

Incorporating Risk-Based Analysis into Transportation Asset Management Plans

presented to

**AASHTO Subcommittee on
Maintenance**

presented by

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CAMBRIDGE
SYSTEMATICS

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NOTICE

11 days remain until
highway
authorization ends

Overview

- ① MAP-21 Asset Management Requirements
- ② Risk Management
- ③ Levels of Risk
- ④ Risk Register
- ⑤ Risk Tolerance and Mitigation
- ⑥ Examples

MAP-21 Asset Management Requirements

- ③ “Risk-based Asset Management Plan” 23 USC 119(e)(1)
- ③ Final Rules Expected in October – TAMP will be due 18 months following
- ③ TAMP sections include:
 - » Financial Plans
 - » Objectives and Measures
 - » Life Cycle Costs
 - » Investment Strategies
 - » Risk Analysis

What is a Risk?

“The effect of uncertainty on objectives”

- Travel
- Golf
- Weather
- Financial Sector
 - » Shark Tank
 - » Entrepreneurialism
- Military
- Board Game
- Kids
- Every activity we engage in has some risk



What is Risk Management?

- ① Not “one size fits all”
- ① Useful for setting priorities, assigning resources, and ensuring success
- ① Includes culture, processes, and organizational structure towards effective management of opportunities & threats
- ① Typical steps:
 - » Identification of Risks
 - » Risk Analysis
 - » Evaluation and Prioritization
 - » Mitigation

Risk Management and Asset Management

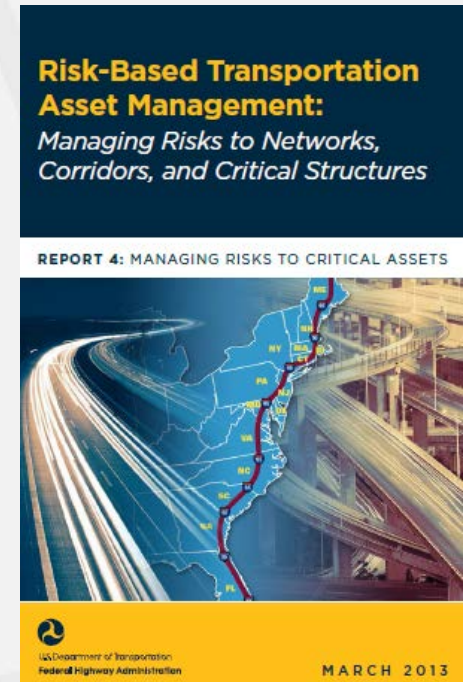
- ① How do we systematically prepare for the critical items?
- ① Just repackaging existing practices?
- ① Risk-Based Investment Prioritization
- ① Reliability Based Maintenance Program
- ① Incorporating Obsolescence
- ① Age and Condition Models can Help Prioritize but Do Not Tell the Whole Story
- ① Need for a *Risk Policy*





Best Practices

- NCHRP 658: Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs
- NCHRP 08-93: Guidebook for State Departments of Transportation (October 2015)
- FHWA Series of Reports on Risk-Based Transportation Asset Management
- International Scan (2011)
 - » *Transportation Risk Management: International Practices for Program Development & Project Delivery*



Risk Frameworks

Outlines Risk Policy



Levels of Risk

- Enterprise /Agency
- Program
- Asset /Project



RESPONSIBILITY: Executives

TYPE: Risks that impact achievement of agency goals and objectives and involve multiple functions

STRATEGIES: Manage risks in a way that optimizes the success of the organization rather than the success of a single business unit or project.

RESPONSIBILITY: Program managers

TYPE: Risks that are common to clusters of projects, programs, or entire business units

STRATEGIES: Set program contingency funds; allocate resources to projects consistently to optimize the outcomes of the program as opposed to solely projects.

RESPONSIBILITY: Project managers

TYPE: Risks that are specific to individual projects

STRATEGIES: Use advanced analysis techniques, contingency planning, and consistent risk mitigation strategies with the perspective that risks are managed in projects.

Why Create a Risk Register?

- ① “Risk” tends to suggest only asset-level risks
 - » e.g., flooding, collisions with structures
 - » Focus on life safety and mobility impacts
- ② Agency/Enterprise and program-level risks overlooked
 - » Politics, management, regulation, litigation, budget constraints
 - » Affect ability to deliver a functional system
- ③ A risk register includes risks from all several categories
 - » Prioritizes based on likelihood and severity of impacts
 - » Risk Scores

Sample Maintenance Risk Items included in Risk Registers

- Deferred Maintenance
- Staffing
- Training
- Material Costs
- Extreme weather
- Traffic incidents / Bridge hits
- Funding Cuts or Increases
- Contractor Shortages
- Contractor Expertise
- Specific asset issues(Guardrail, end treatments, signs)
- Others

Risk Scores

- ③ Variety of scoring options available to use
- ③ Commonality: Likelihood times Consequence
- ③ Ability to add influencers/enhancers

Bottom Line: Score provides an objective starting point in identifying critical items

Prioritizing Risks

On a scale of 1 to 5...

P_S Likelihood Value

Impact Scores

S_S Safety

D_S Damage Impact **R_S** Regional Nature

M_S Mobility

F_S Financial

$$\text{Risk} = P_S \times \frac{S_S + M_S + D_S + R_S + F_S}{5}$$

Prioritizing Risks

Likelihood and consequence

Likelihood		Consequence (Level/Descriptor)				
		1	2	3	4	5
Level	Descriptor	Negligible	Minor	Major	Critical	Catastrophic
1	Low	1	2	3	4	5
2	Medium Low	2	4	6	8	10
3	Medium	3	6	9	12	15
4	Medium High	4	8	12	16	20
5	High*	5	10	15	20	25

Sample Risk Register

Risk ID	Voted Priority	Event/Occurrence	Likelihood	Consequence Score					Other Considerations					Risk Score
				Safety	Mobility	Asset Damage	Other Financial Impact	Funding	Insurance	Regulatory	Political	Reputation		
Agency Risks														
1a	11	Not having enough funds to meet targets due to inflation in construction costs	5	3	4	4	2	√		√	√		19.5	
1b	4	Ability to meet MAP-21 targets for NHS segments under local control	5	3	2	3	2	√		√	√	√	15.0	
1c	6	Revenue variations/uncertainties – inability to predict/project total funds available to CDOT	5	1	1	2	3	√	√		√	√	10.5	
1d	9	Politics in general, combined with leadership changes in the Department	4	1	2	1	2	√	√	√	√	√	7.5	
1e	9	Public perception of CDOT (Negative) – resulting in an inability to garner new funds	2	2	4	3	2	√			√	√	6.3	
1f	11	Not communicating to and getting buy-in at the appropriate levels in CDOT how the RB AMP works	3	1	1	1	1	√			√	√	3.5	
Program Risks														
2a	8	Unfunded maintenance requirements – e.g., regulatory	5	3	3	2	3	√		√		√	15.8	
2b	9	Will I-70 viaduct pull funding from other projects	4	2	3	3	2	√	√		√	√	12.0	
2d	9	Retirement of key people, loss or turn-over of staff, resulting in loss of critical knowledge	4	3	2	2	3				√	√	11.0	
2e	9	Data management (that impacts ability of CDOT to document accomplishments)	5	1	2	2	3			√		√	11.0	
2f	9	Project delivery risks due to organizational or systemic issues, e.g., communication, etc.	3	2	1	1	4	√	√		√	√	7.2	

Sample Risk Register

#	Risk Description	Consequence	Likelihood	Risk Rating	Mitigation
D1	Lack of operating funding	Major	Almost Certain	Critical	<p>Educate elected officials on funding needs.</p> <p>Employ strategic thinking and continuous improvement for efficiency within the Department.</p> <p>Elimination of low priority services.</p> <p>Possible reduction of staff.</p>
D2	Loss of staff	Major	Almost Certain	Critical	<p>Employ succession planning strategies to keep productive employees and focus on recruiting to attract new employees.</p> <p>Continue to cross train employees for the ability to continue delivering services when key employees retire or resign.</p> <p>Continue to employ the workforce development program and structured training to advance the ability of our workforce.</p> <p>Outsource when necessary to fill void of reduced staff.</p>
D3	Cut in federal funding	Major	Possible	High	<p>Adopt an alternate priority program that postpones project lettings.</p> <p>Sell GARVEE bonds to fund needed programs and projects.</p>
D4	Insufficient match for federal funds	Major	Likely	High	<p>Restructure State highway program to allow for maximum funding for match to the federal program.</p> <p>Cut the following programs:</p> <ul style="list-style-type: none"> • Port and Flood Control • Parish Transportation Fund

Sample Risk Register

	Event #	Description	Likelih'd	Consequence					Event Score
				Public Safety	Asset Cond.	Geo. Scope	Mobility	Finance	
Agency-Level Risks	A	Federal officials increase funds across the board for transportation	2		1	5	3	4	7
	B	Federal officials increase funds for preservation and maintenance	3		2	4	3	3	9
	C	State officials propose capital projects for NHDOT while providing a funding stream	3		1	5	3	3	9
	D	State officials increase maintenance funding for NHDOT	1		3	5	3	3	4
	E	State officials relieve the NHDOT operating budget of some cost categories (benefits, raises, overtime, equipment)	2		3	5	3	3	7
	F	New or newly-motivated State officials promote NHDOT's ability to set a realistic budget	3		1	5	3	3	9
	G	Stakeholders and the public have a sophisticated understanding of system performance and needs	2		0	5	0	2	4
	H	NHDOT has a sophisticated understanding of stakeholder and public opinion	2		0	5	3	2	5
	I	Failure to meet regulatory standards leads to reduced flexibility with funds							
	J	Deflation in project costs effectively increases available funds agency-wide	1		1	5	3	3	3
	K	Dedicated capital funding streams exceed revenue projections	2		0	5	3	4	6
	L	Dedicated maintenance funding streams exceed revenue projections	2		3	5	3	3	7
	M	Over-prediction of costs increases available funds agency-wide	3		2	5	3	3	10

Mitigation Opportunities

④ 5 T's

- » Treat
- » Tolerate
- » Take advantage
- » Terminate
- » Transfer

Risk Tolerances

- ③ Understand where tradeoffs actually occur
 - » Minnesota
 - Developed concept of a risk appetite / 10% of pavements was acceptable
- ③ Agency context critical
 - » Risks to be managed should be the most important to the agency
- ③ Resource constraints
 - » Hardening infrastructure; inspection programs; technology and monitoring

Prioritization

☉ Successful practices include:

- » Workshop activities followed by executive participation
- » Re-scoring
- » Surveying
- » Audience Response Systems

☉ Update Cycles

- » Not a static document
- » Needs change over time and with varied resources
- » Fix it First strategies

Examples

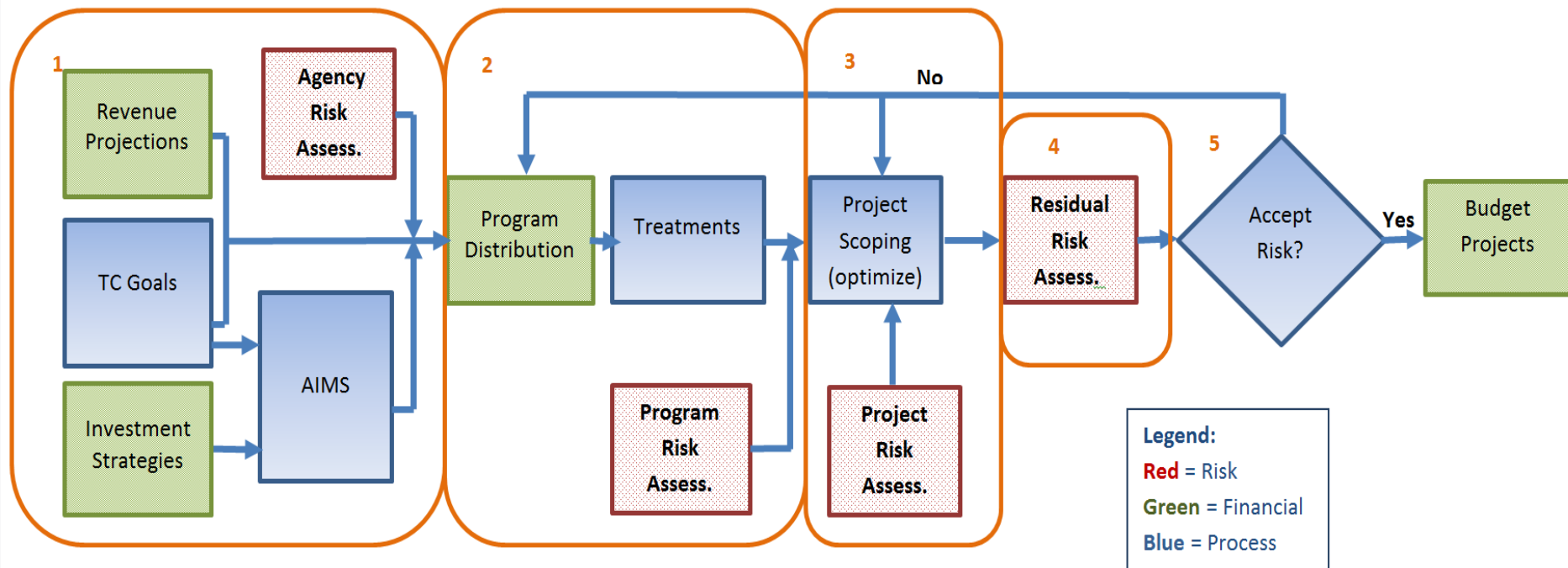
- ④ Georgia DOT used risk to establish priorities on the interstate system
 - » Focus was on loss of service due to pavement or bridge deterioration – risks that could be proactively managed through maintenance
- ④ North Carolina “Tiered Approach”
- ④ Minnesota DOT presented a mature viewpoint on incorporating risk into their decision-making process
 - » “Undermanaged Risks”
 - » Prioritization of mitigation strategies

State Programs

- ④ Washington State
- ④ Minnesota
- ④ North Carolina
- ④ Colorado
- ④ Florida's Risk Toolbox
- ④ Utah

Colorado Risk Analysis

Proposed Framework



Perspectives on Risk

- ③ Individual perspectives on the likelihood and impact may differ from the overall agency perspective
- ③ Keep in mind the sphere of influence for activities
 - » What are the areas that we can influence?
- ③ Transportation Asset Management Plans address a series of activities; not limited to a single mode or asset
 - » As such, risk prioritization across the System is essential

Contact Information

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A 3D rendered scene featuring a large, vibrant red question mark on the left side. To the right of the question mark stands a white, stylized 3D human figure in a classic 'thinking' pose, with its hand resting on its chin. A horizontal grey band with a slight gradient runs across the middle of the image, containing the text 'ARE THERE ANY QUESTIONS?' in a white, serif, all-caps font. The background is a plain, light grey gradient.

ARE THERE ANY QUESTIONS?