

AN EXPLORATION OF ENTERPRISE RISK MANAGEMENT MATURITY FACTORS  
WITHIN TRANSPORTATION ORGANIZATIONS

by

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## SIGNATURE PAGE

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An Exploration of Enterprise Risk Management Maturity Factors within Transportation Organizations  
written by McCullough David Crawford  
has been approved for the Department of Civil, Environmental and Architectural Engineering

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## ABSTRACT

Crawford, McCullough David (M.S., Civil, Environmental and Architectural Engineering)

An Exploration of Enterprise Risk Management Maturity Factors within Transportation Organizations

Thesis directed by Professor Keith R. Molenaar

The purpose of this research is to identify and characterize the factors that distinguish a mature risk management organization in transportation. Understanding these factors will lay the groundwork for a system of measurement, or maturity model, for risk management practices in departments of transportation (DOT) at the enterprise level.

At the enterprise level, transportation agencies in the United States can benefit from the ability to define and self-assess the status of their risk management processes. An appropriate and an effective degree of enterprise risk management will provide these organizations with the data necessary to support the decision-making process while improving strategic planning and performance measurement. The majority of DOTs do not have formal risk management processes at the enterprise level.

What must DOTs have or do to develop a risk management process? This research specifically asks: What are the factors that define mature enterprise risk management within a transportation organization?

This research begins with a literature review that encompasses multiple industries and fields of study that have published findings on risk management. The factors addressed in these publications are combined and organized in a database with definitions, examples, and information on their origin. After compiling the factors, they are assessed for their applicability to the needs of a transportation organization at the enterprise level. This is performed in two steps: The first step is a questionnaire asking 72 industry practitioners to rate each of the factors in terms of its importance to risk management within transportation organizations. The second step is a workshop with a smaller group of eight industry experts used to further clarify and sharpen the results of the questionnaire.

The final product of this research is a list of factors that are important to risk management in a variety of industries that practice risk management, as well as a selection of those factors which are particularly important to enterprise risk management within transportation organizations. This list will form the basis of a maturity model from which transportation organizations can measure their risk management maturity.

## **DEDICATION**

To the ladies who made this possible: Mom, Lindsey, Kali, Kerianne and Cara. Thank you.

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## 1. INTRODUCTION

The purpose of this research is to identify and characterize the factors that distinguish a mature risk management organization in transportation. Understanding these factors will lay the groundwork for a system of measurement, or maturity model, for risk management practices in departments of transportation (DOT) at the enterprise level. In 2010, only 25% of DOTs in the United States currently employ a formalized risk management program at the enterprise level (D'Ignazio, et al., 2011). The remaining 75% do not have a formal process in place to manage the risk events inherent in the world around us. Each risk event to which an organization is exposed, from the small and mundane to the catastrophic, represents an opportunity for growth and improvement, however the built world is continually undergoing an evolution generated by failure from which these organizations, lacking formal enterprise risk management, are not well placed to learn (Petroski, 1992).

## **The Role of Successful Risk Management Practices**

In a world continually exposed to dynamic events, establishing consistent and accurate estimates of activity duration, cost, or final outcome is not an exact science, yet engineers are expected to manage these uncertain events and often make decisions based upon them before their outcomes are defined. Unfortunately, it is often the case that these predictions and the resulting decisions are subjected to events that drive them off course; a risk event. Risk can be any internal and external factors that make it uncertain whether and when an organization will achieve their objectives (International Organization for Standardization, 2009). Risk management is a “process of analytical and management activities that focus on identifying and responding to the inherent uncertainties of managing a complex organization and managing capital facilities” (D'Ignazio, et al., 2011).

A specific example of both the impact and opportunities for risk management can be found when examining cost estimation for transportation infrastructure construction. Plagued by repeated underestimation of cost, 90% of projects in this industry fail to stay within budget (Flyvbjerg, et al., 2002). It has been shown that at the project and program level, a concentrated risk analysis can more accurately portray project costs, which will ensure that decisions are made more accurately and reflect the anticipated outcome with more transparency (Molenaar, 2005). A more transparent and accurate cost estimation would have potentially enabled the projects cited by Flyvbjerg to remain with their estimated parameters.

At the enterprise level, agencies like the DOTs in the United States can benefit from the ability to define and self-assess the status of their risk management processes. An appropriate and an effective level of enterprise risk management will provide an organization with the data to support the decision-making process and improve its strategic planning and performance measurement (D'Ignazio, et al., 2011).

## **Research Question**

Knowing that the majority of DOTs do not have formal risk management processes at the enterprise level, the question arises: What must they do to achieve the necessary level of maturity within

their risk management organization for it to be successful? This question represents a broad, system-wide topic to be examined, but it must first be divided into smaller pieces to be explored. The first step, the focus of this research, is to identify the individual factors that define mature enterprise risk management within a transportation organization.

### **Methodology**

Defining the factors of mature enterprise risk management within a transportation organization requires a broad examination of the body of knowledge; an examination of similar problems from different perspectives can provide innovative solutions (Crawford, 2004). In order to synthesize risk management processes from as diverse a set of perspectives as possible, this research provides a literature review that encompasses as many industries and fields of study. These factors, originating in the literature review, are combined and organized in a list complete with a definitions, examples, and information on their origins.

Once the factors are compiled, they are assessed for their applicability to the needs of a transportation organization at the enterprise level. This assessment is performed in two steps; the first step is a questionnaire asking a large group, 72 industry practitioners, to apply their experience in rating each of the factors in terms of its importance. The second step is a workshop with a smaller group, eight industry experts, who through discussion and rounds of voting establish the importance of any factors that were indeterminate from the first round and address any additional factors that may have been overlooked in the literature review.

### **Conclusions**

This research establishes a list of factors that are important to risk management in industries of many types, then filters those factors, which are particularly important to enterprise risk management within transportation organizations. This filtered list forms the basis of a maturity model from which transportation organizations can measure their risk management maturity. The list includes 19 factors that are important to risk management within transportation organizations, including a description, example,

and in some cases a series of expansions derived from discussion during the workshop. The remaining factors are broken down into categories based on importance: Those of a lesser degree of importance, secondary importance, and those which are unimportant.

## 2. BACKGROUND

Departments of transportation (DOTs) exist within a context that is dynamic and difficult to predict. Providing transportation services to the public while relying on the political system for funding and policy support places a significant burden upon the executives of these organizations. Executives and administrators must coordinate many different resources, from political and social to personnel and financial, all while attempting to anticipate and mitigate future events that might affect their organization. “Managing risks and planning for contingent liabilities are essential components of a holistic DOT management strategy” (D’Ignazio, et al., 2011).

The following section examines the context of enterprise risk management within DOTs, first generally, before examining existing examples that may be relevant. Identified early in the literature review, the concept of organizational culture appears to permeate all aspects of risk management in general and specifically the enterprise level, yet the concept is often hard to define. To ensure this research is clear on the components of organizational culture this topic is discussed later in this chapter.

In order for the results of this research to be utilized in the development of a maturity model, a cursory examination of the elements that form a successful maturity model must be undertaken to develop congruency between the requirements of such a model and the outcomes of this research. Once the necessary background information has been established, the current state of the field is examined, and the primary avenues of exploration are examined for their relevance to transportation organizations.

### Characterization of Risk

At the enterprise level, a transportation organization itself is exposed to many different elements of society and as such the risks it faces come from many angles. Risks and risk management can be refined into categories, and processes as shown in Figure 1, below, further illustrates the diverse nature of the issue.

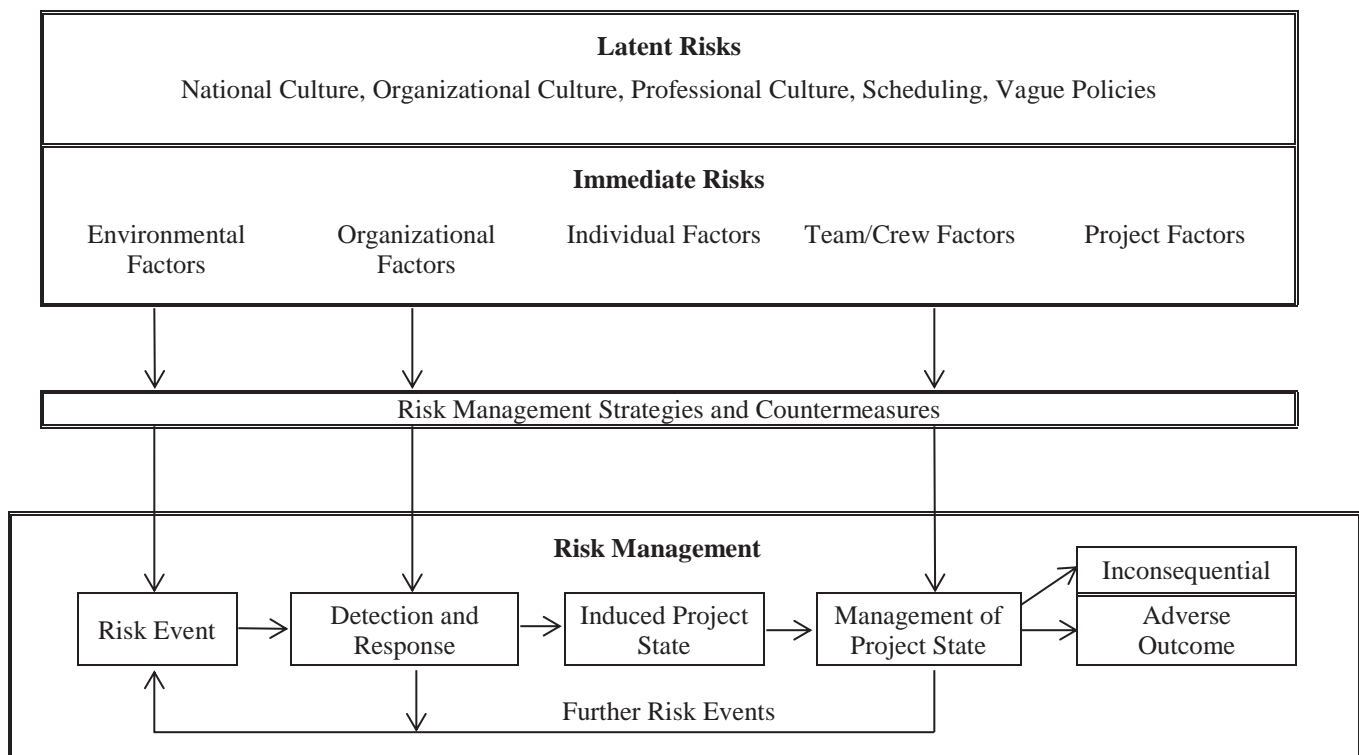


Figure 1: Risk Model, modified from the University of Texas human factors research project (Helmreich, 2000)

Surrounding environment and organizational culture are the sources of latent risks. Latent risks are existing conditions, that interact with the ongoing activities yielding a risk event (Helmreich, 2000).



The other type of risk, immediate risk, is more concrete and situation-based, and it stems from specific sources. For example, if a project is to be constructed in a seismically active region, it is more at risk for seismic damage. Figure 1 shows how risk can originate as either a latent or immediate risk and filter through the existing countermeasures and strategies to encounter the risk management process. Enterprise risk management is the consistent application of techniques that can be utilized to manage both the latent and immediate risks that filter through the existing countermeasures. Enterprise risk management is not a single task or event but a cyclical process to consistently apply and develop.

At the project level, a nearly identical risk management process has been developed, by others, detailing a method that can be applied throughout the project development process. Throughout this process, new risks will be encountered, which will lead to a cyclical interaction between the risk management process and the development process, as shown in Figure 2. Enterprise risk management is not tied to a project development process, but the same cycle of management can be applied in that context.



Figure 2: Risk Management Process (Molenaar, et al., 2010)

This cyclical process can be applied throughout the project lifecycle and can be scaled to fit the needs of any project in any situation. While a formal application of this process is not always applicable, a risk management culture that includes this as a cornerstone will benefit any size project. This cycle was

developed for use with individual projects but the same process is imperative for managing enterprise risk. The steps of this cycle can be defined as follows:

1. *Risk Identification*: Determine which risk might affect the enterprise and record its characteristics.
2. *Risk Assessment/Analysis*: Quantitatively or qualitatively examine the severity and likelihood of a risk.
3. *Risk Mitigation and Planning*: Examine the response options and decide how to implement the response. Acceptance, avoidance, mitigation and transference are the common responses.
4. *Risk Allocation*: Assign responsibility to the party who is best able to manage the potential risk.
5. *Risk Monitoring and Control*: Capture, analyze, and report the performance of the risk management process. Track identified but un-managed risks.

This risk management process originates at the project level of risk management and illustrates how lessons learned in a different context can be easily transferred to enterprise risk management.

### **Existing Risk Management Practices**

Risk management practices have been implemented throughout many industries, and their presence is beginning to grow within construction organizations. The context that these existing risk management practices provide allows this research to gather supporting knowledge and to tie any significant findings into the larger body of knowledge. By connecting what has been shown to be effective in other industries and what is developing in usefulness within the construction industry, this research will be able to introduce the transportation industry to methods of risk management beyond its current scope of practice.

The International Organization for Standardization (ISO) has developed a set of guidelines to help facilitate the development of risk management within any organization at any phase in its overall development (International Organization for Standardization, 2009). The ISO's vision of risk management practice can be broken down into the following principals:

- Risk management creates and protects value

- Risk management is an integral part of organizational processes
- Risk management is part of decision making
- Risk management explicitly addresses uncertainty
- Risk management is systematic, structured and timely
- Risk management is based on the best available information
- Risk management is tailored to fit the specific instance
- Risk management takes human and cultural factors into account
- Risk management is transparent and inclusive
- Risk management is dynamic, iterative, and responsive to change
- Risk management facilitates continual improvement of the organization

The ISO's guidelines for risk management illustrates an effective and easily translatable model for risk management, but within the construction industry risk management has been characterized more specifically by Zou et al (2009). This study describes the inherent risk culture, ability to identify and analyze risk and risk management processes that characterizes a successful risk management culture in contrast to an organization without a risk management process.

Although in the planning, staging, and performing of construction activities within the transportation industry and within other industries, formalized risk management is a relatively new concept; other industries have been practicing various forms of risk management for significantly longer periods of time. While they may not resemble the construction industry, these industries have already developed tools to manipulate and understand their environment, and the construction industry can learn many lessons from the practices of these industries. A prime example of this potential for guidance is seen in tools that can be adapted from the financial industry; many models have been created to take advantage of the wealth of numerical data available in order to predict and balance the risk of certain investments. For example, the Markov Model has been adapted for use pricing and hedging bond risk (Jarrow, et al., 1997). Can it be adapted as a specific risk management tool to aide in the pricing and hedging of material price fluctuations?

A significant amount of research exists regarding the societal construction and management of risk within the medical industry; as this industry involves large organizations tasked with serving the public, it provides a useful model for similarly wide-reaching DOTs. The organizational culture of the medical industry also bears a reasonable semblance to that of DOTs, with project-level organizations relating to departments within a hospital, program-level organizations equating to the hospital as a whole, and the enterprise level corresponding to a system or group of hospitals. This similar organizational structure allows the examination of physiological and cultural barriers that affect risk management to be adapted to the construction industry (Wakefield, et al., 2001).

The safety industry has been approaching risk management with much the same goal as the medical industry: Reduce variation and uncertainty in jobsite activities in order to reduce outcomes that have negative effects on people's lives. As such, one of the primary focuses of research in safety has gone into developing the culture of risk management, rather than simply examining the processes that bring human factors into focus (Grote & Kunzler, 2000).

The software development industry also provides a useful source for risk management strategies, because public works projects have similar hazards, which have been pointed out by Flyvbjerg. Software projects are posed with hurdles such as budget overruns, massive delays, and organizational rejection all of which can lead to project failure and a loss of trust with the client (Lyytinen, et al., 1998).

Within transportation, construction risk management practices are developing from the project level upwards. The focus thus far has been on developing tools that will allow agencies to meet their cost-estimation and cost-control objectives, focusing on the estimation of projects and the communications of those estimates (Molenaar, et al., 2010). With the focus on protecting the bottom line, from the bottom up, there has been no clear examination of a top-down approach to coordinating and synchronizing the entire body of the organization.

At the enterprise level, only 13 DOTs within the United States employ a formalized risk management program, and even fewer utilize a comprehensive approach to encompass their enterprise, program, and project levels despite the benefits of employing risk management (D'Ignazio, et al., 2011).

The organizations that are lacking risk management infrastructure are not immune to risk but simply have not implemented the tools they need to achieve the level of risk management their situation demands.

### Organizational Culture

Defining risk within any society can be difficult and often the result is an individual's expression of concern regarding hazards and how the expected impact of those hazards may affect the individual's way of life. Beyond this level, however, there is significant variation within the body of knowledge on how to construct risk management. The two primary categories that exist within the body of knowledge to define risk management are Pluralism and Cosmopolitanism. Pluralism is generally constructed as risk-averse, favoring distinct communities, a unitary self, and fixity within traditional cultural limits. Cosmopolitanism, on the other hand, is generally considered to be risk-taking, overlapping communities, with multiple selves and fluidity within human limitations (Earle & Cvetkovich, 1997). These two cultural definitions describe very different types of organization, with a cosmopolitan culture being more open to change and willing to aggressively pursue change. In order for an organization to make change and develop its organizational culture of risk management, it must hazard the risk of trying new ideas and therefore must be, to some degree, a risk taking organization. Table 1 illustrates the primary aspects of difference between the two types of organization.

Table 1: Pluralism vs. Cosmopolitanism (Earle & Cvetkovich, 1997)

Pluralism	Cosmopolitanism
<ul style="list-style-type: none"> <li>▪ Acceptance of tradition</li> <li>▪ Culture as privileged</li> <li>▪ Rationalist idealism</li> <li>▪ Goal: self and community defense</li> <li>▪ Backward facing: protecting what is</li> <li>▪ Risk averse, favoring narrow, tight, separate communities</li> <li>▪ Unitary self, fixity within traditional cultural limits</li> <li>▪ Change resulting from force</li> <li>▪ Trust as guarantee</li> <li>▪ Populism</li> <li>▪ Logic and evidence</li> <li>▪ Public participation based on stasis</li> </ul>	<ul style="list-style-type: none"> <li>▪ Tradition is critically examined</li> <li>▪ Culture as contingent</li> <li>▪ Psychological realism</li> <li>▪ Goal: self and community creation</li> <li>▪ Forward looking: living as experiment</li> <li>▪ Risk taking, favoring wide, loose overlapping communities</li> <li>▪ Multiple selves, fluidity within universal human limits</li> <li>▪ Change resulting from persuasion</li> <li>▪ Trust as risk</li> <li>▪ Representation and leadership</li> <li>▪ Persuasion and narration</li> <li>▪ Public participation based on change</li> </ul>

Examining the nature of the construction of risk can be subjective and variant between organizational cultures, resulting in multiple definitions for the same concept between different organizations (Dake, 1992). The sociotechnical approach to risk management within an organization attempts to address this issue by focusing on examining both the social and technical elements involved in an organization's culture, and also by expanding on a cosmopolitan society's need to have broad and fluid boundaries. The sociotechnical process works to develop a culture in which social and technical subsystems of the process are jointly optimized to achieve the system's purpose (Grote & Kunzler, 2000). This concept, introduced from the context of safety management, is used to link safety management, organizational culture, and sociotechnical systems design by doing the following two things:

1. Safety culture is embedded into more general considerations of culture, emphasizing interactions between an organization's material and immaterial reality.
2. Organizational design is related to safety both on the material level, directly affecting task orientation and self-regulation on the shop floor, and on the immaterial level, referring to basic beliefs about human competence and the reliability of humans and technical systems.

In other studies, this information has been used to develop a questionnaire that, when employed with direct observation and interviews, is used to audit an organization's safety culture and management (Grote & Kunzler, 2000). By applying this concept to risk within the transportation industry, multiple types of information can be gathered and identified. Figure 3 shows the origins of organizational characteristics that can be identified using the sociotechnical approach.

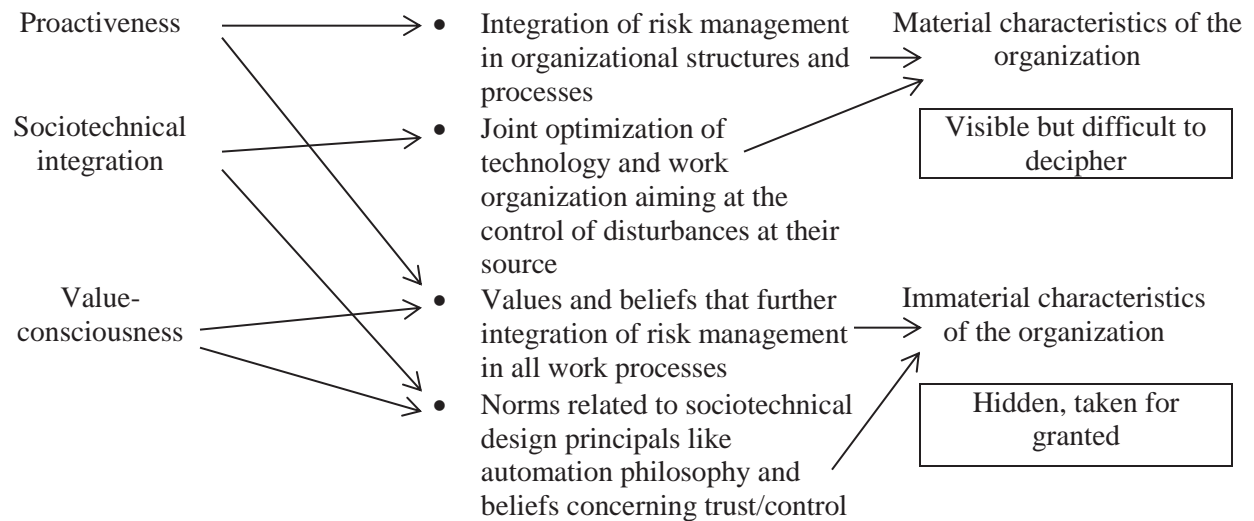


Figure 3: The Sociotechnical approach to identifying factors adapted from Grote & Kunzler (2000).

In engineering, problems are generally addressed from the purely logical and technical side; however a DOT, especially at the enterprise level, does not exist solely in this realm. Risks can be distorted, modified, and amplified through society until their relative importance is significantly changed, and the impacts can spread throughout the organization and the public sector with extensive ramifications beyond those warranted by the event (Kaspersen, et al., 1988). The enterprise level of a DOT is uniquely situated to manage the portrayal of an event and the resulting risk related behavior; however such a culture is normally considered beyond the scope of an engineering organization. This dichotomy represents a situation in which a more cosmopolitan approach to risk management will yield significant benefits and further illustrates the need for enterprise risk management in DOTs to be a truly inclusive process. A more inclusive risk management process would allow a DOT to respond to a risk event in ways that are normally beyond the scope of traditional engineering management processes.

### Maturity Models

The concept of the maturity models in the context of this study originates in software engineering. The Capability Maturity Model (CMM) is the foundation for project and organizational maturity models throughout software engineering as well as studies in other fields, including construction management (Paulk, et al., 1993). The CMM's focus is on continually evolving and improving stepwise processes of

development (Herbsleb, et al., 1997). The CMM is a process for developing the naturally occurring, ad hoc, and chaotic early stage processes into mature and disciplined processes. While the tool was created for the development of software, its ability to appraise process maturity and facilitate the evolution of the development process is readily transferrable to a transportation risk management situation, as the nature of these processes are similar. In both cases, an organization is facing a unique project with a number of risk factors threatening it. These factors must be controlled to ensure the project is completed on time, within budget, and to specification. The CMM process is detailed for transportation construction management in Table 2, a simple modification of an existing software model.

Table 2: The Capability Maturity Model Process modified from Herbsleb, et al. (1997)

CMM Level	Major Characteristics
1. Initial	<ul style="list-style-type: none"> <li>▪ The risk management process is characterized as ad hoc, and occasionally even chaotic. Few processes are defined, and success depends on individual effort and heroics</li> </ul>
2. Repeatable	<ul style="list-style-type: none"> <li>▪ Basic project management processes are established to track cost, schedule, and functionality. The necessary process discipline is in place to repeat earlier successes on projects with similar applications.</li> </ul>
3. Defined	<ul style="list-style-type: none"> <li>▪ The risk management process for both management and engineering activities is documented, standardized, and integrated into a standard process for the organization. Projects use an approved, tailored version of the organization's standard risk management process(es) for developing and maintaining contingencies.</li> </ul>
4. Managed	<ul style="list-style-type: none"> <li>▪ Detailed measures of the risk management process and management quality are collected. Both the risk management process and management are quantitatively understood and controlled.</li> </ul>
5. Optimizing	<ul style="list-style-type: none"> <li>▪ Continuous process improvement is facilitated by quantitative feedback from the process and from piloting innovative ideas and technologies.</li> </ul>

In the context of software development, levels of the CMM process are assigned certain Key Process Areas, which define what elements are to be focused on at that level of maturity. In transportation risk management, these process areas are not defined, leaving a void when it comes to identifying the maturity of the risk management process with a DOT.

A useful adaptation of the CMM is the Organizational Project Management Maturity Model (OPM3), which is a tool developed to evaluate an organization's ability to identify which practices are



desirable, what the state of its own practices are, and finally how exactly it should go about improving itself (Fahrenkrog, et al., n.d.). In order to construct an OPM3 model for a specific field, the following basic components must first be identified:

- Best Practices in Organizational Project Management
- The constituent Capabilities that lead to progressive maturity and indicate the existence or attainment of Best Practices in the organization
- The “navigation paths” needed to traverse these Capabilities on the way to increased maturity in the targeted Best Practices
- One or more observable Outcomes signifying the existence or attainment of each Capability
- One or more Key Performance Indicators, which are the means of measuring each Outcome
- Model context, including the Organizational Project Management Process and the stages of process improvement

With these factors identified, it becomes possible to develop an OPM3 model which has the ability to assess and direct growth of the specific organization in question.

Applying the general concept of a maturity model to civil engineering project management, the general methodology has traditionally been to identify a set of management factors that can be evaluated qualitatively through a survey process in order to rate the organization’s maturity (Ibbs & Kwak, 2000). This methodology can be very effective at rating the generally nebulous topic of management; however, it can also present skewed data if participants are unable to correctly score themselves. Therefore, when assessing an organization’s maturity, it is important to examine multiple categories, such as strategic use, organizational structure, penetration of the system, vision, drivers, and lessons (Holland & Light, 2001). With multiple categories that span the entire system in question it is possible to identify some factors that can be measured quantitatively as well as those which must rely on qualitative analysis. By balancing a

qualitative and quantitative approach, the organization's status can be captured in higher definition, and the flaws of each approach are balanced by the strengths of the other.

The resulting combination of the available information on maturity models, when applied to the construction industry at the project level, is a model simply defined by five attributes, each with four levels of maturity. The five attributes that were chosen to embody the organization's risk management capabilities are (Zou, et al., 2009):

1. Management (people and leadership) capability in relation to risk. The ability of the management structure to adapt and mitigate events when managing a risk.
2. Organizational risk culture. The organization's attitudes, character, and natural tendencies toward the management of risk.
3. Ability to identify risks. The organization's ability to recognize risks when exposed to them.
4. Ability to analyze risks. The organization's ability to successfully quantify risks and identify their sources and likely outcomes.
5. Development and application of standardized risk management processes. The organization's pursuit of a more formal and universal risk management process.

These five attributes do not take into consideration the entirety of every organization, but are considered sufficient for construction enterprises (Zou, et al., 2009). This specific example is drawn from a study of the commercial building sector at the project level; however the nature of activities that organizations are exposed to here can be applicable to enterprise risk management within transportation organizations as they face many similar risk events.

Each attribute within the organization can then be compared to a simple, four-level scale: initial and ad hoc, repeatable, managed, and optimized. This model, though intended for use at the project level, can be used to inform the examination of the literature for factors that define risk management. For example: What characteristics does an organization need to identify or analyze risks?

When employed within a construction organization, this method can identify the area within which the organization is the weakest and most susceptible to risk. This information can then be linked to

a methodology that defines the steps required for improvement between levels, providing organizations a roadmap for their development as risk managers once the factors for enterprise risk management have been implemented within its framework.

### **The Current State of the Practice**

The transportation industry has been slow to adopt the enterprise risk management processes. There is a demonstrated need for risk management at the enterprise level for DOTs in the United States; however only 13 DOTs currently have an enterprise level risk management organization, and even fewer have one which encompasses the enterprise, program, and project levels (D'Ignazio, et al., 2011). D'Ignazio's study also concluded that there is a decisive benefit to employing an enterprise-level risk management process within DOTs.

The enterprise level of risk is uniquely suited to help facilitate a cosmopolitan approach to risk management for the projects it oversees, supporting the project level's development of a more fluid and inclusive culture (Earle & Cvetkovich, 1997). However the factors that define a mature risk management organization at this level are ambiguous, leaving the executives of the DOTs evaluating their risk management procedures based solely on their own experience and judgment. By addressing problems through a systems-based approach, a holistic approach that is more feasible from the enterprise level, the entire organization is able to be more effective and reliable when dealing with the challenges it faces (Reason, 2000).

### **Basic References and Sources of Information**

To draw upon the existing work of others and to synthesize the most complete answer possible, it is necessary to gather information from three primary areas within the general body of knowledge. The first area is that of organizational culture around risk management, which provides insight into construction and implementation of organizational culture. The second area of interest is the body of knowledge surrounding maturity models and maturity measurement. By examining what other studies

have found useful in measuring maturity it becomes possible to understand with greater clarity what may be useful to define organizational maturity within the transportation industry. The third area is that of existing risk management practices, which provides further insight into what is already working in real-world organizations. The synthesis of these three sources answers the question: What is a mature risk management organization?

As discussed earlier, the solution with the broadest possible foundation, which encourages information to be gathered from other fields of study as shown in Figure 4, is often the most successful. Enterprise risk management can then draw upon similarities within these fields for inspiration. The primary references for this research are existing research papers into organizational risk management and studies that examine risk management at other levels of transportation construction management. This study will include examinations of medical and petro-chemical safety risk management cultures and software development, as well as existing practices for risk management at the project level in transportation.

The field of lean manufacturing is a valuable source for management techniques that can be useful when implementing a new management structure, in order to make the transition easier and permanent (Dennis, 2010). Lean manufacturing also features a number of useful and innovative tools which when applied to risk management can help achieve the ISO's recommendation for a risk management organization to remain responsive and continually improving (Mann, 2010).

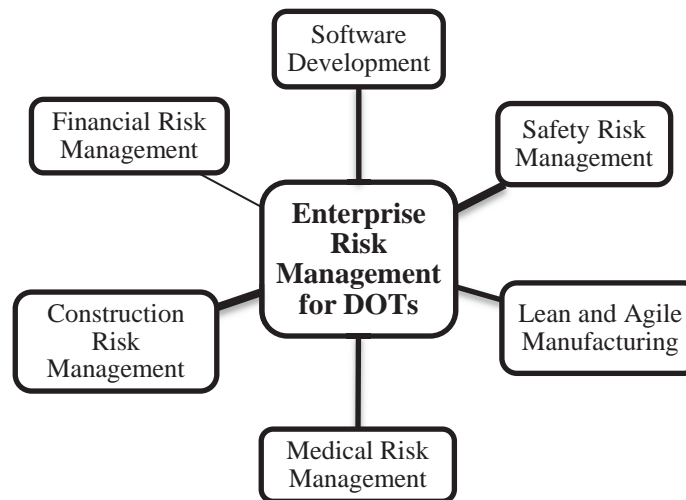


Figure 4: Sources of inspiration for enterprise risk management in DOTs

Risk management at the enterprise level should be a function of a myriad of different factors. Because it exists at the crossroads of numerous facets of society, it must respond to and deal with events originating in multiple theaters all while maintaining the public's trust and goodwill.

### Point of Departure

This research compiles a list of factors from the body of knowledge that characterize the maturity of organizational risk management with the intent to identify the specific risk management needs of DOTs. By defining what constitutes a mature risk management organization for a DOT, these factors will help characterize the potential next steps for development of a risk management culture, as well as help DOT executives gauge their current situations. This research will also provide a standard starting point of evaluation for any DOT's risk management procedure and hopefully increase the simplicity with which a DOT can implement the fundamentals of risk management. The long-term goal is a toolbox of maturity models and development processes for the entire industry.

This thesis will be a synthesis of a broad section of the body of the knowledge, with the intent of finding and rating the most important factors necessary to define mature enterprise level risk management

within DOTs. By uncovering factors that define risk management within transportation organizations, it becomes possible to develop specific tools and implementation strategies. This research can serve as the bridge between the NCHRP study 20-24-74, which identified the need for risk management with transportation organizations, and future research, which will develop the specific tools to implement risk management within these organizations.

### 3. RESEARCH METHOD

This research is composed of two phases. The first phase is a literature review and formal content analysis of the existing knowledge pertaining to risk management culture and organization as well as maturity models to compile a list of factors that define mature risk management. The second phase orients the knowledge and ranks the factors gathered from the body of knowledge as a whole to the specific needs of transportation organizations; this information is gathered through a survey and workshop conducted with industry experts, who are asked to evaluate and rank the factors according to their relevance and applicability to DOTs at the enterprise level.

## Phase 1: Literature Review

The literature review is conducted by surveying and synthesizing publications from disparate sources in an attempt to introduce as broad a foundation of factors as possible to the field of enterprise risk management. The search moves outside of the generally accepted body of “expert” risk management knowledge for construction organizations, introducing solutions that derive from approaching problems in different contexts, which can be a remarkable source of innovation when attempting to solve management problems (Duff, 2003). Another source of potentially innovative solutions is “lay” knowledge, or common practices within different industries; utilizing such sources can be more effective than looking to similar organizations when performing a risk management study (Rasmussen, 1997). When defining an organizational structure that will be useful in providing risk management services, studies have shown that including such non-expert knowledge and approaching problems from a different context can often yield innovative and useful answers to the problems faced.

The majority of the research is conducted through online databases, searching for journal articles and books. The primary online databases are Google Scholar, the ASCE Research Library, and Engineering Village; the uniform resource locator addresses for these databases are included in the bibliography. In these databases the following search terms were used to generate the results:

- risk management culture
- risk maturity model
- project management maturity model
- project management process maturity model (also known as PM model)
- organizational maturity model

## Content Analysis

As the literature review will be covering a significant breadth of knowledge, a method of analysis that is both mutually exclusive and exhaustive will yield the highest quality of resulting factors that are generated. Content Analysis is the most appropriate choice for this research as it allows the distillation of



many diverse factors from a variety of disparate sources into a series of categories that are mutually exclusive and exhaustive (United States General Accounting Office, 1996).

This study is not of the size to allow complete content analysis, nor would it be appropriate. A complete content analysis measures the number of occurrences of variables throughout the content analyzed in order to construct relationships between their frequency and importance in an established field of content (Holsti, 1969). A full content analysis could be applied to the documents of existing risk management organizations within construction to establish which methodologies and cultures are most prevalent. This study, conversely, is focused on the relatively new field of enterprise level risk management in DOTs and as such requires solutions from a broader selection of sources. Thus it draws on an unstructured selection of scholarly research from a range of fields. After an initial survey, some fields proved to have more relevant information, but a source will not be ignored simply for originating beyond the initial areas of focus.

In order to populate the factor database, described later, the first three steps of the content analysis described by Neuendorf is utilized (Neuendorf, 2002). The first step, theory and rationale, has already been discussed. It is clear that DOTs are not fully knowledgeable about risk management practices at the enterprise level, and precisely what risk management at that level should entail is also not clearly defined. It is also clear that, when performing this type of research, it is vital to look beyond traditional or closely-related sources of information in order to truly develop innovative solutions. The purpose of this analysis is to identify factors that have been used to define risk management in other contexts and present them in a fashion that is easily accessible to executives of DOTs.

The second step defined by Neuendorf, conceptualization, begins to define the factor database. There are four types of variables that will be examined from the literature in order to construct broad categories:

- Culture
- Organizational Structure
- Management Tool

- Situation

These categories and the factors that form them can be applied to an organization to answer questions of this nature: Does the organization have a mature risk management culture or a full risk management toolbox? For the purposes of this content analysis, the unit of analysis will be the entire article, and the instances of occurrence within each article will not be counted instead if a variable appears in an article it will be counted once no matter how many repeated occurrences there are.

The third and final step in this abbreviated version of a content analysis is to organize and report the occurrences of the variables that will be developed into the factor database.

The factor database is used to compile occurrences of the variables in a fashion that allows their easy digestion by a panel of industry practitioners. With this consideration in mind, two versions of the database are needed: the first tabulating the occurrences of the variables throughout the sampling of the sources and the second for use in the workshop with industry experts. With two versions of the database only information that is pertinent to the experts review, the information about the definition of the factor, will be introduced to them, thereby reducing their burden of review.

The first database, in Appendix A, tabulates the risk management factor, its type, its field of origin, and the documents in which it was found. This organizational model allows for an easy examination of which factors, according to the limited scope of this literature review, are most prevalent throughout different industries and research pertaining to them. Should this line of inquiry progress, this database would be a useful judge of the common practices in other industries and of cross-industry correlations.

Modifying the first database, the second database, in Appendix B, eliminates the information on the source and nature of these factors and instead focuses on what the factors are and their application to the enterprise-level risk management for DOTs. In order to achieve this different focus, the factors are listed with their name, a short description derived from the source, and a hypothetical example of the factor applied to a DOT. The intent for this second database is to allow the DOT executives, when

presented with the information in a questionnaire format, to easily understand and assess the usefulness of a particular factor in their own risk management.

## **Phase 2: Ranking of Factors**

Following the definition of this initial set of factors, an exploratory step begins whereby the synthesized starting point is applied to the specific situation of DOTs. The factor database, with information regarding the application of the factors, is presented to a panel of industry practitioners in a survey. This process will be followed by a workshop, populated with a panel of industry experts drawn from amongst the original group of participants. In order to achieve consensus among a group of diverse experts with potentially differing opinions, a formalized decision-making and ranking process must be followed. This step is particularly important when objective data is unattainable, either due to the nature of the questions themselves or scope of the data gathering process; this ranking process can generate a cohesive judgment from a panel of experts and has been shown to be particularly effective in construction risk management studies (Hallowell & Gambatese, 2010).

## **Nominal Group Technique**

While a multi-round Delphi method study has been shown to be preferable for qualitative data gathering in construction engineering and management studies, the Nominal Group Technique (NGT) has been shown to be an acceptable alternative when the constraints of a Delphi study cannot be met (Hallowell & Gambatese, 2010). NGT originated in 1968, combining psychological studies of decision conferences, management science studies of aggregating individual judgments, and social-work studies of citizen participation in program planning as a method of effectively combining expert opinions (Delbecq, et al., 1975).

The traditional NGT, as summarized by Rohrbaugh (1981), consists of six steps:

1. Silent generation of ideas in writing
2. Round-robin feedback from group members to record each idea in a terse phrase
3. Discussion of each recorded idea for clarification and evaluation

4. Individual voting on priority ideas through rank-ordering or secret ballot
5. Brief discussion of preliminary vote
6. Final individual voting through rank-ordering or secret ballot with the group decision being mathematically derived

For the purposes of this study, the traditional NGT has the same failings as the Delphi method, in that both would require significantly more time and commitment from the industry experts than is available at this stage in such a study. A traditional NGT or Delphi study would also take more time to implement than is necessary to achieve the level of accuracy that is needed for this preliminary research, and the necessary information can be obtained through other, more direct, means. For this reason, a modified version of the NGT is being presented here and referred to as the iterative expert opinion study.

### **Iterative Expert Opinion Study**

The purpose of the iterative expert opinion study is to provide the same quality of decision and relative ranking as the full NGT, while only requiring the participation of the industry experts for a single, partial-day workshop and short questionnaire.

When identifying potential experts, certain areas of existing expertise were examined. In Table 3 these areas are identified along with the minimum qualifications adapted from Hallowell and Gambatese (2010).

Table 3: Identifying Expert Panelists for the Questionnaire

Characteristic	Minimum Requirement
Identifying Potential Experts	<ul style="list-style-type: none"> <li>▪ Membership in a nationally recognized committee in the focus area of the research</li> <li>▪ Known participation in similar expert-based studies</li> <li>▪ Executive of a DOT with an active enterprise level risk management program</li> </ul>
Qualifying panelists as experts	<p>Must meet four of the following criteria related to the research</p> <ul style="list-style-type: none"> <li>▪ Primary or secondary author of at least three research articles or reports</li> <li>▪ Invited to present at a conference</li> <li>▪ Member or chair of a nationally recognized committee</li> <li>▪ At least five years of experience as an DOT executive or in research related to this field</li> <li>▪ Advanced degree in the field of civil engineering or related fields (minimum of a BS)</li> <li>▪ Professional registration such as Professional Engineer (PE) or similar</li> <li>▪ Actively involved in a DOT's risk management program</li> </ul>

In this study, the first two steps of the traditional NGT - generation and recording of ideas - have been replaced with the Content Analysis and Factor Database discussed previously. While the third step is mitigated by thorough explanations and examples of each factor in the database, it is also addressed during the questionnaire period through continued communication between the respondents and the investigators. This communication also serves as a vector for the generation of new factors, should there have been any omissions in the factor database.

The questionnaire consists of each member of the panel receiving the factor database with the definition of each factor and example. To illustrate the format in which the factors will be presented, an excerpt from the questionnaire is presented below:

#### **Visibility/Involvement of Risk Managers**

*Description:* The agency's risk managers are an active part of the organization's missions and operations.

*Example:* In the agency, employees know where to find or how to contact a risk manager.

The complete survey is included in Appendix C.

While working on this portion, the experts are asked to score the factors in terms of their importance towards determining maturity within a risk management organization. At this phase they are not asked to rank each in order (1, 2, 3...); instead they are asked to rank their qualitative importance to the risk management process. This technique is used because it amplifies the decision-making process, allowing the decision makers a chance to respond with less prejudice (Goodwin & Wright, 2004). The question the respondents are asked to address is:

- How important is this factor in determining a transportation organization's level of maturity?

While the focus is on the importance of the factors, the numerical score is shown to help the respondents understand the relative weight of the ratings. The rankings are made according to the descriptions of each level of importance shown in Table 4.

Table 4: Importance Scale

Ranking	Numerical Score
Very Low Importance	0
Low Importance	1
Medium Importance	2
High Importance	3
Very High Importance	4

The questionnaire itself is conducted in three phases. The first phase consists of internal testing in which members of this research committee complete the questionnaire and examine it for errors and duplications. No results from this phase are included in the final results. In the second phase, the questionnaire is distributed to a small group, eight people. These eight experts will eventually form the workshop panel. As the second round revealed no significant changes to the survey, the results from this phase shall be included in the final dataset. In the third round, the questionnaire is distributed to the large

group consisting of 72 people. This group of respondents provides their feedback to form the majority of the final dataset.

Factors that receive a majority, 55% or more, of responses indicating that they are of very high or high importance in the questionnaire are considered important for future study. Those which receive a significant portion, 30% or more, of responses in the low and very low importance categories are considered unimportant for further study at this time. Those factors which fall in the middle ranking, which do not have a clear majority in favor of either importance or non-importance or which meet both thresholds, are considered indeterminate.

### **Workshop**

In the final phase of this study process, a small group of industry experts convened for a validation workshop, which was conducted through a teleconference and internet-based meeting software package. The purpose of this workshop was to solidify the relative position of any factors which were indeterminate or were identified by the panel members during the questionnaire as missing from the questionnaire itself. The discussion proceeded until the group collectively reached consensus regarding the importance of the factors.

When selecting the industry experts to participate in this study, the focus was on experts who possess an intimate knowledge of the needs and functions of enterprise risk management within a transportation organization. A second and equally important consideration for selection was experience within the academic field of enterprise risk management research, which would mean a proven ability to debate the topic. The workshop panelists must have a proven ability to interact fruitfully within the realm of academia, as their primary addition to this research is their discussion. Their expertise must also be applicable to the situation, in order to allow them to provide more insight into actual functions of enterprise risk management within transportation organizations. The following Table 5, details the requirements for participation in the workshop.

Table 5: Identifying Expert Panelists for the Workshop

Characteristic	Minimum Requirement
Necessary Academic Experience	<ul style="list-style-type: none"> <li>▪ Participate in previous enterprise risk management research</li> </ul>
Qualifying panelists as experts	<p>Must meet one of the following criteria related to the research:</p> <ul style="list-style-type: none"> <li>▪ State or Federal transportation organization executive</li> <li>▪ AASHTO, FWHA, or TRB committee chair</li> <li>▪ Provide consulting services for enterprise risk management within transportation organizations</li> </ul>

This workshop will be conducted in a series of rounds. The first round, utilizing the same online survey tool as the questionnaire discussed previously, will ask this group of experts to rank the factors according to the same question as in the questionnaire:

- How important is this factor in determining a transportation organization's level of maturity?

However in order to facilitate a meaningful consensus, the response options available are simplified. The following table includes the condensed ranking options for the workshop.

Table 6: Workshop Ranking Options

Ranking
Very Low or Low Importance
Medium Importance
High or Very High Importance

At the completion of the first round, those factors which have a consensus amongst the workshop attendees are not reviewed further, and their updated ranking is used in the final determination of their importance. Consensus is defined at the same threshold as used in dividing the factors at the end of the questionnaire: 55% or more of responses in a single grouping. Those factors which are still indeterminate, with no clear consensus, are the focus of a discussion amongst the workshop attendees. After a short period of discussion, wherein the workshop facilitators encourage those who ranked the



factor in each of the three categories to discuss why they ranked the factor as they did, a second round poll, with just that factor, is presented allowing the attendees to rank the factor again in light of the discussion they just partook in. Should the factor still not reach consensus, a discussion is encouraged again, and a third round poll is presented. This process is repeated until either consensus is reached or it becomes clear that it shall not be reached. Consensus generally occurs by the end of the fourth round with the small sample size being used for the workshop, approximately ten people. There were abrupt trends as individuals' opinions and rankings shift. Those factors which, at the end of the fourth round, are still indeterminate will be classified as indeterminate or of secondary importance to future research.

The iterative expert opinion study described above includes the same process as the traditional NGT but shortens the timeline and simplifies the expert panelists' involvement. By reducing the involvement of the industry practitioners, it is possible to explore the possibility of a topic which the industry has not shown an interest in pursuing itself. In order to generate interest from the members of industry for a more in-depth study, it would be necessary to first show that there is some value and applicability to the work being done. The value of enterprise risk management has already been established by other studies, but not to a degree to warrant full-fledged participation by the industry experts. The shortened method used in the present study provides a source of factors that originated in other industries' successful risk management programs and through the study of industry practitioners addresses the factors' relevance to transportation organizations and confirms the inclusion of all relevant factors by allowing the practitioners to add their own factors. The workshop phase combines the experience of the large panel of industry practitioners, the body of knowledge with the highly specific knowledge, and experience of the industry experts in order to expand and more clearly define the factors.

#### 4. ANALYSIS & RESULTS

The results of this research are a set of factors that can begin to define the level of risk management maturity within a transportation organization. These factors originated in broad categories uncovered during the literature review and were distilled during the content analysis into their root form. With the factors defined, the next step was to test them for relevancy within the specific context of transportation organizations. Through the survey and workshop process, industry practitioners applied their knowledge and experience to the predefined factors in order to divide them into three categories. The categories are: factors that are important to risk management maturity, factors that are of secondary or supporting importance, and factors that are unimportant to the measurement of risk management maturity within transportation organizations.

## Content Analysis

When undertaking the content analysis, four primary concepts were identified and pursued as being meaningful in identifying risk management maturity: organizational culture, organizational structure, management tool, and existing situation. These four areas were identified following a broad analysis of multiple industries, which drew on many sources of knowledge to help create a bank of information to define a future maturity model.

The notion of organizational culture is often confused with the more easily quantifiable organizational climate, and as a result there has been significant research into defining the difference. Initially, where climate was constructed as the evolution of Lewin's social psychology of person and situation interaction, culture was derived from social interactionism (Lewin, 1951) (Mead, 1934). However, more recently it has been argued that these two traditions are in fact simply differences in interpretation of the same phenomenon instead of completely different phenomenon (Denison, 1996). The value of this interpretation when identifying the maturity of an organization lies in the ability of culture and climate to be measured. While there may be differences in understanding of the same phenomenon it is important that they yield measurable quantities to be studied. Culture is presented as general concepts, such as beliefs, attitudes, norms, rules, and practices, all of which tend to lack in empirical data to help support their ability to characterize an organization; however narrowing these concepts down to the measurement of attitudes or practices within a specific context yields the concept of a climate (Mearns & Flin, 1999). Within in an organization it is relatively easy to measure the degree to which individuals perceive levels of application of certain practices and the prevalence of specific attitudes. Thus by identifying and examining a series of specific risk management climates, through the identification of factors that define such climates within a DOT, it will be possible to understand the maturity of the organization's overall risk management culture.

Organizational structure defines a specific configuration of activities and responsibilities that is both enduring and persistent. More specifically, for the purposes of this research, organizational structure will refer to the formal configuration of roles, procedures, and the prescriptions of authority sometimes

referred to as organizational framework (Ranson, et al., 1980). These factors have great value in the context of measuring the maturity of an organization, as it is very simple to review organizational charts and existing standard procedures to gauge what is implemented. While the degree to which the organizational charts are implemented and integrated within the actual daily workings of the organization is a question of organizational culture, their existence and completeness is a matter of organizational structure.

The concept of a management tool is easily defined as a specific process that can be implemented within the organizational framework of an organization. It can be a specific plan for standardized situations, a modeling procedure to predict outcomes given known inputs, or regular meetings and communications to disseminate information throughout the organization. During the population of the factor database, this factor type appeared the most frequently likely due to the specific nature of the type itself. Where there are only a few overarching cultural attributes that can be attributed to successful risk management, there are many specific tools that have been developed to function within the specific context of a particular organization providing at least a partial explanation of the prevalence of risk management tools.

The final concept identified is the organization's surrounding environment or the situation it is in. Specifically this study focuses on the enterprise level of an organization; however the level of risk management developed at lower levels and how they support the enterprise can shape the needs at the enterprise level. The degree to which the risk is transported up the organizational tree will shape how much risk the enterprise level is exposed to. This relationship has been shown to define how complete the risk management needs to be (Mearns & Flin, 1999). In much of the literature reviewed, the context of the organization's exposure to risk - that is to say how much the enterprise itself is exposed to risk in this context - is a significant factor in determining the quality of the risk management needed. However for the purposes of this study, this factor would be meaningless, as all the enterprises in the country will be exposed to relatively identical risks.

## Factor Database

As factors were identified, they were inserted in the factor database included in Appendix A, where their occurrences were recorded as well as the general field of study within which they have been found. Recording this information allows future research within the fields from which the factors originate to be conducted more efficiently.

The second factor database, simplified from the first database, was used as the source of the questionnaire. These questions draw upon the sources in which the factor was identified and industry experience to generate a definition and hypothetical example. These will both be understandable and applicable to the enterprise risk managers who will be taking the questionnaire. This database (located in Appendix B) once converted to the questionnaire, the transcript of which is located in Appendix C, will be distributed to a panel of industry practitioners who have participated in previous questionnaires in the subject area.

## Survey Results

The questionnaire was distributed to 72 members of both state and federal departments of transportation. Of these, 29 individuals completed the questionnaire, providing a large enough sample size for some factors to develop clear rankings of importance. The results of the questionnaire are included in Appendix D and are modified to exclude the identifying information collected to account for duplicates in responses. Table 7 lists the factors which, after the completion of the survey, were considered important and those which were considered unimportant.

In order to identify meaningful rankings of the factors, two methods were employed to analyze the results. The first method examined responses to the survey directly looking for those factors that were clearly ranked highly those that were not. The second method took a meta-analysis approach and examined the interdependencies of the responses in an attempt to uncover any meta-factors or underlying relationships.

The responses from the survey with the five levels of importance did not result in any factors clearly falling into a single category of importance. In order to make meaningful connections and to accurately answer the question of which factors are important to enterprise-level risk management within transportation organizations, the rankings were simplified and combined into three categories. The five initial categories were: Very High Importance, High Importance, Medium Importance, Low Importance and Very Low Importance as listed in Table 4. Table 6 lists the simplified ranking: High and Very High Importance, Medium Importance and Low and Very Low Importance.

These three ranking levels are the same that were used in the workshop process, shown in

Table 6, as they reflect the actual goal of this research, which was to establish the factors important to enterprise-level risk management. Appendix D shows the results by these simplified rankings as well. Factors that received 55% or more of the responses in the high and very high category are considered important while those that received 30% or more in the very low and low category are considered unimportant to this research at this time. If a factor did not achieve either of these thresholds, or if it simultaneously achieved both, it is considered to be indeterminate; the indeterminate factors will be the focus of the workshop. These thresholds resulted in the following breakdown of the factors into the important and unimportant categories listed in Table 7.

Table 7: Important and Unimportant Factors after Survey Completion

<b>Important Factors</b>	<b>Unimportant Factors</b>
Visibility/Involvement of Risk Managers	Communicate Cost Uncertainty
Risk Management Knowledge Sourced from All Personnel	Outside Experts on Decision Making Teams
Regular Risk Management / Risk Identification Workshops	Risk Management Communications
Use of Risk Management to Identify Contingency	Risk Management Incentives
All Employees take Responsibility for Risk Management	Risk Database
"No-blame" Risk Management Culture	Actively Balanced Risk Portfolio
Risk Management Training	Risk Management Mapping
Risk Management Strategy	Analytical Risk Modeling Tools
Acceptance of Risk Environment	Opportunity Management

Finally there were 13 inconclusively ranked factors and one factor, Clear Risk Management Organizational Structure, which fell into both the important and unimportant categories; these factors are listed below in Table 8.

Table 8: Inconclusively Ranked Factors after Survey Completion

<b>Inconclusively Ranked Factors</b>	
Risk Management at the Project Level	Consistent Risk Management Definitions
Risk Management Committee	Uniform Documentation of Risk
Risk Management Officer	Awareness of the Relative Severity of Risks
Risk Management Policy	Risk Management is Viewed as a Systems Issue
Risk Management Plans	Visible Risk Management Metrics
Risk Management at the Program Level	Risk Management Goals
Risk Management Accountability	

### **Factor Analysis of Survey Results**

In order to explore the possibility of an underlying pattern or the existence of meta-factors a factor analysis is necessary. However, the matrix math used in these processes requires more responses than factors; therefore four factors were removed based on their limited correlation, within the matrix calculations, with the other factors.

While powerful tools, factor analyses are susceptible to the noise inherent in data collection: this being the case, the larger the response matrix, the more reliable the resulting meta-factors will be (Mulaik, 2009). Due to the small response size in the present study, the resulting meta-factors are highly unreliable and are included in Appendix E only for reference purposes.

When attempting to perform the factor analysis, the intent was to uncover any latent groupings of factors. Factors that combine to form a larger, more inclusive, factor that defines an entire feature of an organization would allow a maturity model to approach an organization with a broader perspective instead of simply focusing on the details as only examining the individual the factors defined by this research would limit it to.

### **Validation of Survey Results**

As it was not feasible to perform a factor analysis on the data produced by this size of survey, an alternative method was required. The questionnaire also included a user submission feature through which the respondents could suggest further factors, that from their experience, they felt should be considered. These submissions are included in Appendix F, along with the method of integration used to include them in the existing database. The aim of this method of allowing the survey respondents the chance to provide their own factors was to expand the knowledge base for this research to include the experience and knowledge of all who participated. All of the respondent's submissions, however, fell within existing factors.

For example, a survey respondent added a factor titled "communication regarding the need for the organization to include regular meetings to discuss the status of risks." This factor falls comfortably



within the bounds of a regular form of communication specified by the existing factor. The existing definition for risk management communications was that the agency communicates regularly on the status of their risk management.

Another example of a survey response that focused on a specific facet of an existing factor was the inclusion of a factor titled: “integrated performance measures with the intent of examining the interaction between quality, durability and safety measures for a particular item.” This description is an example of a systems approach to risk management, examining the factors that surround the specific risk and weighing it in light of its context. Risk management does not occur in a vacuum; instead there is a multitude of interacting elements that shape any given risk and how the enterprise experiences it.

Three of the respondent’s additions can be grouped together to form one idea: management, or leadership buy-in. The three respondent-added factors are leadership support, management support, and budgeting and human resources nimbleness. Management buy-in can be a specific subset of the factor that all employees take responsibility for risk management, or it can form its own factor. However, the value of it forming its own factor is questionable, as this level of risk management is impossible to achieve without the buy-in of the organization’s leadership. Therefore, it would seem that this concept would best fit as a specific check when confirming the buy-in of all employees: Check not only the lowest level of employee but also the highest.

Another respondent’s addition would specify that the employee’s vision of risk management be congruent with the organization’s vision. This notion would again seem to be inherent in a system where all employees are taking responsibility and are active in the risk management program, but it would potentially serve as a valuable metric for assessing the success of the risk management communications related to the organizational strategy for risk management.

Some of the respondent’s additions are tangible risks faced by transportation organizations, however they are risks that are generally the responsibility of project or program-level managers and would not be the concern of the enterprise-level management. Examples of this type of addition include factors for worksite safety, environmental mitigation, and design errors.

All factors submitted by the questionnaire respondents either fit within an existing factor, as a specific case, or present case which is not applicable to the enterprise level of risk management. This result serves as validation of the factors initially included in the survey; had there been other factors important to the industry, it is likely they would have surfaced when these practitioners were surveyed. The highly specific nature of these cases is indicative of a recent experience informing that particular respondents' biases focus on the particular details within an individual factor. Had there been gaps in the literature review containing factors that are applicable to transportation organizations, the questionnaire respondents could have been expected to include them in their responses.

### **Workshop Results**

The survey was taken by a broad cross-section of the industry; by utilizing a more exclusive group of experts with highly relevant experience, the workshop will be able to clarify the importance of the indeterminate factors. Specifically by presenting the factors in an open-ended format, the workshop allows the experts to shape and re-define the factors so they fit exactly within their experience in the transportation industry. The focus for the workshop is on the factors that were not conclusively placed as either important or not important by the survey process.

From the list of indeterminate factors, the workshop attendees in the initial round of voting were able to clarify the position of nine of the factors. The following factors moved from indeterminate to high or very high importance in round one.

- Risk Management at the Project Level
- Risk Management Policy
- Risk Management at the Program Level
- Risk Management Accountability
- Consistent Risk Management Definitions
- Visible Risk Management Metrics

While no factors were demoted to low or very low during the workshop process, some factors were solidified at medium importance in this round.

- Clear Risk Management Organizational Structure
- Risk Management is Viewed as a Systems Issue
- Risk Management Goals

The remaining five factors were still indeterminate after the first round. Therefore in the second round, they were examined in more detail with the panelists discussing their reasoning for their ranking selection in round one.

The second round resulted in the clarification of the remaining factors, and the discussion yielded some valuable insight into the factors and how they relate to the specific situations of the panelists' organizations. After round two, the following factors were rated high or very high.

- Risk Management Committee
- Risk Management Officer
- Uniform Documentation of Risk
- Awareness of the Relative Severity of Risks

The remaining factor, Risk Management Plans, was added to the factors of medium importance by the second round of voting.

## Conclusions

The final factor database contains three levels of importance: high or very high, medium, and low or very low importance. Factors of medium importance make up by far the smallest group. Factors of high or very high importance are grouped together, as are those factors that are of low or very low importance. The final factor database detailing this breakdown is included in Appendix G. This factor database shows which factors are important for the success of enterprise risk management within transportation organizations laying the groundwork for the development of a maturity model. By

performing the validation of factors in two steps the database was reviewed and expanded upon by the industry experts with current knowledge of practices within transportation organizations so that factors form the most applicable basis for a maturity model that is currently available.

## 5. SUMMARY

The purpose of this research was to establish a set of factors for the use in developing a maturity model for enterprise risk management in transportation organizations. The question is: What elements are important to enterprise risk management? What do the 75% of transportation organizations in the United States which currently do not employ any form of enterprise risk management need to focus on developing (D'Ignazio, et al., 2011)? The following chapter concludes the research, which compiled a broad list of factors from many industries through a questionnaire and workshop process in order to identify the 19 most important factors to enterprise level risk management within transportation organizations.

## Summary of Findings

This research resulted in a list of factors that experts and practitioners in the transportation industry identify as important to the level of maturity of enterprise-level risk management. These factors may not be universally important to risk management, and some of them may represent multiple facets of the same concept, but the factors that are important can form the basis of a system of measurement for the maturity of risk management within transportation organizations. These factors are listed in Appendix G along with a description, example, and in some cases expansions and clarifications that developed from the open-ended portions of the research. This research and the resulting factors will form the first step in applying risk management to the enterprise level of transportation organizations. Prior research has identified the benefits of employing an appropriate degree of risk management, showing that organizations can benefit from the management of their risks (D'Ignazio, et al., 2011).

## Questionnaire

The questionnaire portion of this research established a rough estimate for the importance of the factors discovered in the literature review, yet it also provided a validation of the thoroughness of this preliminary identification of factors. The first division of the factors, which occurred at the end of the questionnaire, was a product of the natural breaks within the data itself and with the nature of the questions asked of the respondents. By taking those responses with 55% or more in the highest two categories as being important, the goal was to develop a list of factors that saw a majority of responses in their favor and were worth studying, while also not penalizing any factor excessively for a solid medium response. However, if the factor achieved a strong response in the low or very low category, it would appear to have little value within enterprise-level risk management in transportation organizations. To ensure that any factors with a significantly low or very low response did not falsely register as important, the threshold was set lower at 30% of respondents in those categories.

The primary limitation of the questionnaire round was the number of responses. There were an acceptable number to develop the direct relationships regarding the importance of the factors based on the respondents' responses. However there were not enough responses to suggest any underlying

relationships or to make any universal assumptions regarding the importance of the factors (Nakagawa & Cuthill, 2007). That is to say that with 29 responses, each factor has a fairly smooth, though not always definitive, distribution outlining its relative importance.

### **Workshop**

The purpose of the workshop section was to clarify the importance of factors which had not seen consensus amongst the questionnaire responses. In order to achieve this clarification, the research question was reevaluated in light of the responses to the questionnaire and the resulting separation of the factors. The result of this process was the abbreviated ranking scale used in the workshop, listed in Table 6. By grouping the rankings at the completion of the questionnaire, it was possible to split off nine factors from both the top and the bottom of the rankings, while leaving those with inconclusive rankings, 14 in total, to be discussed and ranked during the workshop.

The factors that were grouped in the very high and high category by the end of this process are those that are considered of the greatest importance in developing a mature risk management organization within transportation organizations. They are the factors, which with appropriate metrics, will form the core of a maturity model to map the growth of such an organization. During the discussion phase of the workshop it became clear that some of the factors may have more relevance earlier in the organization's growth, while others may develop more significance later on as the organization matures. Some factors, such as a risk management officer or risk management training, are important steps in implementing a successful risk management culture; however once this culture has developed, their continued need diminishes significantly as the benefits they would provide are features of the culture itself.

Factors with medium importance, defined in the workshop phase, form the second layer of factors that can be included in a maturity model. These factors should not be the focus of more research. Instead they should be utilized for their ability to support or measure other factors that received a very high or high importance rating. It is also important to note that these factors may form part of a meta-factor that can be used to measure for maturity, however at this stage in this research that is as of yet undefined.

Those factors that received a low or very low ranking throughout this process are not necessarily unimportant to the development of risk management maturity, but they do not have importance on their own, according to the questionnaire respondents. Similar to the factors of medium importance, these factors may form a part of a meta-factor or could be useful metrics or signifiers for factors which are considered important.

One of the major themes that developed from the workshop attendees' discussion of the indeterminate factors was that as an organization develops, so must the maturity model used to define it. The concept of a risk management officer is a prime example of this growth and evolution. Initially it was discussed that such a position would be used as the "champion" of risk management within the organization, the one catalyzing and inspiring the growth of the organization's risk management. However, as the organization matures and risk management is integrated fully within the organization, the role of the risk management officer will evolve into one of continued calibration. The officer would be responsible for ensuring as the organization evolves at different rates in different areas that the risk management remains consistent. The risk management officer would also serve as a central entity to disseminate and coordinate change as external policies and expectations change throughout the growth of the organization's risk management infrastructure.

The initial concept behind risk management goals was to establish if the existence of institutionalized goals was important. However, throughout discussion in the workshop, attendees also agreed that it is very important to include the concept of evolution of goals as the agency develops. This notion will be important when researchers attempt to establish the specific portions of the factor to measure for the maturity model. It also indicates a possibility to uncover specific types of goals that can be used to determine the maturity of an organization.

The workshop attendees, from their experience, thought that the existence of a specific risk management committee was unnecessary within a mature risk management organization. A committee may be important towards developing mature risk management, but in a mature organization all employees, even high level executives, utilize risk management rationale when making decisions.



Therefore, in a mature organization there would be no need for an official risk management committee. The new name for the risk management committee concept is: Risk Management Review at the Executive Level. The concept of oversight from a central location is maintained, but the need for an official title is not seen in a mature organization.

As the risk management organization will be continually evolving, the controlling entity - be it a risk management officer, the high level executives, or both - needs to be able to communicate and record risk consistently across a very diffuse organization. In order for this to be achieved, the workshop attendees stressed the need to document risk in a uniform manner across the organization, allowing risk management to be aligned with the organization's goals. They also stressed that standard definitions and understandings of severity must be developed within all portions of the organization to support the uniform documentation. Related to the idea of uniform documentation is the evolution of the corporate risk appetite, which should be consistent within all branches of an organization. At a minimum, the differences within the organization need to be understood and accounted for at the enterprise level. If differences are not understood the information gathered will not be useful in comparing different programs within an organization itself. These factors, uniform documentation and awareness of the relative severity of risks, connect intuitively to a factor of consistent risk management definitions. This connection suggests the existence of a meta-factor.

Not all factors discussed in the workshop were of primary importance. According to the attendees, risk management plans are already in place within most organizations or are more applicable to the program and project levels of management. This preexistence, however, poses an interesting dilemma when addressing the relevance of these factors, for if they are already in place within most organizations, might they already be a prerequisite or are at least very fundamental to risk management? And if they were missing, would it have serious impact on the capability of that organization? While this study may only be able to identify these as possibilities further study may be able to establish these factors as essential to risk management with transportation organizations.

Included in Appendix G is the final factor database synthesizing the content of the workshop discussion and the respondent's additions to the questionnaire, which were included in order to provide more complete descriptions of the factors that are important to defining the maturity of enterprise risk management within transportation organizations.

## **Limitations**

The literature review identified factors that have some relevance to the maturity of risk management within an organization. The workshop participants, upon reviewing the factors, also felt that all of the factors had some relevance to the maturity of an organization's risk management. With this in mind, those factors that were rated important should be the focus of further research. However, those which were not rated as important should not be dismissed, as they may be able to provide some degree of insight into those that are considered important. These low-rated factors may also be a part of an important meta-factor, provide some easy-to-measure metric for an important factor, or simply be beneficially informative to an organization as they try to develop their risk management infrastructure. This highlights one of the key limitations of this research: the inability to conduct a meaningful factor analysis due to the relatively small number of participants

Another common theme throughout the discussion and review process of these factors is that throughout an organization's life, there will be significant evolution and change that will shape how the factors are understood, applied, and even which factors are relevant to the organization. Thus any resulting maturity model should be able to account for this change, either by growing with the organization or by including a development path within itself. This evolution can also show itself within the organization, as some sections of the enterprise may be at different stages of maturity and need to be developed further to handle the risks to which they are exposed.

## Future Research

This research should be expanded into two key areas. The first area is the exploration of potential meta-factors; the industry experts involved in the workshop suggested that there are several, and the literature supports this conclusion. However, the statistical methods used in this paper were inconclusive in regards to the importance of these meta-factors, as there was not a large enough volume of responses to draw from. More responses should be gathered or alternative methods should be explored in order to identify and rank the importance of any meta-factors within the factors discovered in the present research. The value in uncovering any meta-factors within the factor database is that it would allow the eventual maturity model to focus on the general concepts by providing multiple specific paths by which an organization could progress depending on the organization's unique situation.

The second area in which this research can be expanded is the actual construction of a maturity model utilizing the factors identified to rate the maturity of an organization. In order to construct this model, the relationships between the factors ought to be explored with more depth; also the relative rankings, as well as any factors that support others, ought to be identified. The other key to developing the maturity model is to tie it directly to the industry in which it is to be implemented. This targeting is necessary in order to identify what exactly it means to employ a factor within an organization and if there are any gradations of implementation that can be achieved.

The final piece to successfully expanding this research will be to create a maturity model that can be continuously updated and improved upon so that when it is used in an evolving organization it can be adjusted to fit the organization's changing needs. The field of risk management within transportation and construction organizations in general is growing and developing. This evolution will give rise to new processes that will effect or add to the factors that should be included in an accurate enterprise risk management maturity model for a transportation organization.

## Conclusions

The literature review identified factors that have some relevance to the maturity of risk management within an organization. The workshop participants, upon reviewing the factors, also felt that all of the factors had some relevance to the maturity of an organization's risk management. With this in mind, those factors that were rated important should be the focus of further research and form the basis for an eventual maturity model. Additionally there will be significant evolution and change that will shape how the factors are understood, applied, and even which factors are relevant to the organization. Thus any resulting maturity model should be able to account for this change, either by growing with the organization or by including a development path within itself. This evolution can also show itself within the organization, as some sections of the enterprise may be at different stages of maturity and need to be developed further to handle the risks to which they are exposed.

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## APPENDIX A: Factor Database with sources and origins



### **Visibility/Involvement of Risk Managers**

*Field of Origin:* Safety, Lean Management

*Type:* Culture

*Sources:*

Mann, D., 2010. *Creating a Lean Culture*. 2nd ed. New York: Taylor and Francis Group, LLC.

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Risk Management Knowledge Sourced from All Personnel**

*Field of Origin:* Medical Risk Management, Software development

*Type:* Culture

*Sources:*

Crawford, R., 2004. Risk Ritual and the Management of Control and Anxiety in Medical Culture. *Health (London)*, 8(4), pp. 505-528.

Duff, C., 2003. The Importance of Culture and Context: Rethinking Risk and Risk Management in Young Drug Using Populations. *Health, Risk and Society*, 5(3), pp. 285-299.

Lyytinen, K., Mathiassen, L. & Ropponen, J., 1998. Attention Shaping and Software Risk - A Categorical Analysis of Four Classical Risk Management Approaches. *Information Systems Research*, 9(3), pp. 233-255.

### **Outside Experts on Decision Making Teams**

*Field of Origin:* Construction Risk Management

*Type:* Culture

*Source:*

Molenaar, K. R., 2005. Programmatic Cost Risk Analysis for Highway Megaprojects. *Journal of Construction Engineering and Management*.

### **Regular Risk Management / Risk Identification Workshops**

*Field of Origin:* Construction Risk Management

*Type:* Management Tool

*Source:*

Molenaar, K. R., 2005. Programmatic Cost Risk Analysis for Highway Megaprojects. *Journal of Construction Engineering and Management*.

### **Use of Risk Management to Identify Contingency**

*Field of Origin:* Construction Risk Management

*Type:* Management Tool

*Source:*

Molenaar, K. R., 2005. Programmatic Cost Risk Analysis for Highway Megaprojects. *Journal of Construction Engineering and Management*.

### **Risk Management at the Project Level**

*Field of Origin:* Safety

*Type:* Situation

*Source:*

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Risk Management Communications**

*Field of Origin:* Safety

*Type:* Management Tool

*Sources:*

Grote, G. & Kunzler, C., 2000. Diagnosis of safety culture in safety management audits. *Safety Science*, Issue 34, pp. 131-150.

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **All Employees take Responsibility for Risk Management**

*Field of Origin:* Safety, Lean Management

*Type:* Culture

*Sources:*

Mann, D., 2010. *Creating a Lean Culture*. 2nd ed. New York: Taylor and Francis Group, LLC.

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Clear Risk Management Organizational Structure**

*Field of Origin:* Safety

*Type:* Organizational Structure

*Source:*

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **"No-blame" Risk Management Culture**

*Field of Origin:* Lean Management, Medical Risk Management

*Type:* Culture

*Sources:*

Mann, D., 2010. *Creating a Lean Culture*. 2nd ed. New York: Taylor and Francis Group, LLC.

Wakefield, B. J. et al., 2001. Organizational Culture, Continuous Quality Improvement, and Medication Administration Error Reporting. *American Journal of Medical Quality*, 16(4), pp. 128-134.

### **Risk Management Training**

*Field of Origin:* Software Engineering, Safety

*Type:* Culture

*Sources:*

Grote, G. & Kunzler, C., 2000. Diagnosis of safety culture in safety management audits. *Safety Science*, Issue 34, pp. 131-150.

Lyytinen, K., Mathiassen, L. & Ropponen, J., 1998. Attention Shaping and Software Risk - A Categorical Analysis of Four Classical Risk Management Approaches. *Information Systems Research*, 9(3), pp. 233-255.

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Risk Management Committee**

*Field of Origin:* Safety

*Type:* Organizational Structure

*Sources:*

Grote, G. & Kunzler, C., 2000. Diagnosis of safety culture in safety management audits. *Safety Science*, Issue 34, pp. 131-150.

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Risk Management Officer**

*Field of Origin:* Safety

*Type:* Organizational Structure

*Source:*

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Risk Management Policy**

*Field of Origin:* Safety

*Type:* Management Tool

*Source:*

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Risk Management Strategy**

*Field of Origin:* Safety

*Type:* Management Tool

*Source:*

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Risk Management Plans**

*Field of Origin:* Safety

*Type:* Management Tool

*Source:*

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Risk Management at the Program Level**

*Field of Origin:* Safety

*Type:* Situation

*Source:*

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Communicate Cost Uncertainty**

*Field of Origin:* Construction Risk Management

*Type:* Management Tool

*Sources:*

Molenaar, K., Anderson, S. & Schexnayder, C., 2010. *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs*, Washington, D.C.: Transportation Research Board.

Molenaar, K. R., 2005. Programmatic Cost Risk Analysis for Highway Megaprojects. *Journal of Construction Engineering and Management*.

### **Risk Management Accountability**

*Field of Origin:* Construction Risk Management

*Type:* Management Tool

*Source:*

Molenaar, K., Anderson, S. & Schexnayder, C., 2010. *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs*, Washington, D.C.: Transportation Research Board.

### **Consistent Risk Management Definitions**

*Field of Origin:* Construction Risk Management

*Type:* Management Tool

*Sources:*

Molenaar, K., Anderson, S. & Schexnayder, C., 2010. *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs*, Washington, D.C.: Transportation Research Board.

Molenaar, K. R., 2005. Programmatic Cost Risk Analysis for Highway Megaprojects. *Journal of Construction Engineering and Management*.

### Acceptance of Risk Environment

*Field of Origin:* Sociology

*Type:* Culture

*Source:*

Dake, K., 1992. Myths of Nature: Culture and the social construction of risk. *Journal of Social Issues*, 48(4), pp. 21-37.

### Risk Management Incentives

*Field of Origin:* Safety

*Type:* Culture

*Sources:*

Grote, G. & Kunzler, C., 2000. Diagnosis of safety culture in safety management audits. *Safety Science*, Issue 34, pp. 131-150.

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### Uniform Documentation of Risk

*Field of Origin:* Construction Risk Management

*Type:* Management Tool

*Source:*

Molenaar, K., Anderson, S. & Schexnayder, C., 2010. *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs*, Washington, D.C.: Transportation Research Board.

### Awareness of the Relative Severity of Risks

*Field of Origin:* Medical Risk Management

*Type:* Culture

*Source:*

Crawford, R., 2004. Risk Ritual and the Management of Control and Anxiety in Medical Culture. *Health (London)*, 8(4), pp. 505-528.

### Risk Management is Viewed as a Systems Issue

*Field of Origin:* Medical Risk Management, Lean Management

*Type:* Culture

*Sources:*

Dennis, P., 2010. *The Remedy*. Hoboken: John Wiley & Sons, Inc.

Reason, J., 2000. Human Error: Models and Management. *BMJ*, Volume 320, pp. 768-770.

### Visible Risk Management Metrics

*Field of Origin:* Lean Management

*Type:* Management Tool

*Source:*

Mann, D., 2010. *Creating a Lean Culture*. 2nd ed. New York: Taylor and Francis Group, LLC.

### **Risk Management Goals**

*Field of Origin:* Safety

*Type:* Management Tool

*Source:*

Mearns, K. J. & Flin, R., 1999. Assessing the State of Organizational Safety - Culture or Climate. *Current Psychology*, 18(1), pp. 5-17.

### **Risk Database**

*Field of Origin:* Safety

*Type:* Management Tool

*Source:*

Kasperson, R. E. et al., 1988. The Social Amplification of Risk: A Conceptual Framework. *Risk Analysis*, 8(2), pp. 177-187.

### **Actively Balanced Risk Portfolio**

*Field of Origin:* Financial Risk Management

*Type:* Management Tool

*Source:*

Jarrow, R. A., Lando, D. & Turnbull, S. M., 1997. A Markov Model for the Term Structure of Credit Risk Spreads. *The Review of Financial Studies*, 10(2), pp. 481-523.

### **Risk Management Mapping**

*Field of Origin:* Safety

*Type:* Management Tool

*Source:*

Rasmussen, J., 1997. Risk Management in a Dynamic Society: A Modelling Problem. *Safety Science*, 27(2), pp. 183-213.

### **Analytical Risk Modeling Tools**

*Field of Origin:* Financial Risk Management

*Type:* Management Tool

*Source:*

Jarrow, R. A., Lando, D. & Turnbull, S. M., 1997. A Markov Model for the Term Structure of Credit Risk Spreads. *The Review of Financial Studies*, 10(2), pp. 481-523.

### **Opportunity Management**

*Field of Origin:* Construction Risk Management

*Type:* Culture

*Source:*

Molenaar, K., Anderson, S. & Schexnayder, C., 2010. *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs*, Washington, D.C.: Transportation Research Board.

## APPENDIX B: Factor Database with definitions and explanations

### **Visibility/Involvement of Risk Managers**

*Description:* The agency's risk managers are an active part of the organization's missions and operations.

*Example:* In the agency employees know where to find or how to contact a risk manager.

### **Risk Management Knowledge Sourced from All Personnel**

*Description:* The agency's risk management process is a function of all agency personnel.

*Example:* The agency's risk management committee is not an elite group with sole responsibility to manage risks, all employees and stakeholders are able to provide insight.

### **Outside Experts on Decision Making Teams**

*Description:* The agency includes outside experts in decision-making teams; either as subject matter or specific risk management experts.

*Example:* The agency has a policy of calling upon experts outside of the department to provide a different perspective on decisions with uncertainty.

### **Regular Risk Management / Risk Identification Workshops**

*Description:* The agency periodically conducts multidisciplinary workshops for projects, programs and the organization as a whole.

*Example:* The agency's workshop processes is carried out for the entire organization to reevaluate and address the evolving risk portfolio on a scheduled basis.

### **Use of Risk Management to Identify Contingency**

*Description:* The agency ties risk identification and assessment to cost uncertainty and contingency management at various levels in the organization.

*Example:* The agency uses risk assessment on major projects to identify an appropriate contingency.

### **Risk Management at the Project Level**

*Description:* The agency employs risk management for individual projects.

*Example:* The agency maintains risk registers on selected projects.

### **Risk Management Communications**

*Description:* The agency communicates regularly on the status of their risk management.

*Example:* The agency has a website detailing the risk management activities.

### **All Employees take Responsibility for Risk Management**

*Description:* In the agency every employee participates in risk management.

*Example:* All employees have a clear structure to communicate risks that impact their project or functional role in the organization.

### **Clear Risk Management Organizational Structure**

*Description:* The agency has a defined risk management organizational structure.



*Example:* The agency has an organizational chart detailing the risk management structure for the organization.

### **"No-blame" Risk Management Culture**

*Description:* The agency encourages risk identification and does not automatically place responsibility for the risk on the identifier.

*Example:* An employee identifies a risk event that could make a project infeasible, they are not punished, and instead they are recognized positively.

### **Risk Management Training**

*Description:* The agency trains employees in risk management.

*Example:* The agency provides classes or webinars on the risk management process.

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*Description:* The agency has a committee whose function is to review the risk profile.

*Example:* A twice-yearly meeting of executives to review the risk portfolio.

### **Risk Management Officer**

*Description:* The agency has a person who is responsible for overseeing and coordinating the risk management process.

*Example:* An officer whose responsibilities include continual review of the organization's risk portfolio.

### **Risk Management Policy**

*Description:* The agency has a written policy for handling risk throughout the organization.

*Example:* The agency has a policy defining the level of risk management needed on a project and how contingencies will be allocated.

### **Risk Management Strategy**

*Description:* The agency has a focus on long-term achievements to develop the risk management program.

*Example:* The agency tries to reduce enterprise risk through long term strategic agency investment.

### **Risk Management Plans**

*Description:* The agency has predetermined methods for managing generic risks and risk types.

*Example:* The agency has policies prepared for handling unforeseen site conditions.

### **Risk Management at the Program Level**

*Description:* The agency employs risk management for programs/portfolios (i.e. across multiple projects).

*Example:* The agency manages risks collectively across multiple projects.

### **Communicate Cost Uncertainty**

*Description:* The agency communicates the uncertainty of costs involved in estimates.

*Example:* The agency reports cost uncertainty with a defined percentage or figure of the distribution.

### **Risk Management Accountability**

*Description:* The agency's risks are assigned to individuals and performance is monitored.

*Example:* The agency assigns risks to individuals to manage. Their success or failure is monitored and regularly reported.

### **Consistent Risk Management Definitions**

*Description:* The agency has written definitions and consistently uses risk management terms (e.g. cost escalation, uncertainty, risk and contingency)

*Example:* The agency has written definitions of contingency at the project and program levels.

### **Acceptance of Risk Environment**

*Description:* The agency accepts that there is no zero-risk environment.

*Example:* The agency's focus is on reducing risk, not eliminating it.

### **Risk Management Incentives**

*Description:* The agency provides employees incentives and/or recognition for applying risk management.

*Example:* The agency provides an annual risk management award.

### **Uniform Documentation of Risk**

*Description:* The agency employs a uniform method for documenting and tracking risks.

*Example:* The agency documents the information relevant to a risk in a form that is translatable through the entire organization, potentially in a standard database.

### **Awareness of the Relative Severity of Risks**

*Description:* The agency is aware of the relative importance of risks affecting the organization without becoming indifferent.

*Example:* The agency has developed a standardized classification of risks to be managed at each project management level.

### **Risk Management is Viewed as a Systems Issue**

*Description:* The agency manages risks, not as individual errors/events but, as products of the surrounding conditions and interactions.

*Example:* The agency investigates risk impacts through an event's relationships with other risk events.

### **Visible Risk Management Metrics**

*Description:* The agency uses visual reporting methods for its risk management program.

*Example:* The agency has widely distributed visible graphics showing the percent of project completion versus the percent expenditure of contingency.

### **Risk Management Goals**

*Description:* The agency has a focus on short-term achievements to develop the risk management program.

*Example:* The agency has staffing and training goals for risk management.

### **Risk Database**

*Description:* The agency has a database of risks, their effect and triggering factors.

*Example:* The agency maintains a database across all projects detailing risks experienced, avoided and anticipated.

### **Actively Balanced Risk Portfolio**

*Description:* The agency manages project, program and activity levels to balance risk exposure.

*Example:* The agency only undertakes one major project of a specific type in a region at a time while spending the rest of its budget on maintenance and planning / design.

### **Risk Management Mapping**

*Description:* The agency has organizational maps of risk controllers, objectives, action targets and the actual state of affairs.

*Example:* In the agency major risks and risk categories are mapped so employees understand their impacts and points of control/contact.

### **Analytical Risk Modeling Tools**

*Description:* The agency implements risk modeling tools to track, predict and control risks.

*Example:* The agency uses tools adapted from credit and debt risk management to manage their risk situations.

### **Opportunity Management**

*Description:* The agency manages and tracks opportunities.

*Example:* The agency includes opportunities in their risk database.

**APPENDIX C: Transcript of Survey**

*The following survey was published online using zoomerang.com.*

TITLE: Transportation Organization Risk Management Maturity Factors

INTRO PAGE TEXT:

Risk Management Maturity in Transportation Organizations at the Enterprise Level

You are being invited to participate in a study of risk management practices for transportation organizations at the enterprise level. The objective of this research is to establish the relative importance of a set of factors that describe effective strategies for planning, developing, and managing risk management.

Your individual privacy will be maintained in all published and written data resulting from this study. We expect the project to benefit you by providing a summary of current risk management implementation by transportation organizations and other industries across the country. You will receive no compensation for your participation.

Completing the questionnaire will take 15-20 minutes.

By selecting Start Survey you affirm that you understand the above information and voluntarily consent to participate in the research project entitled: Transportation Organization Risk Management Maturity Factors.

<Start Survey> [Advance to Page 1]

Page 1 - Heading

The use of **enterprise risk management** is evolving in transportation organizations. The purpose of this questionnaire is to explore the factors that define enterprise risk management maturity in transportation organizations. The outcome of this questionnaire will be a ranking of factors that can be used to develop an enterprise risk management maturity model.

Page 1 - Question 1 - Choice - One Answer (Bullets) [Mandatory]

Completion of the following questionnaire requires knowledge relating to risk management practices in transportation organizations. Please select the continue option below if you have this knowledge. If

this is not your area of expertise, select the cancel option and kindly forward the questionnaire to a knowledgeable colleague.

- **Continue:** By selecting continue, I acknowledge that my answers may be anonymously used as part of this study.

- **Cancel:** By selecting cancel, I acknowledge that I do not have knowledge on risk management in transportation organizations or do not wish to participate. We ask that you please route the questionnaire to the appropriate person that has the knowledge to answer these questions. [Skip to End]

Page 1 - Question 2 - Name and Address (U.S) [Mandatory]

Please fill in the following information (Note: we are collecting names only to avoid duplication when aggregating results or sending additional information. Your individual privacy will be maintained in all published and written data):

First Name:

Last Name:

Organization:

Organizational Unit and/or Job Title:

State:

Page 1 - Question 3 - Choice - One Answer (Bullets) [Mandatory]

We are asking for your email so we may contact you with the results of this effort or for additional questions.

- Please do not contact me with the results
- I am available for additional questions. Add email below.

Email Address:

Page 2 - Heading

Overview

Risk management is the consistent application of techniques to manage the uncertainties surrounding the achievement of an organization's objectives. Risk can be managed at many different levels. Risks may be grouped and managed at the enterprise level when they are inherently connected to multiple functions within the DOT or when the responsibility to recognize and respond to the risks lie with upper management. This questionnaire asks you to rate a series of factors that may be important in determining enterprise risk management maturity. When you are rating the importance of each of the following factors, please determine how important each factor is when assigning a level of enterprise risk management maturity for transportation organizations. Please consider the following question when using the rating scale:

Page 2 - Heading

**How important is this factor to determining a transportation organization's level of maturity?**

**(0) Very Low Importance**

**(1) Low Importance**

**(2) Medium Importance**

**(3) High Importance**

**(4) Very High Importance**

Page 2 - Question 4 - Choice - One Answer (Bullets) [Mandatory]

**Visibility/Involvement of Risk Managers**

*Description:* The agency's risk managers are an active part of the organization's missions and operations.

*Example:* In the agency employees know where to find or how to contact a risk manager.

(0) Very Low Importance

(1) Low Importance

(2) Medium Importance

(3) High Importance

(4) Very High Importance

Page 2 - Question 5 - Choice - One Answer (Bullets) [Mandatory]

**Risk Management Knowledge Sourced from All Personnel**

*Description:* The agency's risk management process is a function of all agency personnel.

*Example:* The agency's risk management committee is not an elite group with sole responsibility to manage risks, all employees and stakeholders are able to provide insight.

(0) Very Low Importance

(1) Low Importance

(2) Medium Importance

(3) High Importance

(4) Very High Importance

Page 2 - Question 6 - Choice - One Answer (Bullets) [Mandatory]

**Outside Experts on Decision Making Teams**

*Description:* The agency includes outside experts in decision-making teams; either as subject matter or specific risk management experts.

*Example:* The agency has a policy of calling upon experts outside of the department to provide a different perspective on decisions with uncertainty.

(0) Very Low Importance

(1) Low Importance

(2) Medium Importance

(3) High Importance

(4) Very High Importance

Page 2 - Question 7 - Choice - One Answer (Bullets) [Mandatory]

**Regular Risk Management / Risk Identification Workshops**

*Description:* The agency periodically conducts multidisciplinary workshops for projects, programs and the organization as a whole.



*Example:* The agency's workshop processes is carried out for the entire organization to reevaluate and address the evolving risk portfolio on a scheduled basis.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 2 - Question 8 - Choice - One Answer (Bullets) [Mandatory]

### **Use of Risk Management to Identify Contingency**

*Description:* The agency ties risk identification and assessment to cost uncertainty and contingency management at various levels in the organization.

*Example:* The agency uses risk assessment on major projects to identify an appropriate contingency.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) Very Important
- (4) Very High Importance

Page 2 - Question 9 - Choice - One Answer (Bullets) [Mandatory]

### **Risk Management at the Project Level**

*Description:* The agency employs risk management for individual projects.

*Example:* The agency maintains risk registers on selected projects.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 2 - Question 10 - Choice - One Answer (Bullets) [Mandatory]

**Risk Management Communications**

*Description:* The agency communicates regularly on the status of their risk management.

*Example:* The agency has a website detailing the risk management activities.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 2 - Question 11 - Choice - One Answer (Bullets) [Mandatory]

**All Employees take Responsibility for Risk Management**

*Description:* In the agency every employee participates in risk management.

*Example:* All employees have a clear structure to communicate risks that impact their project or functional role in the organization.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 2 - Question 12 - Choice - One Answer (Bullets) [Mandatory]

**Clear Risk Management Organizational Structure**

*Description:* The agency has a defined risk management organizational structure.

*Example:* The agency has an organizational chart detailing the risk management structure for the organization.

- (0) Very Low Importance
- (1) Low Importance

- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 2 - Question 13 - Choice - One Answer (Bullets) [Mandatory]

**"No-blame" Risk Management Culture**

*Description:* The agency encourages risk identification and does not automatically place responsibility for the risk on the identifier.

*Example:* An employee identifies a risk event that could make a project infeasible, they are not punished, instead they are recognized positively.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 2 - Question 14 - Choice - One Answer (Bullets) [Mandatory]

**Risk Management Training**

*Description:* The agency trains employees in risk management.

*Example:* The agency provides classes or webinars on the risk management process.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 2 - Question 15 - Choice - One Answer (Bullets) [Mandatory]

**Risk Management Committee**

*Description:* The agency has a committee whose function is to review the risk profile.

*Example:* A twice-yearly meeting of executives to review the risk portfolio.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 2 - Question 16 - Choice - One Answer (Bullets) [Mandatory]

### **Risk Management Officer**

*Description:* The agency has a person who is responsible for overseeing and coordinating the risk management process.

*Example:* An officer whose responsibilities include continual review of the organization's risk portfolio.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 2 - Question 17 - Choice - One Answer (Bullets) [Mandatory]

### **Risk Management Policy**

*Description:* The agency has a written policy for handling risk throughout the organization.

*Example:* The agency has a policy defining the level of risk management needed on a project and how contingencies will be allocated.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance

(4) Very High Importance

Page 2 - Question 18 - Choice - One Answer (Bullets) [Mandatory]

**Risk Management Strategy**

*Description:* The agency has a focus on long-term achievements to develop the risk management program.

*Example:* The agency tries to reduce enterprise risk through long term strategic agency investment.

(0) Very Low Importance

(1) Low Importance

(2) Medium Importance

(3) High Importance

(4) Very High Importance

Page 2 - Question 19 - Choice - One Answer (Bullets) [Mandatory]

**Risk Management Plans**

*Description:* The agency has predetermined methods for managing generic risks and risk types.

*Example:* The agency has policies prepared for handling unforeseen site conditions.

(0) Very Low Importance

(1) Low Importance

(2) Medium Importance

(3) High Importance

(4) Very High Importance

Page 3 - Question 20 - Choice - One Answer (Bullets)

**Risk Management at the Program Level**

*Description:* The agency employs risk management for programs/portfolios (i.e. across multiple projects).

*Example:* The agency manages risks collectively across multiple projects.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 3 - Question 21 - Choice - One Answer (Bullets) [Mandatory]

### **Communicate Cost Uncertainty**

*Description:* The agency communicates the uncertainty of costs involved in estimates.

*Example:* The agency reports cost uncertainty with a defined percentage or figure of the distribution.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 3 - Question 22 - Choice - One Answer (Bullets) [Mandatory]

### **Risk Management Accountability**

*Description:* The agency's risks are assigned to individuals and performance is monitored.

*Example:* The agency assigns risks to individuals to manage. Their success or failure is monitored and regularly reported.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 3 - Question 23 - Choice - One Answer (Bullets) [Mandatory]

### **Consistent Risk Management Definitions**

*Description:* The agency has written definitions and consistently uses risk management terms (e.g. cost escalation, uncertainty, risk and contingency)

*Example:* The agency has written definitions of contingency at the project and program levels.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) Very Important
- (4) Very High Importance

Page 3 - Question 24 - Choice - One Answer (Bullets) [Mandatory]

#### **Acceptance of Risk Environment**

*Description:* The agency accepts that there is no zero-risk environment.

*Example:* The agency's focus is on reducing risk, not eliminating it.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 3 - Question 25 - Choice - One Answer (Bullets) [Mandatory]

#### **Risk Management Incentives**

*Description:* The agency provides employees incentives and/or recognition for applying risk management.

*Example:* The agency provides an annual risk management award.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance

(4) Very High Importance

Page 3 - Question 26 - Choice - One Answer (Bullets) [Mandatory]

**Uniform Documentation of Risk**

*Description:* The agency employs a uniform method for documenting and tracking risks.

*Example:* The agency documents the information relevant to a risk in a form that is translatable through the entire organization, potentially in a standard database.

(0) Very Low Importance

(1) Low Importance

(2) Medium Importance

(3) High Importance

(4) Very High Importance

Page 3 - Question 27 - Choice - One Answer (Bullets) [Mandatory]

**Awareness of the Relative Severity of Risks**

*Description:* The agency is aware of the relative importance of risks affecting the organization without becoming indifferent.

*Example:* The agency has developed a standardized classification of risks to be managed at each project management level.

(0) Very Low Importance

(1) Low Importance

(2) Medium Importance

(3) Very Important

(4) Very High Importance

Page 3 - Question 28 - Choice - One Answer (Bullets) [Mandatory]

**Risk Management is Viewed as a Systems Issue**

*Description:* The agency manages risks, not as individual errors/events but, as products of the surrounding conditions and interactions.



*Example:* The agency investigates risk impacts through an event's relationships with other risk events.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 3 - Question 29 - Choice - One Answer (Bullets) [Mandatory]

### **Visible Risk Management Metrics**

*Description:* The agency uses visual reporting methods for its risk management program.

*Example:* The agency has widely distributed visible graphics showing the percent of project completion versus the percent expenditure of contingency.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 3 - Question 30 - Choice - One Answer (Bullets) [Mandatory]

### **Risk Management Goals**

*Description:* The agency has a focus on short-term achievements to develop the risk management program.

*Example:* The agency has staffing and training goals for risk management.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance

(4) Very High Importance

Page 3 - Question 31 - Choice - One Answer (Bullets) [Mandatory]

**Risk Database**

*Description:* The agency has a database of risks, their effect and triggering factors.

*Example:* The agency maintains a database across all projects detailing risks experienced, avoided and anticipated.

(0) Very Low Importance

(1) Low Importance

(2) Medium Importance

(3) High Importance

(4) Very High Importance

Page 3 - Question 32 - Choice - One Answer (Bullets) [Mandatory]

**Actively Balanced Risk Portfolio**

*Description:* The agency manages project, program and activity levels to balance risk exposure.

*Example:* The agency only undertakes one major project of a specific type in a region at a time while spending the rest of its budget on maintenance and planning / design.

(0) Very Low Importance

(1) Low Importance

(2) Medium Importance

(3) High Importance

(4) Very High Importance

Page 3 - Question 33 - Choice - One Answer (Bullets) [Mandatory]

**Risk Management Mapping**

*Description:* The agency has organizational maps of risk controllers, objectives, action targets and the actual state of affairs.

*Example:* In the agency major risks and risk categories are mapped so employees understand their impacts and points of control/contact.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 3 - Question 34 - Choice - One Answer (Bullets) [Mandatory]

### **Analytical Risk Modeling Tools**

*Description:* The agency implements risk modeling tools to track, predict and control risks.

*Example:* The agency uses tools adapted from credit and debt risk management to manage their risk situations.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 3 - Question 35 - Choice - One Answer (Bullets) [Mandatory]

### **Opportunity Management**

*Description:* The agency manages and tracks opportunities.

*Example:* The agency includes opportunities in their risk database.

- (0) Very Low Importance
- (1) Low Importance
- (2) Medium Importance
- (3) High Importance
- (4) Very High Importance

Page 4 - Heading

In the following spaces please add any additional factors you may consider important to measuring the maturity of risk management within a transportation organization.

Page 4 - Question 36 - Name and Address (U.S)

Additional Risk Management Factors?

Factor Name:

Description:

Example:

Rating of Importance:

Page 4 - Question 37 - Name and Address (U.S)

Additional Risk Management Factors?

Factor Name:

Description:

Example:

Rating of Importance:

Page 4 - Question 38 - Name and Address (U.S)

Additional Risk Management Factors?

Factor Name:

Description:

Example:

Rating of Importance:

Page 4 - Question 39 - Name and Address (U.S)

Additional Risk Management Factors?

Factor Name:

Description:

Example:

Rating of Importance:

Page 4 - Question 40 - Name and Address (U.S)

Additional Risk Management Factors?

Factor Name:

Description:

Example:

Rating of Importance:

Page 4 - Heading

Thank you again for your time!

Thank You Page

If you have any questions, comments, or wish to report additional factors please contact us at:

Keith.Molenaar@colorado.edu

**APPENDIX D: Survey Results**

Questionnaire Question Number	Factor Name	Percent Respondents By Ranking					Percent Respondents By Simplified Rankings			Resulting Importance
		4: VH	3: H	2: M	1: L	0: VL	VH & H	M	L & VL	
4	Visibility/Involvement of Risk Managers	0.17	0.41	0.21	0.17	0.03	0.58	0.21	0.20	Important
5	Risk Management Knowledge Sourced from All Personnel	0.34	0.45	0.17	0.00	0.03	0.79	0.17	0.03	Important
6	Outside Experts on Decision Making Teams	0.07	0.24	0.38	0.28	0.03	0.31	0.38	0.31	Unimportant
7	Regular Risk Management / Risk Identification Workshops	0.10	0.45	0.21	0.17	0.07	0.55	0.21	0.24	Important
8	Use of Risk Management to Identify Contingency	0.10	0.48	0.17	0.21	0.03	0.58	0.17	0.24	Important
9	Risk Management at the Project Level	0.21	0.28	0.38	0.07	0.07	0.49	0.38	0.14	Indeterminate
10	Risk Management Communications	0.24	0.24	0.21	0.14	0.17	0.48	0.21	0.31	Unimportant
11	All Employees take Responsibility for Risk Management	0.34	0.38	0.17	0.07	0.03	0.72	0.17	0.10	Important
12	Clear Risk Management Organizational Structure	0.21	0.34	0.10	0.28	0.07	0.55	0.10	0.35	Indeterminate
13	"No-blame" Risk Management Culture	0.38	0.31	0.21	0.03	0.07	0.69	0.21	0.10	Important
14	Risk Management Training	0.21	0.52	0.10	0.10	0.07	0.73	0.10	0.17	Important
15	Risk Management Committee	0.14	0.34	0.24	0.21	0.07	0.48	0.24	0.28	Indeterminate
16	Risk Management Officer	0.14	0.34	0.28	0.21	0.03	0.48	0.28	0.24	Indeterminate
17	Risk Management Policy	0.17	0.31	0.31	0.14	0.07	0.48	0.31	0.21	Indeterminate
18	Risk Management Strategy	0.17	0.38	0.31	0.07	0.07	0.55	0.31	0.14	Important
19	Risk Management Plans	0.14	0.31	0.31	0.24	0.00	0.45	0.31	0.24	Indeterminate
20	Risk Management at the Program Level	0.17	0.34	0.31	0.10	0.07	0.51	0.31	0.17	Indeterminate
21	Communicate Cost Uncertainty	0.10	0.24	0.31	0.24	0.10	0.34	0.31	0.34	Unimportant
22	Risk Management Accountability	0.28	0.21	0.28	0.14	0.10	0.49	0.28	0.24	Indeterminate
23	Consistent Risk Management Definitions	0.21	0.24	0.28	0.17	0.10	0.45	0.28	0.27	Indeterminate
24	Acceptance of Risk Environment	0.17	0.55	0.21	0.07	0.00	0.72	0.21	0.07	Important
25	Risk Management Incentives	0.07	0.03	0.24	0.34	0.31	0.10	0.24	0.65	Unimportant
26	Uniform Documentation of Risk	0.21	0.31	0.21	0.21	0.07	0.52	0.21	0.28	Indeterminate
27	Awareness of the Relative Severity of Risks	0.07	0.31	0.41	0.14	0.07	0.38	0.41	0.21	Indeterminate
28	Risk Management is Viewed as a Systems Issue	0.21	0.28	0.38	0.07	0.07	0.49	0.38	0.14	Indeterminate
29	Visible Risk Management Metrics	0.14	0.31	0.38	0.03	0.14	0.45	0.38	0.17	Indeterminate
30	Risk Management Goals	0.07	0.28	0.38	0.21	0.07	0.35	0.38	0.28	Indeterminate
31	Risk Database	0.10	0.21	0.38	0.17	0.14	0.31	0.38	0.31	Unimportant
32	Actively Balanced Risk Portfolio	0.03	0.28	0.24	0.28	0.17	0.31	0.24	0.45	Unimportant
33	Risk Management Mapping	0.07	0.10	0.31	0.34	0.17	0.17	0.31	0.51	Unimportant
34	Analytical Risk Modeling Tools	0.10	0.14	0.34	0.24	0.17	0.24	0.34	0.41	Unimportant
35	Opportunity Management	0.07	0.28	0.28	0.21	0.17	0.35	0.28	0.38	Unimportant

## APPENDIX E: Factor Analysis Results



		Rotated Component Matrixa						
		Component						
Factor		1	2	3	4	Discription	Type	Origin
Group 1: 10	Number 10	.787				Risk Management Communications	Management Tool	safety
	Number 11	.767				All Employees take Responsibility for Risk Management	Culture	safety / lean
	Number 20	.666				Risk Management at the Program Level	Situation	safety
	Number 31	.646				Risk Database	Management Tool	safety
	Number 15	.640				Risk Management Committee	Organization	safety
	Number 14	.617				Risk Management Training	Culture	safety / software
	Number 23	.604				Consistent Risk Management Definitions	Management Tool	const. rm
	Number 22	.589				Risk Management Accountability	Management Tool	const. rm
	Number 26	.552				Uniform Documentation of Risk	Management Tool	const. rm
	Number 18	.548				Risk Management Strategy	Management Tool	safety
Group 2: 7	Number 7		.417			Regular Risk Management / Risk Identification Workshops	Management Tool	const. rm
	Number 27		.684			Awareness of the Relative Severity of Risks	Culture	medicine
	Number 35		.677			Opportunity Management	Culture	const. rm
	Number 28		.672			Risk Management is Viewed as a Systems Issue	Culture	medicine / lean
	Number 29		.620			Visible Risk Management Metrics	Management Tool	lean
	Number 5		.611			Risk Management Knowledge Sourced from All Personnel	Culture	medicine / software
	Number 12		.464			Clear Risk Management Organizational Structure	Organization	safety
Group 3: 5	Number 25			.833		Risk Management Incentives	Culture	safety
	Number 4			.718		Visibility/Involvement of Risk Managers	Culture	safety / lean
	Number 33			.685		Risk Management Mapping	Management Tool	safety
	Number 32			.579		Actively Balanced Risk Portfolio	Management Tool	investing
	Number 9			.490		Risk Management at the Project Level	Situation	safety
Group 4: 6	Number 6				.757	Outside Experts on Decision Making Teams	Culture	const. rm
	Number 19				.749	Risk Management Plans	Management Tool	safety
	Number 34				.662	Analytical Risk Modeling Tools	Management Tool	investing
	Number 13				.563	"No-blame" Risk Management Culture	Culture	medicine / lean
	Number 8				.548	Use of Risk Management to Identify Contingency	Management Tool	const. rm
Number 21				.535	Communicate Cost Uncertainty	Management Tool	const. rm	

## APPENDIX F: User Submissions

Respondent Submitted Factors			Method of Integration	
Name	Description	Example	Score	
Communication	All levels of the organization have regular meetings discussing status of their risks	Each unit meets monthly to review activities to mitigate risks	4	Expand Risk Management Communications to include regular meetings as a form of communication.
Risk Mitigation Strategy Owner	Each mitigation strategy has an identified owner	The agency has a named mitigation strategy manager, for each mitigation strategy, reporting to the risk owner	4	Expand Risk Management Strategy to include a owner.
Recognized Value of Risk Management Services by Employees	Develop corporate culture where there is an acknowledged value and a demand for risk management services by employees	Provide risk management expertise and services actively used by employees (rather than just manuals and policies). Ready, fire, aim -- not ready, aim, fire. I will forward an article that describes this concept well	4	Risk Management Incentives is in reference to a company's value recognition system, risk management should be a clear part of this.
Clearly identify the Agencies risk reserve amount	There needs to be a clearly identified risk reserve amount and how this is used.	WSDOT uses the validated base estimate compared to the 60th percentile to establish the risk reserve.	4	An expansion on Communicate Cost Uncertainty; add specification of reserve amount
Vision for Organizational Congruency	All employees see risks to office objectives, and see how they fit into managing those risks. Office objectives are then evaluated at a strategic level.	Bottom (ops then strategic) up approach to ensure org. congruency with Vision	4	Re-stating of All Employees take Responsibility for Risk Management, add clarification that employee actions should be congruent with organizational vision
Alignment with agency strategic goals	A direct relationship between identified risk with agency strategic goals	At the enterprise level each identified risk is correlated to an enterprise goal, strategy or objective	4	When risk management is approached as a system's issue, this integration and alignment with the other parts of the system occurs automatically.
Integrated Risk Management	Integrated with Agency Strategy, Asset Management practices, and Performance Management program,	Risk Management practice is an integrative process, directly connected with strategy, asset management, and performance management activities.	4	Another specific case of Risk Management Viewed as a Systems Issue.
Integrated Performance Measures	Performance integrated into risk models that reflect corporate tolerance for risk	Ability to compare pavement measures to safety delays and additional cost caused by poor planning	3	Not a factor for enterprise risk management maturity.
design errors	errors in construction project plans	temporary construction traffic control	3	Not a factor for enterprise risk management maturity.
safety	work zone accidents	accident within the work force	3	
Leadership Support	Leadership continually asks for risk assessment results before decisions are made		4	
Management Support	Risk management needs top-down support! No blame games.	Willingness by management to "hear" and be transparent with "bad" news (i.e., threats)	4	All Employees take Responsibility for Risk Management can be expanded to specify that it includes management.
Budgeting and HR nimbleness	Ability to link budget and HR resources to risks to office, program, project and strategic objectives.			
environmental mitigation	storm water pollution prevention	sitting in an adjacent property	3	
environmental mitigation	endangered species	delays and additional cost caused by inadequate plans	3	Not a factor for enterprise risk management maturity.

## APPENDIX G: Final Factor Database

## IMPORTANT FACTORS

### Visibility/Involvement of Risk Managers

*Description:* The agency's risk managers are an active part of the organization's missions and operations.

*Example:* In the agency employees know where to find or how to contact a risk manager.

### Risk Management Knowledge Sourced from All Personnel

*Description:* The agency's risk management process is a function of all agency personnel.

*Example:* The agency's risk management committee is not an elite group with sole responsibility to manage risks, all employees and stakeholders are able to provide insight.

### Regular Risk Management / Risk Identification Workshops

*Description:* The agency periodically conducts multidisciplinary workshops for projects, programs and the organization as a whole.

*Example:* The agency's workshop processes is carried out for the entire organization to reevaluate and address the evolving risk portfolio on a scheduled basis.

### Use of Risk Management to Identify Contingency

*Description:* The agency ties risk identification and assessment to cost uncertainty and contingency management at various levels in the organization.

*Example:* The agency uses risk assessment on major projects to identify an appropriate contingency.

### Risk Management at the Project Level

*Description:* The agency employs risk management for individual projects.

*Example:* The agency maintains risk registers on selected projects.

### All Employees take Responsibility for Risk Management

*Description:* In the agency every employee participates in risk management.

*Example:* All employees have a clear structure to communicate risks that impact their project or functional role in the organization.

*Expansions:* Employee actions should be congruent with the organizational vision. All employees includes management whose responsibility includes integrating and supporting the risk management.

### "No-blame" Risk Management Culture

*Description:* The agency encourages risk identification and does not automatically place responsibility for the risk on the identifier.

*Example:* An employee identifies a risk event that could make a project infeasible, they are not punished, and instead they are recognized positively.

### Risk Management Training

*Description:* The agency trains employees in risk management.

*Example:* The agency provides classes or webinars on the risk management process.

### **Risk Management Executive Level Review (Formerly Risk Management Committee)**

*Description:* The agency has a committee whose function is to review the risk profile.

*Example:* A twice-yearly meeting of executives to review the risk portfolio.

*Expansions:* As organization matures a committee becomes less important as a stand-alone group, developing into a function of the everyday activities of high level executives. Serves as the central point of oversight for “if it is not overseen from a central location it is unlikely to be done.” Should be developed as high level buy-in, top executives see and use risk results in their decision making processes.

### **Risk Management Officer**

*Description:* The agency has a person who is responsible for overseeing and coordinating the risk management process.

*Example:* An officer whose responsibilities include continual review of the organization's risk portfolio.

*Expansions:* Risk management should be fully integrated and should be everyone’s responsibility in a fully mature organization. In the short term the risk management officer could be the “champion” of risk management the one who instigates and motivates the organization to develop risk management. Later in the organization’s development this position can grow into a calibration position: ensuring that as the organization evolves the entire organization is consistent. In a mature organization can also be the central location to deploy changes driven from outside influences.

### **Risk Management Policy**

*Description:* The agency has a written policy for handling risk throughout the organization.

*Example:* The agency has a policy defining the level of risk management needed on a project and how contingencies will be allocated.

### **Risk Management Strategy**

*Description:* The agency has a focus on long-term achievements to develop the risk management program.

*Example:* The agency tries to reduce enterprise risk through long term strategic agency investment.

*Expansions:* The risk management strategy should have an individual responsible for ensuring its implementation.

### **Risk Management at the Program Level**

*Description:* The agency employs risk management for programs/portfolios (i.e. across multiple projects).

*Example:* The agency manages risks collectively across multiple projects.

### **Risk Management Accountability**

*Description:* The agency's risks are assigned to individuals and performance is monitored.

*Example:* The agency assigns risks to individuals to manage. Their success or failure is monitored and regularly reported.

### **Consistent Risk Management Definitions**

*Description:* The agency has written definitions and consistently uses risk management terms (e.g. cost escalation, uncertainty, risk and contingency)

*Example:* The agency has written definitions of contingency at the project and program levels.

### **Acceptance of Risk Environment**

*Description:* The agency accepts that there is no zero-risk environment.

*Example:* The agency's focus is on reducing risk, not eliminating it.

### **Uniform Documentation of Risk**

*Description:* The agency employs a uniform method for documenting and tracking risks.

*Example:* The agency documents the information relevant to a risk in a form that is translatable through the entire organization, potentially in a standard database.

*Expansions:* Very important to align the risk management with organization goals also ensures consistency across the entire breadth of the enterprise.

### **Awareness of the Relative Severity of Risks**

*Description:* The agency is aware of the relative importance of risks affecting the organization without becoming indifferent.

*Example:* The agency has developed a standardized classification of risks to be managed at each project management level.

*Expansions:* Standard definitions for severity, risk appetite, and risk tolerance across the organization are necessary for the organization to communicate efficiently. Can be seen as a step in building the policies of the organization as the definitions will shape the organization's responses. Connects to consistent risk management definitions.

### **Visible Risk Management Metrics**

*Description:* The agency uses visual reporting methods for its risk management program.

*Example:* The agency has widely distributed visible graphics showing the percent of project completion versus the percent expenditure of contingency.

## **FACTORS OF SECONDARY IMPORTANCE**

### **Clear Risk Management Organizational Structure**

*Description:* The agency has a defined risk management organizational structure.

*Example:* The agency has an organizational chart detailing the risk management structure for the organization.

### **Risk Management Plans**

*Description:* The agency has predetermined methods for managing generic risks and risk types.

*Example:* The agency has policies prepared for handling unforeseen site conditions.

### **Risk Management is Viewed as a Systems Issue**

*Description:* The agency manages risks, not as individual errors/events but, as products of the surrounding conditions and interactions.

*Example:* The agency investigates risk impacts through an event's relationships with other risk events.

## **Risk Management Goals**

*Description:* The agency has a focus on short-term achievements to develop the risk management program.

*Example:* The agency has staffing and training goals for risk management.

*Expansions:* This factor will develop and change as the organization matures.

## **UNIMPORTANT FACTORS**

### **Outside Experts on Decision Making Teams**

*Description:* The agency includes outside experts in decision-making teams; either as subject matter or specific risk management experts.

*Example:* The agency has a policy of calling upon experts outside of the department to provide a different perspective on decisions with uncertainty.

### **Risk Management Communications**

*Description:* The agency communicates regularly on the status of their risk management.

*Example:* The agency has a website detailing the risk management activities.

*Expansions:* Regular risk management meetings are a form of communication

### **Communicate Cost Uncertainty**

*Description:* The agency communicates the uncertainty of costs involved in estimates.

*Example:* The agency reports cost uncertainty with a defined percentage or figure of the distribution.

*Expansions:* The inclusion of a specific reserve amount has been utilized by the Washington State DOT.

### **Risk Management Incentives**

*Description:* The agency provides employees incentives and/or recognition for applying risk management.

*Example:* The agency provides an annual risk management award.

*Expansions:* The agency should ensure that it is recognizing valuable contributions to risk management as well as other areas.

### **Risk Database**

*Description:* The agency has a database of risks, their effect and triggering factors.

*Example:* The agency maintains a database across all projects detailing risks experienced, avoided and anticipated.

### **Actively Balanced Risk Portfolio**

*Description:* The agency manages project, program and activity levels to balance risk exposure.

*Example:* The agency only undertakes one major project of a specific type in a region at a time while spending the rest of its budget on maintenance and planning / design.

### **Risk Management Mapping**



*Description:* The agency has organizational maps of risk controllers, objectives, action targets and the actual state of affairs.

*Example:* In the agency major risks and risk categories are mapped so employees understand their impacts and points of control/contact.

### **Analytical Risk Modeling Tools**

*Description:* The agency implements risk modeling tools to track, predict and control risks.

*Example:* The agency uses tools adapted from credit and debt risk management to manage their risk situations.

### **Opportunity Management**

*Description:* The agency manages and tracks opportunities.

*Example:* The agency includes opportunities in their risk database.