Survey Of Risk Management Policies for Transportation Agencies

(Division of Planning Research On-Call (ROC) Program Task 12)

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16. Abstract

The project and risk management policies and strategies used by other DOTs in the country were evaluated. The purpose is to gain insight into how they measure and manage project development and delivery, and ultimately obtain ideas to improve ODOT's own project management methods. This project entailed a scan of state DOT online documents, a survey of state DOTs and follow-up interviews with selected states.

Main findings of this project are:

- Power BI and SQL is a commonly used tool amongst DOTs. However, most of the sampled and interviewed DOTs rely on spreadsheets for communications
- Several DOTs reported the use of Monte Carlo Simulation for cost estimation. More importantly for this project, they use this method for identification and ranking of risks in a project
- A common recommendation from interviews around project risk management is ***keep it simple and easy to communicate***

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(°F-32)/9 or (°F-32)/1.8	Celsius temperature	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2 or psi	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celsius temperature	1.8°C + 32	Fahrenheit temperature	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2 or psi

* SI is the symbol for the International Symbol of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

Survey of risk management policies for transportation agencies

(Division of Planning Research On-Call (ROC) Program Task 12)

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1 Executive Summary

This report documents the results of a project and ascertaining and evaluating risk management policies and strategies used by other DOTs in the United States. The purpose is to gain insight into how they measure and manage project development and delivery, and ultimately obtain ideas to improve ODOT's own project management methods.

ODOT expends $2 billion or more on construction each year. These projects are managed and reviewed via a series of milestones tied to delivery dates. Managers of these programs meet with ODOT District personnel quarterly to review projects, track costs, and ensure milestones are being met. ODOT tracks projects through its ELLIS application that helps ODOT personnel with various details of project management.

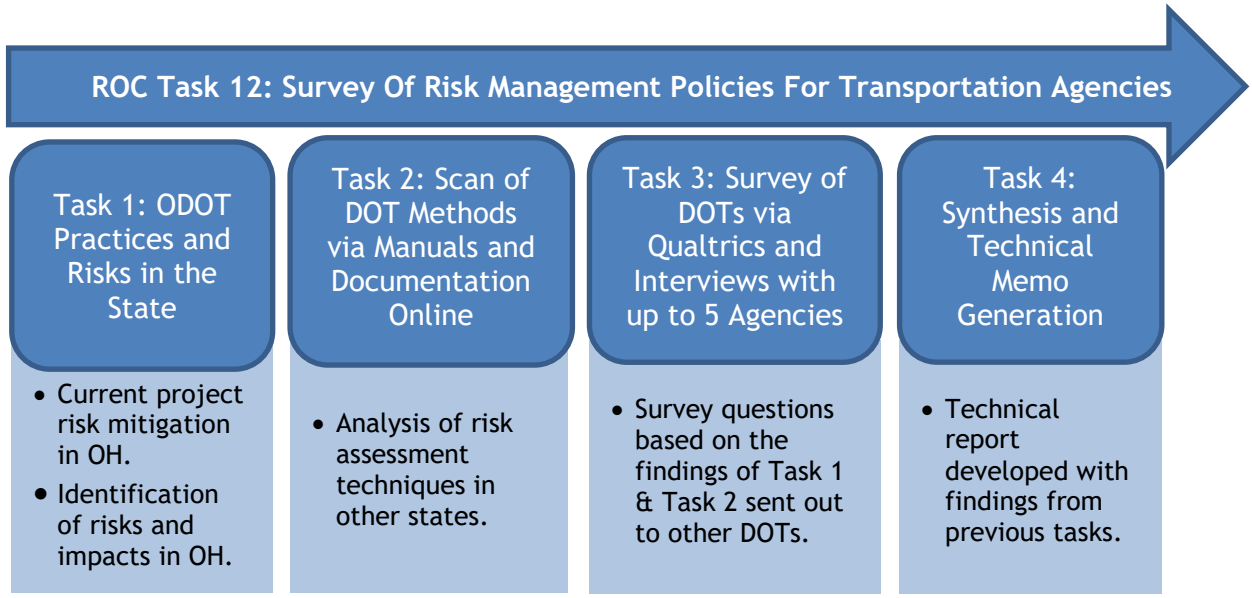


Figure 1: ROC Task 12 Workflow.

The main findings of this project are:

- Power BI and SQL is a commonly used tool amongst DOTs. However, most of the sampled and interviewed DOTs rely on spreadsheets for communications.
- Several DOTs reported the use of Monte Carlo Simulation for cost estimation. More importantly for this project, they use this method for identification and ranking of risks in a project.
- A common recommendation from interviews regarding project risk management is ***keep it simple and easy to communicate***.

As shown in Figure 1, this project has three main tasks, and this report is the final task. The main body of this report summarizes the work in each of Tasks 1-3. The appendices contain:

- Further details on the analysis of documents in some DOTs (e.g., Florida, Indiana and Washington State).
- A summary of findings.

2 Task 1 – ODOT Risk Management Practices

This task entailed conversations with ODOT personnel to discuss prevalent risks in the state, and tools and methods used to manage them. In addition to this, the PI joined two review meetings via Microsoft (MS) Teams where risks for ongoing projects were discussed. The list below shows the list of most prevalent risks causing a project to be delayed or overbudget:

- Right-of-Way (ROW) acquisition
- Utility relocation
- Railroad coordination
- Long construction duration (construction delays)
- Waterway permits (Environmental requirements)
- Inability to hit project milestones
- Increases in project costs
- Funding for the project not being fully committed.

This list was used in the survey conducted as part of Task 3 to compare risks perceived in other state DOTs. In addition to this, ODOT is currently developing dashboards in Power BI and using SQL to create queries that are later exported to MS Excel, which is used to create charts for communication and evaluation of progress in each project.

Two main challenges emerge when following this procedure:

- Complex business rules to access/understand data – many queries combine information from a variety of different data tables and require data qualifications that only few subject matter experts have. This diversity of data requires expert interpretation to return accurate results. This limits the ability for many to create queries.
- Diversity of Needs – There are some standard queries that are used by multiple business units, but in many cases data needs are unique. This limits the value of standardized queries or dashboarding. ODOT wants to create a dashboarding experience that allows users flexibility to create their own data qualifications

3 Task 2 – Scan of DOT methods via manuals and other online documentation

3.1 Summary

The research team, in agreement with the ODOT TAC, started out with finding a fair basis of comparison of transportation performance across a select number of states based on already known information. Eight (8) states in total were studied, each having individual similarities and differences in comparison to Ohio. These states were Florida, Virginia, West Virginia, Washington, Indiana, New York, Michigan, and California. *U.S. News & World Report* (2022) ranks these states using an index derived from commute time, road quality, bridge quality, and public transit usage as follows: Florida (19th), Washington (24th), Virginia (28th), New York (30th), Indiana (33rd), Michigan (36th), California (45th) and West Virginia (49th). The state of Ohio ranks 20th in this ranking. Regarding risk management, California and Washington have thorough documentation and practices of Project Risk Management (PRM); the other states have less detailed documents. The state transportation agencies are designated as follows: Washington State Department of Transportation (WSDOT), Florida DOT (FDOT), Virginia DOT (VDOT), New York State Department of Transportation (NYSDOT), Indiana DOT (INDOT), Michigan DOT

(MDOT), California Department of Transportation (CalTrans), and West Virginia Division of Highways (WVDOH),

DOTs with formal Risk Management Practices (RMPs) implement these strategies as part of a long Transportation Asset Management Plan (TAMP) and/or Project Risk Management (PRM). DOTs tend to focus on Transportation Asset Management in mitigating risk forecasted at the beginning of each fiscal year in line with MAP-21 and FAST Act legislation, which defines risk management as "the processes and framework for managing potential risks, including identifying, analyzing, evaluating and addressing the risks to assets and system performance." (WVDOH TAMP 2019, CalTrans TAMP 2017).

An extensive PRM process can add to the cost of a project at hand. Hence, the extent to which risk management practices are followed through is merited by the complexity, cost, schedule, savings, and opportunities PRM presents to the overall objective of a project (WSDOT, 2018). MDOT recommends formal risk management for all projects. In addition to that, the approach and RM framework should be kept simple and proportionally scalable in budget, according to the accompanying level of risk and project size (MDOT, 2022).

The variation of these differences was studied in the context of the RMP stipulated by the Project Management Body of Knowledge (PMBOK) which include: risk management planning, risk identification, qualitative analysis, quantitative analysis, risk response, and risk control. In the context of transportation risk management, an authoritative/primary source of reference for most DOTs in the process of formalizing risk management was the CalTrans PRM handbook which is based on the foundations of PMBOK risk management procedure. Information on these practices was gathered and put into a summary table in Appendix F which summarizes the current resources available and project management techniques currently in use by these DOTs.

3.2 Documentation of Risk Management Practices

DOTs that have formal risk management practices have documents and management tools in the form of process guides, documentation procedures, reporting and communication templates, existing spreadsheet template, and software applications for use by project teams and stakeholders to streamline and standardize the risk management process across the board. In a more robust attempt, for example, in Washington State, an Executive Order E1053 on "Project Risk Management and Risk-Based Estimating" from the Secretary of Transportation mandates the conditions and extent to which risk management practices need to be factored into projects managed under WSDOT.

3.2.1 Risk Management Process

MDOT recommends consistent RM training and refreshers in between project phases, to institutionalize a risk management culture within an organization. Such training will comprise of the awareness of the benefits of RM, the difference "between traditional project delivery and innovative contract delivery methods", a fundamental understanding in concepts and terminologies used in risk management, the effect of interaction between risks, and how those risks affect the timeline of project delivery. Industry and stakeholder alignment is maintained to enhance the fair sharing of risk (MDOT, 2022).

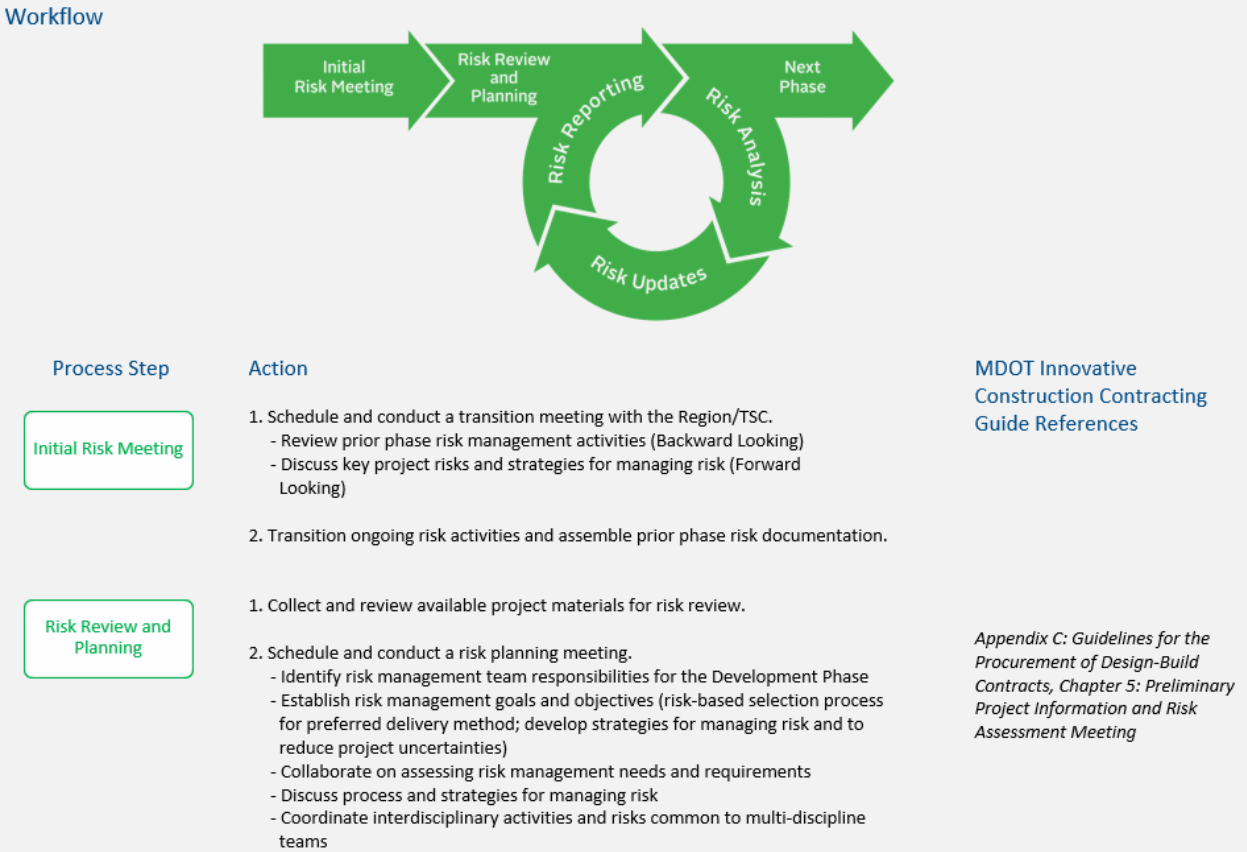


Figure 2: Risk Management Plan for the Project Development Phase.
Source: MDOT Risk Management Best Practices, Final Research Report (MDOT. 2022).

Risk management meetings are a norm in DOTs with robust PRM culture that is usually prescheduled or arranged throughout the lifecycle of the project. The onset of a project will usually involve the project manager and project team members and others directly involved in the project meeting to identify all foreseeable risks.

A visual description of the risk management plan in Figure 2 shows the stages and the actions required for the initial risk meeting and risk review meeting planning. It demonstrates the iterative nature of later parts of for risk management with a project phase.

For cost intensive projects, two workshops are planned in the situation where the complexity and risk associated with the objectives (time, cost, scope, quality) of the project demands cost estimation to be carried out. In order to acquire unbiased assessment of the possible risks, project stakeholders and experts deliberate on uncertainties that present potential cost changes to the baseline cost of the project. These workshops are the Cost Risk Assessment (CRA) workshop and Cost Estimate Validation Process (CEVP®) workshop. A review of the progress of a project will determine when there is a need for any or both workshops - timed typically within the preconstruction phase as shown in Figure 3.

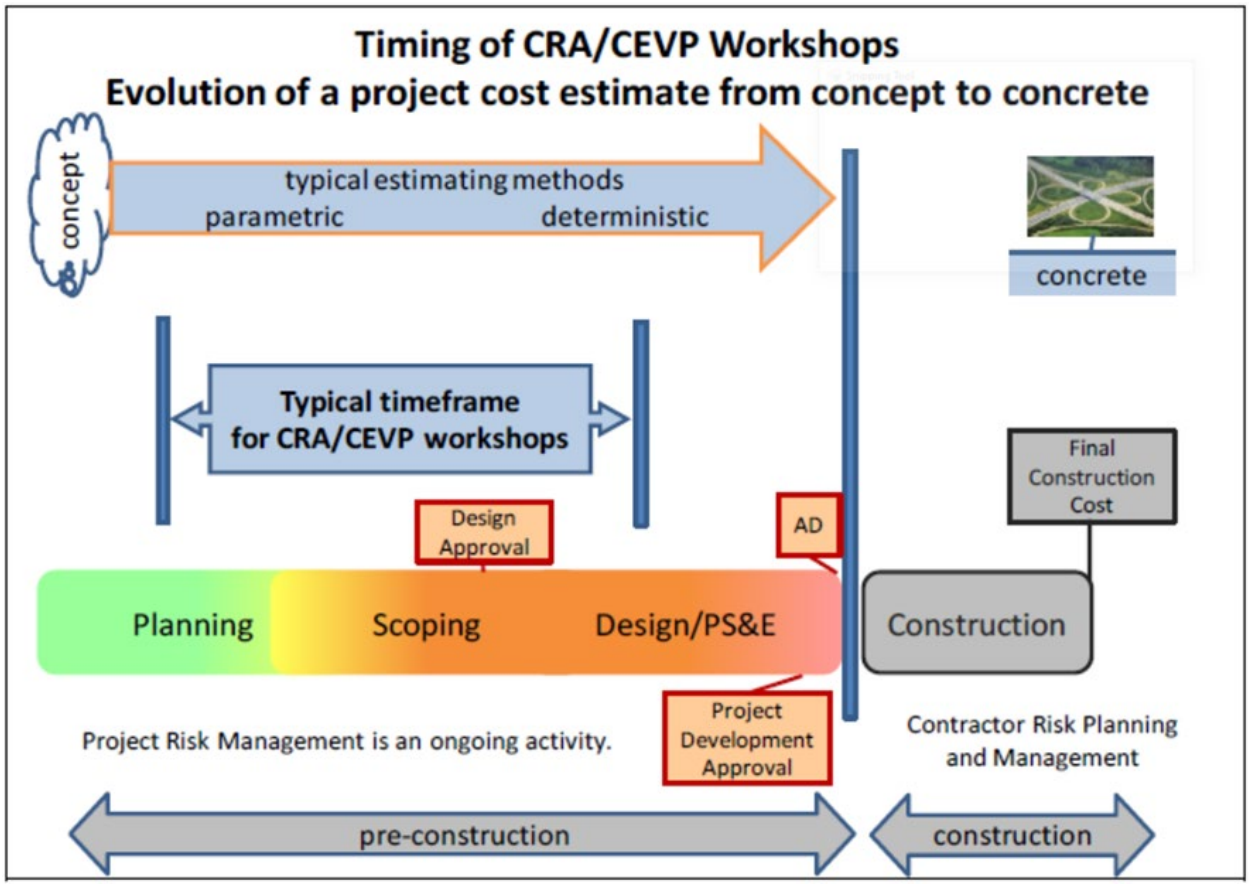


Figure 3: Timing of CRA/CEVP® Workshops (WSDOT, 2018).
Source: WSDOT Project Risk Management, 2018.

3.2.2 Risk identification

Risk identification is a continual process throughout the project lifecycle. The initial stages of risk identification usually involve only the risk management team headed by the project manager. Some DOTs assign risk identification according to the expertise of the members of the team. It may be necessary to involve the expertise of external technical experts, district representatives, and public officers in identifying risks that fall out of the domain of the project team. Risk identification begins with the risk register, a list of all possible risks applicable to various phases within the project development lifecycle. Effort goes into collecting more information on the risk status of a project through the review of project documents, "Lessons Learned database", surveys, interviews, and by referring to the risk-breakdown checklist (WSDOT, 2018). These risks are analyzed by the project team in accordance with the likelihood of the event and the level of impact it may have on the project scope – a term known as qualitative analysis. For less complex projects, involving minimal uncertainties, a "red flag" assigned to more pertinent risks are assigned to individual members of the project team for follow-up and monitoring purposes (NYSDOT, 2009).

Risk management in the area of Asset Management Planning involves accounting for all risks associated with existing infrastructure in all districts as documented within the risk register. The register is reviewed at the beginning of the fiscal year, leveraged with data collected on the conditions of existing infrastructure (in accordance with 23 CFR 667), to identify and prioritize infrastructure that demand urgent consideration on the percept of their impact on mobility, safety, budget limitations and economic impact (WVDOH Final TAMP, 2019).

3.2.3 Qualitative analysis

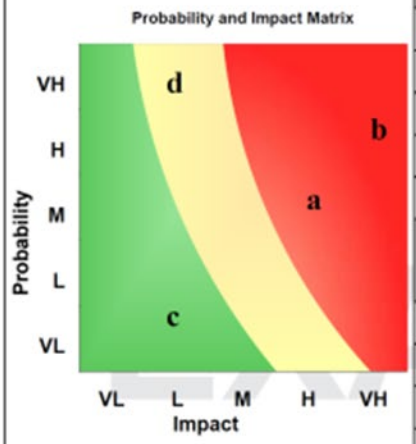
Qualitative analysis in PRM is usually performed to distinguish risks on the bases of their likelihood of occurrence and their impact on a project scope. A risk matrix of likelihood vs impact provides a quick visual aid to identifying each risk in the list. The output of the qualitative analysis is then ranked according to the risk score of each risk element. The calculated total risk score provides the preliminary basis to sanction a project as a high risk, moderate risk, or a low risk, as shown in Figure 4. DOTs will usually stop at qualitative assessment for small to medium sized projects with low to medium total risk score with less potential impact on the project objectives.

A comprehensive qualification of risk affords the prospect to view risk in two dimensions - positive risks (O-opportunities) and negative risks (T-threats). At the end of the qualitative risk analysis, the team can acquire a broad understanding and develop initial mitigation strategies for all risks identified.

"Team members revisit qualitative risk analysis during the project's lifecycle. When the team repeats qualitative analysis for individual risks, trends may emerge in the results. These trends can indicate the need for more or less risk management actions on particular risks, or whether a risk mitigation plan is working" (CALTRANS, 2007).

Qualitative Risk List

count	T/O	RBS #	Risk Title	Probability	Impact
a	T	ENV 30.1	Permits and Permit Appeals	Medium	High
b	T	UTL 20.1	Unidentified Utility Conflicts	High	Very High
c	T	STG 20.4	Change to Substructure Assumptions	Very Low	Low
d	T	ROW 40.1	Managed Access challenge	Very High	Low



Probability (Likelihood)	Synonyms		[1]Approximate %
Very high	Almost certain	Very Sure	≥ 90%
High	Likely	Pretty Sure	80%
Medium	Possible	Maybe	50%
Low	Unlikely	Seldom	20%
Very Low	Rare	Improbable	≤ 10%
Consequence (Impact)	**Synonyms**		**[1]Approximate % of Phase (PE, RN, CN)**
Very high	Very Critical	Very Strong	≥ 10%
High	Critical	Strong	8%
Medium	Moderate	Average	4%
Low	Slight	Mild	2%
Very Low	Very Little	Very Mild	≤ 1%

[1]Suggested percentages; project teams may adjust if they desire.

Figure 4: Sample Risk List, & "Threats-only" Probability vs. Impact Matrix (WSDOT, 2018) ***Source: WSDOT Project Risk Management, 2018.***

Exhibit 2-4 Example Risk ID Sheet, Qualitative

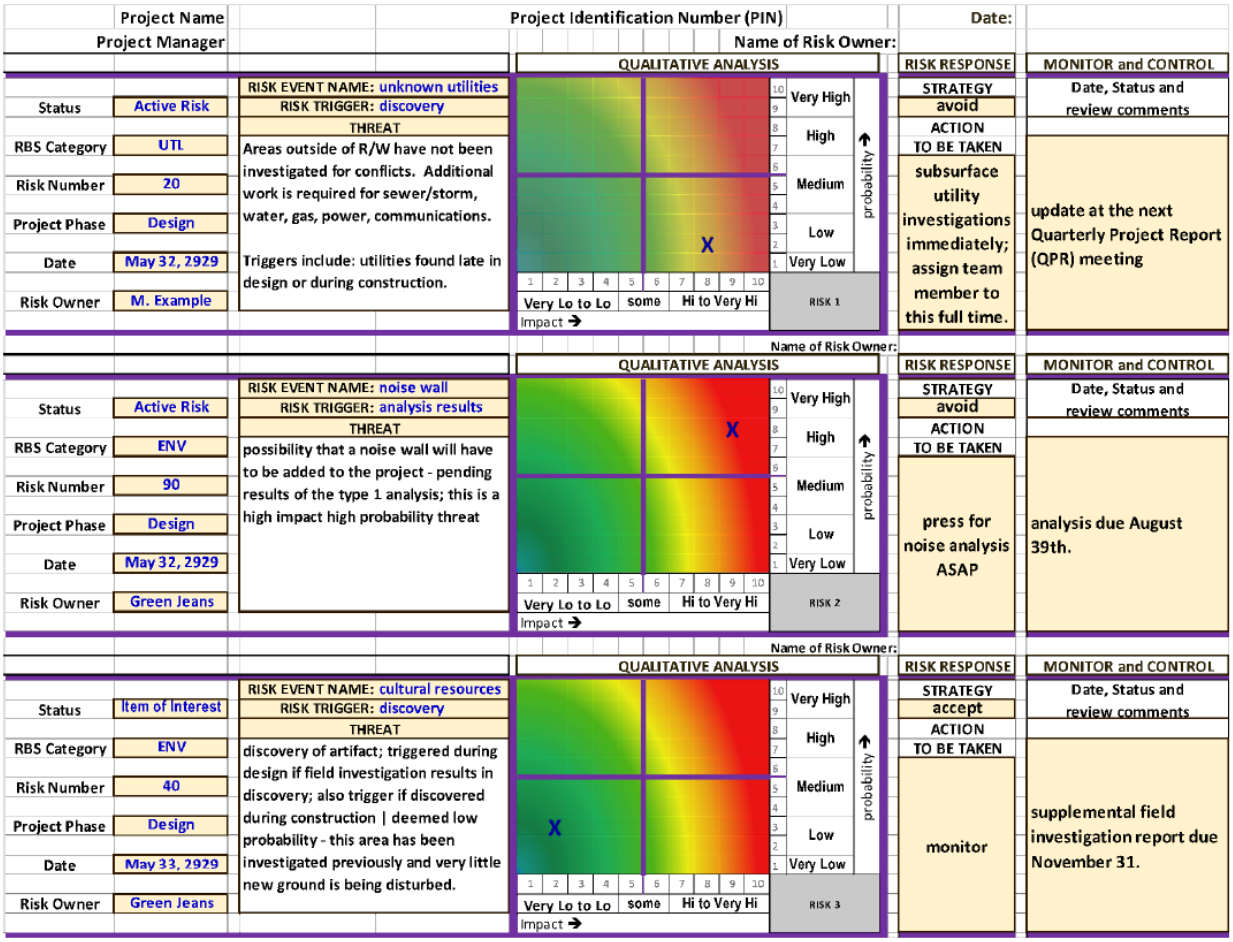


Figure 5 Risk Identification Template (WSDOT, 2018)
Source: WSDOT Project Risk Management, 2018

3.2.4 Quantitative analysis

Quantitative risk assessment is required for more complicated major projects with the tendency to significantly upset their time and cost objectives. In a qualitative analysis, the effects of all future risks are evaluated with the appropriate numerical techniques to identify the aggregate effect on the objective of the project. It is usually done on the proposed mitigation strategies for the highly ranked risks previously carried forward after the qualitative risk analysis on the precepts of cost/benefit analysis with the help of specialized tools such as sensitivity analysis, decision tree analysis and probabilistic simulation techniques. Thus, candidate strategies are scored qualitatively (high/medium/low) with the benefits being reduction in risk score for the implementation of the strategy, while cost is the annualized cost of implementation. The strategies are then ranked from high benefit (low cost) to low benefit (high cost) (WVDOH, 2019).

The appropriate response/mitigation strategy for high-impact risks is formally documented with the measures of success or failure clearly defined for monitoring and reporting during the control phase of the risk management effort.

3.2.5 Risk response

The project manager and project development team designing appropriate risk mitigation strategies for high-risk projects by choosing appropriate responses based on their merits in reducing negative risks or maximizing opportunities. The following response options are considered:

Mitigating threats:

- Avoid/Terminate: Changing the initial project plan or exploring other alternatives to eradicate the risks to the project objectives (I.e. time, cost, scope, and quality). This is achievable by modifications to the project scope, time, and resources.
- Transfer: Shifting aspects of risks involved in the project to a third party better suited at handling those risks. The CalTrans list includes insurance, and risk sharing among stakeholders should be considered amongst other options such as warranties, guarantees, performance bonds, incentive/disincentive clauses, A+B Contractors, etc.
- Mitigate/Treat: Preemptively acting to diminish the probability and/or impact of a risk event to an acceptable level. This is desirable if substantial benefits can be attained at a relatively low cost (WVDOH, 2019)

Maximizing opportunities:

- Exploit: Ensuring all necessary conditions exist for materialization of thje opportunity, e.g., by recruiting the needed talent, etc.
- Share: Strategically allocating some ownership of the opportunity (positive risk) to a third party that is well positioned to realize the opportunity.
- Enhance: Maximizing the key probability and impact drivers of the opportunity to trigger conditions that increase the project's susceptibility to the opportunity.

Strategies for both threats and opportunities:

- Acceptance/Tolerance: These strategies fall into– active and passive categories.
    - Active acceptance includes responses designed with a contingency plan to only be executed when a predetermined condition ("trigger") indicates a strong likelihood of the risk/opportunity happening.
    - Passive acceptance requires no formal action and is left to be managed by the project team by means of enacting recovery plans ("workaround") in the event the risk occurs.

3.2.6 Risk Monitoring and Control

The Florida DOT (FDOT, 2021) recommends risk monitoring and update meetings at the following milestones: scoping field review, design field review, constructability review, value engineering, 90% plans, and project status meetings. CalTrans (CalTrans, 2012) performs risk monitoring through the implementation of risk management techniques while identifying new risks, downgrading previously anticipated risks, and managing residual risks throughout the life of the project. CalTrans also assumes that monitoring can be used as a check on the PRM team activities, and to invoke the "contingency reserve for cost and schedule". Monitoring activities may include recommendations on alternative risk responses, contingency plan implementation, taking corrective actions, and revising project objectives.

3.3 Contract Time Determination (CTD), VDOT

VDOT policy includes the submission of a Contract Time Determination Report (CTDR) for clarification of the thought process behind risk management strategies over the duration of the planned project. In effect a Construction Directive Memorandum CD-2007-11 contains the "Guidelines for Preparing and Submitting the Contract Time Determination Report (CTDR)".

Determination of an optimal completion time for a project is factored into the scheduling of a project. Factors that come to play while determining the duration of a project include: the impact of traffic, suitable alternative period/season for performing a type of work, established production rates, workload of available contractors, potential impacts on business, and possible environmental constraints (VDOT, CTDR Guidelines, 2007). Figure 5 shows an example of planned duration for a phase of a project.

In CTD, units of work are converted to production rates in accordance with the conversion from working days to equivalent calendar days. The difference between the two types of days is in the compensation of the seasonal constraints during the period in which the project is handled. For instance, there are specific calendar durations attached to each activity in a schedule besides the global 7-day calendar, we have the standard 5-day calendar, winter calendar, environmental calendar, landscaping calendar amongst other types of calendars as deemed fit for the period. These special calendars account for the limitations or constraints that come with a particular time of the year restricting certain type of construction activity/activities within the schedule. For example, winter calendar limits the number of available workdays for the intermediate and surface asphalt works for some part of the winter season where temperatures are not favorable for such work. Environmental and landscaping calendars account for permit restriction periods falling within construction schedules, such as breeding seasons, habitat conservation efforts, etc. (VDOT, CTD Report Guidelines, 2007).

Description	Contract Quantity	Units	Base Production Rate	Units	Working Day Duration
Phase I					
Mobilization	5	days	1	days	**5**
Submittals for Water Line	22	days	1	days	**22**
Submittals for Structural and Bridge	22	days	1	days	**22**
Review time for FCWA	22	days	1	days	**22**
Review time for VDOT Structural and Bridge	22	days	1	days	**22**
Install MOT and set up Detour	5	days	5	days	**2**
Install 60" RCP (280.0 LF)	280	lf	48	lf	**22**
Remove 60" RCP install Temp. Drainage	40	lf	100	lf	**2**
Install Str 5-6, 5-7, 5-11, 5-13, 5-9, 5-10, 5-14	7	days	2	days	**7**
Install pipe between Str 5-11 to 5-13	126	lf	144	lf	**2**
Install pipe between 5-9, 5-10 and 5-14	45	lf	144	lf	**1**
Demo existing Asphalt, CG & Retaining Wall	700	cy	1,500	cy	**2**

Figure 6: Example of Duration Calculations for total Project Planned Activities. (VDOT 2007, CTDR)

4 Task 3 – Survey of DOTs via Qualtrics and interviews with up to five agencies

4.1 Survey Design and Results

The research team designed a survey using Qualtrics (See Appendix I to view questions). The survey was sent to DOTs throughout the United States. The survey and follow-up interviews followed Institutional Review Board (IRB) protocols. The survey was submitted to the Ohio University IRB. After review, the IRB determined the survey does not meet the government definition of human subject research, in accordance with 45 CFR 46.102(l) and (f). Therefore, a full IRB review of the survey was not necessary.

The questions and main goals of the survey were oriented based on the findings of Tasks 1 and 2. The selection to contact using the electronic survey and interviews was done in collaboration with the ODOT point of contact. As of February 27th, 17 DOTs filled out the survey. Not all respondents answered every question. Summarized below are the main findings and results of the survey.

• The survey asked respondents to rank eight provided risks (including "other") from most prominent to least prominent.

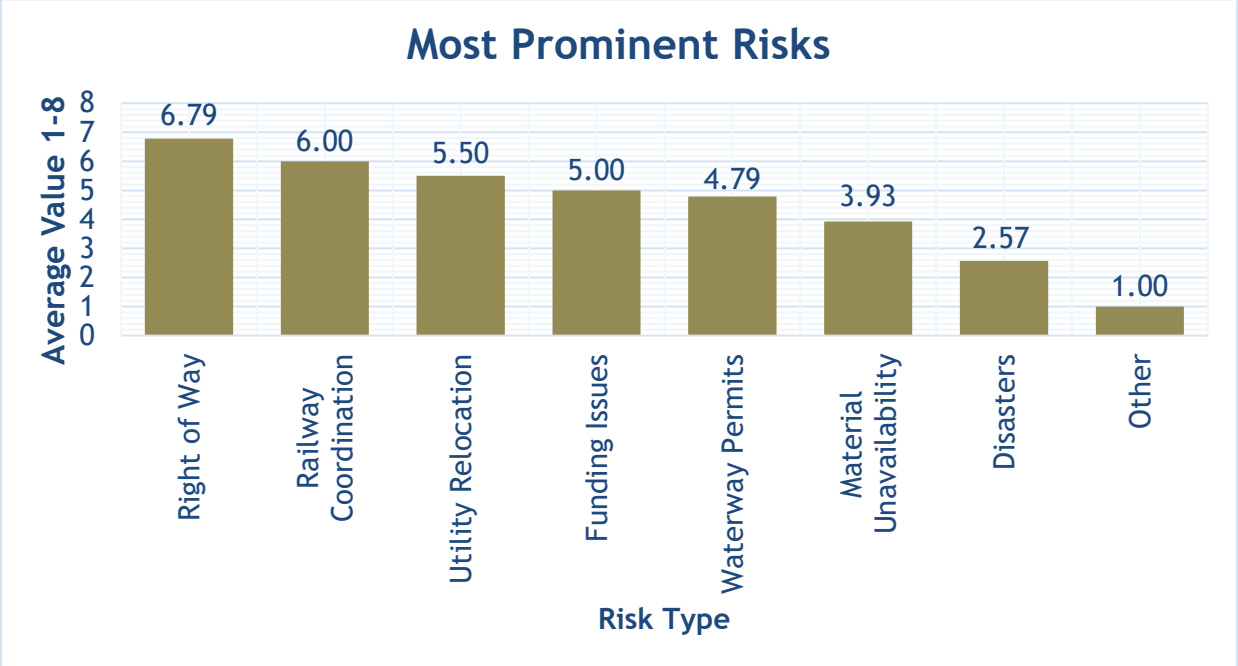


Figure 7: Rank of risks as selected by survey respondents. Higher value indicates a more prominent risk.

• Of the 15 responses to Question 2, 9 belonged to an agency that had a protocol to identify risks prior to the beginning of a project.

• The survey asked respondents to select all options for how risks were communicated in their state for awareness.

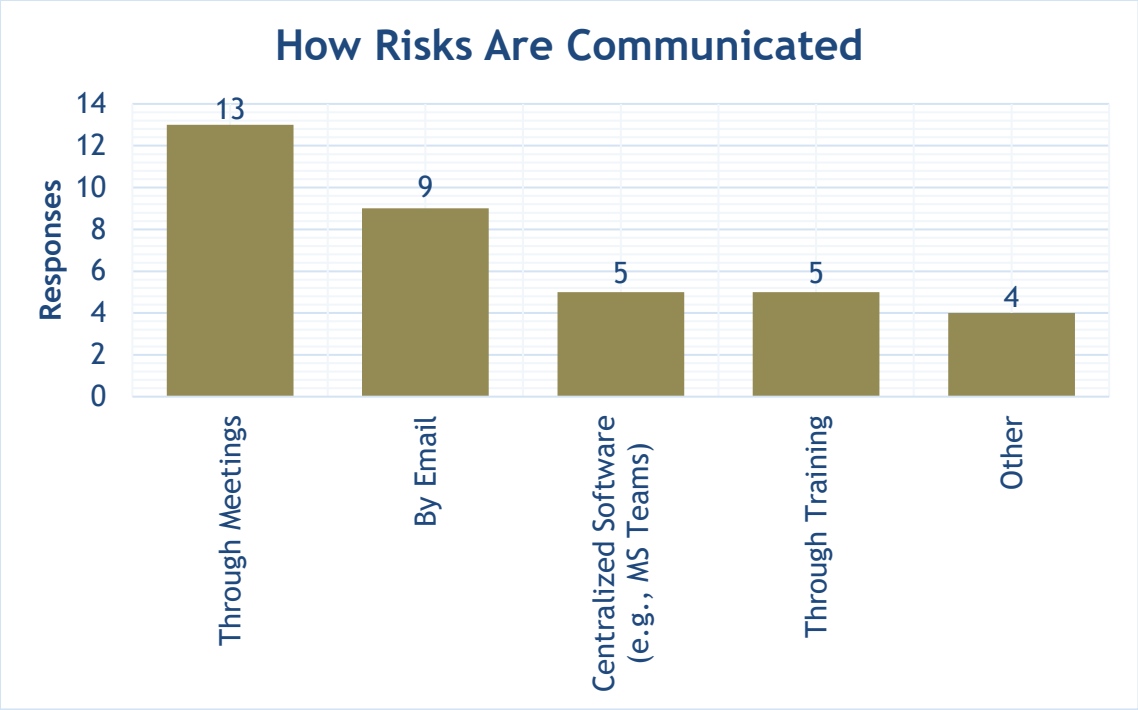


Figure 8: How risks are communicated in state DOTs responding to survey.

• The survey asked respondents to identify the software used for risk management. Responses are given in Figure 9; the most used program is Power BI followed by Microsoft Access and SQL, then Tableau.

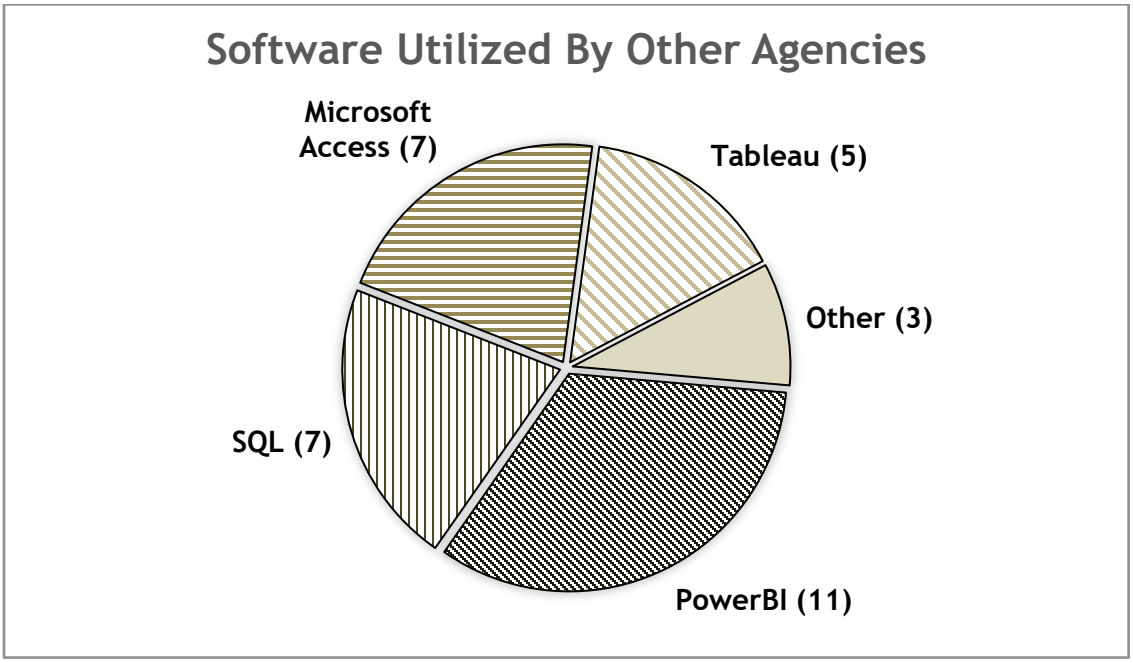


Figure 9: Risk management software used by responding state DOTs.

• 3 of the agencies use risk management for all projects, 12 use risk management tools for some projects and 1 does not use risk management at all.

• 8 respondents indicated their agency developed their risk management tools internally, 3 said their tools were developed by an outside party, and 3 said their tools were developed through observation of other states.

• When asked how they quantify improvements of using risk management tools, 3 said they quantify using percent of on time projects while 4 said using percent of projects completed within budget.

• 5 people said their agency has their risk management tools posted online while 11 said they did not.

• Responses were received from the following states: Utah, Nebraska, Arizona, Michigan, Massachusetts, Montana, Missouri, Kentucky, Virginia, Vermont, Maine, South Carolina, South Dakota, Minnesota

• All responses received were from employees in the Department of Transportation (DOT) for their state.

• 6 respondents agreed to attend a follow-up meeting discussing PRM in their state.

4.2 Follow up interviews with DOTs

The research team conducted four interviews. The purpose of the interviews was to gain a deeper understanding of current practices around project risk management identification and mitigation, and elicit good practices for ODOT. The follow up questions are detailed at the end of Appendix I. Not all questions were asked to all DOTs.

4.2.1 Utah DOT

- *What are the roles and responsibilities around project risk management in your agency?*

Every project that they work on has a full-time project manager assigned to it. These individuals at UDOT are exclusively project managers. Note: 95% of work at UDOT is done by consultants. When a consultant is hired, one of the first activities is to engage in project risk management.

- *How does your agency use Power BI and SQL (or other tools) for the evaluation of risks?*

Power BI and SQL are not used as part of the project risk management process. Power BI is used for dashboarding, but it is not used specifically for risks.

- *Did your agency consider and/or evaluate other tools before implementing Power BI and SQL?*

All risks are documented in MS Excel files. They vary from simple list of risks to qualitative risk models that generate heat maps. They also have a Monte Carlo Simulation of risks. If there is a big program, they will conduct a detailed cost analysis using these tools.

- *How long has your organization had project risk management evaluation, technologies, and team?*

Project risk management has been in place for a long time, at least 10 years.

- *In terms of project risk management communication, how often does your team meet with on-the-ground personnel?*

One meeting at kick-off, and the results of that meeting are documented. The meeting is at the site. Most projects have a monthly call; some have biweekly meetings.

- *Do you have milestone checks for project risk management?*

There are 5 distinct milestones from project design to finalization. At each of these milestones the team reviews the risk registry, identifying new risks and retiring no longer relevant risks.

- Final comments and recommendations:
    - Consider risk in anything they do.
    - Keep it as simple as possible; people will not use when complexity increases.

4.2.2 MN DOT

- *What are the roles and responsibilities around project risk management in your agency?*

MnDOT keeps a risk registry (similar to what Utah does) that needs to be gathered and updated by project managers. Similar to UDOT, MnDOT uses Monte Carlo Simulation for risk and cost estimation.

- *How does your agency use Power BI and SQL (or other tools) for the evaluation of risks?*

MnDOT uses Power BI and Tableau for risk management dashboarding and communications. Appendix J shows screenshots provided by MnDOT.

- *How long has your organization had project risk management evaluation, technologies and team?*

The processes for project risk management have been in place for more than 15 years.

- *In terms of project risk management communication, how often does your team meet with on-the-ground personnel?*

For big projects, every 6 months. For smaller size projects between 7 to 8 months apart.

- *Do you have milestone checks for project risk management?*

Yes, they are registered in the environmental impacts and final design documentation of each project.

4.2.3 Vermont AOT

- *What are the roles and responsibilities around project risk management in your agency?*

There is not a formal project risk management process in Vermont Agency of Transportation (AOT). In the case of risks, the agency mostly reacts when risks capitalize.

- *How does your agency use Power BI and SQL (or other tools) for the evaluation of risks?*

Power BI is used for dashboarding around lifecycle cost management.

- *Did your agency consider and/or evaluate other tools before implementing Power BI and SQL?*

The main reason to use Power BI was that it was available for them as part of subscription.

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Appendix A: FDOT Project Risk Management Highlights

What Risk management features seek to answer

Risk Management Feature	Simple Question
Risk Management Scalability	What's the **appropriate level of risk management which can be cost-effectively applied** for this project?
Risk Identification	What risks might **negatively or positively** affect achieving the project objectives?
Qualitative Risk Analysis	What is the **likelihood** of risk occurrence and level of **impact** of a risk occurring in descriptive or qualitative terms of high, medium, and low?
Quantitative Risk Analysis	**How** could a risk affect the project in terms of **cost and schedule**?
Planning and Response	**What** can be done to mitigate the risk?
Ownership and Communication	**Who** will be responsible to manage risk, follow up on mitigation actions and coordinate and communicate?

Benefits of some risk management features

Feature	Benefit
Scalable Approach	The appropriate level of risk management including the level of risk analysis and mitigation is applied based on project size and complexity.
Project Team	Risk management is based on a prioritization of risks. The expertise of team members is leveraged by having the team identify and assess the risks, as well as identify mitigation strategies within the functional area of their expertise (e.g., design, construction, right of way, permits, drainage, utilities, hydraulics, geotechnical, etc.)
District Risk Expert(s)	Each District has staff that may be more experienced in Risk Management. These individuals can assist the Project Manager in the development and implementation of the project risk management plan.
Ownership of Risks and Responsibilities	A risk owner is a person or entity (e.g., work unit) that has been given the authority, responsibility, and resources to manage a particular risk and is accountable for doing so. This assignment should be made based on who is best able to manage that risk. Risk owners support the Project Manager in risk monitoring and implementation of a selected response. It should not be assumed that Project Manager does all the work to manage the risk; but rather serve as a process facilitator.
Risk-Based Decision-Making	Project values such as cost, schedule, and quality should be balanced when making decisions. This practical focus results in a need to have a formal risk management program with objectives to improve project performance (cost, schedule, disruption and longevity).

Approach to risk management according to total project cost

Range	Description
LOW RANGE	**Total Project Cost up to $20 Million** • Use qualitative risk-based analysis • Review of risks by internal design team • Project manager takes the lead on risk updates • Project manager conducts self-modeling (Risk Based Graded Approach) • Quantify risks and update risk mitigation strategies in regular project meetings • Mainly applied to projects < $20 million, however may be used on projects up to $50 million based on technical complexities and risk modeling opportunities
MID RANGE	**Total Project Cost $20 Million to $100 Million** • Use quantitative risk-based modeling • Internal project design team takes the lead on cost and schedule risk updates • Quantify risks within a 1-day to 2-day workshop (led by internal risk team) • Update risk register as needed (at least once prior to the Work Program update) • Mainly applied to projects from $50 million to $100 million, but may be used on projects < $50 million based on technical complexities and risk modeling opportunities
HIGH RANGE	**Total Project Cost greater than $100 Million and FHWA Major Projects (greater than $500 million or as designated by FHWA)** • Use quantitative risk-based modeling with workshop (CO Consultant Contract) • Internal and external team takes the lead on risk updates • Base cost and schedule is validated by external team • Quantify cost and schedule risks within a 2-to-4-day workshop led by external risk team (Projects not designated as a FHWA Major Project may be handled by internal risk team as required) • Annual updates just prior to Work Program update and as needed • Mainly applied to Major Projects and projects > $100 million (may be used on projects < $100 million based on technical complexities and risk modeling opportunities)

Roles and Responsibilities

Position	Roles and Responsibilities
Project Manager	• Lead and facilitator for risk management on the project. • Develop and manage the project's risk register. • Develop and implement the Risk Management Plan. • Assign risks and response actions to risk owners • Track, monitor & update risks and the effectiveness of risk response actions. • Produce risk management reports for Department management. • Incorporate risk management into project meetings. • Incorporate risk management into Value Engineering Study. • Elevate issues to district management for resolution as necessary.
Risk Owner	• May be a project team member, district discipline lead, or other stakeholders. • Assess & suggest risk response strategies & action plans for assigned risks. • Provide updates for the identified risk strategy. • Inform the PM if the risk materializes (or if potential risks is no longer risks).
Project Team	• Includes Project Manager, Risk Owners, and other team members. • Assist PM with the identification, assessment, review & monitoring of risks. • Suggest appropriate risk response strategies. • Assist in identifying risk owners and developing risk response strategies. • Identify, analyze, and plan responses for new risks, & add to risk register. • "Retire" risks whose opportunity has passed. • Perform risk response actions when appropriate. • Identify & share risk management lessons learned after project completion.

Recommendations for risk integration within project phases

Project Phase	Risk Integration
Planning	If project complexity is unknown, consider qualitative risk analysis and consider risk mitigation strategies. Communication with Metropolitan Planning Organizations and local municipalities may help to identify unforeseen risks. Risk management enhances stakeholder focus and interaction.
Programming Development	Risk management (especially quantitative analysis) can help project team validate the estimated cost and schedule
Scoping	Risk management can be used to evaluate and support the alternatives analysis
Design Field Review	Look to integrate potential risks that are identified in design field reviews.
Final Design	Look to integrate potential risks that are identified in the design phase.
PS&E	Many of the risks that would occur in the design phase should be retired by this phase.
Construction	The construction team should take a fresh look at any risks that were identified during the design phase and were categorized for occurring during the construction phase. Likewise, risks could be identified and categorized for potential occurrence during the maintenance phase.

Risk Management Process

The process to incorporate risk management into an FDOT project consists of a series of steps, which are applied at the outset of the project and verified throughout the project. The major risk management process steps are illustrated below.

Uncertainties are the greatest at the project's beginning. As the project progresses, more and more information is known and the uncertainties are reduced. However, the only time that the actual cost of a project is truly know is after construction is complete and all the bills are paid. This could be years after the project began. The total project cost is divided into three categories:

- Costs that we can actually quantify at any point in time
- Costs that we know we are going to incur, but which we cannot yet quantify
- Costs that we do not yet recognize

Traditionally we have developed the Engineer's Estimate by being conservative in estimating those items that we can quantify either by inflating the quantity of those items, or by inflating the estimated cost or, usually, both. To that we add a contingency to account for the items that we cannot quantify and to cover the unrecognized costs (Risks). The contingency is usually a percentage of the known costs.

The Risk Management process attempts to develop a more realistic risk-based cost estimate by removing the intentional overestimates of the known items, providing an allowance for those items that cannot be quantified, and developing an estimate of the potential costs of risks based on a thorough understanding of the project's specific risks.

The following table provides a description for each step in the risk management process. Each step is then explained in greater detail in this chapter.

Initial Project Management Meeting

Step	Description
Define Project Base	• Define the "base" project scenario against which events (risks) can subsequently be identified, assessed, and eventually managed. The base cost and schedule should only include events that are planned for the project (no contingencies). Variability of impact in the planned events should be captured in the base as well. If there is any uncertainty that an event will occur, then it will need to be included in the risk assessment part of the process.
Identification	• Identify a comprehensive set of risks. This is accomplished by brainstorming scenarios that might change project performance. • Categorize each risk by the phase that risk might occur.
Assessment and Analysis	• Assess the impacts of each of the threats and opportunities in the risk register, and then prioritize them on that basis. • Generally accomplished by subjectively assessing the risks (i.e., the probability of the events occurring and the impacts if it does occur. • Analytically combine the base and risks to determine a range of outcomes (cost & schedule) for project (e.g., ultimate project escalated cost and schedule).
Risk Response Planning	• Identify and evaluate possible ways to proactively reduce risks and exploit opportunities, focusing on the most severe. • Evaluate each possible action in terms of its cost-effectiveness, considering changes in both base factors (e.g., additional cost) and risks (e.g., reduced probability), and select those that are cost-effective. • Consider subsequently re-analyzing the project performance for this risk mitigation program, based on which budgets and milestones can be established.
Monitoring and Control	• Implement the Risk Management Plan as the project proceeds by monitoring the status of risk mitigation activities and changes in risk and monitoring budget and milestones, especially with respect to contingencies. • This might involve periodic updates at regular intervals (such as monthly project progress meetings) or at major milestones or changes. • Contingencies might be reduced as engineering reports or designs are completed and risks are avoided or mitigated.

Initial Project Risk Management Meeting

At the outset of each project, a Project Risk Meeting will be held independently or in conjunction with the project kick-off meeting or Scoping Field Review. The first time that the Project Team Members meet, the PM should brief the team on the following:

- The importance and objectives of the project risk management process
- The roles and responsibilities
- The risk register
- The communication check points
- Key risk management activities in the project schedule
- Expectation that risk is managed, documented and reported via a formal process

The project team will identify what events might occur and thus change the project relative to the base conditions. The threats and opportunities are then listed in the risk register for later risk management activities. Developing this risk list is a creative process.

On Low Range projects, it is helpful if the project manager involves the key members of the project team in this task. FDOT PMs should also involve Project Managers from the preceding and following phases in identifying potential risks.

On more complicated Mid and High Range projects where use of a quantitative risk analysis process is required, the FDOT PM will involve the key members of the project team in this task. On these projects, the key members should include the PM, sponsor, customer, external stakeholders, and a representative from engineering, procurement, quality, HR, safety, finance, and operations. FDOT PMs should also involve PMs from the preceding and following phases in identifying potential risks.

Qualitative Assessment: Threats and opportunity Rating on Cost and Schedule Impact

Rating →	1 Very Low	2 Low	3 Medium	4 High	5 Very High
Cost Impact of Threat	Insignificant cost increase	<5% cost increase	5 – 10% cost increase	10 – 20% cost increase	>20% cost increase
Cost Impact of Opportunity	Insignificant cost reduction	<1% cost decrease	1 – 3% cost decrease	3 – 5% cost decrease	>5% cost decrease
Schedule Impact of Threat	Insignificant delay	<1 month delay	1 – 3 months delay	3 – 6 months delay	>6 months delay
Schedule Impact of Opportunity	Insignificant improvement	<1 month improvement	1 – 2 months improvement	2 – 3 months improvement	>3 months improvement
Probability	1–9%	10–19%	20–39%	40–59%	60–99%

Project Risk score calculation spreadsheet

ITEM #	RISK ELEMENT	RISK ASSESSMENT	RISK PRIORITY	RISK TOTAL
1	UTILITIES			0
2	PROJECT SCHEDULE			0
3	COORDINATION			0
4	ENVIRONMENTAL			0
5	CONTAMINATION			0
6	REGULATORY INVOLVEMENT			0
7	RESOURCE AVAILABILITY			0
8	MATERIAL AVAILABILITY			0
9	EXPERIENCE / CAPABILITY			0
10	PROJECT FUNDING			0
11	POLITICAL VISIBILITY			0
12	PUBLIC INVOLVEMENT			0
13	SAFETY			0
14	RIGHT OF WAY			0
15	CONSTRUCTION / CONSTRUCTABILITY (MOT)			0
16	MAINTENANCE			0
17	TOLLS			0
18	TECHNOLOGY			0
19	FACILITIES / ARCHITECTURE			0
20	OTHER			0
			PROJECT RISK SCORE	**0**
	Project Risk Score = 0 - 120	*Low Risk*		
	Project Risk Score = 121 - 20	*Medium Risk*		
	Project Risk Score = > 200	*High Risk*		

Risk Response Strategies

RISK RESPONSE STRATEGIES	
For Threats	**For Opportunities**
Avoid • The Project Manager recommends changing Possible actions include changing the scope, adding time or adding funds. • Remove threat cause or change the project plan to eliminate the risk or protect the project from its impact. • Possible actions include changing the scope, project work plan and/or consultant contract, adding time or adding funds. • Not all threats can be avoided or eliminated, and for others, this approach may be too expensive or time-consuming.	***Exploit*** • Exploit is an aggressive response strategy, best reserved for those "golden opportunities" having high probability and impacts.
Transfer • Change the scope of a proposed or existing contract to transfer the risk to a consultant, contractor, or insurance company. • Find another party willing to take responsibility for its management and bear the liability of the threat. • Ensure that the threat is owned and managed by the Team member or stakeholder best able to manage it effectively. • Usually involves payment of a premium, and the cost-effectiveness of this must be considered.	***Share*** • Allocate ownership of an opportunity to another party who is best able to maximize its probability of occurrence and increase the potential benefits if it does occur. • Allow sharing in the potential benefits (e.g., Construction Value Engineering Proposals).
Mitigate • Reduce the probability and/or impact of an adverse event (threat) to acceptable threshold. • Take early action to reduce the probability and/or impact of a threat is often more effective than repairing damage after risk has occurred. • May require resources or time and is a tradeoff between doing nothing versus mitigation cost.	***Enhance*** • Modify the "size" of the positive risk. • Increase probability and/or impact, and maximizing benefits realized for the project. • If the probability can be increased to 100 percent, this is effectively an exploit response.
Acceptance • When it is not possible or practical to respond to the risk by the other strategies, or a response is not warranted by the importance of the risk, the best decision may be to accept certain risks. • When the Project Manager and the project team decide to accept a risk, they are agreeing to address the risk if and when it occurs. • A contingency plan or workaround plan may be developed for that eventuality.	

Example Response Strategies

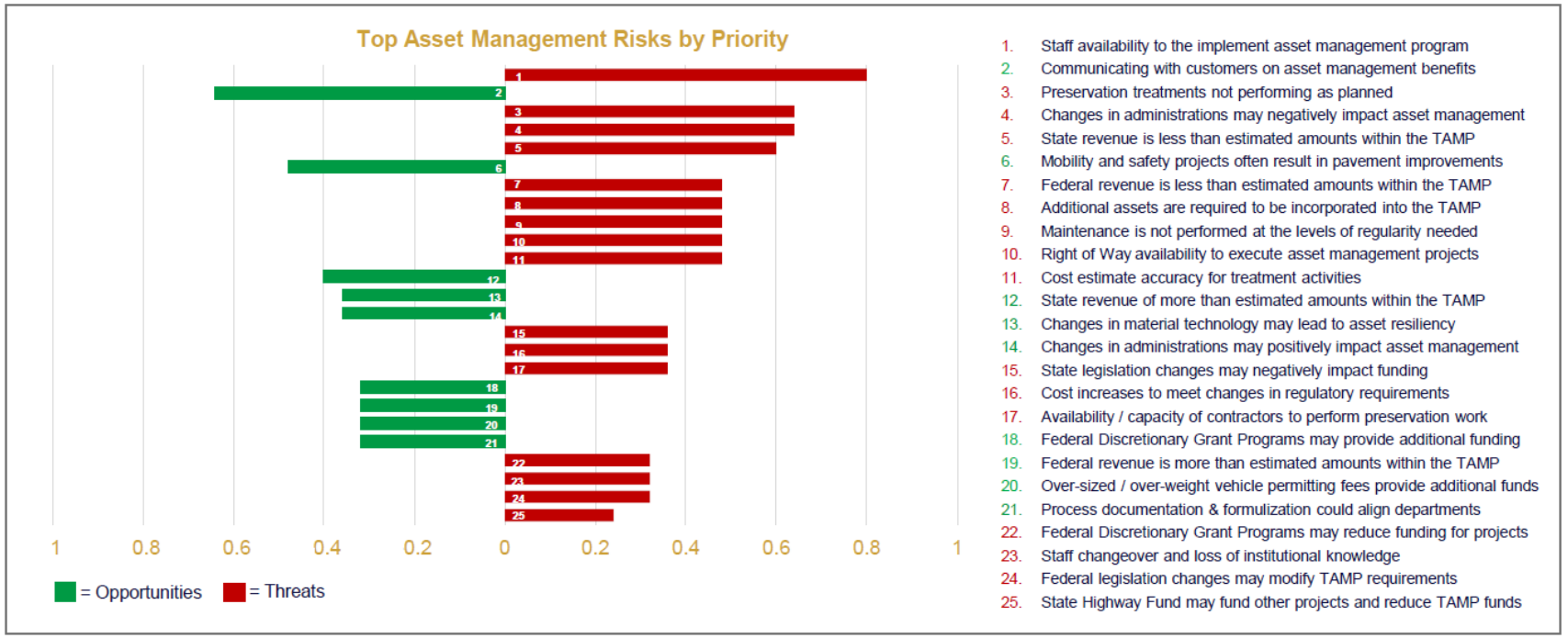
RISK RESPONSE EXAMPLES		
Phase	**Risk Statement**	**Risk Response**
Design	Inaccuracies or incomplete information in the survey file could lead to rework of the design.	**Mitigate**: Work with Surveys to verify that the survey file is accurate and complete. Perform additional surveys as needed.
	A design change that is outside of the parameters contemplated in the Environmental Document triggers a review which causes a delay due to the public comment period.	**Avoid**: Monitor design changes against ED to avoid reassessment of ED unless the opportunity outweighs the threat.
Environmental	Potential lawsuits may challenge the environmental report, delaying the start of construction or threatening loss of funding.	**Mitigate**: Address concerns of stakeholders and public during environmental process. Schedule additional public outreach.
	Nesting birds may delay construction during the nesting season.	**Mitigate**: Schedule contract work to avoid the nesting season or remove nesting habitat before starting work.
Right of Way	Due to the complex nature of the staging, additional right of way or construction easements may be required to complete the work as contemplated, resulting in additional cost to the project.	**Mitigate**: Re-sequence the work to enable right of way certification.
	Due to the large number of parcels and businesses, the condemnation process may have to be used to acquire right of way, which could delay start of construction by up to one year, increasing construction costs and extending the time completion.	**Mitigate**: Work with right of way and project management to prioritize work and secure additional right of way resources to reduce impact.
Construction	Hazardous materials encountered during construction will require an on-site storage area and potential additional costs to dispose.	**Accept**: Ensure storage space will be available and include disposal costs.
	Unanticipated buried man-made objects uncovered during construction require removal and disposal resulting in additional costs.	**Accept**: Include a supplemental work item to cover this risk.

What are INDOT's Risks to Asset Management?

INDOT has developed a risk management framework to help identify opportunities and threats related to asset management, quantify and prioritize them based on their probability and impact, and develop risk mitigation strategies based on the highest priorities. INDOT assesses its risks according to likelihood and consequence (probability and impact).

Using its risk management framework, INDOT has identified its top 25 risks related to asset management, including 16 threats and 9 opportunities. The chart below depicts the risks by severity, measured on a scale of 0 to 1. Risks were identified during a risk assessment workshop prepared for the TAMP. Descriptions of the top opportunities and threats are on the following page; for additional details on risks and mitigation strategies, please refer to the TAMP.[53]

Figure 23: Opportunities and Threats to INDOT's Asset Management Program



[53] Indiana Department of Transportation, *Transportation Asset Management Plan*, August 2019

Appendix C: WVDOH Asset Risk Management Highlights

Risk Level	Asset Class	Event/Occurrence	Likelihood	Safety	Mobility	Asset Damage	Other Financial Impact	Risk Score	Comments / Notes	"Risk Management Options (Treat, Tolerate, Transfer, Terminate)"
									snow and ice/how good was the winter. But agree that it is a net deficit.	
Program	Bridge	Minor bridge hits	4	2	3	3	1	36.0		Need to track bridge hits to be able to analyze problem areas and investigate mitigation strategies.
Agency	Pavement	Not delivering programmed pavement projects on time.	4	1	1	5	2	36.0	Once project is let, getting it constructed in the planned year is a problem because of contractor availability and other uncertainties. Project selection/STIP processes are a problem since get on the program too easily but getting into STIP more of a problem. E.g. a thin OL project was change ordered into mill and fill.	Review and improve process to better encourage on-time delivery of pre-construction phases and set more realistic dates.
Program	Pavement	Not using the right repair method for the problem in resurfacing projects (Non-Expressway NHS)	4	2	1	4	1	32.0	Lack of training is main cause. Consequence is that the pavement fails prematurely. What drives this is folks just doing whatever is the quickest and easiest. E.g. a Purchase Order project. May also be a funding issue.	same risk as previous - recommend remove
Agency	Pavement	Mines causing damage to NHS through subsidence etc.	3	3	3	3	1	30.0	A mine is seeking a permit to mine under I-70	Require permits. Review mineral acquisition policy.
Program	Pavement	Utility cuts take place in newer pavement (more on Non-IS NHS)	5	1	1	2	1	25.0	Better communication and availability of information regarding planned utility and pavement projects. Monthly coordination meeting worked well in past experience.	Better communication and availability of information regarding planned utility and pavement projects. Monthly coordination meeting.

Appendix D: WSDOT Project Risk Management Highlights – Risk Breakdown Structure (RBS)

Level 1	Project Risk									
Level 2	Environmental & Hydraulics ENV	Structures & Geotech STG	Design / PS&E DES	Right-of-Way ROW	Utilities UTL	Railroad RR	Partnerships Stakeholders PSP	Management / Funding MGT	Contracting Procurement CTR	Construction CNS
Level 3	ENV 10 NEPA/SEPA	STG 10 Design Changes	DES 10 Design Changes	ROW 10 ROW Plan	UTL 10 Coordination	RR 10 Design Coordination	PSP 10 Tribal Issues	MGT 10 Management Change	CTR 10 Change in Delivery Method	CNS 10 Traffic Control and Staging
	ENV 20 ESA Issues	STG 20 Design Changes	DES 20 Deviations' Approval	ROW 20 inflation	UTL 20 Conflicts	RR 20 Construction coordination	PSP 20 Public Involvement	MGT 20 Delayed Decision Making	CTR 20 Contract Language	CNS 20 Construction Permitting
	ENV 30 Environmental Permitting	STG 30 Changes to design Criteria	DES 30 architecture or landscape changes	ROW 30 Limited Access IJR		RR 30 Right of Entry	PSP 30 Additional Scope for third parties	MGT 30 Cash Flow Restrictions	CTR 30 Delays in Ad/Bid/Award	CNS 30 Work Windows
	ENV 40 Archaeological Cultural		DES 40 Projects by other agencies affected	ROW 40 Managed Access Appeal				MGT 40 Political/Policy Changes	CTR 40 Market Conditions	CNS 40 Schedule Uncertainty
	ENV 50 Hazardous Materials		DES 50 Changes to Design of Traffic Items	ROW 50 Acquisition Issues				MGT 50 State Workforce Limitations	CTR 50 Delays in Procurement	CNS 50 Marine Construction
	ENV 60 Wetlands / Habitat		DES 60 Design / PS&E Reviews	ROW 60 Additional ROW is required					CTR 60 Contractor Non-Performance	CNS 70 Earthwork Issues (re-use,
	ENV 70 Stormwater, Potential								CTR 70 Availability of Specialty	CNS 80 Coordination with Adjacent
	ENV 80 Impacts during Construction									CNS 90 Contractor Access / Staging
	ENV 90 Permanent Noise Mitigation									CNS 100 Construction Accidents
	ENV 900 Other ENV Issues	STR 900 Other STR Issues	DES 900 Other Design Issues	ROW 900 Other ROW Issues	UTL 900 Other UTL Issues	RR 900 Other RR Issues	PSP 900 Other PSP Issues	MGT 900 Other MGT Issues	CTR 900 Other CTR Issues	CNS 900 Other CN Issues

The RBS provides several functions and benefits to the project team and to management, including:
1) Consistency with taxonomy (wording); 2) Organizes risk events into common categories; 3) Helps identify trends with respect to common usage of risk eventcategories & event types, categories & event types along with their probability and impact values; 4) Helps to identify common risk events among projects that the Region and HQ offices should be aware of due to their potential cumulative effects; e.g. negotiating agreements with agencies or other municipalities; 5) Provides a basis to work from for risk elicitors during CEVP workshops; 6) Provides a basis for development of independent risk surveys for those that are unable to attend a CEVP workshop.

This RBS serves as a starting point in assessing project risks in CEVP and CRA workshops; and also for smaller projects that may not conduct a formal workshop.

RBS CODE	RISK TRIGGER (CAUSE or PRECIPITATING EVENT)		RISK EVENT	CONSEQUENCE (effect on project objectives)	PROBABILITY	IMPACT ($ or time)
ENV 10.01	As a result of...	the public involvement process	NEPA/SEPA document challenge	delays delivery of EA document	70%	↑$5M, 8 weeks
ENV 10.02	Because of...	public pressure and internal reviews	env documentation increases,	need to prepare an EIS	10%	↑$0.1M, 6 months
ENV 10.03	Due to...	reviews by WSDOT Environmental	design info deemed inadequate	additional design, cost, and time	10%	↑$0.1M, 4 months

Appendix E: WSDOT Transportation Asset Management Plan (MAP 21) Highlights

Exhibit 5-1: WSDOT Asset Risk Management Integration with Strategic Plan Objectives[1,2]

WSDOT Strategic Plan *Enterprise-level* **Goal Area**	**Practical Solutions:** Prioritize innovative, timely and cost-effective decisions with our partners to operate, maintain, plan, and build our multimodal transportation system.							
WSDOT Strategic Plan *Enterprise-level* **Practical Solutions Strategy**	**Asset Management:** Establish asset management plans supported by needs descriptions and funding strategies; manage assets to appropriate service levels.							
WSDOT Strategic Plan *Enterprise-level* **Asset Mgmnt. Objectives**	# 1: Document an asset management plan for each identified asset class within the four major asset categories identified in our Agency Executive order. Each asset management plan will provide information necessary to perform fundamental investment trade-off analysis.	# 2: Leverage agency work efforts on performance measures and the Performance Framework to begin scenario analysis of investment trade-offs in order to inform policy direction and agency budget requests.	# 3: Integrate operating and capital asset management investment strategies to enhance desired performance outcomes at reduced life-cycle costs.	#4: Expand the factors considered in asset management strategies to more effectively respond to changing circumstances, to refine risk management mitigation efforts, and to provide feedback on the quality or effectiveness of operational and capital delivery strategies.				
WSDOT MAP-21 *Network-level* **Asset Mgmnt. Objectives**	**Pavement MAP-21 Asset Objectives:** • Design and preserve long-life pavement structures. • Minimize the number of pavement lane miles in poor condition.			**Bridge MAP-21 Asset Objectives:** • Design and preserve resilient structures. • Minimize the number of load posted or load restricted bridges. • Minimize the number of bridges in poor condition. • Minimize the number of bridge closures due to condition.				
WSDOT MAP-21 *Network-level* **Asset Risk Mgmnt. Objective**	Evaluate risks identified for each of the agency risk categories, as they relate to ability to deliver on Pavement and Bridge MAP-21 Asset Management Objectives over the 10-year planning period.							
WSDOT MAP-21 *Network-level* **Asset Risk Category[3]**	Current and Future Environmental Conditions	High-Risk, High-Value Assets	Financial	Legal or Policy Compliance	Demand	Information and Decision Risks	Operational	Hostile Acts, Malfeasance, Accidents

Exhibit Notes:

[1] Source is from the WSDOT Transportation Safety, Quality, and Enterprise Risk Division in partnership with the Capital Program Development and Management division.

[2] For further detail about WSDOT's Strategic Plan, see the November 2018 document entitled *Strategic Plan Strategies, Objectives and Measures*.

[3] Categories derived from FHWA's Nov., 2017 document *Guidance on Incorporating Risk Management into Transportation Asset Management Plans*.

Pavement Asset Risk Summary

Exhibit 5-3: Summary of Pavement Asset Risk Management for Studded Tire Impacts

Consideration	Studded Tires
Risk Statement and Impact	If studded tires continue to be used, then premature rutting and wear will occur on bridge and road pavements, reducing life and increasing life-cycle costs.
Asset Risk Category	Operational
Level of Risk	Very High
Risk Treatment Strategy	Active Acceptance
Current Strategy	Support legislation to ban the use of studded tires. Damage to asphalt and concrete pavement on state highways is estimated at $20 to $29 million a year. This estimate is driven by a study performed by the Pavement office. In 2019, legislation (HB 1309) was proposed that would increase the fee associated with studded tire sales, and ultimately phase out the ability to purchase new studded tires. This bill did not pass the Legislature.
Risk Treatment Plan	No additional treatment plan known at this time. In place treatment is to communicate the financial impact of allowing studded tires.
Anticipated Level of Risk Post Treatment	High

See [2] page 43-48 For other Asset Summaries e.g. funding impacts, pavement treatment impacts, etc.

Appendix F: Summary Of Findings — Project Risk Management Practices In Select DOTs

Table 1: Summary of Risk Management Practices Across Select DOTs

DOT	DOCUMENTATION			RISK MANAGEMENT APPROACHES				
	Process Guide & Reference Management		**Meeting & outputs**	**Identification Method**	**Qualitative**	**Quantitative**	**Response**	**Control**
Florida (FDOT)	1. Risk Management General 2. Risk Management Process 3. Risk Management Plan 4. Risk Management Tools 5. Risk Management Glossary 6. Project Concept Report Template 7. Risk Grade		• Objectives, roles and responsibilities, risk register, communication checkpoints, risk management activities in project schedule, official documentation for checking success of risk mitigation. [3]	• Organizational risk, External risk, Environmental risk, project management risk, and technical risk. [2] pp.3	• Five-point rating guide for probability of risk and threats occurring and cost and schedule impact. [2] pp.6 Use of 3-point risk grading [7] • Output: Risk register	• Interview of stakeholders, sensitivity analysis, decision tree analysis, simulation with probabilistic modeling (i.e. Montecarlo)	• Risk: Avoid, transfer, mitigate, acceptance. • Opportunities: Exploit, share, enhance • Risk response planning table with Phase, Risk Statement and Risk Response. • Possible updates/change to risk profile . • [2] pp. 8-13.	• Planning reduction actions for each risk, protocols for contingency management, protocol for recovery plans. • Information gathering and distribution. • Risk monitoring and updating during project development/ milestone meetings. [2] pp. 13 -14
Virginia (VDOT)	1. Contract Time Determination Guidelines 2. Project Development Process 3. Project Risk management Procedure 4. Risk management worksheet guidance.	5. Risk management worksheet 6. Risk summary and authorization form (PM_103A) 7. Risk Analysis Matrix (PMB_103.xlsx)	• For tier II and high-risk projects [2]	• Expertise specific risk identification [3] .	• Grade-based assessment.[6] • Output: Project Assessment Matrix with list of identified risks and potential response to risk events.[7]		• Risk: Accept, mitigate, transfer, avoid • Documentation: Finalization of Risk assessment Matrix with final decisions and responses.	• Headed by project manager • Response action initiated by PM • Updates and reevaluation of risks as project continues.
West Virginia (WVDOH)	1. WVDOH Transportation Asset Management Plan (2019-Final TAMP)		• Annual meetings to update risk register. • Risk mitigation sessions with directly affected stakeholders	• Refresher on risk, previous risk register and lesson learned. • All stakeholder participation in updating the risk register.	• Risk score on Likelihood, safety, mobility, asset damage and other financial impact • Output: Prioritized risk ranking on Risk Register (pp. 86, Appendix A) Candidate mitigation strategies	• Cost and Benefit Estimation on Candidate mitigation strategies • Output: Risk Register Ranking of from high benefit/low cost to low benefits/high cost	• Implementation of highly ranked strategies. • Tolerate, treat, transfer, terminate, take advantage.	• Monitoring of implemented strategies and updating strategy

DOT	DOCUMENTATION		RISK MANAGEMENT APPROACHES				
	Process Guide & Reference Management	**Meeting & outputs**	**Identification Method**	**Qualitative**	**Quantitative**	**Response**	**Control**
Washington State (WSDOT)	1. Executive Order E1053 2. Project Risk Management Guide (With Exhibits/ Descriptions) 3. 2019 Transportation Asset Management Plan (MAP 21) *Chapter 5*	• Conducted by Internal Project Risk Assessment Team CRA (1-3days) CEVP® (1-5 days)	• *SMART: Specific, Measurable Attributable, Relevant and Timebound* (Exhibit 2-2) • Document reviews • Information gathering: Brainstorming, Lesson Learned Database, other -questionnaire, interview, etc. • Risk Breakdown Structure (Exhibit 2-3) • Identification Sheet. (Exhibit 2-4) • Output: Risk Register (Exhibit 2-2 to 2-5)	• 5 x 5 Probability vs. Impact Matrix (Exhibit 3-2) • Double 4 x 4 Probability impact matrix for positive and negative impact • Risk management Plan Spreadsheet. (Exhibit 3-4 to 3-5)		• Recommendation: Build to conform activities into the Work Breakdown Structure (WBS) Ref: Master Deliverable List. Plan this in the project management planning phase • Actions: Threats: Avoid, Transfer, Mitigate • Opportunities: Exploit, Share, Enhance • Input: Risk Management & Planning Spreadsheet. (Exhibit 5-1)	•Tracking and documentation of response actions. • Input: Risk Management Plan worksheet. (Exhibit 6-1 to 6-5)
Indiana (INDOT)	• Strategic Asset Management Plan (2020).	• Asset Management Team Committee meeting to grade and rank projects under consideration.	• 25 Preidentified risk (16) and opportunities (9) to be scored on a continues scale between 0 and 1. • Output: Tornado diagram ranking of all sources of risks.	• Probability vs Impact matrix for threats and opportunities (Appendix F). • Output: Top asset management risk prioritization of unified risks and opportunities (pp. 56)		*Risk mitigation strategies acknowledged but not shown in document under review.*	• Reviewing and updating the SAMP at least once every 4 years. • Will also update the Asset Management Plan when changes are needed.

DOT	DOCUMENTATION		RISK MANAGEMENT APPROACHES				
	Process Guide & Reference Management	**Meeting & outputs**	**Identification Method**	**Qualitative**	**Quantitative**	**Response**	**Control**
New York (NYSDOT)	1. Appendix 15 - Risk management for project development guide (2009) 2. New York State Department Asset Management Plan	▫ Project development team. ▫ Development of risk management plan from IPP to scoping phase. ▫ Internal and external stakeholders and representative meeting to identify all possible risks associated with a project. [1]	▫ Potential sources of risks (Ref. "potential risks" worksheet in [RM_Sample design tool)] Output: Ongoing updates to risk register and documenting of the risks' effect of the risk's characteristic on the project.	▫ Probability vs impact rating (1 -3) ▫ Mitigation /allocation. ▫ Consideration of epistemic or aleatory risk	▫ Recommended for the most likely risks with high impacts	▫ Input from initial risk register. ▫ Creation of a red flag item list ▫ Avoid, transfer, mitigate, accept. ▫ Identification of risk owner. [2] *See pp. 6-0 to 6-8 for complete initial risk register.*	▫ Documentation of ongoing risk management processes. ▫ Output: Risk management charter
Michigan (MDOT)	1. Risk Management Best Practices Final Research Plan (SPR-1711-Report) pp.19 - pp.25 2. Transportation Asset Management Plan	Plan Step 1 - Initial risk meeting. RM Plan Step 2 – Risk Review and Planning RM Plan Step 3 – Risk analysis and allocation meetings	Risk register, RBS, Ratings Guidelines.	Ranked risk High risk priority report	Event driven contingency calculation		Monthly Risk assessment checklist report

Appendix G: Software and software vendors Used for Risk Management in Construction

1. Procore – Manages construction projects, resources, and financials from planning to closeout. Used by Project Managers and Project Engineers. 49% mid-market and 44% small business.
    - Connects owners, GC's and subcontractors if desired.
    - Most widely used
    - Used heavily by contractors.
2. SiteDocs – Mostly concerned with safety compliance.
    - Builds forms.
    - Analyzes data.
    - Integration and sharing.
3. Fieldwire – Described as jobsite management software.
    - Mobile platform for quick and easy communication with all parties involved.
    - Plans easily accessible.
    - Scheduling, inspection, reports, forms, submittals, etc.
    - Overall, in-depth project management software.
4. Autodesk Construction Cloud – General construction cloud software.
    - Includes a specific software called "BuildingConnected"
    - Bid management, subcontractor qualification, and risk management.
5. Fonn – Construction management software.
    - Project reports
    - Drawing management
    - Project collaboration
    - Task management and check lists.
6. Zepth – More of a risk management software than the others.
    - Project Financials
    - Quality and Safety
    - Field Reports
    - Easy collaboration and communication.
7. RiskWatch – Designed specifically for risk assessment among different categories.
    - Ease of use
    - Customizable
    - Dashboards and analytics

Note that several of these are project management software designed for a contractor setting but may be able to be integrated into a risk assessment technology capable of monitoring many different projects.

Appendix H: Discussion of the Capabilities of Power BI Software

Power BI is a unified, scalable platform for self-service and business intelligence (BI). The software is a collection of apps and services that turn vast amounts of data into understandable visualizations and insights. The software connects with databases to create reports customized for the particular use of an organization or business.

Key capabilities include:

- Creation of reports and dashboards.
- Variety of effective visualizations that can be changed in size based on relevance.
- Wide range of data sources can be used, such as SQL, Excel, Azure, Access, etc.
- Power BI can filter datasets from multiple data sources to create visualizations.
- The dashboards can be easily customized to offer personalization for the type of business or organization.
- Tiles are blocks within the dashboards and they can be manipulated in size or other properties.
- Reports can be made displaying a complete presentation of relevant data and crucial insights based on available data sets.
- Creation of apps that can involve several dashboards and reports into a centralized place.
- Power BI can be asked questions in natural language to locate desired information.
- Data can be exported to Excel through Power BI.

Appendix I: Survey Questions administered through Qualtrics

Purpose of this survey (10 minutes to complete): The Ohio Department of Transportation (ODOT) expends $2 billion or more in construction each year. ODOT meets with district personnel to track costs and ensure milestones are met. The purpose of this survey is to identify ***project risk management tools and methods*** that can help mitigate risks of overbudget and/or overtime.

1. Which ones of the following tasks can represent a risk for project delays or overspending for your agency? Please rank them from highest to lowest risk.
    a. Right of Way Acquisition
    b. Utility Relocation
    c. Railway Coordination
    d. Waterway permits (Environmental)
    e. Increase in costs and funding issues
    f. Material Unavailability
    g. Natural or manmade disasters and disruptions
    h. Other
2. Does your agency have a template or protocol to identify risks of overspending or delays prior to the beginning of a project?
    a. Yes
    b. No
3. How are these risks communicated to the separate districts or regions in your state for awareness?
    a. Centralized software or platform (e.g., MS Teams)
    b. By Email
    c. Through Meetings
    d. Through Training
    e. Other
4. Does your agency utilize any of the following tools (select all that apply)?
    a. Power BI
    b. SQL
    c. Tableau
    d. Microsoft Access
    e. Other
5. Does your agency utilize project risk management tools and methods?
    a. Yes, for all projects.
    b. Yes, for some high investment projects.
    c. Yes, for some projects.
    d. No.
6. How were your risk management tools and methods and tools developed?
    a. They were internally developed by our agency.
    b. They were developed by an outside party.
    c. They were developed through observation of other states.
    d. They are contracted as a per need basis.
    e. NA
7. How do you quantify the improvement from using project risk management tools and methods?

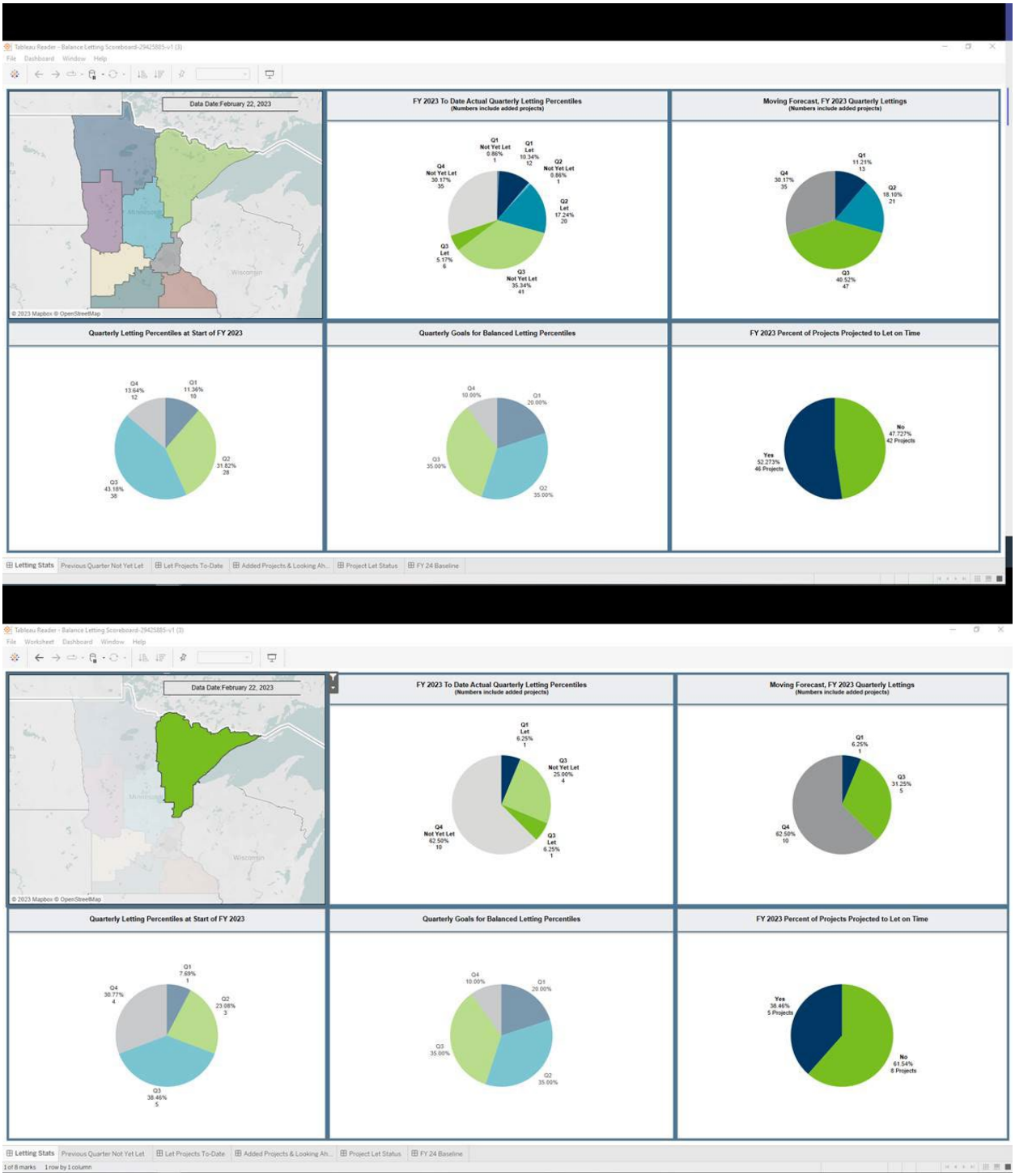
    a. % or number of on schedule projects.
    b. % or number of projects completed within budget projections.
    c. NA
8. Are your project risk management tools online and open to the public?
    a. Yes
    b. No
9. Select your state
    a. Drop-down with all states
10. Select your county
    a. Drop-down with all counties
11. Select your agency
    a. State DOT
    b. City DOT
    c. MPO
    d. Other
12. Would you be willing to have a short (20 min) conversation as a follow up to this survey?
    a. Yes (please enter your name and email)
    b. No

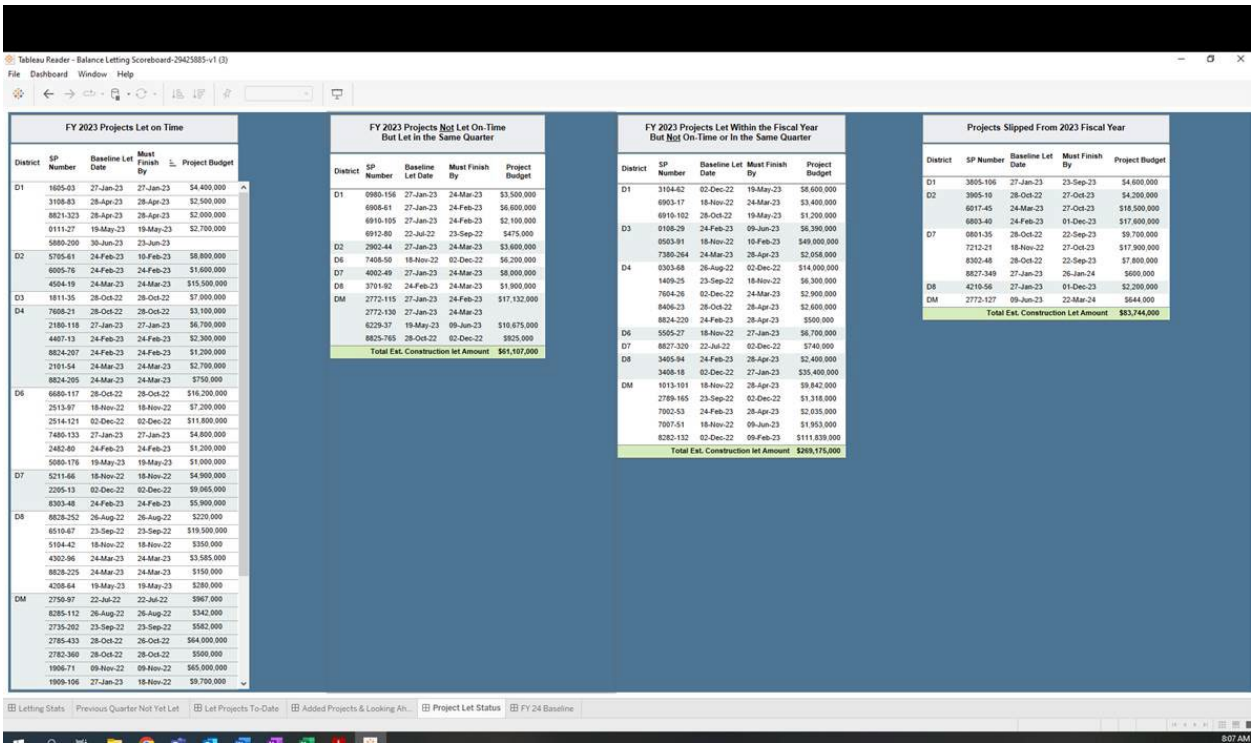
Thank you very much for your help!

Follow-up interview questions:

- What are the roles and responsibilities around project risk management in your agency?
- How does your agency use Power BI and SQL (or other tools) for the evaluation of risks?
- Did your agency consider and/or evaluate other tools before implementing Power BI and SQL?
- How long has your organization had project risk management evaluation, technologies and team?
- In terms of project risk management communication, how often does your team meet with on-the-ground personnel?
- Do you have milestone checks for project risk management?

Appendix J: Screenshots of dashboards used at MnDOT

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File Dashboard Window Help
FY 2023 Projects Let on Time
FY 2023 Projects Not Let On-Time But Let in the Same Quarter
FY 2023 Projects Let Within the Fiscal Year But Not On-Time or In the Same Quarter
Projects Slipped From 2023 Fiscal Year
Letting Stats
Previous Quarter Not Yet Let
Let Projects To-Date
Added Projects & Looking Ah...
Project Let Status
FY 24 Baseline
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