

Risk-Based Transportation Asset Management:

*Evaluating Threats,
Capitalizing on Opportunities*

REPORT 1: OVERVIEW OF RISK MANAGEMENT



U.S. Department of Transportation
Federal Highway Administration

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NOTE FROM THE DIRECTOR

The Federal Highway Administration (FHWA) continuously seeks innovative ways to improve the management of the nation's highway infrastructure. The Office of Asset Management offers this series of reports on risk management as another means by which transportation agencies can better understand and manage their highway assets.

The use of risk management among U.S. transportation agencies largely is limited to managing risk at the project level generally focused during construction. Risk management at the project level helps to identify threats and opportunities to projects' cost, scope and schedule. However, we at the FHWA along with our partners at state and local transportation agencies recognize the growing need for a better understanding of risk management at program and organizational levels.

Today, the leading international transportation, banking and insurance organizations have explored the benefits of risk management at the program and enterprise level and use it as a tool to protect their investments. Based on those practices, the Office of Asset Management is offering this series of reports on how risk management can be scaled up to asset management programs, and to the entire enterprise of a transportation agency.

It's important for highway agency officials to consider incorporating risk management in the decision-making process for several reasons. First, they have seen the benefits of risk management at the project level. Second, they have heard from their international colleagues that risk management can pay dividends when used at the broader program and enterprise level, particularly when agencies don't have enough funding to address their priorities. Third,

managing risk is an integral step in following a comprehensive asset management framework as described in the *AASHTO Asset Management Guide—A Focus on Implementation*. Finally, the U.S. Congress has proposed that states develop “risk-based transportation asset management plans.” These factors convinced the Office of Asset Management to offer this series of reports.

We believe you will find these reports helpful as you develop your asset management program and make investment decisions. This series of reports will help the transportation agencies to meet the increasingly complex challenges involved in making decisions and communicating them effectively to the public.

Sincerely,

A handwritten signature in black ink, appearing to read "JB Wlaschin". The signature is fluid and cursive, with a prominent initial "J" and a long, sweeping underline.

Butch Wlaschin

Director of the Office of Asset Management

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Background

As the United States considers developing risk-based transportation asset management (TAM) plans, agencies will need to understand risk and how it can be used to improve decision making in asset management programs. This is the first of five reports that define risk, explain risk management and examine their application to TAM both in the U.S. and abroad. This first report provides an overview of risk management as applied to managing physical assets.

Introduction

Understanding risk and how to manage it is emerging as another core competency expected of transportation agencies. In the United States, inclusion of risk-based asset management plans in the 2012 proposed transportation bill drew the attention of transportation decision makers to this topic. The International Organization of Standardization (ISO) issued a new standard on risk management that describes it as a fundamental component of modern management. Transportation agencies in England, Scotland, Australia, New Zealand and Europe are incorporating risk as a major component of their management frameworks. Professional standards in fields such as finance, health care, construction and information technology demand that risk management be incorporated into governance. Transportation agencies increasingly will face expectations that they embrace risk management to demonstrate competency, responsiveness, stewardship and transparency.

The Federal Highway Administration (FHWA) Office of Asset Management offers this report as the first of five that will explore what risk management is and how it can be applied to transportation asset management. The use of risk management among U.S. transportation agencies largely is limited to managing risk during construction. These five brief reports will describe how the benefits of risk management can be expanded to programs that manage existing highway assets.

These reports will:

- ▶ Define risk and risk management;
- ▶ Illustrate how they can be applied to managing infrastructure assets;

- ▶ Delineate how risk management differs from, but also complements, performance management and asset management;
- ▶ Provide a brief step-by-step outline for how agencies can begin managing risks;
- ▶ Elaborate on how risk management is being used by transportation professionals in the U.S. and internationally to improve decision-making, demonstrate accountability and increase transparency;
- ▶ Illustrate how risk management can improve programs, and;
- ▶ Discuss how risk management helps agencies prepare for and respond to natural and man-made disasters.

What is Risk and Risk Management?

Different industries use many different definitions of risk and risk management. Some industries define risks narrowly and equate them to hazards or threats. This usage reflects the common, every-day definitions of risks as threats or dangers. Others, however, increasingly use a much broader definition of risk. Many consider risks to include both possible threats and possible opportunities. ISO defines risk as “the effect of uncertainty on objectives”⁽¹⁾ and it notes that uncertainty could be positive or negative. Other definitions equate risk to variability or to the chance that desired outcomes won’t be achieved. The New Zealand transportation agency is an international leader in risk and asset management and its defines risk as “the chance of something happening that will have an impact on objectives. It is measured in terms of a combination of the likelihood of an event and its consequence.”

This expansive application of risk is evident in the definition of risk management used by the New South Wales (Australia) Government Asset Management Committee. It defines risk management as a systematic process to identify risks that may impact on the organization's objectives, analyze their consequences and develop ongoing measures to treat them. These broader definitions of risk expand risk management to an enterprise-wide framework for setting priorities, assigning resources and ensuring organizational success.

Assessing Negative Threats, Positive Opportunities

The broader definitions of risk emphasize that risks are not always negative. If risks equate with uncertainty or variability they hold promise that they could be positive, as well as negative. The World Road Association says that risk management could be called "opportunity management." The field of financial management has long understood this implication. "No risk, no reward" is a basic investment premise. A financial advisor who only offers clients no-risk investments is unlikely to earn them a substantial return. Therefore, risk management is more than barricading an organization against all threats. Modern risk management involves protecting against excessive risk while capitalizing upon opportunities that have acceptable risk levels. The English Highways Agency notes that its risk management obligation is twofold. It must protect the public from hazards and threats to desired transportation outcomes but it must also ensure that it identifies, evaluates and capitalizes upon all reasonable opportunities.

A simple illustration could be the following. An agency has a well-crafted pavement program. The program relies on sound inventory data, good forecasting, methodical preventive

maintenance, timely reactive treatments and a well-balanced mix of pavement preservation, rehabilitation and replacement. The agency has forecasted its program for the next five years and is confident it has developed a sound short-term and long-term pavement program that will achieve its short-and-long-term performance targets. However, the risk of volatile construction prices creates a major program risk. If prices rise, the agency's purchasing power will decrease and it will not be able to afford all the treatments it needs. If prices fall, it faces new opportunities to increase investments or achieve a higher level of service. A balanced risk-management program would hedge against rising prices by methodically trying lower-cost treatment innovations while closely monitoring construction prices. The degree of risk or uncertainty caused by price volatility would be documented, reported to stakeholders and tracked as a risk to the department's pavement objectives.

Another real-world example is how the Washington State Department of Transportation uses video technology to manage risk and capitalize on opportunities for bridge deck inspection. Some of its decks are known to be in good condition yet have high traffic volumes and narrow shoulders. It is unsafe for inspectors to visually inspect the deck without closing lanes. Lane closures are expensive to the agency and disruptive to the public. The agency selectively uses pavement profiling vans' video equipment to take images of decks which are then reviewed for cracking. If no cracking is seen, no manual deck inspection is required. This avoids risk to inspectors and inconvenience to the public. To minimize risk that the video won't identify fine cracks, a manual inspection occurs at least once every three inspection cycles. Also, the technology is not used on any deck likely to have substantial cracking or which can be easily inspected manually. With this balanced approach, the agency reduces risk to its inspectors and to the public while rationally capitalizing

on the opportunity provided by a new application of technology to deck inspection. Resources saved can be devoted to additional inspection of high-risk bridge components.

This background context of how risk can be both positive and negative leads to the definition of risk that will be used in these reports. Risk is the positive or negative effects of uncertainty or variability upon agency objectives. Building from this definition of risk, these reports will use as the definition of risk management the one adopted by the New Zealand Transport Agency. Risk management is the cultures, processes and structures that are directed towards the effective management of potential opportunities and threats.

This definition of risk management is broader than many used in the U.S. including the one used in the Transportation Asset Management Guide, A Focus on Implementation. These Risk-Based Asset Management reports recognize that different agencies can use different definitions. The one used in these reports supports a broad approach to risk management and includes managing threats and capitalizing on opportunities. Some agencies may choose to adopt a narrower approach that focuses only on threats. Both approaches are valid. Agencies can adopt the one best serving their needs.

Moving from Project to Enterprise Risk

U.S. transportation agencies regularly use risk management at the project level to control cost, scope and schedule. However, the emerging use of risk management is to apply it at the program and enterprise levels. These reports will explain how the tools of risk management that are used effectively at the project level can be scaled up to the

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program or enterprise level as agencies implement and advance their asset management programs.

One risk management author⁽²⁾ notes that to apply risk management at the program level, one needs to differentiate it from risk measurement. Risk measurement is a technical discipline in which actuarial specialists model the probabilities of investment risks to insurance providers or investors. When risk management is confused with risk measurement, it often is relegated to an isolated, technical function.⁽³⁾

Risk management requires the active, anticipatory managing of threats, variability, uncertainty and opportunities by leaders and managers at all levels of the organization. A simple way of thinking about risk management is to ask, “What could stop us from reaching our objectives and how can we deal with it? How we can turn uncertainty or change into opportunity?” By applying these questions to the program and enterprise level, leaders can escalate the benefits of project risk management to the program and enterprise.

Basic Steps of Risk Management

Illustrating the steps of risk management can help to clarify its application. Most guides to risk management follow steps similar to those used in the ISO standard. These include:

Establishing the Context—This involves understanding and documenting the social, cultural, legal, regulatory, economic and natural environment to which the agency is sensitive. The context allows risk management to be tailored to the agency’s needs and circumstances. Included in this step is the development of the agency’s risk policy designed around the agency’s unique objectives. These objectives can include issues such as improving network reliability by reducing the need for frequent maintenance and repair, or providing the lowest reasonable whole-life costs for assets. Also, included is creation of the agency’s internal and external risk management communication process. This allows information to flow up and down through the agency and externally with key stakeholders.

Risk Identification—In this step, the agency formally identifies the risks that could affect its objectives. These can be external such as price changes, legislative actions, economic changes, climatic events, seismic events or malevolent acts. Risks also can be internal such as operational failures, data failures, conflicting internal program objectives or a lack of trained personnel for key tasks. All risks are generally recorded in a formal Risk Register as shown in Figure 1 (see next page).

Risk Analysis—This step evaluates the probability of risk with its consequence. The calculation can be qualitative and based upon expert judgment. Or it can be quantified simply in a 1 to 10 scale, or it can be subject to complex mathematical modeling. Most such analysis is relatively simple. Despite the method used, the intent of this step is to understand the risks and their magnitude.

Risk Evaluation—This step supports decision making by comparing the magnitude of the risks identified in the preceding two steps with the agency’s risk tolerance.

ASSET MANAGEMENT RISK REGISTER									
Risk Category	Risk Event					Risk Mitigation Strategy/Treatment			
Enterprise/Strategic	Funding changes	4	4	16		Monitor budget process; inform legislators			
Enterprise/Strategic	Material price changes	3	4	12		Monitor prices, prepare investment scenarios			
Enterprise/Strategic	Lack of staff acceptance of TAM	2	5	10		Emphasize agency adoption of TAM			
Programmatic Risk	Model forecasts	3	4	12		Calibrate, validate model outputs			
Programmatic Risk	TAM staff turnover	4	3	12		Conduct training; succession planning			
Programmatic Risk	Lack of staff acceptance of TAM	3	3	9		Emphasize agency adoption of TAM			
Project/Activity	Districts' completion of preventive maintenance activities	3	2	6		Monitor PM program activities			
Project/Activity	Timely collection of asset condition data	3	2	6		Provide more resources for data collection			
Project/Activity	Flooding degrading drainage structures	2	3	6		Monitor events, prepare to respond			
						Likelihood			
						R=Rare	1		Impact
						U=Unlikely	2		N=Negligible
						P=Possible	3		L=Low
						L=Likely	4		M=Medium
	A=Almost Certain	5		4	V=Very High				
					5	E=Extreme			

Figure 1. This is a stylized risk register for an asset management program. It illustrates risks that can occur at the enterprise or strategic level, the program level or the project/activity level. The risks are ranked by their likelihood and consequence, and color-coded by rank.

Risk Treatment—This decision-making step applies what one guide calls the Five Ts. These are to treat, tolerate, terminate, transfer or take advantage of the risk.

Although the steps are described as being distinct and separate, most guides note they tend to overlap and blend into each other. They also occur within a context that is illustrated in Figure 2. This figure from the ISO standard is cited extensively in risk management guidance from North America to New Zealand. It notes that the steps of risk management occur within the context of continuous communication and consultation and continuous monitoring and

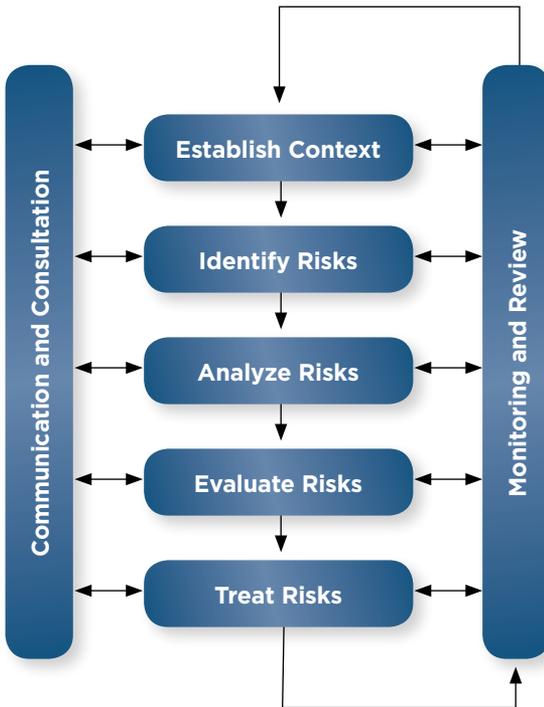


Figure 2. ISO's risk management framework.

review. The communication flows up and down the organization and into and out of it with stakeholders. In addition, the monitoring occurs within the agency, as well as outside from oversight bodies, legislators, the media and the public.

Why Manage Risks?

Initially, one could argue that many risks are external and beyond an agency's ability to control. Therefore, why try to manage what can't be controlled?

Legal frameworks such as the Sarbanes Oxley Act in the United States or the Local Government Act in Australia argue just the opposite. They infer that because risks are inevitable that it is incumbent on every steward of shared resources to anticipate risk, strategize how to mitigate it or capitalize upon it and be prepared to act when it arises. Assumed in risk management frameworks is not the question of whether risks will occur. Rather, the question is whether the agency has prepared to blunt the effect of negative risks and prepared to quickly capitalize on positive ones?

Threats in these frameworks are not considered to be only physical threats, but also threat of program failure. Failure includes failing to achieve organizational objectives or achieving desired asset condition levels. As such, risk management is a tool to address external risks but also to increase the agency's likelihood of success.

The lines between good risk management and overall good management are blurring, according to an edition of the Harvard Business Review dedicated to risk management.⁽⁴⁾ Risk management used to be more of a specialty discipline in industry, much like human resources. Today, financial and environmental regulations create pressures on executives to ensure that their organizations are anticipating and

responding to risks. Now, risk management is a core discipline and one that executives need to embrace as a personal and corporate responsibility. The modern executive must understand risks but not be paralyzed by them. A credible manager of risk is also a risk taker. He or she should weigh the risks and returns, then document that the organization has made a well-analyzed decision. In the world of corporate governance, many concerns of running a large organization are being reframed in terms of risk, which means that the role of risk managers and their tools will be increasingly important. An example is the Sarbanes-Oxley Act that creates criminal penalties for corporate officers who fail to perform due diligence to prevent financial fraud or malfeasance in publicly traded corporations. Similarly, U.S. transportation agencies who fail to manage risks to public safety can be held liable in court. The emergence of federal risk-based asset management plans expands the requirements that transportation agencies incorporate risk in their basic decision-making processes and would be a means of showing due diligence.

The benefits of risk management are enumerated in several principle documents such as the ISO standards and national legislation in countries that require formal risk management plans. These benefits include:

Protecting public safety—Mitigating threats to public safety and health is one of the best understood reasons for risk management. In the asset management context, examples of risk to the public include loss of pavement friction, diminished reflectivity or visibility of signs and pavement markings, poor drainage that creates standing water on roadways, pavement rutting that can contribute to hydroplaning and increased stopping distances, or guardrail that is no longer crashworthy. Addressing these issues also protects the agency from liability claims.

Protecting public value—In many contexts, protecting public value is a prime focus of risk management. For transportation agencies in Great Britain, Australia and elsewhere a key focus of risk management is protecting the value of transportation assets. Risks come from excessive loadings, missed maintenance treatments, faulty modeling, sub-standard materials, poor construction, inadequate condition data, inadequate preventive maintenance programs and what the Asset Management Guide calls the “unrelenting deterioration” caused by traffic, weather and environmental conditions.

Achieving public objectives—Program risk management seeks to identify risks to achieving program goals, which almost always are driven by important societal objectives. Risks to programs can be external such as costs or funding. However, they also can be internal such as operational failure or conflicts between programs.

Complying with public regulations—A need to comply with regulation commonly drives program risk management. Failing to meet regulatory compliance can be viewed as indifference or unresponsiveness to key public concerns, such as environmental quality.

Increasing public trust—If risks are inevitable, an agency that does not anticipate them and prepare for them is less likely to win public confidence.

Identifying opportunities—A well-balanced risk approach capitalizes on low-risk, high-return opportunities. A risk management approach can ensure that new opportunities to protect public safety, increase public value and serve public interests are identified.

Improving decision-making—Systematically ranking risks and evaluating opportunities leads to improved agency decision-making.

Where Does Risk Management Fit?

Figure 2 and the preceding discussion could prompt the question of whether risk management is a comprehensive framework that replaces performance management or asset management. It is not. A review of the literature and interviews with key risk practitioners uncover no examples where risk management has replaced transportation asset management or performance management. Rather it is a complementary discipline that supports both as shown in Figure 3. Figure 3 represents a visualization developed by a FHWA International Technology Scanning Program team that



Figure 3. Risk management complements other management frameworks.

studied risk management practices. The team concluded that risk management is a process that works with asset management and performance management to help an agency achieve its strategic objectives. Although Figure 3 shows clear boundaries between the three disciplines, in reality, the three are likely to blend somewhat when applied concurrently.

The definitions of risk management, asset management and performance management help to clarify their complementary roles.

Transportation Asset Management is a strategic and systematic process of operating, maintaining, upgrading and expanding physical assets effectively throughout their lifecycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision-making based upon quality information and well defined objectives.⁽⁵⁾

A Performance Management System can be defined as an on-going process that sets strategic policy priorities using performance trend data and performance forecasts to guide development of the capital program and operational activities.⁽⁶⁾

To clarify the roles of asset management and performance management, they have a similar set of core principles that include:

- ▶ both are strategic and systematic;
- ▶ they rely on sound data and information;
- ▶ they are focused on investments.

The differences are that Asset Management focuses on managing physical assets for the lowest reasonable

whole-life costs which drives it to focus upon long-term performance and metrics and not only upon current or short-term performance. To achieve the lowest reasonable whole-life costs, some activities are emphasized, such as preservation and preventive-maintenance, that do not provide immediate, short-term benefits.

FHWA and the AASHTO Subcommittee on Asset Management have said that asset management refers to the management of transportation physical assets while performance management refers to applying these same principles to all aspects of the system, including operations, safety, congestion relief/reliability, environmental concerns, and to key aspects of organizational performance such as project delivery and customer service.

Risk management mitigates threats and identifies opportunities that could affect either the asset management or performance management objectives.

Identifying Threats to a TAM Program

What are threats to an asset management program? If threats are events or occurrences that could impede asset management objectives then they could come in many forms, both internal and external including:

- ▶ Premature asset failures caused by faulty construction or materials;
- ▶ Chance failures caused by unpredicted events such as barges striking bridges or truck fires weakening beams;
- ▶ Abrupt failures caused by climatic or seismic events such as flooding, landslides or seismic activity;

“Creeping failure” caused by gradual degradation spurred by traffic, environmental factors, corrosion and climate.

Those threats tend to be project or asset-specific failures, or isolated externally caused failures. Also creating uncertainty for assets are programmatic threats such as:

- ▶ Wear-out failures caused by inadequate maintenance programs;
- ▶ Decision failures caused by inaccurate data or models;
- ▶ Resource failures caused by reductions in appropriations or increases in prices;
- ▶ Operational failures caused by process breakdowns;
- ▶ Demand failures caused by unanticipated vehicle loadings.

Senior executives “own” or are responsible for the policy or strategic threats that can include:

- ▶ Failure to manage their physical assets for the long-term as official policy;
- ▶ Legislative mandates such as “worst first” that could detract from sound asset management;
- ▶ Substantial reductions in asset management funding, or;
- ▶ Internal bureaucratic resistance to asset management that can be addressed only by senior leadership.

For many agencies hard pressed by higher prices, aging infrastructure and inadequate budgets, the margin of error in their asset management plans is small. Many miles of pavement may be in marginal condition and at the point of rapid decline down the pavement deterioration curve.

Or, substantial number of bridges could be on the verge of structural deficiency. The occurrence of any of these failures could result in failure to meet asset-condition targets for the at-risk pavements and bridges. Failure to meet some targets, such as achievement of preservation and preventive maintenance programs, leads to higher costs later. Or, they can lead to lower margins of highway safety and other diminished levels of service to the public. Because risks to assets are inevitable, failure to properly anticipate them increases the probability of failure of the asset management program. Therefore, modern frameworks of asset management are increasingly likely to view risk management as an essential component of success.

Who Manages These Risks?

The lists of risks to asset management success cuts across many disciplines, many functions, many responsibilities both within and outside of a transportation agency. How are these risks assigned? Who monitors them? Manages them? Capitalizes on them?

Most risk management practitioners and guides stratify risk between at least three and no more than five levels. The most common divisions are:

Enterprise Risks—These would be risks that affect more than one major program or major objective of the organization. These risks generally are “owned” by the chief executive, executive team or governing body. They tend to be external risks such as those related to budgets, legislative requirements, regulatory reforms, public sentiment, or significant internal personnel or managerial decisions. They tend to be “make or break” risks that can determine the success or failure of major departmental objectives and which cannot be controlled by one program manager.

One author says⁽⁷⁾ that senior executives either engage in enterprise risk management or they regularly engage in crisis management. The best laid plans are subject to unpredictability of both internal and external factors. Adopting an enterprise-wide view of risk allows the senior leadership to constantly scan the horizon for what could impede its organization-wide objectives.

Later in this report, the process to prioritize risks by their probability and potential impacts will be described. This prioritization identifies the risk factors that senior executives will own. High-risk items may require constant attention while low-risks ones require only occasional monitoring. The risks assigned to the executive level almost always are ones that are too broad to be encompassed within one program or organizational division. They also tend to influence core activities, or activities mandated by the political process.

Program Risks—Programs generally are defined as collections of related projects or on-going efforts to ensure achievement of specific organizational objectives. As such, a program could be a collection of construction projects, or a set of related activities such as managing pavements, bridges or roadway appurtenances. Programs can focus on capital items, operational activities, regulatory functions, organizational intelligence and other related activities. Some international agencies even consider entire roadway functional class networks to be programs. Their logic is that the functional class network provides specific programmatic benefits at the national, regional or local levels. Risks at the program level can be numerous. A series of project cost estimate failures at the project level can create risk to an entire construction program. Or, program risks can be caused by conflicts within the agency that impede program effectiveness. Breakdowns in information systems or data quality can threaten the quality of an entire program.

Changing the objectives or management of a program creates risk and uncertainty.

Generally, program risk is assigned to the program managers. Within the program, risks can be further subdivided to the program managers within offices or geographic districts.

Project or Activity Risk—Obviously, project risk is assigned to the individual project manager, such as the one managing a construction project, or the creation of a new product such as a new information system. Activity risks are assigned to activity owners, such as those who manage the individual preventive maintenance activities at a district, or the pavement data collection activities or the modeling activities.

Generally, guidance recommends creation of a department-wide risk management plan that cascades responsibility from the chief executives down to front-line managers. A typical framework would be for there to be an enterprise risk management plan that incorporates the separate risk management plans from the programs, projects and enterprise.

Communicating and Monitoring Risks

Risks are dynamic. They can rise and fall with changing conditions. Their dynamic nature requires a continuous reporting and monitoring process as illustrated in Figure 2. Practitioners of Risk Management such as TransLink in British Columbia, or the Highways Agency in England or the New Zealand Transport Agency keep abreast of risk through regular updates and through required reports. TransLink officials report that the risk management update is a central component of their board meetings and agency governance. References to risk management appear 187 times in the

2010-2011 Annual Report of the New South Wales (Australia) Roads and Traffic Authority. It communicates risk in dozens of areas such as traffic safety, the licensing of young drivers, regulatory compliance, financial management, construction, culvert management, slope maintenance, bridge inspection, pavement rehabilitation and permitting of oversized vehicles. Multiple risk management plans and “risk registers” exist at these different programs and they are monitored and adjusted periodically.

The risk management standards set by ISO, the Project Management Institute (PMI) and the Institute of Risk Management and Insurance (IRMI) say that establishing the communication framework is essential to successful risk management. Because risk factors are dynamic, they may require prompt response or adjustment, both to avoid threats but to also capitalize on opportunities. Enterprise and program threats also can occur because of internal operational failures or because of conflicting priorities between divisions. Prompt reporting of these conflicts and breakdowns allow them to be escalated and resolved more quickly.

Communication also is important because veteran practitioners say that the entire discipline could be considered as a verb, not a noun. It may be more accurate to discuss managing risks, which connotes a very active and dynamic process, than to discuss risk management which sounds more like a static discipline. The active nature of managing risks requires effective communication mechanisms between the diverse participants. The communication network generally includes inputs and outputs to external groups such as legislators and the public. Changing circumstances can be communicated from the outside to the agency, or from the agency to the external stakeholders.

Tailoring Risk Management

To keep it relevant, risk management guidance generally recommends establishing the “agency context.” This step involves identifying the objectives of the organization, the environment in which it operates, and the stakeholders with whom it interacts. Most guidance says risk management should serve the agency, its stakeholders and their objectives. As such, the risks managed should be those most important to the agency and its stakeholders.

This attuning of risks with agency priorities makes risk management a strategic tool that helps the agency achieve its objectives and prioritize scarce resources.

Risk management is about striking the balance between risk and opportunity or finding the “sweet spot” between the two. Any person or organization operating in a fiduciary role for stakeholders faces a responsibility to reduce risk, to manage volatility, maximize value and promote continuity. Increasingly, organizations recognize that risk comes in new forms, such as risk of failing to comply with regulation, risk to reputation, and risk from changing external conditions. In an age of widespread and nearly instantaneous news media and social media reaction, these risks quickly can affect an organization’s operations. An enterprise-wide assessment of all risks to success can prepare an organization to prevent negative events, and can improve its credibility if one occurs. Risk management is similar to a sound investment strategy. It assigns resources to areas of high returns and relatively low risks, and it diminishes investment of resources into high-risk, low-return areas. By having a formal risk-management framework an organization can increase its credibility with shareholders by documenting that it has rationally anticipated risk and plans to address its negative implications while capitalizing upon opportunities.

The situational nature of risks indicate that they can change over time or they can vary between geographic areas within the same agency. Different traffic volumes, climate, geology, or environmental resources can cause risks to vary between regions. Some activities such as compiling pavement inventory data may be routine and low risk until a new pavement-data-collection system is deployed. Until the system is tested and de-bugged it may remain as a high-risk asset management activity. As it matures, its risk profile falls.

Simple Tools for Managing Risk

Although the practitioners of risk management describe its effects as important, they tend to describe its tools as simple. The “Risk Register” is a primary tool of many transportation agency risk management programs. The register is a simple Excel spreadsheet that lists the risks that have been considered. It includes their rankings, to whom they are assigned and what response actions are under way. Color coding the risk registers to resemble “heat maps” is commonly used as seen in Figure 4. This example comes from the International Infrastructure Management Manual (IIMM) and illustrates the typical logic of a risk register. Risks are ranked by their likelihood based on an A to F or similar scale. Then, the consequence of the risk is calculated. The risks are then computed to be low, medium, or high and color-coded accordingly. Appropriate responses are assigned to the appropriate risk owners. Although Figure 4 represents the simplest type of risk calculation, the logic it contains is universal to all risk registers and represents the relative simplicity of the basic risk management tool.

One risk management author advocates for a “modesty of tools and a boldness of goals.”⁽⁶⁾ By this, he means that it is more important for executives to actively manage their known risks than to acquire complex risk tools. Complex

LIKELIHOOD		CONSEQUENCE			
	1	2	3	4	5
A	L	L	L	M	S
B	L	L	M	S	H
C	L	M	S	H	H
D	M	M	S	H	H
E	M	S	H	H	H
F	S	H	H	H	H

SCALE: Low, Moderate, Significant, High

Figure 4. The IIMM example of a risk scale.

tools are used in the worlds of Wall Street finance and insurance for risk measurement but not generally for corporate, enterprise risk management. Enterprise risk managers are more likely to rely on the judgment of veteran staff to qualitatively weigh common enterprise risks than they are to invest in complex software systems in an attempt to quantify hard-to-measure risk factors. In later reports, more complex means of weighing risks will be discussed. They typically include Delphi tools for identifying risk weights and using Monte Carlo routines for calculating the probability of different risks occurring. However, the use of these tools is more common at the project level, where risks are more readily quantified. These types of tools are much less common at the enterprise and program risk management levels.

The advice to simplify tools is similar to that provided by the U.S. international study tour team whose major recommendation after reviewing successful risk management practices abroad is to “keep it simple.”

The study tour's team's summary emphasizes that although they found impressive and mature enterprise risk managements systems in the visited countries, the systems featured simple, easily understood analyses.

The study tour team's unpublished summary emphasizes that although they found impressive and mature enterprise risk managements systems in the visited countries, the systems featured simple, easily understood analyses. A few of the agency officials interviewed emphasized that they preferred simple spread-sheet based risk registers and risk plans over complex, proprietary and highly quantified software. The more complex outputs are less transparent to stakeholders. They also require agency officials to spend their time managing software instead of managing risks. Spreadsheets, heat maps and simple graphics were used primarily to illustrate the outcomes of the risk analyses.

The study tour team concluded that one of the greatest benefits of the risk management process is the ability to communicate information simply to decision makers throughout the organization and externally to stakeholders. An analysis may be more statistically rigorous if produced by a probabilistic model but if it is wrapped in jargon it is of little value to stakeholders.

New Zealand law requires agencies to use risk management but it emphasizes common-sense application as well. One study of how risk⁽⁹⁾ is used by local governments in New Zealand said, "There should not be undue effort applied to

scoring risk beyond the expertise of the staff contributing to the scoring.”

A major private-sector organization, the International Risk Management Institute (IRMI), makes a similar point. “While (risk management) seems intimidating to many business-people—possibly because of the unique vocabulary that risk and insurance professionals use—the risk management process is not really difficult to understand. It is simply a common-sense approach to using a number of readily available tools to handle an organization’s risk in the most cost-efficient manner possible.”⁽¹⁰⁾

To simplify managing risk, some of the international guides not only use simple tools, but also simple language. The official guidance to transportation agency staff in Scotland, England and Australia is peppered with plain-spoken advice and examples. The Australian state of Victoria’s risk management guide emphasizes embedding risk management into its culture, which it defines as “the way we work around here.” Transport Scotland describes risk as “the chance of something happening that will impact on safety or service.” Transport Scotland describes risk management as addressing complex external issues but also emphasizing basic, core services such as ensuring damaged signs are quickly replaced. The English Highways Agency uses simple acronyms and alliterations. Its manual for rating risks relies on a BRAG scale, or Black for critical, Red for high, Amber for medium and Green for low. When risks are found, risk owners must remember and apply the 5Ts. They are to Treat the risk, Tolerate the risk, Transfer the risk, Terminate the risk or Take Advantage of the risk. The guide advises that Highway Agency workers should not fear taking a well-considered risk, rather they should be encouraged to take risks that can improve public safety or service.

Managing Risk is Not New, Formalizing It Is

Once risk and risk management are described, it is apparent they are not new to US transportation officials. Agencies have for many decades used risk-based approaches even if they have not described them as such. US transportation agencies invest more resources into maintaining high-volume, high-risk roadways than they do in low-volume, low-risk ones. Bridge engineers invest more resources into inspecting and monitoring high-risk bridges than they do with low-risk ones. High-risk assets such as traffic signal controllers receive far more attention than do low-risk assets such as isolated maintenance sheds. Safety analysts scour statewide crash data to identify high-risk locations for safety improvements. The identification of risk and the mitigation of it permeate U.S. transportation practices.

What is missing in US transportation agencies that is evident abroad is formal, policy-based, comprehensive documentation of risk management. What the U.S. scan team found when visiting the international risk management leaders was the explicit, formal embrace of risk management that allowed them to communicate to stakeholders that they had identified, measured and managed risks to the public. These agencies could demonstrate their policies, their risk registers, their risk responses and how they had prioritized their resources to reduce the greatest threats. The risks they identified also were not only safety threats. They also included programmatic risks that could prevent the agency from achieving important public objectives. These included compliance with environmental standards, achievement of agency programs and the protection of public value. A formal risk management approach brings with it policies, processes and results that can be explained

to stakeholders. Figure 5 from the TransLink agency in British Columbia illustrates the comprehensive nature with which it manages risks and reports them to its board. It identifies risks in many areas from its strategic priorities to its regulatory requirements. It measures the probability and impact of each risk and reports on them regularly to its board and stakeholders. As a result, risk is a major tool for prioritizing its efforts and for communicating with its stakeholders.

As the scan team members wrote after viewing the risk management systems abroad, “Transportation agencies manage some of the largest public assets and budgets in federal, state and local governments. It is their corporate responsibility to set clear strategic objectives to manage these assets in a manner that improves the economic growth and livability of their regions. Risks can affect an agency’s

Likelihood (36 months)		Likelihood	Risk Map			
≥ 90%	Almost Certain	5	M	H	E	E
≥ 70% to > 90%	Likely	4	M	M	H	E
≥ 25% to < 70%	Possible	3	L	M	M	H
> 1% to > 25%	Unlikely	2	L	L	M	H
≤ 1%	Rare	1	L	L	L	M
Impact	Impact	1	2	3	4	
		Minor	Moderate	Major	Extreme	

**Strategic Political Reputation • Financial • Human Resources
Business Effectiveness • Safety • Environmental
Reporting • Regulatory**

Figure 5. Framework Tools.

ability to meet its strategic goals. As network and delivery managers, it is incumbent upon these agencies to identify risks, assess the possible impacts, develop plans to manage the risks and monitor the effectiveness of their actions.”

The ISO risk management standard makes a similar point that the hallmark of a mature organization today is that its risk management is comprehensive, recordable and transparent. The International Infrastructure Management Manual describes risk management as a visible, core business driver and not an isolated function. In England, Treasury Department guidance says, “Government will be open and transparent about its understanding of the nature of risks to the public and about the process it is following in handling them. Government will make available its assessments of risks that affect the public, how it has reached its decisions, and how it will handle the risk.” The English Highways Agency says risk management is a high-profile component of good stewardship of assets along with other formal and recordable processes such as life-cycle costing, long-term strategies, and performance monitoring. The New South Wales Roads and Traffic Authority rates risk management among its key governance drivers along with performance management, and high-quality planning. For the RTA, risk is well documented and widely referenced.

Also less common in the U.S. than in the agencies abroad or among the private sector here, is the degree to which risk management cascades across an agency. Risk management at the project level in the United States is generally assigned to project managers, or to program managers at most. What is likely to change in the U.S. is the degree to which risk management responsibilities expand across more programs, such as asset management ones. The IRMI says risk management is more successful if widely integrated. “To be truly successful, however, risk management must permeate an

organization. A risk manager or even a department full of risk managers cannot maximize the benefits of the process without the understanding, cooperation, and active support of others within the organization.”

Managing Risks to Assets

With both chambers of Congress and the administration proposing that state transportation agencies adopt risk-based asset management plans, it is likely that the emphasis upon risk management will grow. State transportation officials are likely to begin emulating their counterparts in the private sector and abroad and begin to incorporate risk into their asset management processes.

How might a risk-based asset management program look? This report only will touch briefly upon how the concepts explained so far may be applied to transportation asset management. The second Risk-Based Asset Management Report will examine those concepts in much greater detail. In summary, the application of risk management to managing assets is likely to include the following developments.

Strengthening program risk management: Transportation agencies likely will become more experienced at program and enterprise risk management as opposed to only project risk management. Managing risks to an entire asset management program probably will require a program risk management approach, such as that described by the Project Management Institute. Asset management risks would be considered as ones that transcend most individual projects and activities and could influence all asset management activities, goals and processes. The types of risks to assets would include those articulated on pages 15 and 16. The management of those risks is likely to be sensitive to the following types of strategies.

Adopting sound asset management practices: A fundamental risk management approach will be to have a sound asset management approach. An agency's assets are more likely to be at risk if they are not managed within a clearly articulated and understood asset management framework. Asset management applies systematic economic and engineering principles to a broad range of assets over all phases of their lifecycle. Coordinating such complex activities within a large transportation agency begins with clear asset management policies, procedures and practices. A programmatic approach to managing risks to agency assets is likely to begin with the establishment of a sound asset management program.

Coordinating Program and Project Activities: Internal risks to asset management can involve a lack of coordination between the many decision makers who identify asset treatments. Often, the individuals who decide on maintenance treatments are different from those who make rehabilitation or replacement decisions. Ineffective internal coordination of all asset-treatment decisions during the assets' lifecycles can be a risk, while improving the coordination can be a major opportunity.

Evaluating Asset Data: Sound asset data lies at the heart of sound asset management decision-making. Significant research has documented shortcomings in asset inventories. Many agencies struggle with incomplete asset inventories or disjointed inventories that do not link to common referencing systems. As agencies consider threats to the achievement of their asset management objectives, poor quality data is likely to be a consideration.

Improving models: Inadequate forecasts of traffic loadings and material performance have been identified as one of the primary causes of premature pavement failures at the project level.⁽¹¹⁾ The importance of sound modeling grows

even greater at the network level when agencies base multi-year pavement and bridge programs upon the outputs of network pavement and bridge models. One source⁽¹²⁾ said that modern decision makers are like pilots who must fly by instrument. Modern organizations are so complex that decision makers must rely on models but if they are inaccurate, it is like flying blind. As agencies develop multi-year, performance driven and risk-based asset management plans, they increasingly will rely on models, or at least forecasts. It is likely that the quality of these models and forecasts will be viewed as both a threat and an opportunity for asset managers.

Managing Risks to Knowledge: Risks to asset management knowledge comes from attrition, retirements and agency downsizing. When knowledge is viewed as a key asset, its loss through turnover can be viewed as an asset management threat. Just as physical assets need renewal, so do the knowledge assets of an organization.

Identifying Preservation Opportunities: Preserving assets is almost always less expensive than repairing or replacing them. However, research has indicated that preservation treatments are not always consistently applied across entire highway networks. Developing the internal procedures to ensure that preservation occurs is likely to become an identified risk. Most funding sources were established for repair or replacement treatments and may not be eligible for preservation. Capitalizing upon the long-term benefits of preservation may become a widely recognized threat and opportunity.

Identifying High-Risk Assets: In a risk-based framework, the assets most at risk probably would be identified, at least by category. Some assets such as high-volume, fracture-critical bridges are likely to be included as critical assets. Others

could be pavement sections and bridges on the verge of declining into substandard condition and requiring preventive treatment. Others could be high-impact safety assets such as traffic signals, lighting elements, pavement markings or signage. Many agencies have heterogeneous asset conditions. Some asset classes or some areas of a state may have disproportionately at-risk assets. These are likely to be identified and monitored programmatically.

Managing Asset Budgets: Lack of adequate investment is probably the most universally identified threat to achieving asset management goals. Although funding may be beyond the entire control of an asset management program manager, the monitoring of investment levels will be important.

Monitoring Construction Prices: Price escalation has moderated somewhat in recent years but the price increases between 2005 and 2008 illustrated how significantly material costs can reduce effective investment levels. Purchasing power was seriously eroded in those years and has not returned completely. Cost increases are likely to be a significant asset management uncertainty.

The identification and management of these risks would provide a significant new component to the agency's asset-management framework. Risks such as these would be identified in the asset management risk register and they would be prioritized based upon their probability and their potential impact. The potential impacts of these risks to asset management goals would be articulated, as would be the strategies for addressing them. Some would be tolerated as not significant and only requiring monitoring. Others, could be treated, such as strengthening agency data systems or models, improving asset management practices or increasing coordination among asset owners. Others may be avoided altogether by eliminating their underlying cause.

Some could represent major opportunities that the agency seeks to capitalize upon. In a risk-based asset management program, these uncertainties would no longer be confined to the internal considerations of the agency but are likely to be clearly expressed to stakeholders as issues that could affect asset management objectives.

Summary and Conclusions

As states focus on advancing their transportation asset management program, they are likely to place an increased emphasis on becoming competent in not only project risk management, but also program and enterprise risk management. Congressional calls for states to develop risk-based asset management plans for the National Highway System probably will be a major impetus to the spread of risk considerations into asset management programs. This will require new skills in transportation agencies. This also will give those agencies new means to allocate resources and to communicate effectively with stakeholders. Threats that could imperil success will be identified, and the rational risks that agencies take in order to overcome those threats can be explained.

Agencies already are dealing with risks, they just often are not formally documenting it. Agencies are struggling to keep abreast of rising material prices, inadequate budgets, antiquated data systems, aging highway assets, and rising public expectations. Agency officials are well-aware of these risks but without a programmatic risk management approach they lack the means to effectively articulate the magnitude of these risks and how these risks can impede agency goals. Agencies already take well-considered risks in order to capitalize upon opportunities, or to preserve scarce resources. However, the decision-making process when taking these

risks may not always be documented or easily explained later to stakeholders.

Risk management provides a comprehensive framework for explaining risks, documenting decisions and identifying new opportunities. Risk management can be a logical complement to existing frameworks of performance and asset management. Both performance and asset management focus upon achieving internal objectives by maximizing internal resources. In many ways, performance and asset management seek to ensure reliability and optimized use of agency resources. Risk management specifically addresses variability, uncertainty and issues that are often beyond an agency's control. Risk management does not eliminate threats to performance or asset management goals but it provides a logical, transparent framework for dealing with them.

ENDNOTES

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