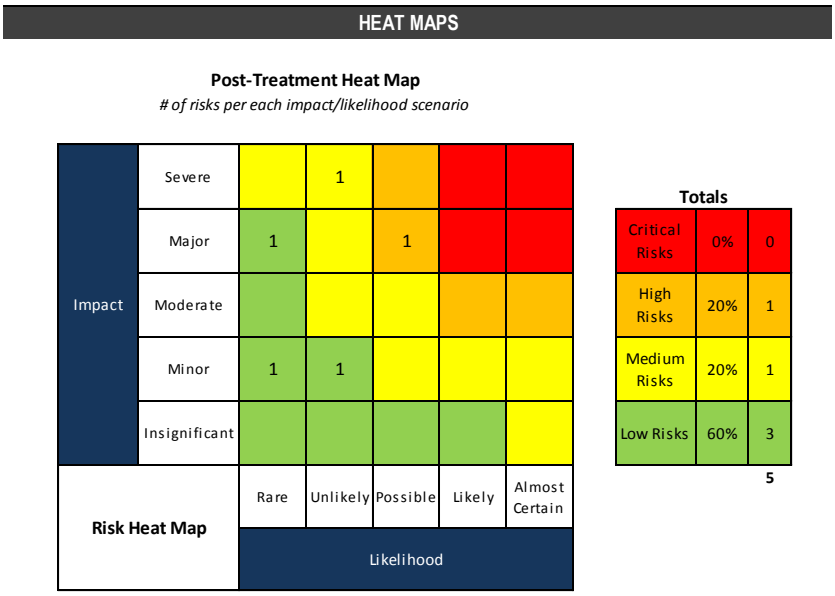
The first output sheet is a comprehensive "Risk Register" sheet. The sheet is populated based on the data entered in the previous four input sheets and includes both the pre-treatment and post-treatment risk ratings. Figure 6 provides a screenshot of the comprehensive "Risk Register" sheet from the enterprise-level example.

Figure 6: Comprehensive Risk Register Screenshot

RISK REGISTER										
RISK IDENTIFICATION				ANALYSIS	RISK MANAGEMENT					
ID	Date Identified	Brief Risk Description	Risk Category	Pre-Treatment Risk Rating	Response Action/Strategy	Responsible Individual	Monitoring & Updating			Post-Treatment Risk Rating
							Trigger Event(s)	*Status*	*Risk Resolution*	
1	02/01/16	Delivering signature bridge construction project late	Reputation & Credibility	Critical	Treat	Tom Smith	Actual construction falls behind schedule	Active	07/01/16	High
2	02/01/16	IT System breach resulting in limited TMC functionality	Transportation System Performance	High	Treat	Diane Wilson	Some vulnerabilities in IT systems are detected	Active	12/31/16	Medium
3	02/01/16	Major workzone accident	Safety	High	Terminate	Jerry Oscar	Actual construction falls behind schedule	Active	09/14/16	Low

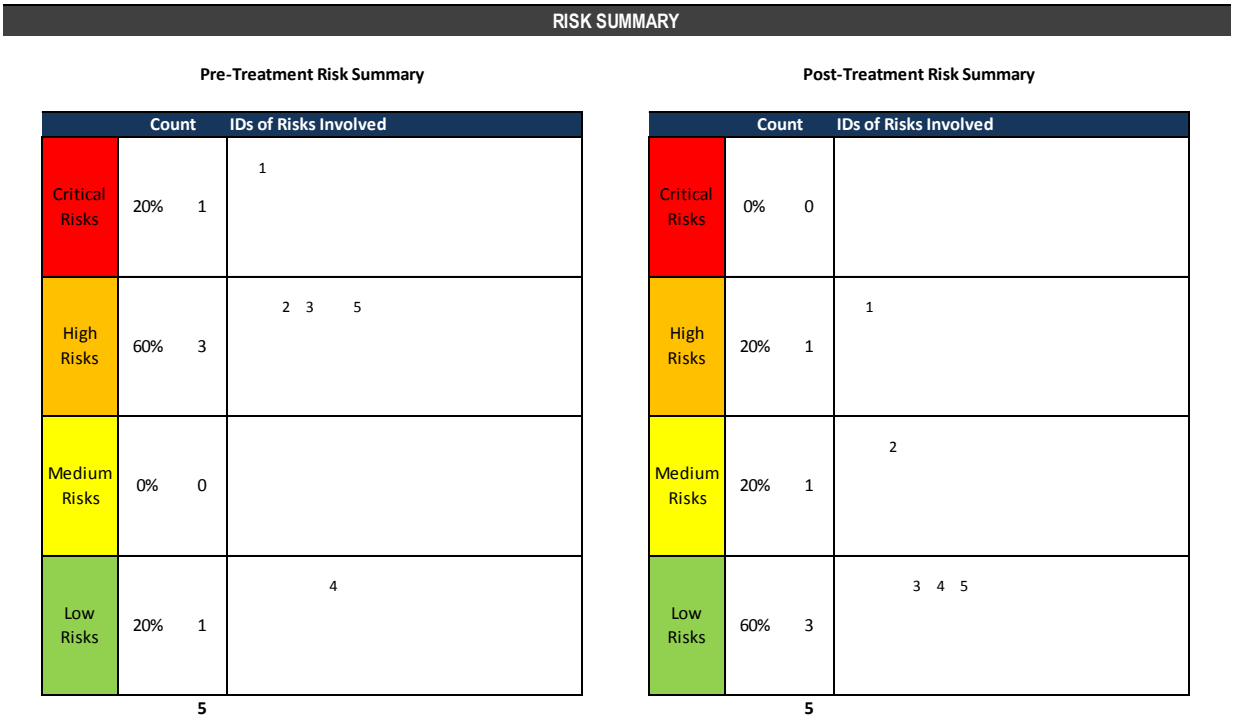
There is also a "Heat Map" output sheet. The heat map is a visual aid that presents the likelihood and impact of multiple risks. Heat maps are provided for both pre and post-treatment risk ratings. A screenshot of the post-treatment heat map from enterprise-level example is shown below in Figure 7.

Figure 7: Post-Treatment Heat Map Screenshot



The final output sheet contained in the risk register tool is the "Risk Summary". This output sheet identifies the risk, based on the Risk ID, and shows which risk rating level risks are categorized into. Further, a side-by-side comparison (pre-treatment versus post-treatment) shows how risk response measures change the risk rating of certain risks. Figure 8 provides a screenshot of the "Risk Summary" sheet from enterprise-level example.

Figure 8: Risk Summary Screenshot



RISK SUMMARY

Pre-Treatment Risk Summary

	Count		IDs of Risks Involved
Critical Risks	20%	1	1
High Risks	60%	3	2 3 5
Medium Risks	0%	0	
Low Risks	20%	1	4
		5	

Post-Treatment Risk Summary

	Count		IDs of Risks Involved
Critical Risks	0%	0	
High Risks	20%	1	1
Medium Risks	20%	1	2
Low Risks	60%	3	3 4 5
		5	

THREATS VERSUS OPPORTUNITIES

The spreadsheet-based risk register tool prepared for this research project was designed to manage risks that are considered threats, meaning uncertainty with a presumed negative impact, i.e., a possible event that results in an adverse consequence. Opportunities are uncertain events with a positive impact, i.e., a possible event that results in a benefit. ISO-31000 does not explicitly discuss managing opportunities but does promote improved identification of opportunities and threats. Taking or increasing risk in order to pursue an opportunity is noted as a treatment option in ISO-31000.

While taking advantage of opportunities is an important aspect of the risk management process, separate impact (consequence) levels, likelihood (probability) ranges, and risk ratings would need to be defined for managing opportunities; this could not be easily accommodated in the risk register tool. Nonetheless, the risk treatment option of take advantage presents an opportunity to embrace an identified opportunity.

CHAPTER 5: CONCLUSIONS

Successful and effective ERM practices require a formal and rigorous process. A spreadsheet-based risk register tool can be valuable in facilitating ERM implementation. However, a risk register tool is no substitute for executive leadership related to ERM, an ERM governance structure, and ERM workshops and training to promote awareness. The research team believes that the spreadsheet-based risk register tool developed in this project, along with the pre-populated enterprise and program-level example risk registers, can facilitate improved ERM practices. The risk register tool, however, is not a substitute for conducting risk management workshops and developing risk management training programs. Rather, it is decision support tool to promote good risk management practices.

The risk register survey conducted as part of this research effort revealed that a large number of state DOTs continue to use spreadsheet-based risk register tools. International transportation agencies and non-transportation organizations appeared to apply document-based and web-based risk register tools more frequently. The spreadsheet-based risk register tool was developed in alignment with industry best practices and international standards. It is intended to support good practice risk management and promote compliance with MAP-21/FAST Act requirements for risk-based asset management plans.

Population and use of this risk register tool does not guarantee compliance with MAP-21, FAST, or the ISO-31000 standard. An organization's risk management governance along with staff commitment, availability, and capability to support risk management activities are equally, if not more, important to effective risk management as the risk register tool itself. Although the spreadsheet-based risk register tool was developed to be a standalone product, users are strongly encouraged to review *Managing Risk Across the Enterprise: A Guide for State Departments of Transportation* (NCHRP 08-93) for further information on ERM, particularly on guidance related to ERM governance structures and training. Additional risk management resources are listed in the Annotated Bibliography section of this report.

ANNOTATED BIBLIOGRAPHY

COSO. Enterprise Risk Management – Integrated Framework. Committee of Sponsoring Organizations of the Treadway Commission (COSO), PricewaterhouseCoopers LLP, New York, NY, 2004.

The Committee of Sponsoring Organizations of the Treadway Commission (COSO) issued the original version of Internal Control – Integrated Framework in 1992 to assess and enhance an organization's internal control systems. Thousands of organizations use this framework; it has been incorporated into regulations, and was revised and reissued in 2013. There were many high-profile business organization failures during the period following the internal control framework's development, demonstrating the need for an ERM framework. Enterprise risk management is defined and is considered a process that manages risks and opportunities that affect value creation or preservation. Eight fundamental concepts related to the definition of ERM are defined as are eight interrelated components of ERM. An organization's objectives are directly related to the eight components of ERM. The effectiveness of an organization's ERM is based on whether or not the eight components are present and functioning properly.

Curtis, J.A., et al. *Transportation Risk Management: International Practices for Program Development and Project Delivery*. FHWA Report FHWA-PL-12-029, U.S. Department of Transportation, Washington, D.C., 2012.

While many U.S. transportation agencies have only recently begun to implement formal risk management policies and procedures, some leading international transportation agencies have mature risk management practices. This international scan tour observed that risk management supports strategic organizational alignment, assists in assigning risks to those parties best positioned to manage them, and facilitates improved decision making and accountability through all levels of an organization. International agencies visited on this can tour included representation from New South Wales, Australia; Victoria, Australia; Queensland, Australia; London, England; Cologne, Germany; Rotterdam, Netherlands; and Glasgow, Scotland. Recommendations for implementation of risk management practices in the U.S. include developing executive-level support for risk management, defining risk management leadership and organizational responsibilities, and improving trust with stakeholders.

Gordon Proctor & Associates. *NCHRP 08-93: Managing Risk Across the Enterprise: A Guide for State Departments of Transportation – Draft Final*. Transportation Research Board. Washington, D.C., forthcoming 2016.

This guide details how state DOTs can establish and benefit from an ERM program by providing a comprehensive framework to identify and manage risk. It defines ERM as a comprehensive approach to addressing risks at all levels of the organization. The guide demonstrates how ERM complements strategic planning and performance management. With a focus on ERM, the guide describes how managing risks provides agencies with new skills to increase the likelihood of achieving their strategic objectives. Extensive summaries of how risk management is being applied to transportation program areas nationally and internationally are included.

Hallowell, M., K. Molenaar, and B. Fortunato. *NCHRP 20-24(74): Executive Strategies for Risk Management by State Departments of Transportation*. Transportation Research Board. Washington D.C., 2012.

This report describes that state-of-the-practice in how U.S. state DOT executives applied risk management practices based on a review of literature, a survey of DOTs, and structured interviews. Of the 43 DOTs that completed a survey only 13 had formalized ERM in place. Findings also indicated that formal risk management tools exist and add value to DOTs that use them. DOTs face new, high-magnitude risks based on internal and external pressures and can employ ERM practices that have been implemented by other large private and public sector organizations. Developing a culture of risk management and providing training on ERM were found to be essential to effective implementation. Recognizing that each state's enterprise management practices are at a different level of maturity, the study identified common recommendations for DOT executives to improve their risk management practices.

ISO. ISO 31000 Risk Management – Principles and Guidelines. International Organization for Standardization, Geneva, Switzerland, 2009.

This international standard provides principles and generic guidance on risk management broadly applicable to any industry, sector, and organization, public or private. The Standard establishes a number of principles that when satisfied make risk management effective; it recommends that organizations develop, implement, and continuously improve a framework to integrate risk management processes into an organization's overall governance, strategy, planning, management, reporting, policies, values and culture. A particular industry or sector has its individual needs, audiences, perceptions, and criteria. Thus, an important aspect of the Standard is "establishing the context" as an activity at the outset of the generic risk management process. Existing management practices and processes of many organizations include components of risk management and some organizations may have formal risk management processes. Organizations can decide to carry out a critical review of their existing practices and processes in light of the International Standard.

D. Rose, et al. *NCHRP 08-36(121): Successful Implementation of Enterprise Risk Management in State Transportation Agencies*. Transportation Research Board. Washington, D.C., 2015.

This report identified, analyzed, and described the qualities of successful implementation of ERM at state DOTs. Issues that may impact ERM implementation were identified through a survey of 44 DOTs, interviews, and case studies. The case study DOTs were analyzed based on seven elements: origin of the ERM program, factors influencing ERM implementation, organizational support and structure, processes of ERM implemented, changes implemented to improve/strengthen ERM program, results achieved due to ERM implementation, and lessons learned/recommendations for other DOTs. Five agencies, Caltrans, MassDOT, MoDOT, NYSDOT, and WashDOT were selected for case studies. Research results suggest that DOT ERM programs are still in their infancy yet many agencies realize that mature ERM programs and a culture of ERM take time to establish. A series of recommendations are provided for DOTs looking to advance the maturity of their ERM programs.

S. Varma and G. Proctor. *Risk-Based Asset Management Report 2: Managing Asset Risks at Multiple Levels in a Transportation Agency*. FHWA Report FHWA-HIF-12-050, U.S. Department of Transportation, Washington, D.C., 2012.

The Federal Highway Administration (FHWA) sponsored a series of five reports on the topic of risk-based asset management to help agencies understand how managing risks can improve decision making in asset management programs. Report two describes several risk management frameworks implemented in the U.S. and internationally to support transportation agency decision makers in the management of risks at different levels. This report acknowledges that project-level risk management activities at U.S. transportation agencies are relatively mature and focuses more on program and enterprise-level risk management. Much like asset management, risk management can cascade through different levels of an organization's hierarchy from the enterprise-level to individual assets. Risk management can be institutionalized through documented policies and procedures, assigned roles and responsibilities, and training at the enterprise, program, and project-levels. Establishing formal risk management processes and governance structures may require the development or acquisition of new tools or training but can also spur new management models encouraging staff to take ownership and responsibility for managing risks.

APPENDIX A: SURVEY QUESTIONNAIRE

**Two versions of the questionnaire were created (Transportation Agencies and Non-Transportation Organizations), although differences were very minor. Differences are indicated in italics for question #3.*

Version 1: Development of Risk Register Spreadsheet Tool at State Departments of Transportation

NCHRP Project 08-36 Task 126: Development of Risk Register Spreadsheet Tool

You are being invited to participate in a study of the use of risk registers as part of enterprise and/or program-level risk management practices and strategies. The research (Project 08-36 Task 126) is being sponsored by the American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Planning National Cooperative Highway Research Program (NCHRP).

For purposes of this survey, ERM is the consistent application of techniques to manage the uncertainties surrounding the achievement of an organization's objectives. This includes risks related to planning, investment management, public outreach, human resources, and other aspects of the organization that are not tied to a specific project but still affect the achievement of strategic objectives. Program-level risk management applies the same iterative risk management process used at the enterprise-level but to risks common to clusters of projects.

The objectives of this research are to: (1) identify transportation agencies and other organizations that are using enterprise and/or program-level risk management to achieve the organization's strategic goals and objectives; and (2) understand how risk registers are used to support formal enterprise and/or program-level risk management across different organizations**.** Your privacy will be maintained in all published and written data resulting from this study. One survey response per organization will be accepted. However, collaboration of multiple individuals involved in enterprise and/or program-level risk management activities to prepare a response is encouraged.

We expect the project to benefit your organization by providing a summary of the current state-of-practice in the use of risk registers in enterprise and/or program-level risk management in transportation agencies and other organizations that own, operate and maintain large physical infrastructure assets in the United States and around the globe.

The product of this research, an enterprise and program-level risk register spreadsheet tool with associated user guidance, will be publicly available on the Transportation Research Board's (TRB) website upon completion of this study. You will receive no compensation for your participation. Completing the questionnaire will take approximately 10 to 15 minutes.

Q1 I understand the above information and voluntarily consent to participate in the research project entitled NCHRP 08-36 Task 126 Development of Risk Register Spreadsheet Tool.

1. Yes
2. No

If No Is Selected, Then Skip to End of Questionnaire

Q2 Please complete the following information. Note: We are collecting names only to avoid duplication when aggregating results and assist in distributing the final research products. Your individual privacy will be maintained in all published and written data.

First Name:
Last Name:
Job Title and/or Organizational Unit:
Organization:
Industry:

Q3 Please indicate your state.

For the non-transportation organization version of the questionnaire this question asks for the organization's size (i.e., number of employees), type (i.e., construction and/or engineering), and sector (e.g., industrial, manufacturing, utilities, etc.)

3. Alabama
4. Alaska
5. Arizona
6. Arkansas
7. California
8. Colorado
9. Connecticut
10. Delaware
11. District of Columbia
12. Florida
13. Georgia
14. Hawaii
15. Idaho
16. Illinois
17. Indiana
18. Iowa
19. Kansas
20. Kentucky
21. Louisiana
22. Maine
23. Maryland
24. Massachusetts
25. Michigan
26. Minnesota
27. Mississippi
28. Missouri
29. Montana

30. Nebraska
31. Nevada
32. New Hampshire
33. New Jersey
34. New Mexico
35. New York
36. North Carolina
37. North Dakota
38. Ohio
39. Oklahoma
40. Oregon
41. Pennsylvania
42. Rhode Island
43. South Carolina
44. South Dakota
45. Tennessee
46. Texas
47. Utah
48. Vermont
49. Virginia
50. Washington
51. West Virginia
52. Wisconsin
53. Wyoming
54. Puerto Rico

Q4 Does your organization engage in enterprise or program-level risk management activities? (Check all that apply)

- ❑ Yes, Enterprise Risk Management
- ❑ Yes, Program-Level Risk Management
- ❑ No, my agency does not engage in enterprise or program-level risk management activities. Please explain.

Q5 Does your organization have a formal enterprise or program-level risk management policy/directive in place? (Check all that apply)

- ❑ Yes, Enterprise Risk Management
- ❑ Yes, Program-Level Risk Management
- ❑ No, my agency does not have a formal enterprise or program-level risk management policy/directive. Please explain.

If No Is Selected for both Q4 and Q5, Then Skip to End of Questionnaire

Enterprise Risk Management – Risk Register Tool

The following questions are specific to a risk register tool. In the case of this survey, a **risk register tool** is any document, spreadsheet or database that is used to track, monitor and manage enterprise or program-level risks.

Q6 Does your organization have a formal method to track, monitor, and manage enterprise and/or program-level risks?

- Yes
- No (If no, how do you track, monitor, and manage your risks?) _____

If No Is Selected, Then Skip to End of Questionnaire

Q7 What tools does your organization use to track, monitor, and manage enterprise and/or program-level risks? (Check all that apply)

- ❑ Database risk register tool (e.g., web-based risk management information system)
- ❑ Spreadsheet risk register tool (e.g., Microsoft Excel, Google Sheets format to manage risks)
- ❑ Document risk register tool (e.g., Microsoft Word, Google Doc format to manage risks)
- ❑ Other, please explain _____

Q8 What is the name of the software program/tool (if applicable). If there is no name, please describe it.

Q9 Approximately how often is the enterprise-level and/or program-level risk register tool updated?

- Monthly
- Quarterly
- Semiannually
- Annually
- Other _____

Q10 Approximately when was the risk register tool first used within the organization (please indicate year and month, if known)?

Q11 By what department/group is the risk register tool maintained?

- ❑ Separate risk management department/group
- ❑ Executive staff
- ❑ Audit department/group
- ❑ Internal controls department/group
- ❑ Planning department/group
- ❑ Other _____

Q12 Who (positions) is responsible for maintaining the risk register tool?

Q13 Do you know of any individuals at your organization that would be able to provide us with more information concerning enterprise and program-level risk management and/or complete this questionnaire?

- Yes (please provide email address or contact number) _____
- No

Q14 Are you available for additional questions or do you wish to receive the results of this effort? (Check all that apply)

- ❑ Available for additional questions
- ❑ Not available for additional questions
- ❑ Please contact me with the results (Provide email address) _____
- ❑ Please do not contact me with the results

We appreciate you taking the time to take this questionnaire and your help with this project. If you have selected that you would like to receive the results of this questionnaire, we will distribute them once the responses are collected and aggregated.

Thank you.

APPENDIX B: IN-DEPTH INTERVIEW GUIDE

Drawing on the findings from the survey, we will conduct interviews with several organizations representing our survey population: State DOTs, International Transportation Agencies, and Non-Transportation Organizations. These interviews will allow us to collect examples of risk registers, dive deeper into how agencies are implementing risk registers, and identify best practices around their use. Further, we will request materials such as risk register user guides (if available), risk management policies, and risk management protocols (to the extent the organization is willing to share) from the agencies to help aid in the development of a risk register spreadsheet tool.

MATERIALS REQUEST

We will request risk register tools and supporting materials, to the extent the organization is willing to share. We will assure organizations that their register will not be shared publicly and that the materials will only be used in aggregate to develop a generalized risk register.

- Risk Register Tool/File or Detailed Screenshots of Risk Register (if can't share)
- Policy and/or Procedures related to Enterprise and/or Program-Level Risk Management and Risk Registers
- List of Enterprise and Program-Level Risk Categories
- Qualitative and Quantitative Risk Assessment Structure including both Impact and Probability Ratings/Rankings (heat maps, etc.)
- Sample meeting agendas, presentations and/or minutes from meetings in which decision makers use the risk management data and update the evaluations.

INTERVIEW AGENDA & QUESTIONS

- Introductions and explanation of interviewee role(s).
- Risk Management Overview
    - Provide an overview of your enterprise and/or program-level risk management.
    - Describe the origins of your enterprise and/or program-level risk management.
- Risk Register Use & Development
    - How does your risk register support your enterprise and/or program-level risk management?
    - How is the risk register used to identify, assess, and monitor your risks?
    - Please walk us through the process.
    - Provide us with any sample agendas, presentation or minutes from meetings in which the risk register information is a central point of discussion.
    - When was the risk register developed? Have there been recent iterations to the register? What sparked these iterations/changes?
- Risk Identification
    - How are risks identified and entered into the risk register?
    - Who adds the risks to the register and how often is this done?
- Risk Categories
    - Is your risk register divided into risk categories?
    - What are these categories?
    - How were these categories chosen? Have these categories been changed recently?

- Risk Assessments
    - What goals/measures are risks being assessed against (i.e., physical assets, reputation, etc.)?
    - How were your ratings, or risk tolerances, for these goals/measures originally developed?
    - Who makes the risk assessments (both probability and impact)?
- Risk Register Structure
    - How was the current type of risk register (database, web-based, etc.) chosen? Has it always been this type?
    - For agencies conducting both enterprise and program-level risk assessments, are there any differences between the enterprise and the program-level risk register? If so, what?
- Risk Monitoring
    - How is the risk register used to monitor risks?
    - How often is the risk register checked/reviewed/updated? Who has access to the risk register?
- Other Risk Register Questions
    - What did you do before the current version of risk register or before a risk register period?