GEORGIA DOT RESEARCH PROJECT 18-12

FINAL REPORT

EVALUATION OF GEORGIA DEPARTMENT OF TRANSPORTATION OFFICE OF PROGRAM DELIVERY PROJECT MANAGEMENT ORGANIZATIONAL STRUCTURE IN COMPARISON TO OTHER STATES' DOT PRACTICES TIER 1: BEST MANAGEMENT PRACTICES (BMPS) OF DESIGN-BID-BUILD TRANSPORTATION PROGRAM-PROJECT DELIVERY

OFFICE OF PERFORMANCE-BASED MANAGEMENT AND RESEARCH
600 W. PEACHTREE STREET NW
ATLANTA, GA 30308

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16. Abstract:

The goal of this research is to identify and document the best management practices (BMPs) in state departments of transportation (DOTs) with regard to the structure of traditional (i.e., design–bid–build) project delivery. To achieve this goal, the researchers conducted an extensive literature review, survey, content analysis, and interviews with subject-matter experts in other state DOTs. The research categorized different state DOTs' organizational structure models into two major groups, including centralized and decentralized organizations, which are further classified into 13 organizational structure models with similar characteristics (e.g., the position of the project management and functional units and existence of the Project Delivery Bureau). Innovative and best practices in project management were identified in several areas, such as establishing a Project Delivery Bureau, leadership and accountability, and a uniform letting schedule throughout the fiscal year. The identified BMPs provide state DOTs with potential values in streamlining their project development process, improving accountability and transparency in project development, providing efficient allocation of resources, managing and resolving issues/conflicts between project participants at the lowest level, and improving the coordination between the functional and project management units.

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EVALUATION OF GEORGIA DEPARTMENT OF TRANSPORTATION OFFICE OF PROGRAM DELIVERY PROJECT MANAGEMENT ORGANIZATIONAL STRUCTURE IN COMPARISON TO OTHER STATES' DOT PRACTICES TIER 1: BEST MANAGEMENT PRACTICES (BMPS) OF DESIGN-BID-BUILD TRANSPORTATION PROGRAM-PROJECT DELIVERY

By

Baabak Ashuri, Ph.D., DBIA

Minsoo Baek, Ph.D.

Raj Shah

Gordon Kingsley, Ph.D.

Georgia Institute of Technology

Contract with

Georgia Department of Transportation

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U.S. Department of Transportation
Federal Highway Administration

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The primary objective of this research project is to identify best management practices (BMPs) in state departments of transportation (DOTs) with regard to the organizational structure of traditional (design–bid–build, or DBB) project delivery for highway projects. The project aims to identify and analyze the BMPs of other state DOTs that have a design–bid–build program similar to the Georgia DOT program, for project management organizational structure, project management processes and tools, training of project managers (PMs), and other innovative practices. To achieve the primary objective, the researchers conducted surveys and interviews with subject-matter experts in other state DOTs and extensive content analysis on the documents provided by the state DOTs. Through the surveys, interviews, and content analysis, they categorized the state DOTs' organizational structure models according to similar characteristics (e.g., the position of the dedicated project management unit and functional units, existence of a project delivery bureau, and engineers from different functional offices for the roles and responsibilities of PMs) and identified innovative and best practices in the project management for DBB highway projects.

The researchers categorized different state DOTs' organizational structure models into two groups, centralized and decentralized organizations, which are further classified into 13 organizational structure models with similar characteristics as follows:

- Centralized Organizational Structure Models
    - Centralized Organizational Structure Model C1 (Division of Program Delivery Parallel to Division of Engineering Reporting to Chief Engineer)
    - Centralized Organizational Structure Model C2 (Project Development Office over Project Management, Design, Right of Way (ROW), Bridge, and Utilities Units)
    - Centralized Organizational Structure Model C3 (Project Delivery Bureau over Project Management, Design, Location and Environmental, ROW, Bridge and Structures, and Utilities Units)
    - Centralized Organizational Structure Model C4 (Project Development Bureau over Bridge, Project Management, Design, ROW, Utilities, and Construction Units)
    - Centralized Organizational Structure Model C5 (Director of Highway Operations over Project Management, Roadway Design, Environmental, Structures, ROW, Utilities, and Construction Units)
    - Centralized Organizational Structure Model C6 (Engineering Division over Highway Design, Bridges, Environmental Coordination, ROW and

- Decentralized Organizational Structure Model D5 (District Design Engineer over Drainage Design, Roadway Design, Surveying and Mapping, Consultant Project Management, and Structures Design Offices)
- Decentralized Organizational Structure Model D6 (District Engineer over Project Management, Construction, ROW, and Design Units)

Furthermore, the researchers summarized the innovative and best practices in project management in the following areas: (1) establishing a project delivery bureau, (2) leadership and accountability, (3) uniform letting schedule throughout the fiscal year, (4) performance evaluation dashboard for highway program development and delivery, (5) a blended approach to assign a PM to a project, (6) training program for PMs, (7) project issue resolution practice, (8) risk management, (9) project resource selection, (10) environmental coordination unit, (11) trust between state legislature and state DOTs, (12) project management leadership group, (13) improving coordination and promoting collaborative environment, (14) enterprise project management initiative, and (15) establishing project classification for a customizable project management practice.

Based on the surveys and interviews with the subject-matter experts and content analysis on documents from other state DOTs, the following recommendations are offered for enhancing efficiency in managing DBB highway projects:

- The Bureau of Project Development/Project Delivery enables the department to streamline the project development process and develop a project-centered culture in the organization.
- Active engagement of headquarters (HQ) and district leadership in reviewing project progress improves accountability in project development and delivery.
- A uniform letting plan throughout the year enables the agency to have better project resource planning.
- A customized, scalable, and flexible performance dashboard provides management with an effective tool to track the trends of specific measures and monitor project progress. Moreover, the dashboard enhances transparency in communicating internally and with the public.
- Assignment of project managers based on the size, complexity, and risks of the project enables the department to efficiently utilize the knowledge and experience of project managers.
- Project management training helps create a common knowledge base for project managers and project teams to meet the agency's goals and objectives.
- A practice of project issue resolution enables the department to manage and resolve issues/conflicts between project participants at the lowest level.
- A systematic approach for risk identification, assessment, and mitigation enhances program delivery.

- Establishment of an environmental coordination unit within the Project Development Division improves coordination between the functional and project management services, and the environmental office during the project development process.
- Timely delivery of a highway program is essential to establishing trust between state DOTs and state legislatures.

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CHAPTER 1 INTRODUCTION

The key mission of state departments of transportation (DOTs) is to meet budget and schedule targets for delivering highway projects. Increases in the level of project complexity, business networks, environmental regulations, and intense public interest and involvement make it more difficult for state DOTs to deliver projects within budget and on time (Ashuri et al. 2007; McMinimee et al. 2009). Project management plays a critical role in achieving the agency's goals and objectives (Clevenger 2018). In addition, developing a culture within the organization to support the project manager (PM) and project management efforts is critical for success in the highway industry (Marshall and Rousey 2009).

1.1. Effect of Organizational Structure on Project Success

Several studies have identified major aspects that can affect the success of project management in the construction industry. For instance, the study conducted by Ruskin and Estes (1986) stressed that the organizational environment surrounding the projects considerably influences the success of a project. Those authors also highlighted that PMs should understand how organizational factors, such as organizational structure, staffing, and the organization's attitude toward risk, affect projects. According to the National Cooperative Highway Research Program (NCHRP) Project 20–24 (83) Report (Secrest et al. 2012), the organizational structure of a state DOT significantly impacts the overall performance of planning, environment, design, right of way, maintenance, and various administrative functions on achieving agency goals. In addition, the organizational

structure of the agency has a critical impact on the level of political support and decision-making authority of the responsible parties and the acquisition of approval processes during the project development process (Mostaan and Ashuri 2017; Fard et al. 2010; Ford and Randolph 1992).

The allocation of resources and distribution of authority between a single central office and multiregions or districts varies with the dimensions of organizational structure (e.g., centralized and decentralized organizations, matrix structures, and use of outsourcing and privatization). In addition, establishing a suitable organizational structure of project management that aligns with agency goals and objectives is essential to smoothly execute construction projects, as well as improve the efficiency of communication and coordination among the members of the project team (Cheng et al. 2003).

1.1.1. Matrix Organizations

The organizational structure of the state DOT refers to the method through which roles and responsibilities are transferred within the hierarchy of the organization based on the capabilities of the staff (Lockwood et al. 2011). The *matrix organizational form* seeks to combine the advantages of the *functional organizational form* and *project organizational form* (Kerzner and Kerzner 2017). In a matrix organization, the traditional hierarchy is overlaid by some form of lateral authority, communication, or influence (Gobeli and Larson 1986). This form of organization creates a dual chain of command, one along the project line and another along the functional line in the organization. As shown in Figure 1, based on the authority and role of the PM and functional offices, the matrix type of organization can be divided into three categories: weak matrix, balanced matrix,

and strong matrix. The strength of the matrix organization is determined by the influence of the PM over the performance of the projects.

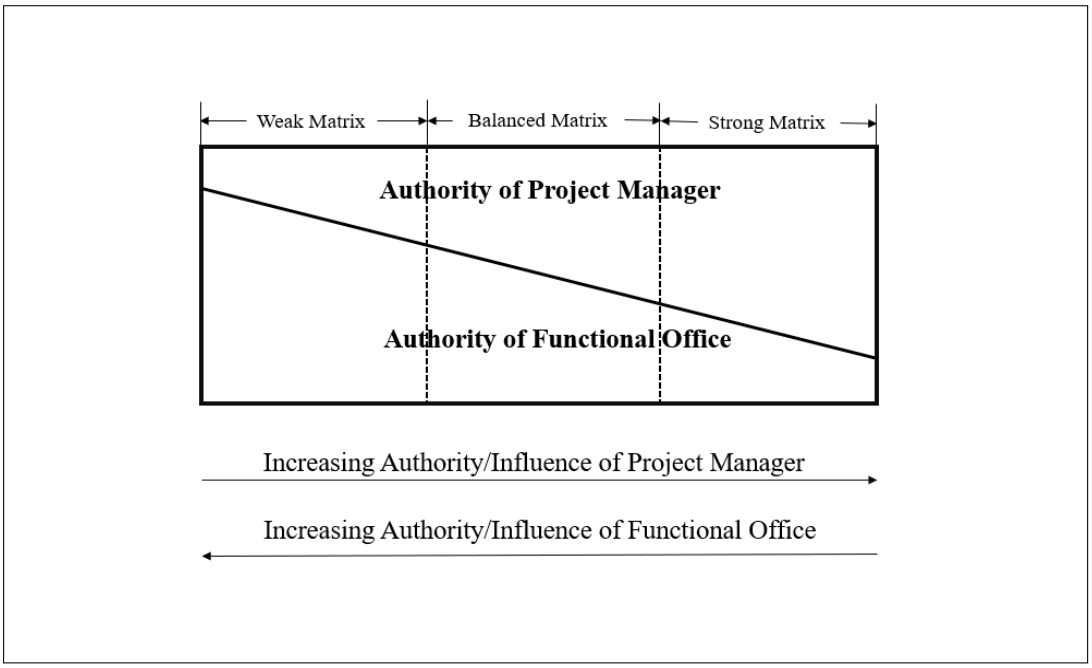


Figure 1 Spectrum Showing Different Types of Organizational Structures (Larson and Gobeli 1987)

The weak matrix organization retains many of the features of a functional organization, and the primary role of the PM is more of a coordinator or expediter for the project (PMBOK Guide 2001). In a strong matrix structure, the project is at the center of the organization and the PM is responsible for the successful completion of the project, rather than just overseeing the project as in a weak matrix organization (Larson and Gobeli 1987). The balanced matrix falls in between the strong and weak matrix organization structures, where there is shared authority between the PM and the functional office for the successful completion of the project in the organization (Ford and Randolph 1992).

1.1.2. Current Organization of State DOTs

State DOTs are typically vertically oriented bureaucratic organizations, organized around hierarchical reporting and control, with high degrees of specialization of roles and formalization of tasks and activities. Specifically, most state DOTs are primarily functional in their structural orientation, meaning that the reporting and management structure is organized around specialized functions; for example, environmental is a distinct functional unit from delivery, construction, or maintenance (AASHTO 2009). In a survey conducted by NCHRP 20-24 (83), 20 of 27 respondents were in favor of considering changes in the organizational structure or making the organization more adaptable to deliver critical and large projects in their organizations (Secrest et al. 2012). A state DOT's overall capability as an institution, as well as performance based on the prescribed roles and responsibilities, can be determined through four important elements: (a) organizational structure, (b) culture and leadership, (c) resource allocation, and (d) partnership (Lockwood et al. 2011). The organizational structure for project management in state DOTs is critical for their core function, which is the timely delivery of transportation projects that are often delivered through the design–bid–build (DBB) method.

Some of the critical factors that must be included while considering the organizational structure for project management according to Thomas et al. (1983) are: (1) project size and duration, (2) organizational experience, (3) resources, (4) differences in the types of projects, (5) project importance, (6) technology uncertainty, (7) financial uncertainty, (8) number of projects, and (9) cost and schedule control. These factors are essential to defining the best organizational structure for the transportation agency to suit its project type and complexity and inherent characteristics (Thomas et al. 1983). For

example, Thomas et al. (1983) pointed out that greater size and duration of the project requires higher authority of the PM to meet the project objectives and keep the team focused on the project for the duration of the project.

1.2. Challenges in State DOT Organizational Structure

1.2.1. Project Manager Authority

Different organizational structures provide varying levels of authority to the project manager for effective project management. For instance, McKenna (2000) indicated that the responsibility allocated at the individual level can be counterbalanced by assigning appropriate authority for efficient and effective project management. According to NCHRP Project 20-68A (McMinimee et al. 2009), it is critical that state highway agencies establish clear authority and definition of roles and responsibilities for all participants within the project management structure. The authority and roles and responsibilities should be recognized by other members of the project team for effective project management (McMinimee et al. 2009).

1.2.2. Project Management Methods and Skills

Over the past few years, it has become evident that project managers cannot deliver successful projects based solely on their technical skills. PMs working in a matrix organization structure face a severe communication paradigm, which makes interpersonal or soft skills a key factor for the project success. To successfully deliver projects, PMs should utilize the tools and practices that support project management throughout the project development process. Baek et al. (2016) indicated that PMs can benefit from

effective tools and strategies for project management that are identified from state DOTs in the United States. The authors identified five areas of opportunity for project management: (1) project scope and concept development, (2) concept-level risk identification and assessment, (3) preliminary and final design summary reporting, (4) value engineering and alternative analysis, and (5) cost estimate validation and review. Gransberg et al. (2012) proposed the five-dimensional model for complex transportation project management, including cost, schedule, technical, financing, and context. Their proposed model enables state DOTs to better conceptualize the complex project's scope by recognizing the impacts of the project context, project financing, cost, and the actual period to deliver a project. For example, the increasing use of innovative funding sources and alternative financing mechanisms (Ashuri and Mostaan 2015; Mostaan and Ashuri 2016) have introduced a new organizational management to state DOTs for developing public-private partnership (P3) projects. According to Ashuri et al. (2017b), a rigorous process to select the project management method can greatly benefit the transportation agency in dealing with complexity in the execution of projects.

The study conducted by Shahandashti et al. (2018) identified key performance indicators for portfolio management through the survey and structured interviews with subject matter experts in the construction industry. The authors found the top five areas, cost, schedule, cash flow, change management, and safety, in which both contractors and owners use metrics for measuring the performance of a portfolio of projects. The findings of this study indicated that the measurement of the identified key areas can provide the construction owners and contractors with critical information to improve the performance of program and portfolio management. Liang et al. (2019) empirically showed how the

level of experience of project managers is a key factor influencing the overall performance of the project.

In addition, according to research conducted by Ashuri and Bahrami (2017), a set of project management skills (e.g., leadership, technical, managerial, financial, and procurement) is critical for achieving project goals. A study conducted by Clevenger (2018) found that state DOTs seek improved project management skills because of federal and local legislation and limited resources. The author also suggested that a formal training and certification process for project management provides several benefits, including consistency in the knowledge and skills achieved by participants, expressed endorsement and recognition by leadership, and a sense of accomplishment and closure for employees. Several leadership skills and project management strategies were identified by Ashuri et al. (2019) and Amekudzi-Kennedy et al. (2016) as targeted training opportunities to enhance the utilization of disadvantaged business enterprises (DBEs) in transportation project development.

The task of project management takes place in a dynamic environment, where the project management is carried in a continuously changing environment that requires effective information exchange within a certain time frame to aid the PM in making quick and accurate decisions (Ahmad 1999). PMs can be empowered to make those swift decisions by using advanced tools and technologies that provide precise information that can be visualized, optimized, studied, and quantified with greater accuracy (Salem and Mohanty 2008).

1.2.3. Early Risk Identification

It is essential for the project manager to understand the various risks associated with the project as early as possible, classifying them into appropriate risk factors to represent the project cost overrun or schedule delay for the project, and prepare an appropriate risk mitigation strategy for the risk associated with the project (Baek et al. 2016; Ashuri et al. 2017a; Ashuri et al. 2018a; Ashuri et al. 2018b). The early identification of the project risks allows the PM to obtain critical knowledge from subject-matter experts (SMEs) on various types of risks and helps the PM develop effective risk mitigation strategies (Ashuri et al. 2018a; Ashuri et al. 2018b). According to Ashuri et al. (2018a) the risk management strategies thus developed can help the PMs better understand project issues from the perspective of SMEs and can also be used to establish a platform for systematic communication between the project management team and SMEs in the different offices such as environmental services, Right of Way (ROW), communications, utilities relocation, and bridge design, in the early phases of the project. Ashuri et al. (2015; 2017a) highlighted that a well-structured tool for establishing, monitoring, and updating cost and schedule estimates, integrated with risk analysis tools, is critical for controlling cost and schedule overrun during the development phase of the project.

1.3. Research Problem for This Project

The Georgia DOT (GDOT) Office of Program Delivery (OPD) is interested in enhancing its efficiency in managing design–bid–build projects. In particular, GDOT is interested in a better understanding of the state of the practice in organizational structure models that are currently used by other state DOTs in managing their DBB programs.

Therefore, the research objective is to identify best management practices (BMPs) in state DOTs with regard to the organizational structure of traditional (i.e., DBB) project delivery for highway projects. The research is aimed to identify and analyze the BMPs of other state DOTs with a DBB program similar to GDOT's program, for project management organizational structure, project management tools, training of project managers, and other innovative practices. The research is also aimed at understanding the difficulties and problems faced by other similar DOTs that have already gone through the transition process in their organizational structures in order to help the GDOT project management team identify potential areas for improvement and define effective strategies for enhancing its own project management organizational structure.

CHAPTER 2 RESEARCH METHODOLOGY

2.1. Overview

The primary objective of this research was to identify and document best management practices in state DOTs with regard to their project management organizational structure with a design–bid–build project delivery program. To achieve this objective, this research used a qualitative research methodology that is proposed by Lee et al. (2019), containing an extensive literature review, a survey, a content analysis, and interviews with subject-matter experts in other state DOTs. The following tasks (see Figure 2) are conducted:

1) Review the academic/professional literature on organizational structure models for design–bid–build project delivery
2) Conduct background data collection and peer state confirmation, and literature review
3) Develop a fact-finding survey, distribute the survey, and analyze the survey results to identify the best management practices of design–bid–build project delivery organization
4) Conduct follow-up interviews to prepare case studies of organizational structure for design–bid–build project delivery
5) Summarize and present in this research report the findings from all the information collected through emails, structured interviews, and content analysis

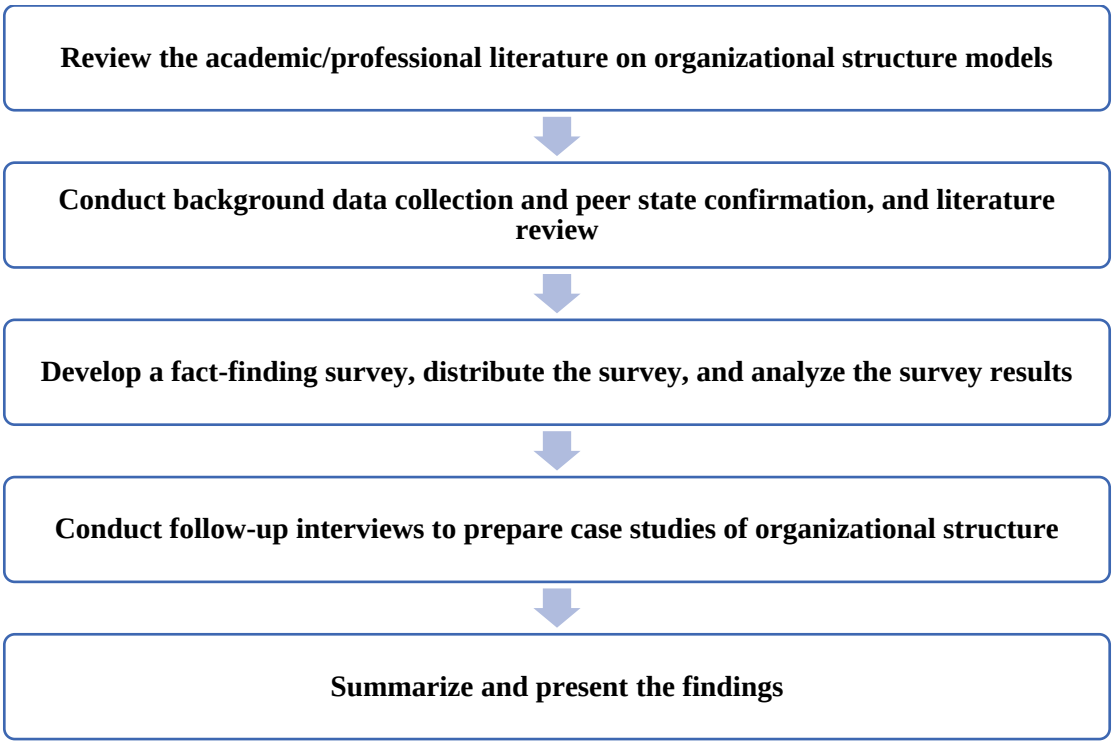


Figure 2 Overview of Research Methodology Steps

2.2. Discussion of Research Methodology Steps

This section discusses each step in the research methodology. The subsequent chapters synthesize the information obtained from the state DOTs in these steps (Chapter 3) and identify their best management practices (Chapter 4). Chapter 5 provides recommendations from those identified best practices.

1. *Review the academic/professional literature on organizational structure models for design–bid–build project delivery:*

   The main goal of this task was to collect information and data related to the current knowledge about organizational structure of DBB project delivery, key

professional leadership staffing requirements for project management roles, and organizational culture.

2. *Conduct background data collection and peer state confirmation, and literature review:*

   The research team collected background data covering the DOTs for all 50 states with regard to their traditional project delivery and organizational structure.

   Particular emphasis in this step was collecting the following information for each state:

   - Scale of the state program (dollars and number of projects let)
   - Structure and placement of the project management unit in the state DOT's organizational chart, especially with respect to other functional DOTs
   - Relationships between the project management unit and other functional units
   - Usage of the dedicated project management role vs. the task responsibility assigned to the design engineer, or other team member(s)
   - Reporting lines for project managers and other project team members from functional and resource units
   - Project delivery procedures and guides, and project management manuals
   - Performance metrics to measure the performance of project managers and project management team members

3. *Develop a fact-finding survey, distribute the survey, and analyze the survey results to identify the best management practices of design–bid–build project delivery organization:*

   The objectives in this step of the work were to: (1) identify the range of current project delivery structures used by state departments of transportation, with specific attention to the relative authority of the project manager and the functional or divisional manager; (2) understand from interviews the opinion of subject-matter experts on the impact the structural changes or other modifications to PM tasks, responsibilities, or alignment with other units have on project delivery performance; and (3) identify challenges in managing project interrelated tasks in the project-oriented organization and describe best practices to overcome those issues and enhance the performance of the project management organization. The survey instrument was designed for identifying and comparing the following across states:

   - Organizational structure: extent of horizontal activities, strength of horizontal structure (weak/balanced/strong)
   - Assignment of roles, responsibilities, tasks and functions to PMs and other team members, including managerial control and reporting
   - Performance indicators and measures (objective and subjective)
   - Overall organizational culture
   - Relationships with district offices and local governments
   - History of organizational changes in the state DBB project delivery
   - Utilization of consulting firms in project management (comparable to government estimators or similar positions)

- Experience, expertise, skillsets, and credentials of PMs (or comparable role), and current practices with regard to PM training and onboarding
- Project management software programs, and other communication and coordination systems used
- Educational and training methods

4. *Conduct follow-up interviews to prepare case studies of organizational structure for design–bid–build project delivery:*

   The research team selected ideal-type or relevant peer cases for follow-up phone interviews to collect additional information on current practices and agency experience with implementation and transition of organizational structure for DBB project delivery.

5. *Summarize and present in this research report the findings from all the information collected through emails, structured interviews, and content analysis:*

   In the final step of the research methodology, the research team assembled all the work performed in the earlier stages in an efficient manner to create a synthesis of all the findings. It was essential to compile this entire process and document the findings in a clear and lucid manner—from the first step of conducting the extensive literature review for finding gaps in the existing research; distributing the survey to each state to identify its DBB project delivery structure; reporting lines, roles and responsibilities, and other related activities; distributing the questionnaires over email and following-up with interviews of these contacts to collect additional information on current practices and agency experience with implementation and

transition; and performing content analysis on all the responses and documents shared by the interviewees. The research team identified the best practices of other state DOTs in project management organizational structure and discussed emerging trends in establishing a performance measurement environment for project management in the agency. A critical summary of all responses to the survey and interview questions, along with the review of all the DOTs' resources that were shared, are provided in the next two chapters.

CHAPTER 3 STATE DOTS' PROJECT MANAGEMENT PRACTICES AND ORGANIZATIONAL STRUCTURES

3.1. Introduction

The organizational structure of an enterprise has a critical impact on the success of its execution of strategic goals and implementation of operational tasks. The organizational structure influences the execution behaviors of the organization by shaping not only the competence of the organization, but also the processes that shape performance (Wolf 2002). Agencies in charge of construction programs adopt an effective organizational structure as the management framework to oversee the various activities of a construction project and other activities of an organization (Ubani 2012). In addition, the organizational structure is the basis of defining the levels of hierarchy, spans of roles and responsibilities, and mechanisms for integration and problem solving (Walton 1986). Thus, establishing an efficient and effective organizational structure is essential for state DOTs in delivering their projects within budget and on time.

According to the Strategic Highway Research Program's (SHRP's) *Guide to Improving Capability for Systems Operations and Management* (Lockwood et al. 2011), the organizational structure of state DOTs can be defined as how structure aligns responsibilities and accountabilities vertically and horizontally. The vertical and horizontal structure with alignments of the responsibilities and accountabilities can be described by a matrix organizational structure, which combines a functional silo structure with a strong horizontal communication and coordination mechanism (Secrest et al. 2012).

The matrix structure of an organization can be classified into three types (i.e., weak, balanced, and strong matrices) based on the relationship, authority, and arrangement of the functional offices and project management office. In the weak matrix (or functional matrix), projects rely on the delivery of activities by SMEs with a clear division of tasks, but managerial incentives or reprimands related to project performance must be handled by functional managers (Ford and Randolph 1992; Shirazi et al. 1996). Figure 3 displays a DOT organizational structure with a weak matrix structure.

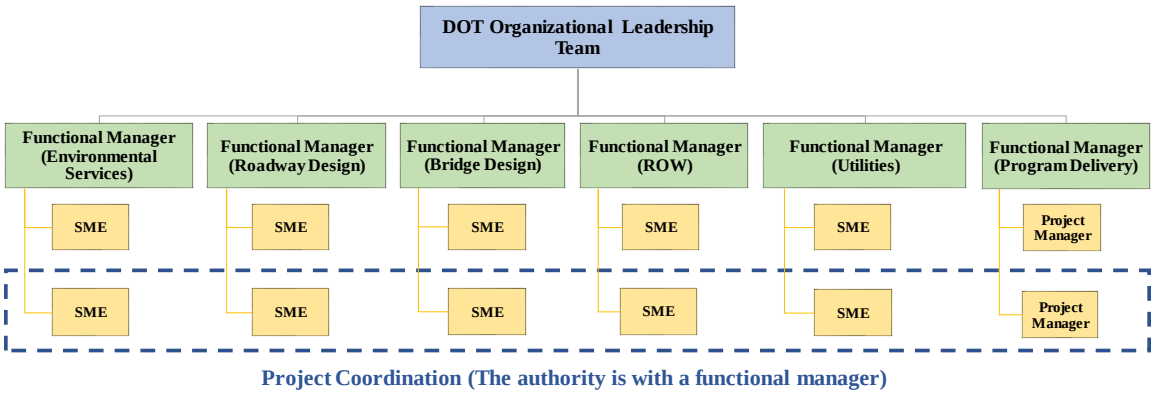


Figure 3 Structural Alignment: "Weak" Matrix

When one functional area plays a dominant role in the project development, the weak matrix is suitable. Thus, the major benefit of the weak matrix is that in-depth expertise can be brought to a project within the most crucial aspects of the project. However, the weak matrix has a narrow band of the project manager's authority over the functional units for project development (Kuprenas 2003; Papaoikonomou 2006). In addition, the functional or weak matrix has poor integration between functional units as cross-functional communication and coordination, which can result in diminished performance because of slow response time and the need of rework as a result of the lack of horizontal, direct communication among functional units (Papaoikonomou 2006).

Increasing the "strength" of the PMs by specifying roles and responsibilities where they have authority over project team members can improve their ability to manage projects. One option is to balance the strength of both the functional manager (FM) and the PM, either by requiring them to share control over certain responsibilities, or by delegating particular areas of influence (such as placing FMs over the technical content of project activities and PMs over the selection and assessment of project team members). This is referred to as a balanced matrix. Figure 4 displays a simplified representation of a modified DOT organizational structure oriented around a balanced assignment of managerial authority between the PM and the FM. Under the balanced matrix, PMs have indirect authority to expedite and monitor the project, while the FMs retain primary responsibility for their specific tasks in the project development (Kuprenas 2003; Papaoikonomou 2006; Feger and Thomas 2012). In addition, FMs and PMs share the responsibility for assigning the project resources (Feger and Thomas 2012). A balanced matrix's use of cross-functional structures can improve information processing across activities, improve team member work satisfaction, provide greater flexibility, provide effective resource allocation, and support technical excellence (Ford and Randolph 1992; Papaoikonomou 2006; Schnetler et al. 2015).

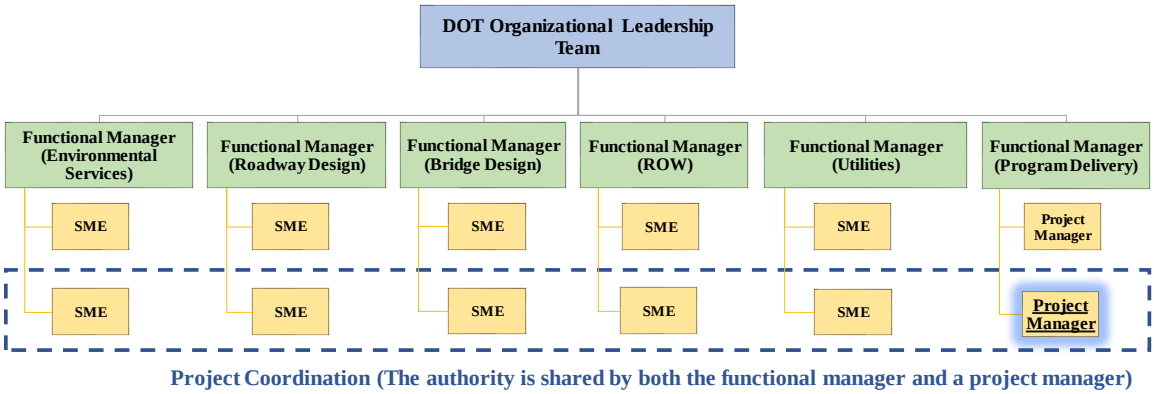


Figure 4 Alternative Structural Alignment #1: "Balanced" Matrix

The primary challenge with a balanced matrix is the lack of unity of command. Project team members are accountable to both the FM and the PM (though ideally this should be coordinated cleanly by the managers), and this can create team and organizational conflict between PMs and FMs, which leads to the slow response time and personnel issues (e.g., staff stress and turnover; Schnetler et al. 2015). Additionally, while the balanced matrix provides a mixture of the efficiency benefits of the functional structure and the project orientation of the product structure, some organizations may seek to optimize project flexibility and PM control. A strong matrix, or project matrix, exists when the project is the dominant structural entity and the PM has primary control over resources and project activities (Ford and Randolph 1992; Kuprenas 2003; Feger and Thomas 2012).

Figure 5 displays one candidate representation of a strong matrix structure, oriented around the project as the core product and activity of the DOT. The tension between FM and PM roles is resolved somewhat by establishing the primacy of the PM in the project-based organization. However, the transition to a strong matrix can be problematic, as existing managers will be ceding power to others and the organizational culture will be pressured to adapt to new understandings of role primacy. The functional units remain,

with some room for variation in their level of influence. For example, a DOT could choose to retain functional meetings and coordination systems but move functional staff out of physical co-location and into project-based spaces (such that all project team members are physically proximate to each other). A more modest change would place project team selection, or even hiring, promotion, and contracting decisions, into the hands of PMs. Both the balanced and strong matrix formats place greater burden on the qualifications and skills of PMs, particularly the balanced matrix where PMs must not only manage their team members but also their relationship with a broad suite of functional managers (Kuprenas 2003).

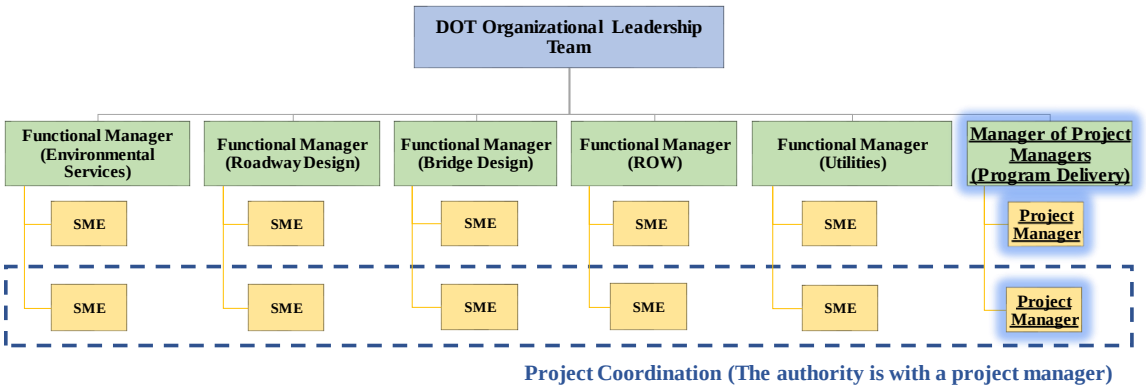


Figure 5 Alternative Structural Alignment #2: "Strong" Matrix

The use of consultants for project delivery is an additional element that is becoming increasingly core to the delivery of projects. Some states, such as Arizona, Florida, and Utah, outsource over 80% of their traditional project delivery, though it is currently commonplace (as for GDOT) to retain an in-house PM to oversee consultant project delivery and management.

3.2. Organizational Structure Models

The organizational structures of several state DOTs were analyzed in order to review their similarities and differences and develop organizational structure models used by the DOTs for project management. Several factors were considered in classifying different state DOTs' organizational structure models into groups with similar characteristics, for instance, relative position of the dedicated project management unit with respect to other preconstruction units, such as the design, environmental, and right of way (ROW) offices, and the relative role of district offices in handling various aspects of project delivery. The identified models were classified into two broad groups depending on the level of involvement from district offices in performing project delivery tasks during the preconstruction phase of the project. The first group represents different types of organizational structure models found in state DOTs with a *centralized approach* toward project management (i.e., project management tasks for preconstruction services are led and conducted at the central [headquarters] office). The second group represents different types of organizational structure models found in state DOTs with a *decentralized approach* toward project management (i.e., project management tasks for preconstruction services are led and conducted in district [region] offices throughout the state).

Seven organizational structure models (named C1–C7) and six organizational structure models (named D1–D6) were identified for DOTs with the centralized and decentralized approaches toward project management, respectively. The identified models show how various state DOTs have defined the relationships among their functional and project management units to develop projects throughout various phases of project

development. Each identified model represents a group of state DOTs with similar organizational structures in handling project management tasks.

3.2.1. Identified Organizational Structure Models for Centralized DOTs

3.2.1.1. Centralized Organizational Structure Model C1 (Division of Program Delivery Parallel to Division of Engineering Reporting to Chief Engineer)

Model C1 (see Figure 6) presents the structure of a centralized organization, where the Division of Engineering is over the Offices of Environmental Services, Roadway Design, Bridge Design and Maintenance, and Right of Way, while the Office of Program Delivery is over the project managers. The Offices of Utilities and Construction are located under separate divisions. The PMs are below the functional offices in this type of organization structure. Under this organizational model, the head of the Office of Program Delivery appoints the PM to the project. Functional subject-matter experts are assigned to the project by the heads of the related functional offices. This type of organization structure facilitates collaboration for the design team of the project but provides less opportunity for enhanced collaboration among the collective project team members. Critical issues among the project team members, especially between PMs and functional-area team members, need to be resolved at a higher level in the organization. The Georgia DOT provides an example of organizational model C1.

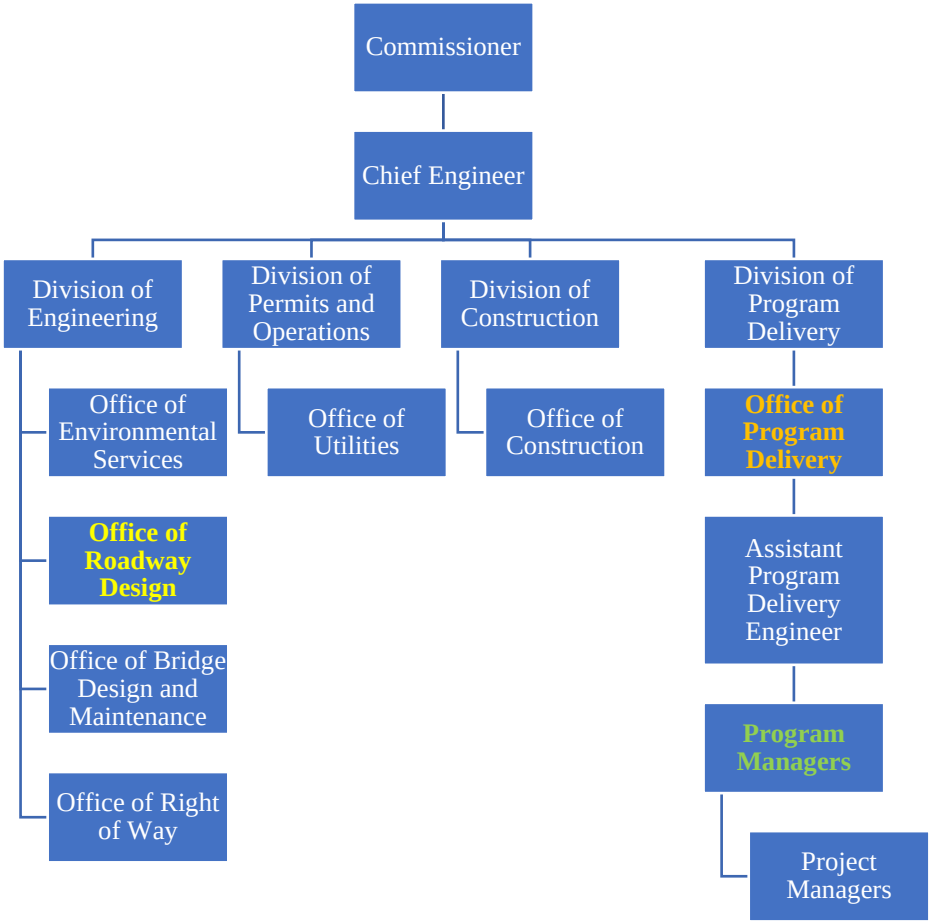


Figure 6 Centralized Organizational Structure Model C1
(Division of Program Delivery Parallel to Division of Engineering Reporting to Chief Engineer; e.g., Georgia DOT)

3.2.1.2. Centralized Organizational Structure Model C2 (Project Development Office over Project Management, Design, ROW, Bridge, and Utilities Units)

Model C2 (see Figure 7) presents the structure of a centralized organization, where there is a Project Development Office (PDO) over the Offices of Right of Way, Design, Project Management, Utilities, and Bridge. The Project Management Office is located parallel to the other functional offices. The Environmental Office is located at the same level as the PDO. The Construction Office is located under the Operations Office. Under this organizational model, the head of the Project Management Office appoints the PM to

the project. Functional SMEs are assigned to the project by the heads of the related functional offices. The PDO provides significant opportunities to streamline collaboration among project team members during the preconstruction phase of the project. Compared to model C1, the issues among the project development team are resolved at a relatively lower level. Examples of organizational model C2 can be found in the Arizona and Louisiana DOTs.

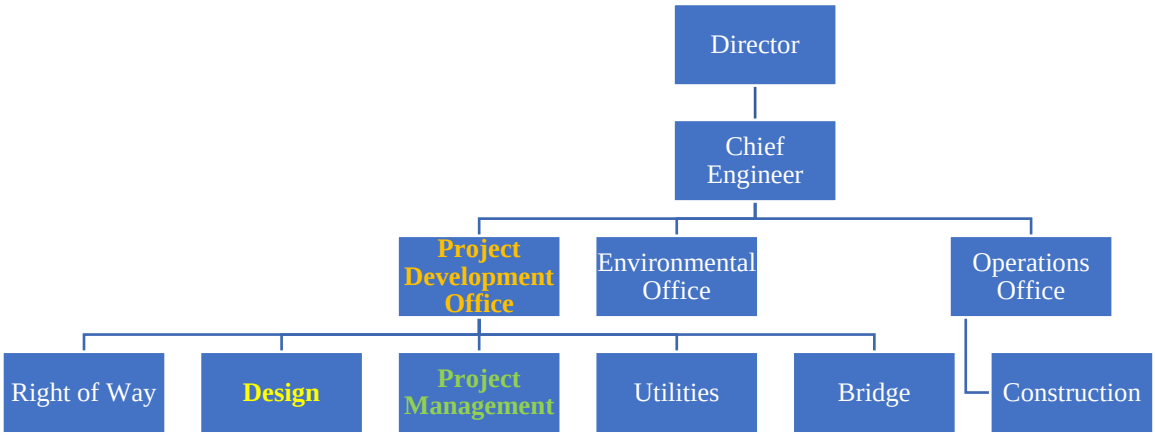


Figure 7 Centralized Organizational Structure Model C2
(Project Development Office over Project Management, Design, ROW, Bridge, and Utilities Units; e.g., Arizona and Louisiana DOTs)

3.2.1.3. Centralized Organizational Structure Model C3 (Project Delivery Bureau over Project Management, Design, Location and Environmental, ROW, Bridge and Structures, and Utilities Units)

Model C3 (see Figure 8) presents the structure of a centralized organization, where the Project Delivery Bureau is over the Right of Way, Design, Utilities, Bridge and Structures, Location and Environment, and Project Management Offices. One of the main differences between models C2 and C3 is that the environmental office is also located under the Project Delivery Bureau in model C3. The Project Management Office is located

parallel to the other functional offices. The Construction and Materials Office is located under the Operations Bureau. Under this organizational model, the head of the Project Management Office appoints the PM to the project. Functional SMEs are assigned to the project by the heads of the related functional offices in collaboration with the PM. The Project Delivery Bureau acts as the focal point to streamline collaboration among project team members during the preconstruction phase of the project. Similar to model C2, the issues among the project development team get resolved at the lowest possible level in the Project Delivery Bureau. An example of organizational model C3 can be found in the Iowa DOT.

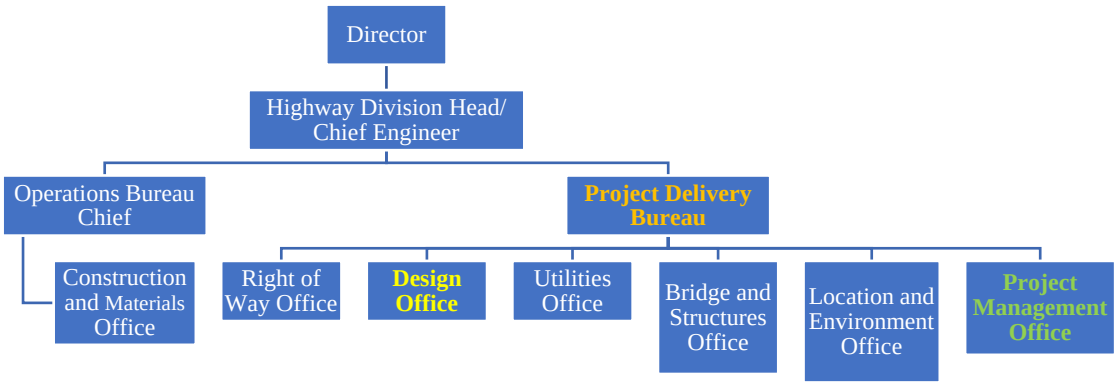


Figure 8 Centralized Organizational Structure Model C3 (Project Delivery Bureau over Project Management, Design, Location and Environmental, ROW, Bridge and Structures, and Utilities Units; e.g., Iowa DOT)

3.2.1.4. Centralized Organizational Structure Model C4 (Project Development Bureau over Bridge, Project Management, Design, ROW, Utilities, and Construction Units)

Model C4 (see Figure 9) presents the structure of a centralized organization, where the Project Development Bureau is over the Offices of Bridge, Utilities, Design, Construction, Right of Way, and PMs. The main difference between models C3 and C4 is

that the Environmental Office is not located under the Project Development Bureau in model C4, but the Construction Office is located under the Project Development Bureau. The Environmental Office in this organizational model is located under the chief engineer. The PMs are located parallel to other functional offices. Under this organizational model, senior PMs or the head of the highway program manager, located within the Project Development Bureau, assign the project manager to the project. Similar to model C3, functional SMEs are assigned to the project by the head of the related functional offices in collaboration with the PM. This type of organization structure allows more collaboration for the project team, as the project is at the center of all activities in the organization. Also, any conflicts among the project team members are resolved at the lowest possible level in the Project Development Bureau. An example of organizational model C4 can be found in the Maine DOT.

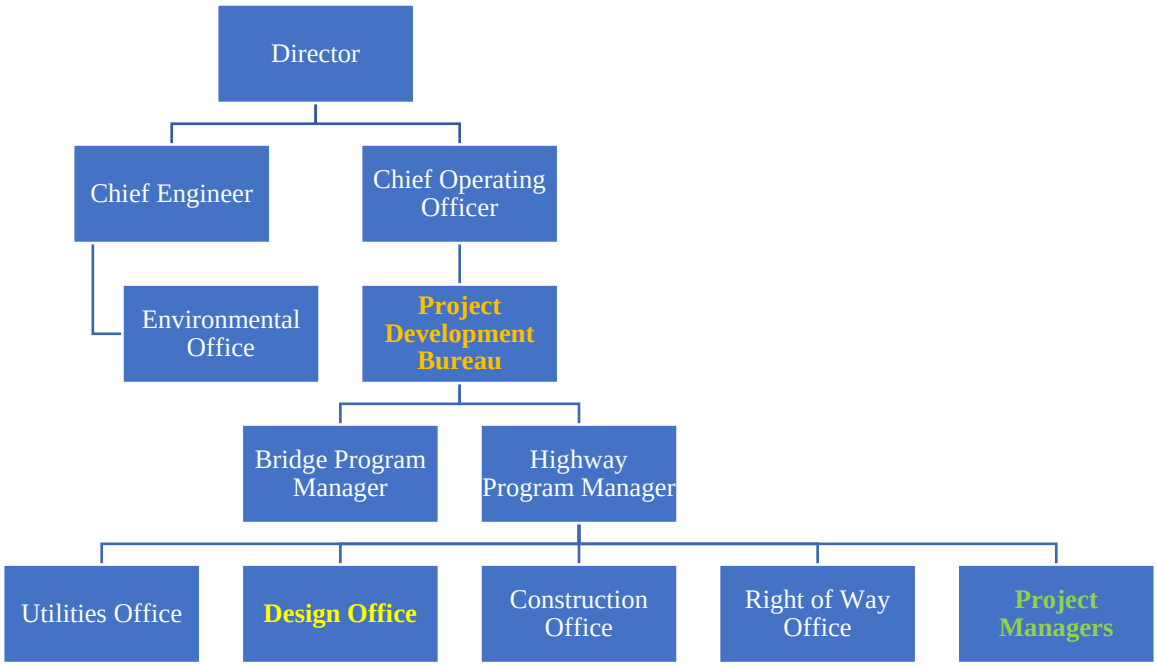


Figure 9 Centralized Organizational Structure Model C4
(Project Development Bureau over Bridge, Project Management, Design, ROW, Utilities, and Construction Units; e.g., Maine DOT)

3.2.1.5. Centralized Organizational Structure Model C5 (Director of Highway Operations over Project Management, Roadway Design, Environmental, Structures, ROW, Utilities, and Construction Units)

Model C5 (see Figure 10) presents the structure of a centralized organization, where the director of highway operations is above the Construction, Roadway Design, Right of Way, Environmental, Structures, and Utilities Offices, and the Project Management Unit. The Project Management Unit is located parallel to other functional offices. Under this organizational model, the head of the Project Management Unit assigns the PM to the project. Functional SMEs are assigned to the project by the head of the related functional offices in consultation with the PM. Great efforts are made to ensure that the focus of the organization stays on the project throughout all phases of the project development. An example of organizational model C5 can be found in the North Carolina DOT.

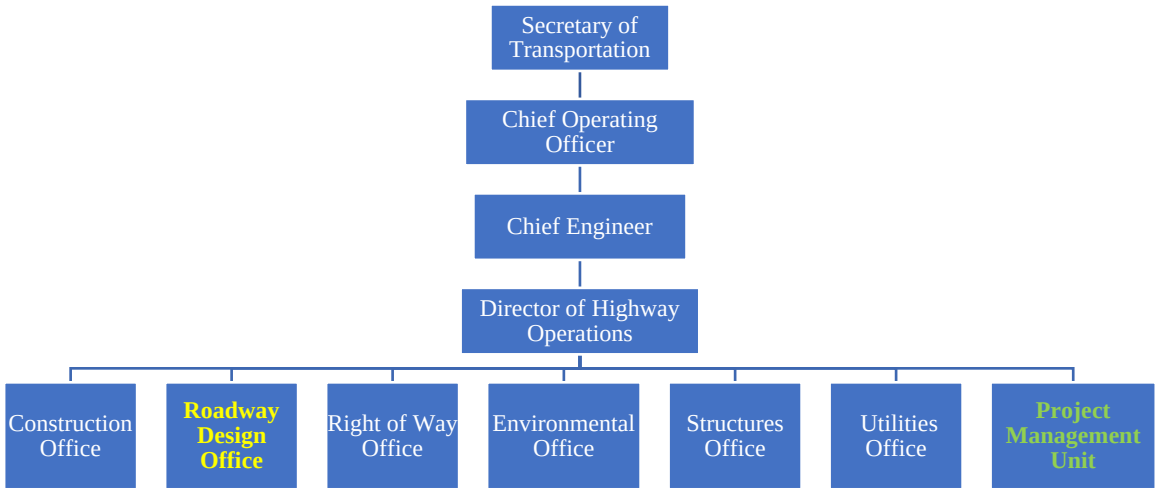


Figure 10 Centralized Organizational Structure Model C5 (Director of Highway Operations over Project Management, Roadway Design, Environmental, Structures, ROW, Utilities, and Construction Units; e.g., North Carolina DOT)

3.2.1.6. Centralized Organizational Structure Model C6 (Engineering Division over Highway Design, Bridges, Environmental Coordination, ROW and Utilities, and Asset Management Units; Project Management Within the Asset Management Division)

Model C6 (see Figure 11) presents the structure of a centralized organization, where the Bureau of Engineering and Construction is over the Engineering and Construction Divisions. The Engineering Division is over the Highway Design, Bridges, Environmental Coordination, Right of Way and Utilities, and Asset Management Divisions. The Project Management Office is within the Asset Management Division and is located below the other functional offices. Under this organizational model, the head of Asset Management Division assigns the PM to the project. Functional SMEs are assigned to the project by the head of the related functional offices. One of the major distinctive features of this organizational structure model is the new unit for environmental coordination. The Environmental Planning Unit, located under the Bureau of Policy and Planning, is responsible for developing the policies and procedures, but there is another unit called the Environmental Coordination Division that provides support to the project development team as part of project management efforts. This organizational structure model allows better coordination for the project management team, especially in the area related to the environmental planning for the project. An example of organizational model C6 can be found in the Connecticut DOT.

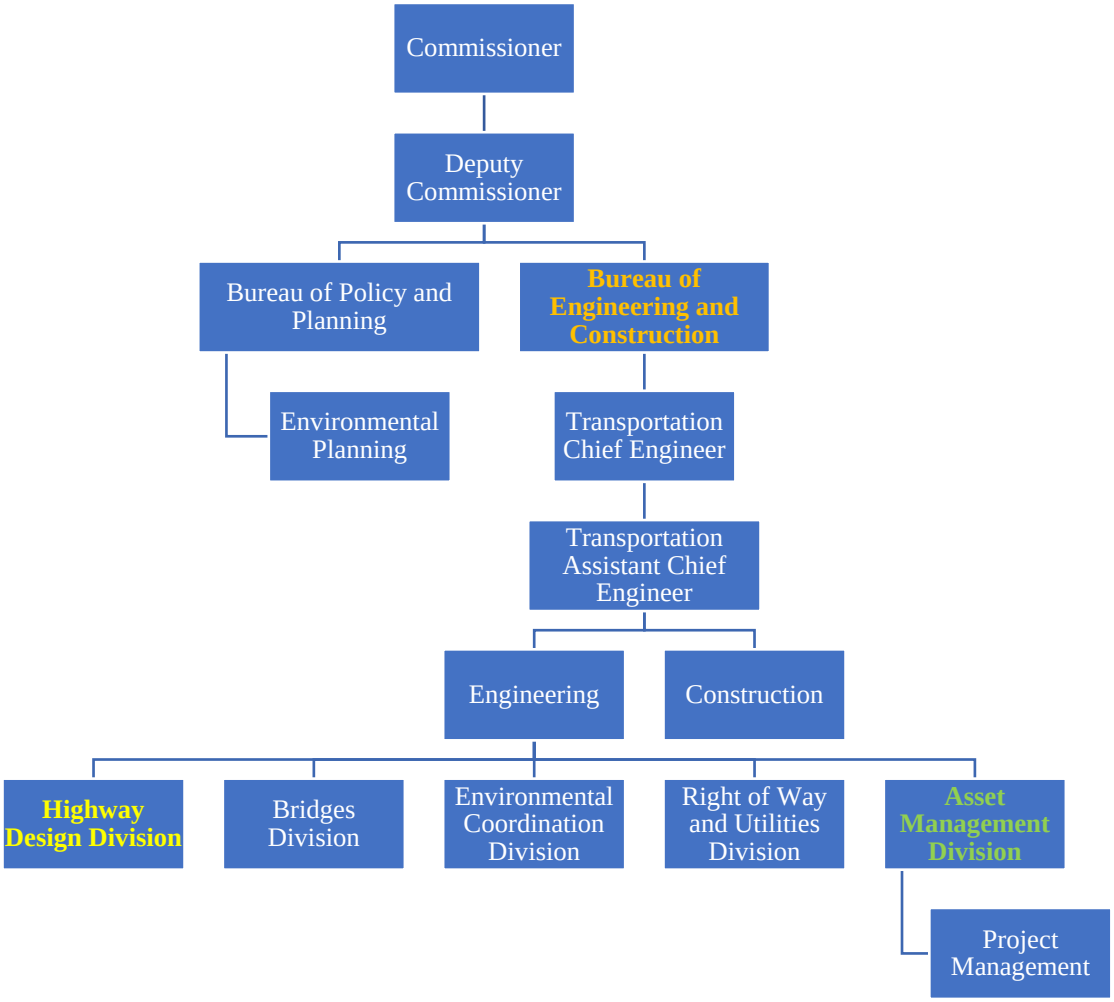


Figure 11 Centralized Organizational Structure Model C6 (Engineering Division over Highway Design, Bridges, Environmental Coordination, ROW and Utilities, and Asset Management Units; Project Management Within the Asset Management Division; e.g., Connecticut DOT)

3.2.1.7. Centralized Organizational Structure Model C7 (Chief Engineer over Project Management, Highway Design, ROW and Assets Management, Bridges and Infrastructure, and Construction and Materials Units)

Model C7 (see Figure 12) presents the structure of a centralized organization, where the chief engineer is over the Highway Design, Right of Way and Assets Management, Project Management, Bridge and Infrastructure, and Construction and Materials Offices. The Environmental Office is located under the planning, multimodal, and grant engineer.

The Project Management Office is located parallel to other functional offices. Under this organizational model, the head of the Project Management Office assigns the PM to the project. Functional SMEs are assigned to the project by the head of the related functional offices in collaboration with the PM. An example of organizational model C7 can be found in the New Jersey DOT.

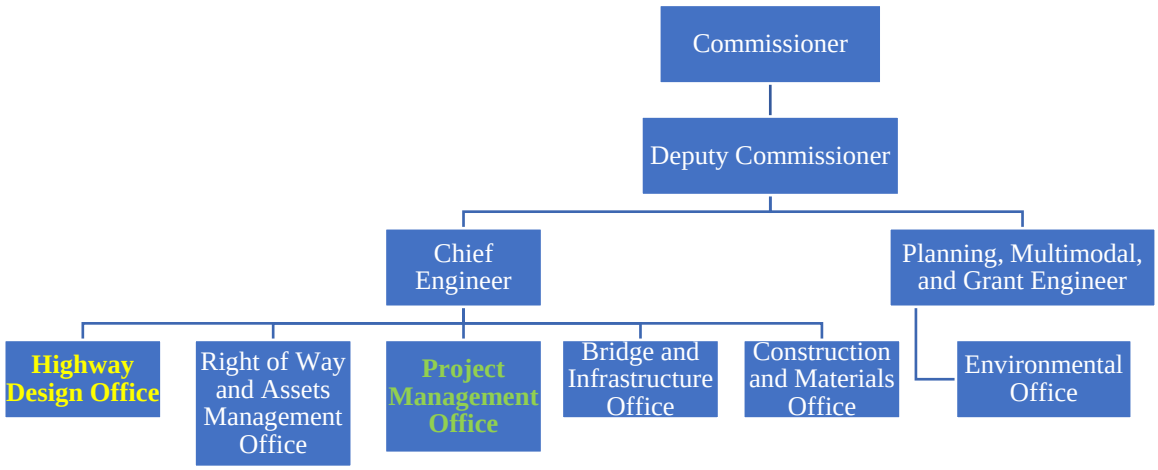


Figure 12 Centralized Organizational Structure Model C7 (Chief Engineer over Project Management, Highway Design, ROW and Assets Management, Bridge and Infrastructure, and Construction and Materials Units; e.g., New Jersey DOT)

3.2.2. Identified Organizational Structure Models for Decentralized DOTs

3.2.2.1. Decentralized Organizational Structure Model D1 (Project Management, Construction, Environmental, Right of Way (Utilities), and Design Offices under District Director)

Model D1 (see Figure 13) presents the structure of a decentralized organization, where the chief engineer is over the Offices of Construction, Design, Engineering Services, Environmental, Project Management, and Right of Way (Utilities) in the headquarters (HQ). At the district level, the district director is over the Offices of Construction, Project

Management, Design, Environmental, and Right of Way (Utilities). The offices in the headquarters are generally responsible for providing assistance and support to the district offices, except for Environmental. The Environmental Office, located in the headquarters (HQ), is responsible for carrying out the environmental planning work for all the projects throughout the entire state. Within each district, the Project Management Office is located parallel to the other functional offices.

Under this organizational model, the head of the Project Management Office assigns the PM to the project. Functional SMEs are assigned to the project by the head of the related functional offices in collaboration with the PM. This organizational structure model provides a unique opportunity to the people in the district office to utilize their expertise and knowledge to minimize project risks from the local standpoint. Also, issues among the project team members are resolved at the lowest possible level in the district office. An example of organizational model D1 can be found in the California DOT (Caltrans) and the Missouri DOT, where the HQ offices provide assistance and support to the Project Management Office and functional offices in the district. In the Utah DOT, functional offices in the HQ provide functional services to the district for mega projects and complex projects.

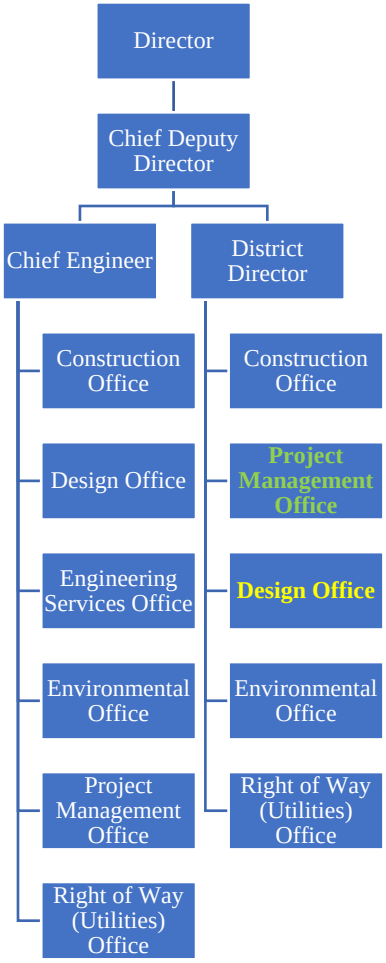


Figure 13 Decentralized Organizational Structure Model D1 (Project Management, Construction, Environmental, ROW (Utilities), and Design Offices under District Director; e.g., Caltrans, Missouri DOT, and Utah DOT)

3.2.2.2. Decentralized Organizational Structure Model D2 (Project Development Office in the District over Project Management and Design Units)

Model D2 (see Figure 14) presents the structure of a decentralized organization, where the deputy chief engineer is over the Offices of Construction, Structure and Bridge, and State Location and Design Engineer at the headquarters. The Project Management office is located under the State Location and Design Engineer's Office at the HQ. The Environmental and the Right of Way and Utilities Offices are located under the Chief of Policy at the HQ. At the district level, the district engineer is above the Right of Way and

Utilities, Construction, and Project Development Offices. Within the Project Development Office at the district level, the Project Management and Design Offices are located. The offices in the HQ are responsible for developing and managing large projects, while the district offices are responsible for managing the smaller projects.

At the headquarters, the Project Management Office is located under the state location and design engineer. At the district level, the Project Management Office is parallel to the Design Office, but, relatively, it is at a lower level compared to the Right of Way and Utilities and the Construction Offices.

Environmental and bridge design works are conducted centrally at the HQ offices of Environmental, and Structure and Bridge, respectively. Under this organizational model, the head of the Project Management Office in the HQ and the district office assigns the PM to the project. Functional SMEs are assigned to the project by the head of the related functional offices at both HQ and district levels. An example of organizational model D2 can be found in the Virginia DOT, where the Project Management Office and functional offices in the HQ are responsible for developing and managing large projects, while small projects are developed and managed by the Project Management Office and functional offices in the district.

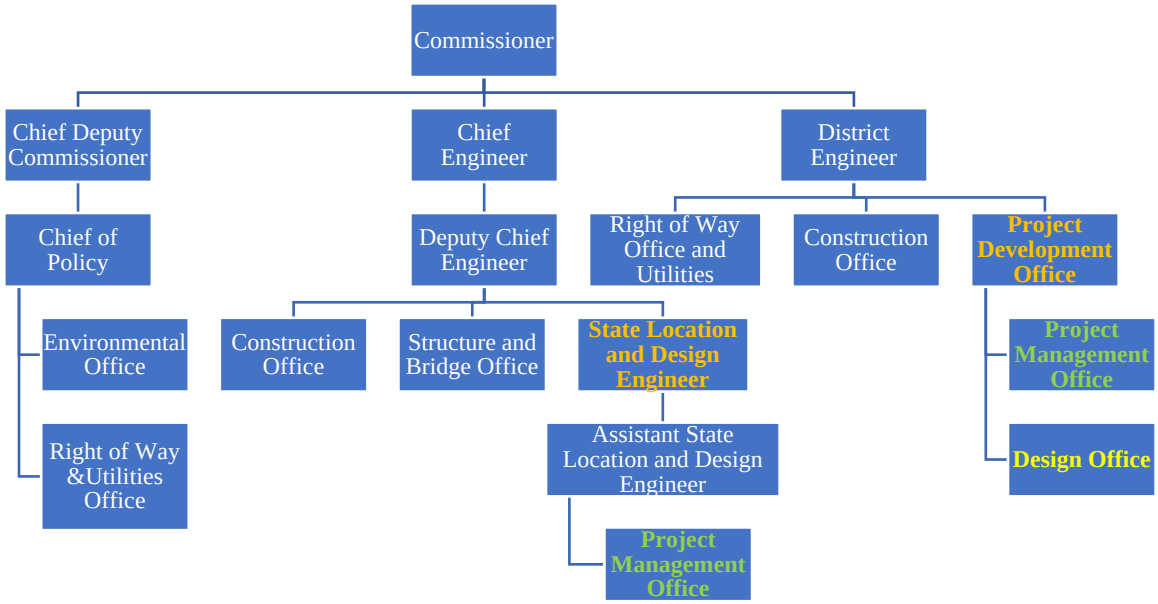


Figure 14 Decentralized Organizational Structure Model D2
(Project Development Office in the District over Project Management and Design Units; e.g., Virginia DOT)

3.2.2.3. Decentralized Organizational Structure Model D3 (Program Management Office in the District over Project Engineering, Design, Environmental, Hydraulics, Planning, ROW and Utilities, and Construction Units)

Model D3 (see Figure 15) presents the structure of a decentralized organization, where the chief engineer is over the mega projects and is responsible for developing and managing all the mega projects within the organization at the headquarters. The mega projects team acts as a separate entity in the organization. At the district level, the Program Management Office is located above the Construction Administration, Project Engineering, Environmental, Design, Hydraulics, Planning, and Right of Way and Utilities

Offices. The Project Engineering Office at the district level is responsible for managing the projects within the district. Within the district, the Project Engineering Office is located parallel to the other functional offices. Under this organizational model, the project engineers are appointed by the head of the Project Engineering Office for the projects at the district level. Functional SMEs are assigned to the project by the head of the related functional offices at the district level. The program management at the district level facilitates project coordination and collaboration among the team members and provides a platform for resolving project issues at the lowest possible level in the district office. An example of organizational model D3 can be found in the Washington State DOT.

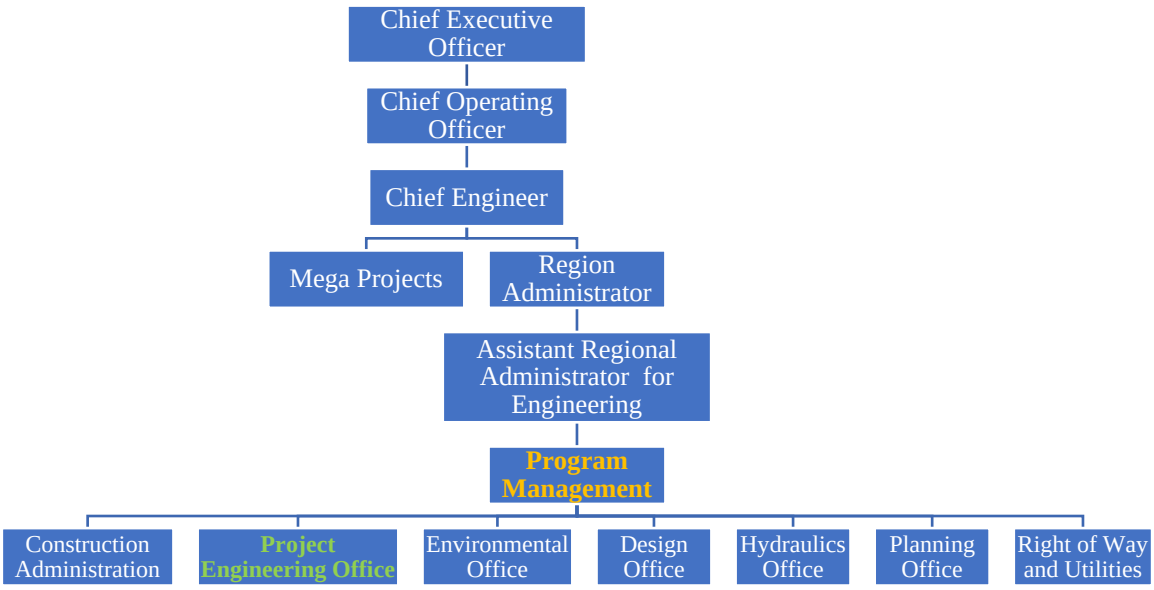


Figure 15 Decentralized Organizational Structure Model D3
(Program Management Office in the District over Project Engineering, Design, Environmental, Hydraulics, Planning, ROW and Utilities, and Construction Units; e.g., Washington State DOT)

3.2.2.4. Decentralized Organizational Structure Model D4 (Program Management Office in the District Office over Roadway Design, Advanced Project Development, Bridge Design, Project Delivery, Right of Way, and Utilities Offices; Engineers from Different Functional Offices Acting as Project Managers During the Various Phases of Project Development)

Model D4 (see Figure 16) presents the structure of a decentralized organization, where Engineering and Safety Operations is over the Offices of Bridge, Construction, Design, and Maintenance at the headquarters. The Office of Project Planning and Development is above the Environmental Affairs and Right of Way Offices at the headquarters. At the district level, the deputy district engineer is above the director of transportation planning and development and the director of construction. Within Transportation Development and Planning at the district level are the Roadway Design, Advanced Project Development, Bridge Design, Project Delivery, Right of Way, and Utilities Offices. Headquarters offices are responsible for providing support and assistance to the district offices, except for the Environmental Affairs Office that is responsible for preparing and developing the environmental plans and policies for all the projects across the entire state. Engineers from the functional offices at the district office act as PMs on the project during different phases of the project. Under this organizational model, the head of the functional office appoints the PM for the particular phase of the projects. Functional SMEs are assigned to the project by the head of the related functional offices at both headquarters and district levels. The director of transportation planning and development at the district level facilitates collaboration and coordination among the project team members throughout different phases of project development. Also, issues among the project team are resolved at the lowest level in the district office. An example can be found in the Texas DOT where engineers from the functional offices act as PMs during different

phases of the project, and functional offices in the HQ provide assistance and support to the functional offices in the district for project development.

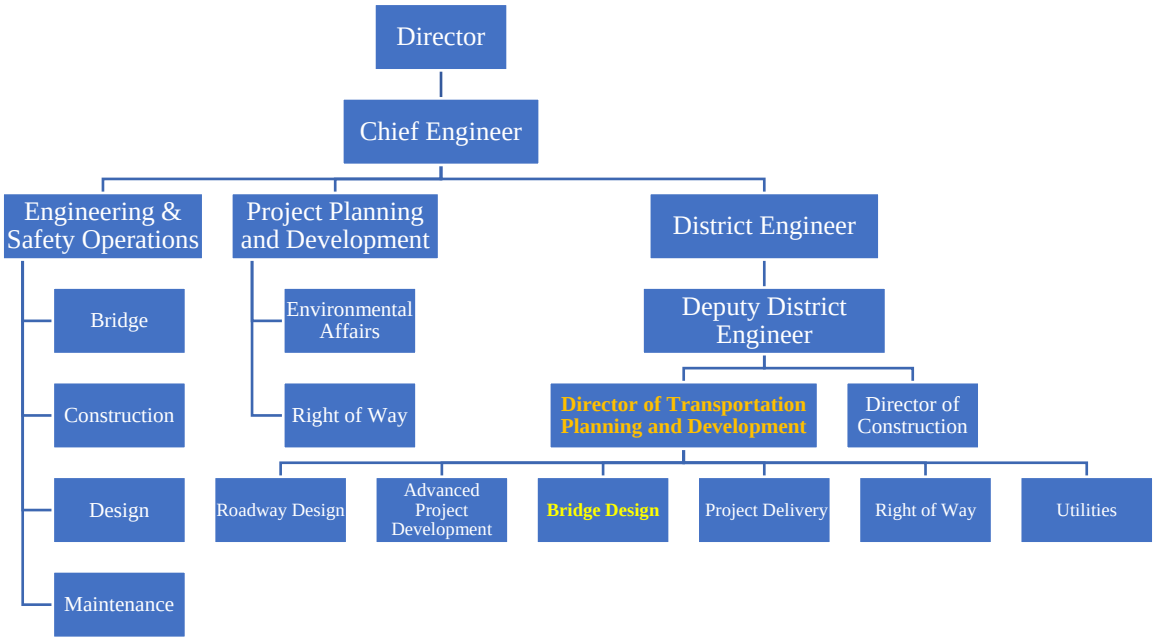


Figure 16 Decentralized Organizational Structure Model D4 (Program Management Office in the District Office over Roadway Design, Advanced Project Development, Bridge Design, Project Delivery, Right of Way, and Utilities Offices; Engineers from Different Functional Offices Acting as Project Managers during the Various Phases of Project Development; e.g., Texas DOT)

3.2.2.5. Decentralized Organizational Structure Model D5 (District Design Engineer over Drainage Design, Roadway Design, Surveying and Mapping, Consultant Project Management, and Structures Design Offices)

Model D5 (see Figure 17) presents the structure of a decentralized organization where the assistant secretary is above the Right of Way, Project Management, Design, and State Construction Offices at the headquarters. At the district level, the district director of

transportation development is above the Right of Way, District Design Engineer's, and Planning and Environmental Offices. Under the district design engineer, the Drainage Design, Roadway Design, Surveying and Mapping, Consultant Project Management, and Structures Design Offices are located. The offices in the headquarters are responsible for providing support and assistance to the district offices. The Consultant Project Management Office in the districts is responsible for managing the projects at the district level. At the district level, the Consultant Project Management Office is parallel to the Drainage Design, Roadway Design, Surveying and Mapping, and Structures Offices, but the Right of Way and the Planning and Environmental Offices are at higher levels relative to the position of the Consultant Project Management Office.

Under this organizational model, the head of Consultant Project Management appoints the PM. Functional SMEs are assigned to the project by the head of the related functional offices at both HQ and district levels. The district design engineer facilitates collaboration among the project team members and coordinates efforts among project participants. Also, issues among the project team are resolved at the lowest level in the district office. An example can be found in the Florida DOT.

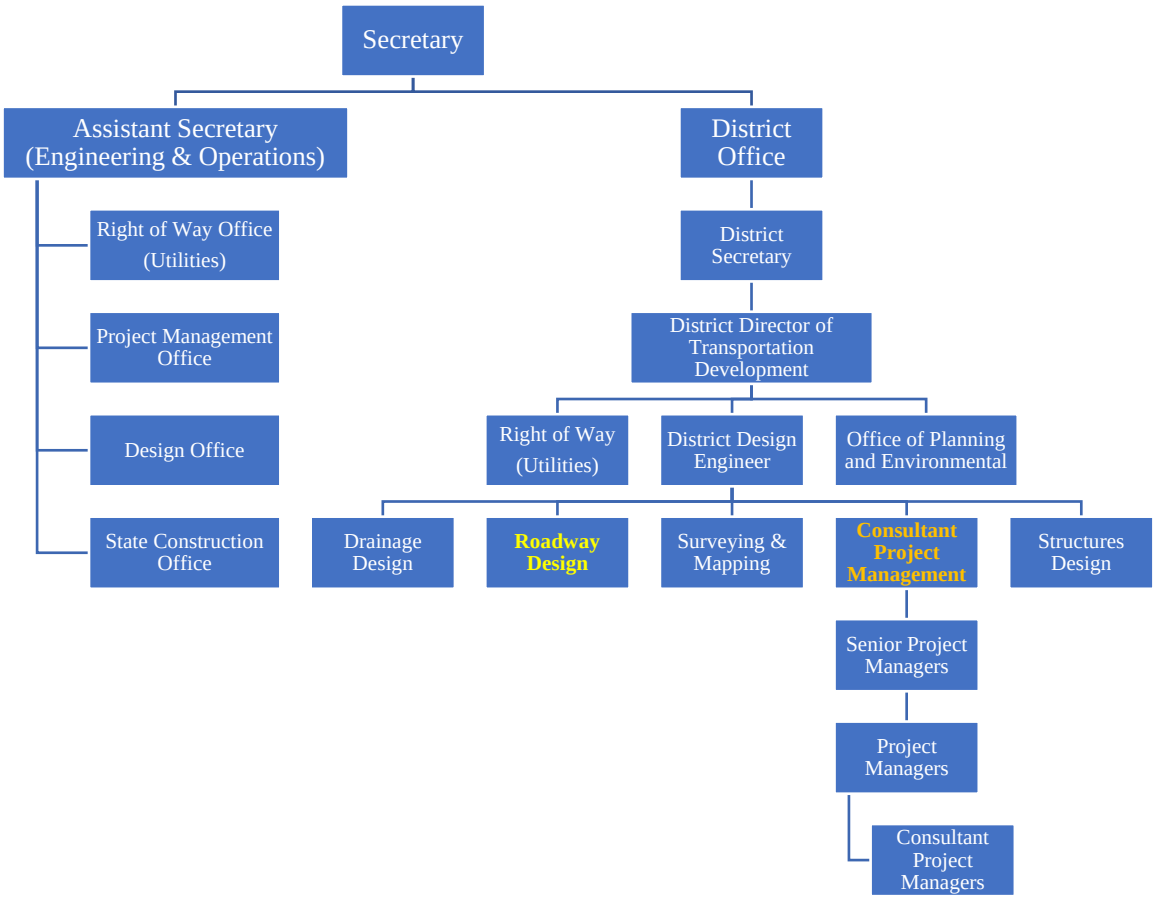


Figure 17 Decentralized Organizational Structure Model D5 (District Design Engineer over Drainage Design, Roadway Design, Surveying and Mapping, Consultant Project Management, and Structures Design Offices; e.g., Florida DOT)

3.2.2.6. Decentralized Organizational Structure Model D6 (District Engineer over Project Management, Construction, ROW, and Design Units)

Model D6 (see Figure 18) presents the structure of a decentralized organization, where the assistant commissioner for engineering services is above the Bridge, Project Management and Tech Support, Environmental Stewardship, and Land Management Offices at the headquarters. At the district level, the district engineer is above the program development manager and the program delivery manager. Under the program development

manager, the Project Management and Right of Way Offices are located, while the Construction and Design Offices are located under the program delivery manager. The Hydraulics and Environmental Coordination Units are located within the Design Office. Headquarters offices are responsible for providing support and assistance to the district offices. The Project Management Office located in the district is responsible for managing the projects within the district. At the district level, the Project Management Office is parallel to the Right of Way, Construction, and Design Offices. One of the main features of this organizational structure model is that the Environmental Coordination Unit located in the district office helps coordinate the efforts of the design team with the Environmental Stewardship Office located in the HQ.

Under this organizational model, the head of the Project Management Office assigns the PM to the project. Functional SMEs are assigned to the project by the head of the related functional offices at both the headquarters and district levels. The program development manager facilitates collaboration among the project team members and coordinates efforts among project participants. Also, issues between the project team are resolved at the lowest level in the district office. An example can be found in the Minnesota DOT.

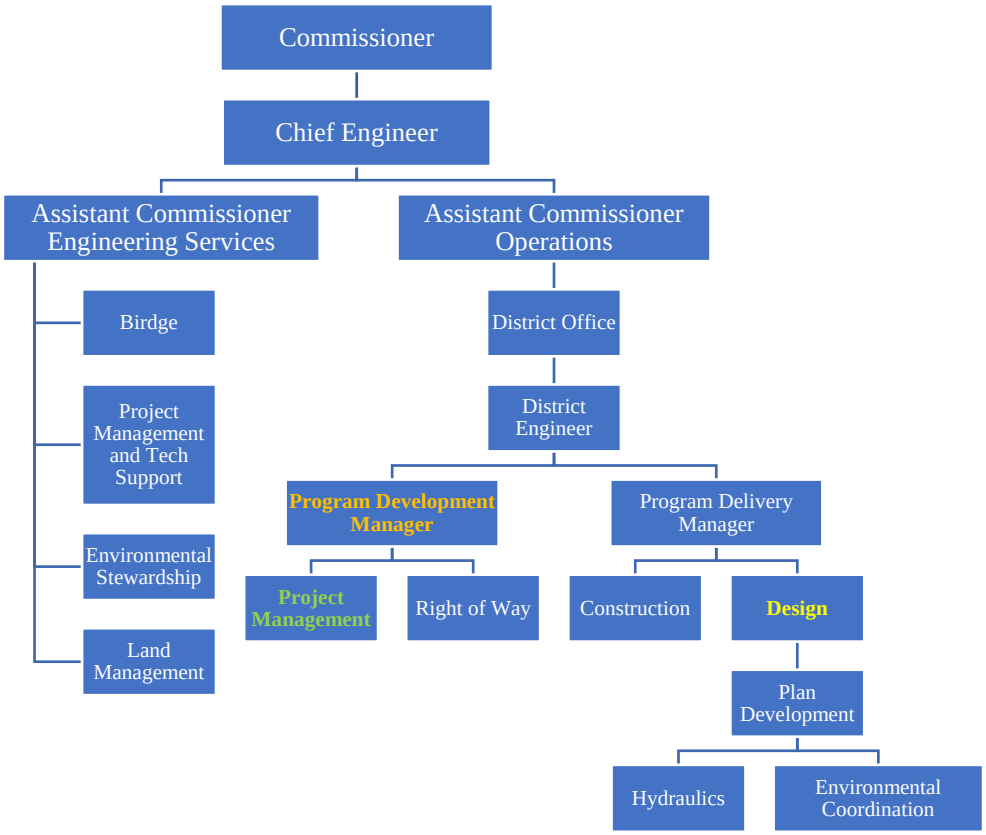
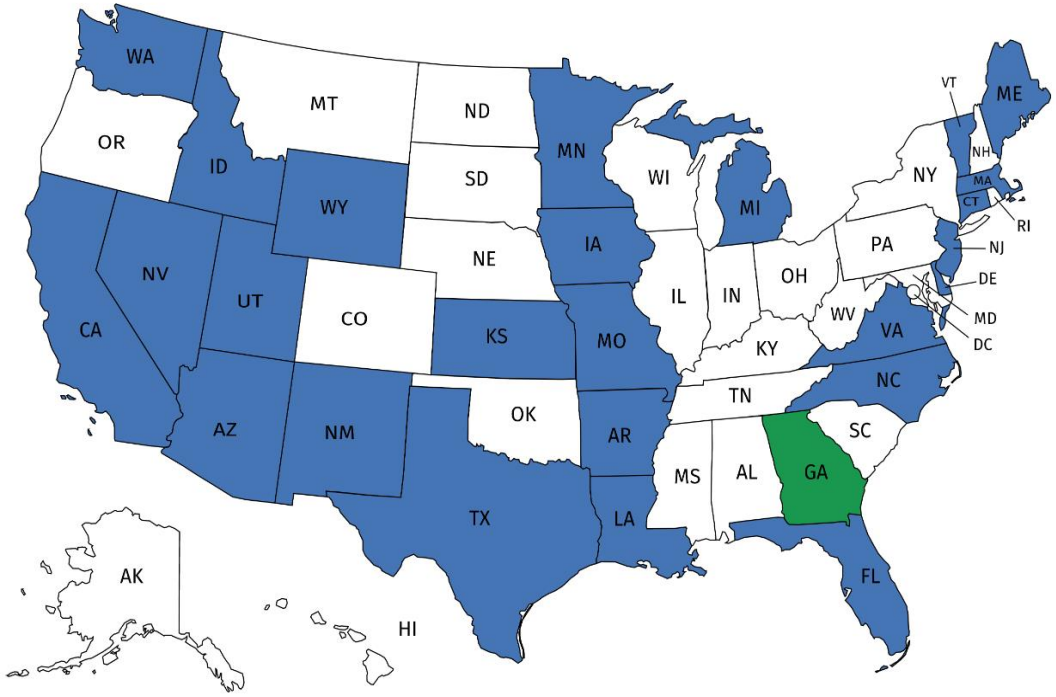


Figure 18 Decentralized Organizational Structure Model D6
(District Engineer over Project Management, Construction, ROW, and Design Units; e.g., Minnesota DOT)

3.3. State DOTs' General Information

To understand the organizational structure and project management practices of other state DOTs, surveys were sent to all 50 state DOTs and follow-up interviews were conducted in all the states. Among 50 states, 25 responded to the survey. Figure 19 shows the state DOTs to which the researchers sent the surveys and the state DOTs that responded to the survey.



Legend

State responded to Survey

State didn't respond to Survey

State conducting the Survey

Figure 19 Survey General Information

3.3.1. Average Size of State DOTs' Design–Bid–Build Programs

Table 1 shows the approximate average sizes of the design–bid–build programs for some of the state DOTs. As each state DOT has different methodologies in calculating the size of the highway programs, four major cost elements (i.e., preliminary engineering, right of way, utilities, and construction) were used to determine the size of state DOTs' highway program. Table 1 presents the highway program sizes of 17 state DOTs who provide definite responses for their programs.

The main purpose for preparing this list is to understand the nature and sizes of the DBB programs in the various state DOTs throughout the United States and compare their innovative or best practices identified in the field of project management in correspondence with their program sizes.

Table 1 Size of Respondent DOTs' Highway Programs in Fiscal Year 2018

DOTs	Preliminary Engineering	Right of Way	Utilities	Construction	Other	Size of Highway Program in FY 2018 (DBB Projects)
Texas	✓	✓	✓	✓		$6 Billion
California	✓	✓	✓	✓	✓(1)	$4.5 Billion
Washington State	✓	✓	✓	✓	✓(2)	$3 Billion
Florida				✓		$2 Billion
North Carolina	✓	✓	✓	✓		$2 Billion
Georgia	✓	✓	✓	✓		$1.5 Billion
Connecticut	✓	✓	✓	✓		$1.2 Billion
Virginia	✓	✓	✓	✓		$1 Billion
Kansas	✓			✓	✓(3)	$800 Million
Arkansas				✓		$800 Million
Michigan				✓		$800 Million
New Jersey				✓		$758 Million
Iowa				✓		$660 Million
Utah	✓	✓	✓	✓	✓(4)	$650 Million
New Mexico	✓	✓	✓	✓		$400 Million
Delaware	✓	✓	✓	✓	✓(5)	$400 Million
Maine	✓	✓		✓	✓	$400 Million

Notes:

(1) Support costs (Environmental, Right of Way, Design, and Construction) and capital costs (Construction and Right of Way)
(2) Local agreements
(3) Construction engineering
(4) Costs for construction engineering, incentives, and contingency
(5) Environmental and construction inspection
(6) Environmental mitigation

3.3.2. General Information about Project Managers and Size of the Projects Assigned to Project Managers

Table 2 provides general information about PMs in state DOTs and the size of the projects assigned to a PM at any time during the project development process. Table 2 presents the general information of PMs in 22 state DOTs who provide definite responses for the PMs in their DBB programs.

Table 2 Survey General Information of Respondent State DOTs

DOTs	Average Number of Projects Assigned to a PM	Typical Size of all Projects Assigned to a PM	Average Number of PMs in DBB Program
Arizona	5–10	$5–$10 Million	31
California	10–15	< $5 Million	225(1)
Connecticut	5–10	$10–$25 Million	56
Delaware	< 5	< $5 Million	30(2)
Florida	10–15	> $250 Million	196(3)
Georgia	10–15	$100–$250 Million	50
Idaho	< 5	$10–$25 Million	60
Iowa	5–10	> $250 Million	5(4)
Louisiana	10–15	> $250 Million	3(5)
Maine	> 20	< $5 Million	20
Michigan	> 20	$100–$250 Million	100
Minnesota	5–10	$10–$25 Million	150
Missouri	> 20	$25–$50 Million	4(6)
North Carolina	5–10	$50–$100 Million	40
Nevada	5–10	$50–$100 Million	25(7)
New Jersey	10–15	$100–$250 Million	55
Texas	5–10	$100–$250 Million (10)	370(8)
Utah	10–15	$100–$250 Million	24
Vermont	5–10	$25–$50 Million	9(9)
Virginia	5–10	$10–$25 Million	100
Washington State	< 5	< $5 Million	45

Notes:

(1) Midpoint of range 200–250
(2) Between the Project Management Office and Bridge Design
(3) Each district has on an average 28 PMs
(4) In its newly established Project Management Office
(5) At the moment on current projects
(6) For current projects
(7) Midpoint of range 20–30
(8) Functional managers act as PMs and midpoint of the range 330–410
(9) All PMs are in the Bridge Design section
(10) Midpoint of the range $50–$500 Million

CHAPTER 4 IDENTIFIED BEST MANAGEMENT PRACTICES OF DESIGN–BID–BUILD TRANSPORTATION PROGRAM PROJECT DELIVERY

4.1. Introduction

Project managers in transportation agencies operate in a dynamic environment and are under constant pressure to deliver their projects successfully on time and within schedule. Transportation agencies have developed or adopted different practices to aid and improve the project management of their state projects. Although the practices, adopted by the transportation agencies, vary depending on the nature of the work, organizational structure, and problems that they face, the underlying theme of such practices is to aid project managers in managing their projects efficiently. Thus, this chapter discusses innovative and best practices in project management, as identified through survey, content analysis, and interviews with subject-matter experts in other state DOTs. From these, the identified best practices for project management can help highway agencies efficiently deliver design–bid–build transportation projects.

4.2. Establishing a Project Delivery Bureau

Establishing a Project Delivery Bureau puts the project at the center of all agency activities and helps to improve coordination and collaboration during the different phases of the project. Furthermore, the Project Delivery Bureau helps the agency to focus more on the project goals and objectives, rather than focusing on individual concerns of different functional units in the agency. Through the surveys and interviews with SMEs and content

analysis on documents from other state DOTs, the research team found that several state DOTs, including Iowa, Arizona, Louisiana, Virginia, Washington State, and Maine, implement the concept of the Project Delivery Bureau to improve their project management capabilities.

4.2.1. Iowa DOT's Project Delivery Bureau

Iowa DOT started its Enterprise Project Management Initiative (EPMI) to improve the project management for Iowa DOT projects. Within the EPMI, the Highway Division Project Management Office (PMO) was created under the Project Delivery Bureau to improve the project management capabilities of the Highway Division. As part of the EPMI initiative, under the Project Delivery Bureau, the PMO planned to improve the project management capabilities in the Highway Division in the following ways (Iowa DOT 2018):

- Increasing transparency and accountability in the organization for meeting the project schedules, budget, and quality standards
- Providing better information and decision-making processes related to the resources needed to deliver quality projects on time and within budget
- Establishing better controls and mechanisms for reporting project cost, schedule, and quality
- Providing a more comprehensive and risk-based approach to the management of large, complex projects
- Improving existing processes for developing and managing small- to medium-sized projects with varying levels of complexity

- Providing data, tools, insights, and recommendations that will help upper management create clarity and consistency in prioritizing and managing a portfolio of projects for programming and development

4.2.2. Arizona DOT's Project Management Group

The Arizona DOT also developed a Project Management Group (PMG). Arizona DOT's highway program is managed at the headquarters. The PMG, located under the Infrastructure Delivery and Operations Division, manages all highway projects. The transportation manager oversees the senior project manager and project manager in the management group.

Arizona DOT has improved its capability of project management by implementing the following recommendations:

1) Provide standard work effort by establishing standardized work items, which can be used for both small and large projects
2) Promote higher contribution from the project participants by holding frequent meetings with the project participants
3) Provide more authority to the PM for efficient project management on projects to empower the PM
4) Promote a collaborative environment within the organization by conducting discussion and critical thinking sessions and sharing ideas, which help make better decisions for the projects
5) Implement creative ways for sharing knowledge in project management, such as implementing lunch and learn sessions

6) Do not allow incomplete submittals, which are a waste of time for the project management team to review

4.2.3. Louisiana DOTD's Project Development Division

The Louisiana Department of Transportation and Development (DOTD) established the Project Development Division (PDD) to implement the concept of a project delivery bureau. Figure 20 depicts the structure of Louisiana DOTD's project development division. The PDD was established with the primary aim of accomplishing the agency's mission through effective communication and leadership of the project and assigning adequate resources of the functional specialists and PMs to the projects. The PDD is over the Location and Survey, Road Design, Bridge Design, Right of Way, and Pavement and Geotechnical Offices. The Project Management Office is within the PDD.

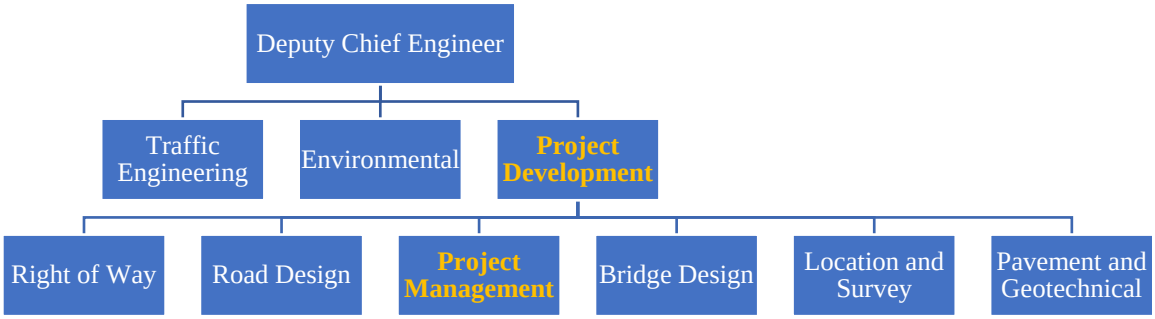


Figure 20 Concept of Project Delivery Bureau for Louisiana DOTD

4.2.4. Virginia DOT's Project Development Office in the District Office

The Virginia DOT is a decentralized organization, and its highway project development and programing and investment management are at the district level. Figure 21 shows the structure of the Virginia DOT's Project Development Office (PDO). In the

district office, the PDO is responsible for developing and managing the highway projects for the district. All the functional offices are located within the PDO; this arrangement helps improve the coordination and communication between the functional offices for different phases of the project. In addition, the location of the functional offices within the PDO can help resolve issues at the lowest possible level. The PDO in the Virginia DOT allows the use of multidisciplinary concurrent efforts to develop transportation projects from initial planning to construction. Furthermore, the PDO allows the project work to be accomplished parallel to different disciplines in the department. The PDO, thus, requires the efforts of all the functional offices in each stage of the project development process (VDOT 2016).

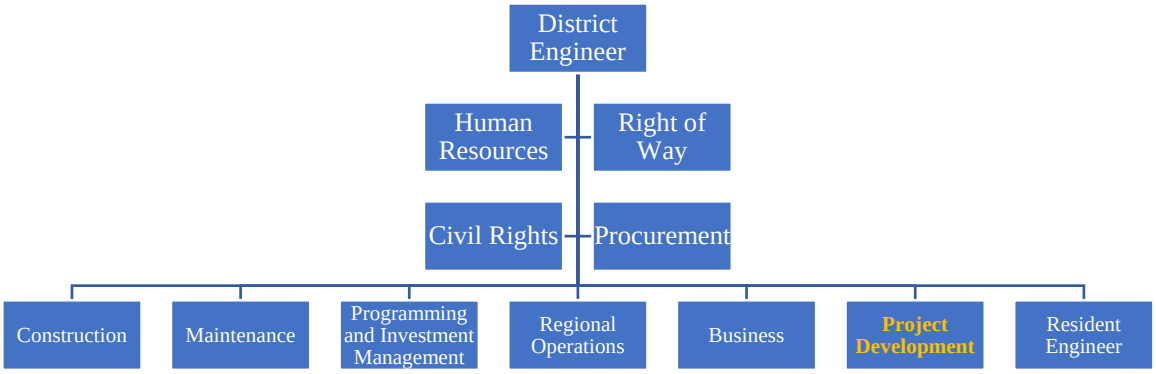


Figure 21 Project Delivery Bureau in Virginia DOT

4.2.5. Washington State DOT's Program Management Office in the Regional Office

The Washington State DOT has established its Program Management Office to develop and manage Washington State DOT's Highway Program. Figure 22 depicts the

organizational structure of the Washington State DOT's Program Management Office. As Washington State DOT is a decentralized organization, the Program Management Office

Figure 22 Project Delivery Bureau in Washington State DOT

is located in the regional office. The Program Management Office is responsible for project management on the projects in the region and is led by the engineering manager located in the district office. The Program Management Office houses all of the functional offices in the region and is responsible for all the projects in the region except the mega projects, which are handled by the headquarters. The Program Management Office helps to coordinate the efforts of all the functional offices in the region for the projects and resolve the issues between the different functional offices at the lowest possible level in the organization and as quickly as possible to avoid adverse effects of issues on the project.

4.2.6. Maine DOT's Bureau of Project Development

The Maine DOT has developed a Bureau of Project Development in its organization to enable better coordination and collaboration during the project development phase of the project. The Bureau of Project Development takes charge of project development and construction of the Maine DOT's projects (MaineDOT 2018). The organizational structure of the Maine DOT's Bureau of Project Development is depicted in Figure 23. The organizational structure is based on programs (i.e., highway, bridge, property, and multimodal programs) and project teams (e.g., contracts and specifications, and materials testing and exploration) (MaineDOT 2018).

The director of the Bureau of Project Development leads the office and provides required support to coordinate the efforts of all the functional offices within the Bureau to successfully deliver the Maine DOT projects on time and within budget. The Maine DOT's Bureau of Project Development allows for better coordination and collaboration among the project team members since the Project Management Office and the functional offices are

located under the Highway Program. Furthermore, any issues in developing and managing the projects are resolved at the lowest possible level.

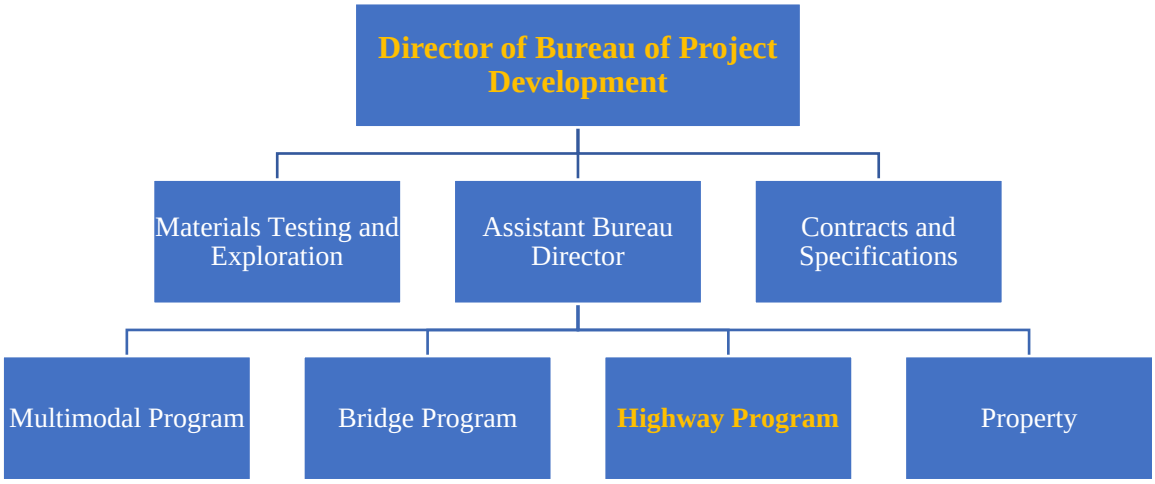


Figure 23 Project Delivery Bureau in Maine DOT

4.3. Leadership and Accountability

Several state DOTs, such as Caltrans and the Arizona and Utah DOTs, have focused on improving leadership and accountability, in order to elevate the status of effective project management in their organizations. The increased focus on leadership and accountability promotes more collaboration within the project team and commitment for meeting the project objectives and milestones within the prescribed cost, schedule, and scope. In this section, more information is provided from these states on how this focus on leadership and accountability contributes to effective project management.

4.3.1. Arizona DOT's Emphasis on Leadership and Accountability

At the Arizona DOT, progress review meetings are held every quarter to evaluate the performance of the project participants. A higher management team from the

headquarters visits every region every quarter for these meetings. The progress review meetings are mandatory for everyone involved on the project. The PM presents the project in the progress review meetings, and all the participants are expected to contribute to the meetings. To ensure that all the project participants are contributing to the meetings, the senior PM also attends. The senior PM has to make sure that everyone on the project team is participating and contributing to the progress review meeting for the project. Apart from the progress review meetings, the project team is also evaluated based on the performance of the project lettings, comparing between the actual date of the project letting and the established date for the project letting on the baseline schedule.

4.3.2. Utah DOT's Leadership and Accountability

At the Utah DOT, the headquarters leadership takes an active role in providing oversight and reviewing the project progress at the regional level. The HQ leadership visits every region every quarter for status meetings on all active projects in the region to assess the performance of the region on its active projects. Every quarter, the deputy director, director's staff, and the Federal Highway Administration (FHWA) team visit the regions for a status meeting on all active projects. The status meeting is also attended by the region's program manager and directors to evaluate the performance of the completed projects and review the performance of the active projects. For the review of each project, a two-hour status meeting is held with the PMs. The PMs in the Utah DOT are responsible for the evaluation of the performance of SMEs both from internal functional units and from consultants.

4.3.3. Caltrans' Leadership and Accountability

Similar to the Utah DOT, the California DOT uses status meetings for evaluation of its projects and reviewing their progress. At Caltrans, the status meetings are held at regular intervals during the life of the project. The project team provides input on all aspects of the project development and puts forward any difficulties it is facing in managing the project. The status meetings are also attended by the district director and chief deputy district director to evaluate the performance of the functional units and PM on the project.

4.4. Uniform Letting Schedule Throughout the Fiscal Year

Conventionally, several state DOTs have suffered from an uneven schedule of letting for their programs in which a huge portion of their projects are let during the last quarter of the fiscal year. Several state DOTs, such as the Arizona and Minnesota DOTs, have rigorously implemented a uniform letting schedule throughout the fiscal year to have a more even and predictable schedule for their programs, in order to best meet their fiscal deadlines and deliver their promised projects. A balanced letting schedule helps PMs and members of the project team better manage their limited resources to deliver their planned projects within a fiscal year. A balanced schedule of project letting also helps the transportation industry, as engineering consultants and highway contractors can plan their resources more efficiently to respond to the DOT's expectations. The increased number of bidders and the decreased quantity of submitted bids are important advantages of a more uniform schedule of project letting throughout the fiscal year.

4.4.1. Arizona DOT's Uniform Letting Plan

Until most recently, the Arizona DOT was letting out most of its projects in the last quarter of the fiscal year. On average, every year 70%–80% of the projects were let out in the last quarter of the fiscal year, which caused severe problems for resource allocation, project management, and contract management. Thus, the Arizona DOT has adopted a more uniform project letting schedule that enables the agency to provide better project management and resource allocation for the projects. Table 3 provides the Arizona DOT's current project letting schedule for its program. This practice also allows better planning for the scope of the project and better control of schedule and budget.

Table 3 Arizona DOT Project Letting Schedule

Quarter in Fiscal Year	% of the Total Projects Let Out
1st Quarter	20%
2nd Quarter	30%
3rd Quarter	30%
4th Quarter	20%

4.4.2. Minnesota DOT's Balanced Letting Process for Projects

Minnesota DOT has developed and implemented a balanced letting plan for each fiscal year. The balanced letting process is a method for strategically distributing the project letting dates among the four quarters of a fiscal year to provide a balanced distribution of available resources and other requirements throughout the fiscal year. Table 4 presents the Minnesota DOT's new balanced letting plan for its projects. With its implementation, most of the projects are let out during the second and third quarter (i.e., Fall and Winter), which has resulted in a better bidding environment and a greater

number of bidders for the projects. Note that during the cold months, as the construction work is going slow, the contractors can focus more on bidding, which results in a better bidding environment. In addition, the balanced letting plan allows the Minnesota DOT to balance the highs and lows of its staffing resources. It also helps the highway contractors to be well prepared to plan their workloads evenly, which results in lower bid amounts (MnDOT 2019).

Table 4 Balanced Letting of Projects in Minnesota DOT

Quarter in Fiscal Year	% of the Total Projects Let Out
1st Quarter	20%
2nd Quarter	35%
3rd Quarter	35%
4th Quarter	10%

4.5. Performance Evaluation Dashboard for Highway Program Development and Delivery

A dashboard for measuring the performance of the project and program (e.g., cost, schedule, and safety) can improve the transparency of the organization (Masoumi et al. 2015). An appropriate dashboard allows for performance evaluation of the projects, project teams, and members of the project team based on a consistent set of criteria that is uniformly understood and accessible to decision makers in the agency. A desirable performance dashboard should be customizable for the organization with standardized processes and centralized databases (Masoumi et al. 2015). Within the dashboard, each project can be selected to obtain further information about the project, such as total expenditures for the project, estimated date of completion, PM for the project, and total finance for the project. The main purpose of the performance dashboard is to evaluate the

status and progress of projects in the organization, based on a set of predetermined metrics/criteria (e.g., budget, letting schedule, other activity milestones) to allow uniform evaluation of the projects. The predetermined metrics also allow for establishing performance goals and objectives for evaluation, which helps the organization improve those aspects of the projects by which the project is evaluated. The dashboard helps the agency evaluate the performance continuously throughout the life of the projects, which helps it make corrective decisions as, and when, required.

4.5.1. Virginia DOT's Performance Reporting Systems

The Virginia DOT (VDOT) has developed a benchmarking system to measure, monitor, and manage performance of the project during the project development process and construction. Its dashboard displays the information in a graphical format for the performance of the projects based on the budget and schedule of the projects compared with the baseline project goals and objectives. Moreover, the benchmark system helps inculcate higher responsibility and accountability in the organization and greatly increases its transparency. The Virginia DOT's dashboard is a major step by the organization to provide a single integrated reporting platform for key performance indicators (e.g., highway performance, safety, and condition) in its projects. The dashboard has seven performance dials that can be further explored by clicking the dials as shown in Figure 24.

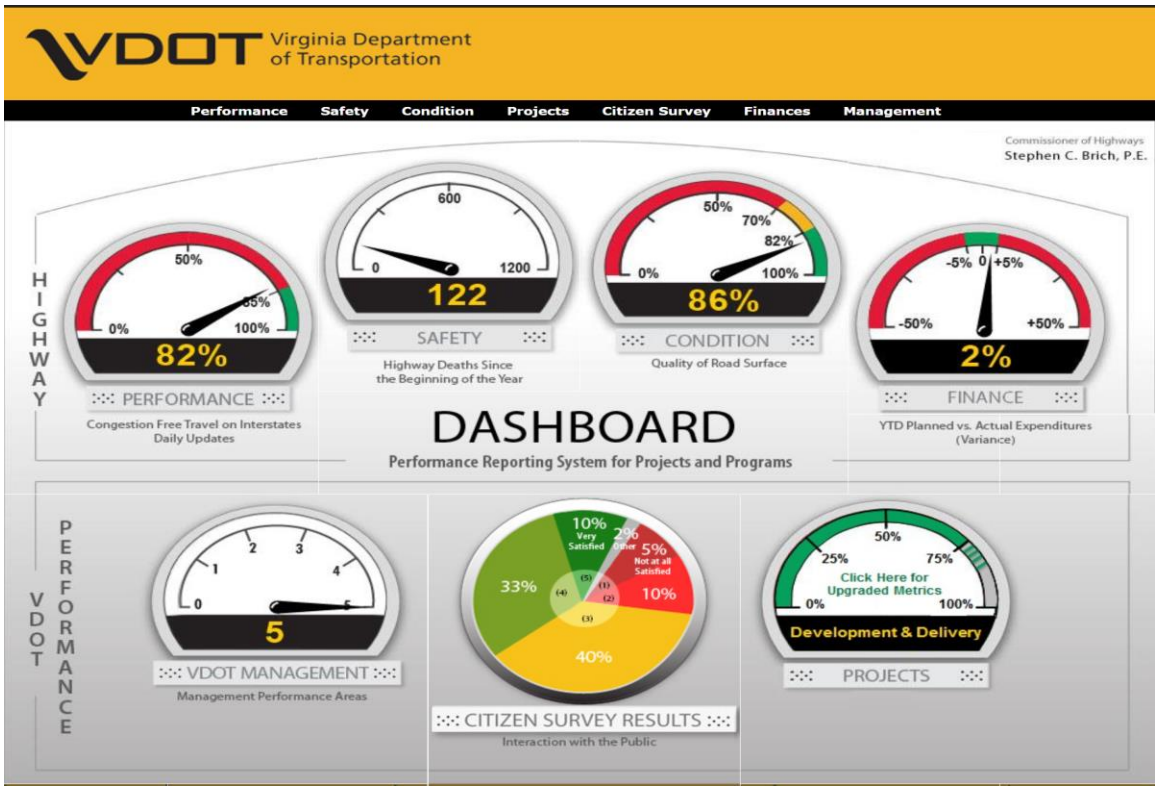


Figure 24 Virginia DOT's General Dashboard

The seven dials are Performance, Safety, Condition, Finance, VDOT Management, Citizen Survey Results, and Projects, which are further defined in Table 5. The entire database for the dials and sections within it can be downloaded by anyone into an Excel format. This centralized database can improve the performance of project management by minimizing communication delays and extended document transmittal times (Durham et al. 2018). The seven dials have been divided into two sections, namely: Highway (dials 1–4) and VDOT (dials 5–7) performance. The dashboard also displays the data from the public survey for assessment of the Virginia DOT. The dashboard developed by the Virginia DOT compares the performance of the project with its baselines, which are developed based on specific task milestones. Based on the comparison, the performance of the Virginia DOT projects is presented on the dials (VDOT 2007b).

Table 5 Seven Dials of Virginia DOT's Dashboard

Seven Dials of VDOT's Dashboard	Description
Highway Performance	The *performance dial* provides valuable data regarding the performance of various projects. The performance can be viewed specific to certain details (e.g., congestion, travel speeds, travel time, incident duration, hours of delay, and overall performance).
Highway Safety	The *safety dial* provides information regarding the number of deaths since the beginning of the year. The detailed information provides comparison on month-to-month bases of the current data and the past 3 years' average. It also classifies the accidents into several categories.
Highway Condition	The *condition dial* displays the information regarding the quality of the road surface in percentage basis in comparison to the previous years. The data also include the condition of the bridges and ride quality on the routes.
Highway Finance	The *finance dial* provides information on the planned expenditures vs. actual expenditures. The detailed information provides a financial report for current fiscal year or any fiscal year from the last 13 years.
VDOT Management	The *VDOT management dial* shows the performance of the agency on a scale of 0–5 (i.e., 5 being the highest). Every agency reports its effectiveness in the five critical areas of emergency preparedness, financial management, government procurement, human resources, and information technology.
Citizen Survey Results	The *citizen survey results dial* shows the results based on the satisfaction of the people in the state with the performance of VDOT. The satisfaction of the citizens is rated on a scale of 1–5, with 5 being very satisfied and 1 being not at all satisfied.
Projects	The dashboard uses performance metrics based on the Smart-scale business rules developed by the Virginia state government. The status of all types of projects is measured on cost and schedule based on milestones that are common to all the projects. The dashboard is broadly divided into two sections (VDOT 2007b), including project development and project delivery.

Figure 25 shows the financial report from Virginia DOT's Dashboard, which provides information regarding planned revenue, actual revenue, and variance of the two metrics. The report also provides a graph showing how the purchase power of the agency has changed since 1996 (VDOT 2007b).

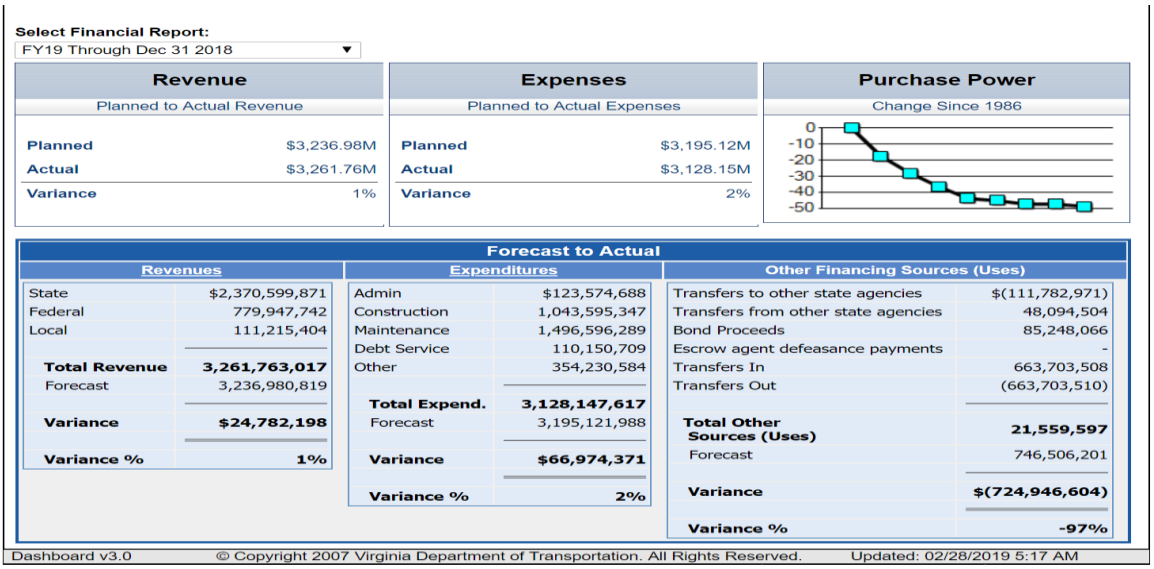


Figure 25 Financial Report from Virginia DOT's Dashboard

Within the subsection of project development and project delivery, the Virginia DOT dashboard provides detailed insight into projects and how they are performing based on several project criteria. The projects are color-coded based on their performance as far as schedule and cost. This section of the dashboard also gives the reason for the color coding of the project for all the projects within the selected fiscal year, as shown in Figure 26, and provides information regarding project ID and the district responsible for the project. (VDOT 2007b)

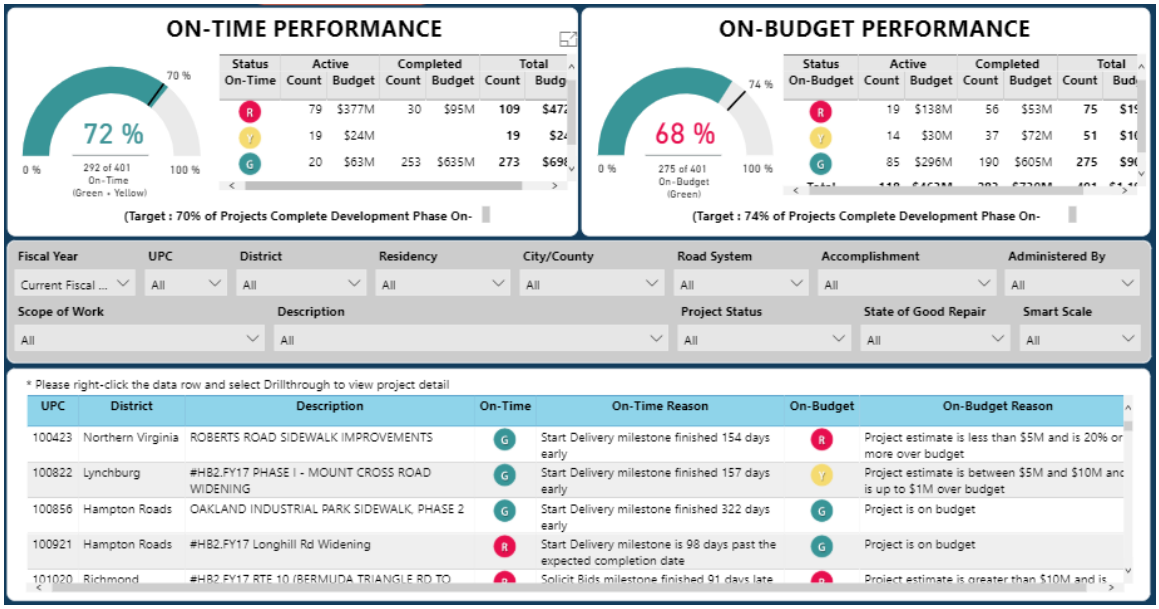


Figure 26 Virginia DOT's Project Development Dashboard

The Virginia DOT has developed a set of parameters for measuring the performance of its projects for the schedule. The parameters for the schedule during the project development phase activities have been divided into three color codes (i.e., green, yellow, and red) on the performance dashboard. The first set contains activities, such as local agreement, start development, determine requirements, engage public, and utility relocation. For this set of activities, if the project activity is completed 30 days (i.e. >30 days) earlier than the baseline date, then the project is closed green. If the activity is completed within 30 days (i.e. $\leq$ 30 days) of the baseline date, then it is color coded yellow. If the activity in the first set is completed after the baseline date, then it is colored red to indicate delay on the project. The color-coding parameters for the different activities during the project development phase of the project are shown in Table 6 (VDOT 2007b).

Table 6 On-time Criteria for Project Development Color Coding on the Virginia DOT Dashboard

Activities	Early Finish		Baseline Finish Date	Late Finish
Local Agreement	> 30 days early	≤ 30 days early		> 0 days late
Start Development				
Determine Requirements				
Engage Public				
Utility Relocation				
Complete Purchasing Right of Way	> 60 days early	≤ 60 days early		
Obtain Permits				
Solicit Bids				
Start Delivery	> 30 days early	≤ 30 days early		> 0 days late

For the on-budget criteria during the project development phase of the project, the Virginia DOT has divided its projects into three categories based on the project value. Each category has a different set of parameters for color coding to represent the performance of the project during the project development phase. The first category, for example, represents the projects that are less than $5 million in total value. For such projects, if the project is completed on the baseline estimate or less, then it is color coded green. If the project is completed with the cost of the project exceeding the project value by less than 20%, then it is color coded yellow. If the project cost exceeds the baseline estimate by more than 20%, then it is color coded red. Table 7 provides information about budget criteria for different project categories during the project development phase of the project (VDOT 2007b).

Table 7 On-budget Criteria for Project Development Color Coding

Approved Budget	Current Estimate		
< $5 Million	≤ 0	> 0 to < 20%	≥ 20%
$5 Million to $10 Million	≤ 0	> 0 to < $1M	≥ $1 M
> $10 Million	≤ 0	> 0 to < 10% or < $5 M*	≥ 10% or ≥ $5M*

*whichever is less

For on-time criteria during the project delivery stage of the project, the Virginia DOT measures the interim milestones and the complete delivery date for color coding of the projects, with a different set of parameters established for each. For interim milestones, the project is coded green if the milestone is achieved at least 14 days earlier than the baseline date. If the milestone is achieved earlier than the baseline date but not more than 14 days early, then it is color coded yellow, and if it is achieved after the baseline date, it is color-coded red. Table 8 shows the parameters for the interim milestones and the complete delivery date for the project delivery phase of the project (VDOT 2016).

Table 8 On-time Criteria for Project Delivery Phase Color Coding on Virginia DOT Dashboard

Milestones	Early Finish		Baseline End Date	Late Finish
Project-specific Interim Milestones	> 14 days	≤ 14 days		> 0 days
Complete Delivery	> 0 days			> 0 days

For performance based on budget during the project delivery phase, the projects are divided into two categories: active projects and completed projects. Based on the project category, a different set of parameters is used for color coding the projects. Table 9 shows the parameters the Virginia DOT uses for color coding parameters for the active and completed projects for the project delivery phase (VDOT 2016).

Table 9 Criteria for Color Coding of Budget Performance for the Project Delivery Phase on Virginia DOT Dashboard

Projects That Have Not Been Executed: No Status			
Active	Neither the current contract amount nor the cost of work to date exceed the award amount by more than 3%	Either the current contract amount or the cost of work to date exceeds the contract award amount by 3% to 10% for construction contracts, or by 3% to 25% for maintenance contracts	Either the current contract amount or the cost of work to date exceeds the contract award amount by more than 10% for construction contracts, or 25% for maintenance contracts
Completed	Unaudited final cost is less than 110% of award amount for construction contracts, or within 125% for maintenance contracts		Unaudited final cost is not known; either the cost of work to date or the current contract amount exceeds 110% of the construction contract award amount, or 125% of the maintenance contract amount

The Virginia DOT dashboard also provides data regarding the completion and progress for all projects ranging from the current fiscal year to those planned to be completed in upcoming fiscal years. The dashboard distinguishes between VDOT-managed and locally managed projects (VDOT 2007b).

4.5.2. Utah DOT's Program Delivery Dashboard

The Utah DOT has developed a dashboard to evaluate the performance of its projects and programs at the regional level. The dashboard is used as a benchmarking

system to measure, monitor, and manage the performance of projects during the project development process and construction within the regions. The dashboard presents the data in a graphical format and provides a year-to-year comparison of the regions in meeting the project schedule, budget, and scope and also a comparison of the actual letting date and committed letting date for the project. In addition, the dashboard provides a detailed explanation and graphs that explain the performance of the projects within each region compared to the baseline of the projects, current advertising performance, and advertising performance history. The dashboard was developed based on a comprehensive set of metrics, as shown in Table 10. The Utah DOT has developed a set of metrics to measure the performance of the organization and the regions regarding schedule, scope, and budget. The performance evaluation is based on the performance of the region and overall program on all of the predetermined criteria and, based on that, the health scores for schedule, scope, and budget are assigned.

The dashboard page displays two dashboards (i.e., Zero Fatalities Dashboard and Program Delivery Dashboard). The Utah DOT's Program Delivery Dashboard shows two dials that represent information on the percentage of projects on time and the percentage of projects on budget compared with the established baselines for performance evaluation (UDOT 2019). Furthermore, the dashboard provides year-to-year comparison of the regions in meeting the project schedule, budget, and scope and comparison of the actual letting date and committed letting date for the projects. The dashboard allows higher accountability and responsibility within the organization. Further information can be obtained by accessing the second layer of information in the dashboard. This interface

provides advertising status, cost, and performance of the projects for the specific region. Figure 27 depicts the Utah DOT's dashboards (UDOT 2019).

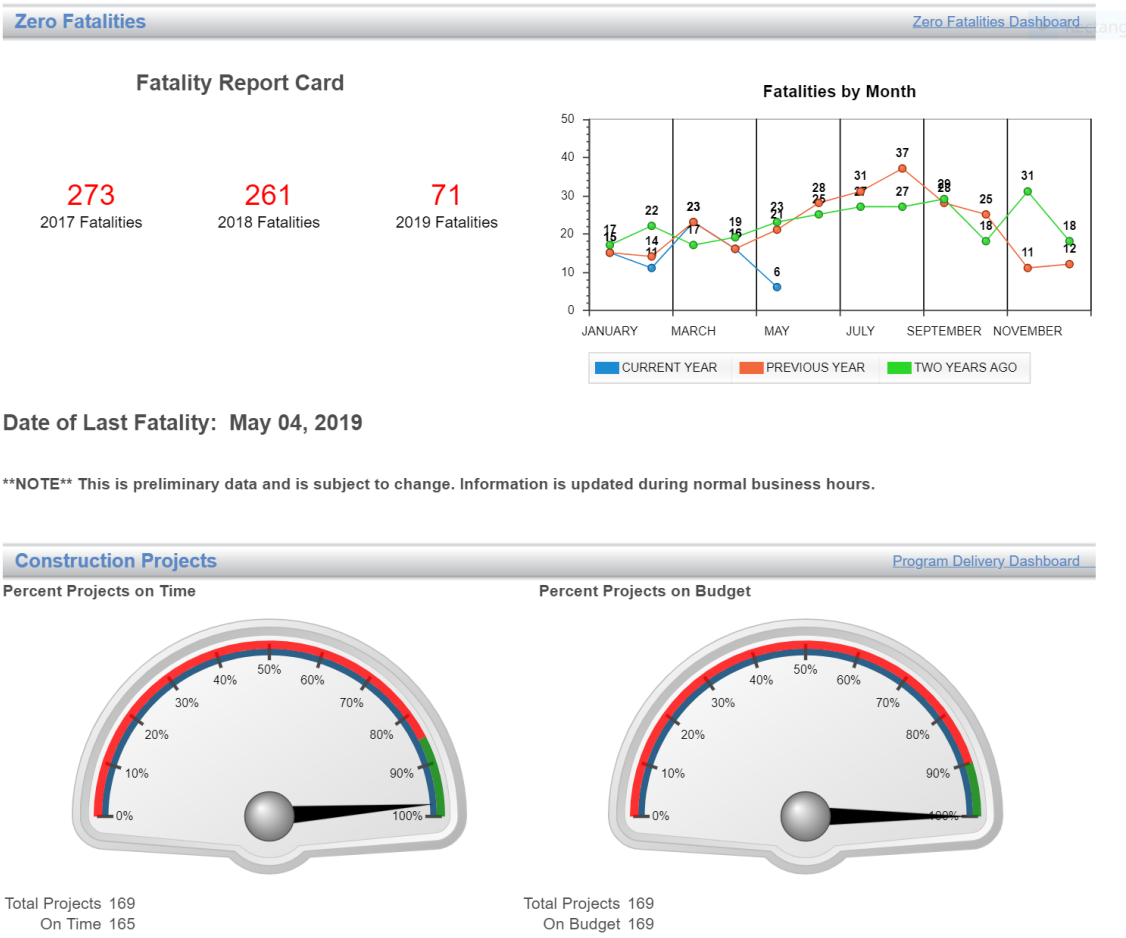


Figure 27 Utah DOT's Program Delivery Dashboard

The second layer provides information on the program health (e.g., overall performance) of the organization based on the performance of the four districts on schedule, budget, and scope criteria. The program health score and the regional reporting metric are calculated by multiplying the weighted score already predetermined and the score of the region/program based on the performance of projects on cost, schedule, and scope criteria. The weighted score used by the Utah DOT for the calculation of the

performance are 73.6, 6.5, and 19.9 for schedule, budget, and scope, respectively. Figure 28 shows the performance of the overall program at the Utah DOT, while Figure 29 shows the performance of Region 3 in the Utah DOT (UDOT 2019).

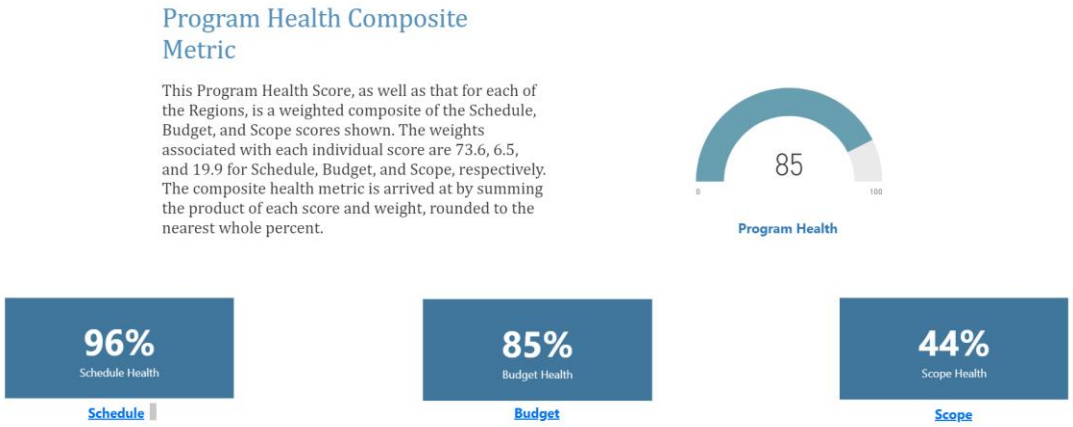


Figure 28 Overall Performance of the Organization in Utah DOT's Dashboard

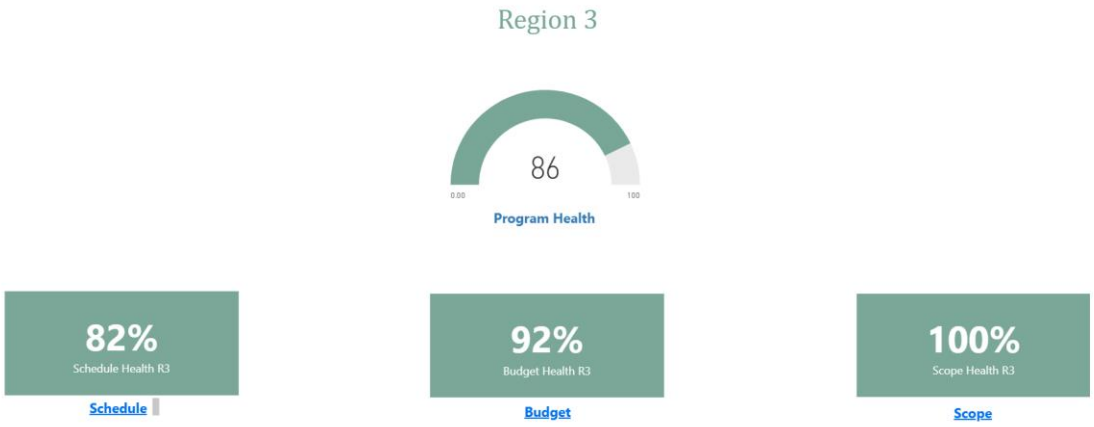


Figure 29 Performance of Region 3 in Utah DOT's Dashboard

The performance of the regions and the overall performance of the organization are further bifurcated, which can be assessed by clicking either the schedule, budget, or scope health options. This third layer provides detailed descriptions of all the metrics used for calculating the scores and other related data. The data are represented in graphical format, but the dashboard also allows the user to download the data. Table 10 shows the various metrics used for performance evaluation for schedule, budget, and scope (UDOT 2019).

4.5.3. Caltrans' Performance Evaluation of Program Delivery

The California DOT (Caltrans) uses a quarterly report to provide a quick glimpse of the current status of the measures relative to its respective goals. Caltrans depicts current data and targets in the form of dial gauge charts on a dashboard to represent the progress of the respective measures. In addition, Caltrans uses a graphical chart to provide management with a tool to track the trends and monitor the progress of the specific measures, so that appropriate adjustments can be made *en route* to achieve the strategic goals and objectives of the project. The dashboard gauges are divided into green, yellow, and red bands. The green band represents the potential level of performance within the target range. The red band represents the area where the measure falls outside of the target range. The yellow band indicates that the measure is progressing toward meeting or beating its respective target. The dashboard is updated every quarter based on evaluation of the projects throughout the state and is presented in the form of a quarterly report (Caltrans 2013).

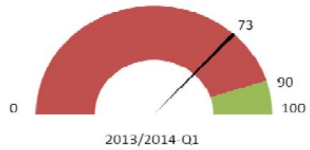
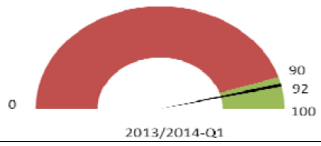
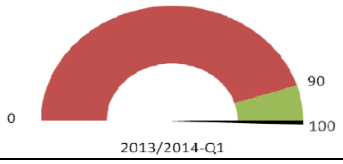
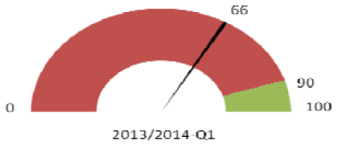
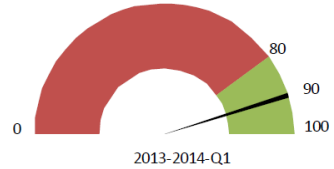
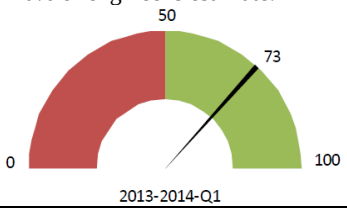
Table 10 Utah DOT's Program Delivery Metrics

Type	Dashboard	Description
Schedule Health	Preconstruction Advertising Status	Detail for the Preconstruction Advertising Status
	Current Advertising Performance	Monitoring Current Advertising Performance (85% Goal)
	Advertising Performance History	Advertising Performance Trend over the Years
	Current Preconstruction Schedule	Committed vs. Actual Advertising Date
	Current Preconstruction Scoping	Number of Projects in the Scoping Stage, Monthly
	Current Preconstruction Schedule	Number of Projects Submitted for Advertising, Monthly
	Preconstruction Schedule History	Number of Projects That Were Advertised Each Month
	3-Year Advertising Results	Number of Projects Advertised Each Month
	Right Time Advertising History	Monitoring Advertising Performance (75% Goal)
	Projects That Do Not Advertise	Number of Projects That Will Not Advertise
Budget Health	Project Budget Estimate in Preconstruction	Current Value of Various Federal Obligation and Funding Categories
	Potential Available Funds	For Projects That Have Reached Substantial Completion
	Federal Obligation Projection	Current Value of Federal Obligation
	Obligation Goal Status	Current vs. Remaining Obligation Status
	Obligations vs. De-obligations	Obligations vs. De-obligations
	Current Year Federal Estimate	Federal Obligations vs. Federal Fiscal Year
	Obligation Total	Dollars vs. Federal Fiscal Year
	Project Values	Awarded vs. Advertised
Scope Health	Change Orders and Overruns vs. Original Contract Amount	Measure of Maintaining Project Scope
	Final Construction Expenditure vs. Original Contract Amount Trend	State Fiscal Year vs. Number of Projects

The delivery goal is measured by six dashboards, including: (1) Project Approval and Environmental Document (PA/ED); (2) Right of Way (R/W) Certification; (3) Ready To List (RTL); (4) Construction Contract Acceptance (CCA); (5) Cooperative Agreements

(i.e., percent successfully developed within the 60-day performance measure); and (6) Percent of Project with Low Bid Within ±10% of Engineer's Estimate. The performance evaluation of the projects within the district is based on a comparison of the actual delivery with the planned delivery for the projects throughout the previously mentioned milestones (Caltrans 2013).

The stewardship goal is measured by three dashboards: pavement conditions (percent of distressed lane miles), federal subvention formula funds obligated for local projects, and percent of total payments made to vendors and other government agencies within the time limits. Finally, Caltrans measures the service goal to promote quality service through an excellent workforce using three dashboards: a review of Request for Authorization to Proceed packages, percent of external survey respondents (e.g., Caltrans is doing a good or excellent job), and stakeholder surveys. Sample dashboard gauges for the delivery goal are presented in Figure 30 (Caltrans 2013).

Performance Measure	Baseline	Target	Current Data	Comments
PM 3.2a Project Approval and Environmental Document (PA/ED)[1] – Percent of projects. 	**93**	**>90**	**73**	This measure is reported quarterly. Baseline is the fourth quarter data for FY 2005/06. The percentages represent delivery of 27 of 37 planned milestones through the first quarter of FY 2013/2014.
PM 3.2b Right of Way (R/W) Certification[2] – Percent of projects. 	**99**	**>90**	**92**	This measure is reported quarterly. Baseline is the fourth quarter data for FY 2005/06. The percentages represent delivery of 23 of 25 planned milestones through the first quarter of FY 2013/2014.
PM 3.2c Ready to List (RTL)[3] – Percent of projects. 	**99**	**>90**	**100**	This measure is reported quarterly. Baseline is the fourth quarter data for FY 2005/06. The percentages represent delivery of 13 of 13 planned milestones in Director Dougherty Contracts for Delivery through the first quarter of FY 2013/2014.
PM 3.2d Construction Contract Acceptance (CCA)[4] – Percent of projects. 	**88**	**>90**	**66**	This measure is reported quarterly. Baseline is the fourth quarter data for FY 2005/06. The percentages represent delivery of 19 of 29 planned milestones through the first quarter of FY 2013/2014.
PM 3.2e Cooperative agreements – Percent successfully developed within the 60-day performance measure. 	**40**	**>80**	**90**	This measure is reported quarterly. Baseline reflects the percent of cooperative agreements in FY 2009/10 that were successfully developed within the 60-day performance measure. For the1st Quarter of the 2013/14 fiscal year, 90% of all Coops were completed with a total of 70 Coops processed.
PM 3.5b Percent of projects with low bid within ±10% of engineer's estimate. 	**33.5**	**>50**	**73**	Target is at least 50% of the projects have a low bid within ±10% of the engineer's estimate. Baseline reflects the cumulative data for FY 2005/06.

Notes:

1. The PA/ED milestone represents completion of preliminary engineering and environmental analyses and investigations for the project alternatives under investigation, as required by the National

Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA); state and federal approval of a final Environmental Document (if required); selection of a preferred alternative; and approval of the selected project through the Project Report.

2. At the R/W Certification milestone, certification is made that all R/W activities (i.e., appraisals, acquisitions, relocation assistance, utility coordination, etc.) have been completed in accordance with the Code of Federal Regulations, per 23 CFR 635.309(c)(1), (2), or (3).
3. The RTL milestone is a point at which projects are ready to be advertised to attract bids from the contractors.
4. CCA means that all construction project work has been completed in accordance with all the requirements of the contract.

Figure 30 Performance Evaluation on the Caltrans Dashboard

4.6. A Blended Approach to Assign a Project Manager to a Project

State DOTs have different practices in assigning project managers to the projects to effectively and efficiently utilize the resources of the project managers. The decision depends on several factors, such as the skillset of the PMs and major project characteristics (i.e., type, size, and complexity). State DOTs, such as Caltrans and the Iowa and Nevada DOTs, have adopted a more blended approach for the assignment of PMs for their projects. Caltrans has divided the projects into categories based on several factors, such as project cost, complexity, and project management skills required. Based on the project category, the PM is assigned to the project for efficient project management. The practice of the assignment of the PM, with consideration for the project management requirements such as skills, experiences, and certificates, helps state DOTs allocate the resources more prudently. Furthermore, the practice helps state DOTs develop project-specific training programs, which enables the PM to better handle a specific category of the projects.

4.6.1. Caltrans' One-Hat and Two-Hat Project Managers

The California DOT (Caltrans) uses the approach of one-hat and two-hat project managers for managing and delivering its projects. Caltrans assigns the PMs to projects in

accordance with the complexity of the project (e.g., project size and functional requirements) (Caltrans 2007).

Figures 31 and 32 depict the organization structure of the one-hat and two-hat approaches and their coordination with the functional offices respectively. A one-hat PM is a single entity who is assigned to the sole role of managing and making sure that the project is delivered within the established baseline of cost, schedule, and scope.

> *"The primary responsibilities and roles of One-Hat project manager are:*
>
> - *One-Hat project managers hold responsibility for project management and supervision of Functional Units.*
> - *One-Hat project managers are assigned from the program and project management office.*
> - *The general rule in the organization is that all project managers should be One-Hat.*
> - *One-Hat project managers determine what tasks are done, when they are done, and how much each task costs.*
> - *One-Hat project managers are assigned to all major capital projects greater than $1 Million dollars in capital outlay (i.e., STIP, State Highway Operation and Protection Program (SHOPP), Locally funded, and Toll projects, Projects with multiple functional units involved, and projects with a significant amount of local and private entity involvement)." (Caltrans 2007)*

A two-hat project manager is a single entity who is assigned generally as a functional manager and is also assigned to the role of managing the project and making sure that the project is completed within the established baseline. The primary responsibilities and roles of a two-hat PM are (Caltrans 2007):

- *"Two-Hat project managers are responsible for both the project management and supervision of Functional Units.*
- *Two-Hat project managers are assigned from functional units.*
- *Two-Hat project managers are assigned to projects less than $1 Million and single function (where a single functional office is required) projects.*

- *Two-Hat project managers may be assigned to projects where the project requirements do not significantly compromise the functional requirements of the project manager or create a conflict of interest between the two roles of the project manager."*

Generally, most of the projects at Caltrans are assigned with a one-hat PM.

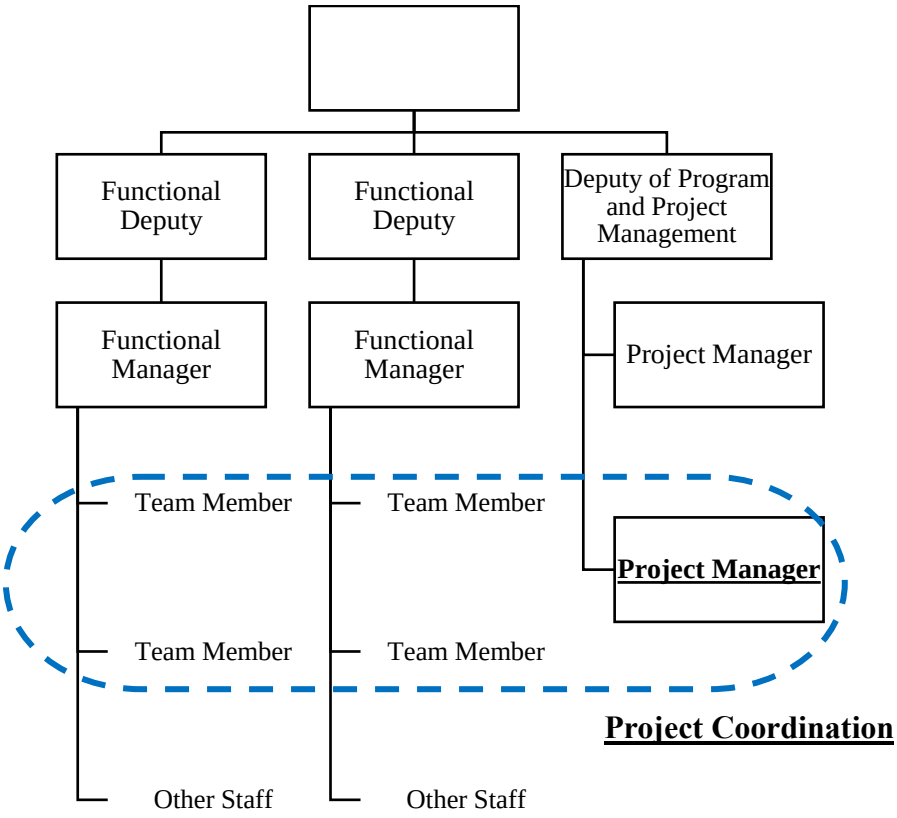


Figure 31 One-Hat PM Approach of Caltrans

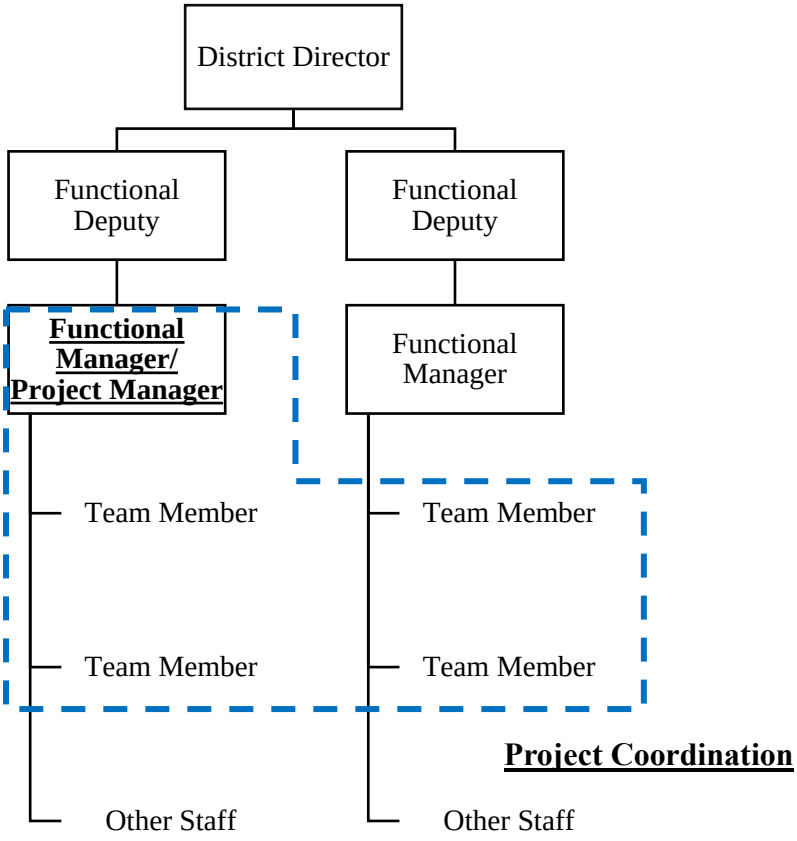


Figure 32 Two-Hat PM Approach of Caltrans

4.6.2. Iowa DOT's Project Manager Assignment Based on Project Types

The Iowa DOT assigns project managers based on the project type. This approach helps the Iowa DOT assign the resources efficiently and effectively manage the projects to meet the project baselines (Iowa DOT 2013). Table 11 provides the classification of the project types and assignment of the PMs to the project types (Iowa DOT 2013).

Table 11 Assignment of Project Managers in Iowa DOT

Project Type		Assignment of PM
Mega Projects (e.g., > $1 Billion or Politically Complex Projects)		Senior PM from the Project Management Office
Complex Projects (e.g., Interstate Reconstruction and Urban Corridor New or Reconstruction Projects)		PM from the Project Management Office
Routine Projects	New Alignment	Engineers from the Location and Environment Office are appointed as PMs
	Minimal Alignment and Right of Way Required	Engineers from the Design Office are appointed as PMs

4.6.3. Nevada DOT's Project Management Assignment Based on Size of Projects

The Nevada DOT assigns project managers based on the size of the projects. For large projects (i.e., >$100 million or politically complex projects), PMs from the project management division are assigned for the project, and the PM is the single point of contact for the project. For small projects (i.e., <$100 million), engineers from the Roadway Design Division are assigned to act as PMs. The PMs are responsible for developing and collaborating with the other functional units located in the district office.

4.6.4. Virginia DOT's Project Categorizations for Assigning Project Managers Based on Required Certifications

The Virginia DOT has developed educational guidelines to help individuals advance their careers in project management. The educational guidelines also play a key role in the development of the project management training plan. For determining participation in the project management development program, the individual project manager's role in the organization and project, project complexities, priorities, and business needs are considered. Based on these factors, a training plan is developed for program participants. Table 12 presents the project categories with project types and

required certificates for assigning PMs. The primary objective of the training is to improve the successful completion of the Virginia DOT's projects by matching project management training with the department's six-year improvement plan. The district Project Management Office is responsible for overseeing administration of the project management development plan (PMDP). The curriculum and classes are also decided based on the categories of the projects managed by the project participants. The projects are classified into five categories for assigning the appropriate level of PMs on the projects (VDOT 2007a).

Table 12 Project Categories with Project Types and Required Certificates at Virginia DOT

Categories	Certificates	Descriptions
Category I	Associate's Certificate	No plan projects or projects that are small and short in duration
Category II	Associate's Certificate	Minimum plan projects, which are relatively simple, single-season construction projects
Category III	Associate's Certificate	Full construction projects, which are multiseason construction projects of medium complexity
Category IV	Master's Certificate	Very large, complex construction plan projects, which are multiseason construction projects of large complexity (generally greater than $100 million)
Category V	Master's Certificate	Major, multicontract projects requiring seamless interaction among contractors

The PMs are expected to discuss with the functional managers and the head of the project management office about project needs to determine the level of participation in the project management project plan (i.e., for larger projects, PMs discuss with Head of Project Management office located in the central office. For smaller projects, PMs discuss with Head of Project Development Office located in the district office.). District leadership

generally considers the following factors for the development of the PMDP (VDOT 2007a):

- Business needs
- Career objectives
- Project opportunities
- Experience level
- Observed project management competency and performance
- Communication, leadership, and interpersonal competencies

There are three levels of certifications available in the program for PMs, apart from the managing projects course that is for project team members.

1) Level 1: Associate's Certificate in Project Management
2) Level 2: Master's Certificate in Project Management
3) Level 3: Project Management Professional (PMP) Certificate

Table 13 shows the minimum recommended level of PDMP certification required for managing different categories of the projects and also for the project team (VDOT 2007a).

Table 13 Recommended PMDP Certification Level at Virginia DOT

Project Management Role	Recommended PMDP Certification Level
PMO	Master's Certificate
Category V	Master's Certificate
Category IV	Master's Certificate
Category III	Master's Certificate
Category II	Associate's Certificate
Category I	Associate's Certificate
Team Member	Managing Projects Course Only
Administration	Managing Projects Course Only

Note:

PMO: Project Management Office

4.7. Training Program for Project Managers

Developing a training program for project managers is essential to improving the capability of the PMs in handling various sizes and complexities of transportation projects. State DOTs, such as the Virginia, Arizona, Florida, and Minnesota DOTs, have established training programs for PMs. With increasing focus on soft skills, apart from the technical skills of PMs, a training program is an ideal platform to provide training specific to those soft skills. The training program can be in the form of a webinar or an accelerated course in collaboration with state universities. A well-structured training program helps the highway agencies enhance the skills and knowledge of their PMs required for efficient project management, and it helps PMs adapt to the dynamic environment of the projects they manage.

4.7.1. Virginia DOT's Training Systems for Project Managers at the Transportation Project Management Institute (TPMI)

The Transportation Project Management Institute is an eight-day training program developed jointly by the Virginia DOT and the University of Virginia. The TPMI provides intensive residential training for managing the development phase of transportation projects. The primary objective of the TPMI is to advance the knowledge and skill set of project managers to complete the projects on time and on schedule. The program has been specifically developed for PMs from the Virginia DOT, local government, and private consulting firms. The training uses experts in the field of psychology to equip PMs, apart from technical skills, with the soft skills required for team building. Cooperative learning among the participants being the central component of the TPMI, an application process has been established to ensure an appropriate cohort of participants collaborates in the institute (VDOT 2019). Table 14 highlights the major benefits of the TPMI.

Table 14 Major Benefits of Virginia DOT's Transportation Project Management Institute

Major Benefits of TPMI
• **Identifies the best project management practices**
• **Strengthens project managers' competencies**
• **Improves the organization's effectiveness in managing the project scope, budget, and schedule**
• **Provides an opportunity to impact project management policies, procedures, and practices**
• **Assesses real-life case studies to exercise relevancy and applicability on everyday projects**
• **Provides an opportunity for professional network development**
• **Provides an opportunity for valuable relationship and exchange of project management practices and experiences between Virginia DOT and industry**

The comprehensive TPMI program consists of various topics that are of interest to the participants. The curriculum has been designed such that it provides all the necessary knowledge for PMs to manage projects throughout the project development phase. The curriculum includes the following topics (VDOT 2019):

- Understanding personality
- Leading the project team
- Communication skills
- Project development process
- Project planning
- Risk management
- Project scope management
- Scheduling
- Estimating
- Ethics
- Consultant procurement process
- Negotiations
- Effective presentations

4.7.2. Arizona DOT's Project Delivery Academy

The Arizona DOT (AZDOT) established the Project Delivery Academy to provide ongoing training in a dynamic setting to focus on the key areas within project development and construction. In addition, the Project Delivery Academy provides an open forum for discussion and idea sharing that follows the Arizona DOT's *Project Development Process*

Manual (AZDOT 2019). The Project Delivery Academy provides training through seven modules, which can be accessed at any time, and allows PMs to learn at their own pace and favorable time (AZDOT 2018). Table 15 provides the training modules in Arizona DOT's Project Delivery Academy.

Table 15 Training Modules for Arizona DOT's Project Delivery Academy

Training Module	Topic	Description
1	Planning and Programming	Focuses on the Multimodal Planning Division's planning process and the five-year transportation program, along with training from the local public agencies section.
2(a)	Development Project Initiation and Scoping	Discusses the development process and has representatives from right of way, utilities, and environmental to provide training and guidance.
2(b)	Development Design and Clearances	Addresses contracts and specification issues and identifies the roles different groups serve.
3	Construction and Maintenance	Highlights critical issues regarding construction and maintenance operations.
4	Financial Management	Highlights important areas via representatives from FHWA, AZDOT Finance and Resource Administration, Accounts Receivable and Accounts Payable departments, and Project Accounting and Project Closeout department.
5	Communication and Development	Provides training and insight from the Disadvantaged Business Enterprise Section and the Civil Rights Group, along with hands-on soft skills and interpersonal communication training.
6	Project Office Resource Tools and Resources	Provides hands-on live training via the Project Resource team on various applications and tools that are used by PMs, including Project Review Board (PRB) request forms, Project Information Retrieval Tool (PIRT) application, and Task Order Assignment Schedule Tracker (TOAST) application.

4.7.3. Florida DOT's Project Management Training

The Florida DOT has developed a series of webinars to train project managers on important topics for the project development process and on the use of new processes and

tools in the organization. The Florida DOT's Project Management Office, located in the headquarters, is responsible for developing and updating the webinars. Previously recorded online webinars allow the PMs to learn at their own pace and convenience (FDOT 2018). Table 16 provides the series of Florida DOT project management webinars.

Table 16 Florida DOT's Project Management Webinars

Webinar Title	Description
PM 101	This webinar training will discuss the FDOT project management process and principles.
Project Suite Enterprise Edition	This webinar will provide information on how to use Project Suite Enterprise Edition and how PMs interact with other FDOT tools and resources.
Communications	This webinar will focus on communications, media relations, and stakeholder analysis.
Project Development and Environment (PD&E) Project Management	This webinar will focus on the processing involved in project development and environmental studies' project management.
Contract Types and Scope Development	This webinar will focus on the contract types and scope development in project management.
Consultant Acquisition	This webinar will focus on understanding the procurement cycle, critical dates, and events for procurement.
Americans with Disabilities/ Accessibility (ADA) & Right of Way	This webinar will focus on understanding how the American Disabilities Act affects the design and construction of pedestrian movement along Florida DOT right of ways.
Quality Management	This webinar will focus on the department's quality control and quality assurance, QA/QC tools, phase submittals, and successful strategies.
Standard Plans and Implementations	This webinar will focus on the upcoming updates and revisions as part of the transition to standard plans.
Scheduling	This webinar will focus on the basics of scheduling and the critical path method.
CADD Deliverables	This webinar will focus on a brief history of Florida DOT CADD/ Industry history, when to deliver 3D engineered models, QA/QC as defined by Florida DOT, QC review of the model, 3D deliverables, and intelligent model designs.
Standard Plans Update	This webinar will provide an overview of updated standard plans and the new website layout Turnouts, Utility Adjustment, Traffic Separators, Sidewalk & Curb Ramps Intelligent Transportation Systems Indexes–CCTV Poles and Dynamic Message Signs (DMS).
Estimates	This webinar is an overview of the Program Management Office's estimate program.
Risk Management	This webinar is an overview of the Florida DOT risk management program.
Survey and Mapping	This webinar is an overview of the Florida DOT Survey and Mapping Office.
Research and Development	This webinar is an overview of the Florida DOT Research Center and how projects are managed under this office.
Value Engineering	This webinar is an overview of the value engineering (VE) process. Participants will learn about the process, when it is applied, what it is applied to, who participates, and how VE interacts with the cost risk assessment process.

Note:

QA: Quality Assurance

QC: Quality Control

CADD: Computer Aided Design and Drafting

CCTV: Closed Circuit Television

4.7.4. Minnesota DOT's Training of Project Managers

The main aim of establishing project manager training is to provide to employees involved in the program delivery the knowledge and skills needed to manage and complete the projects. The Minnesota DOT (MnDOT) has partnered with the University of Minnesota to provide training for project management. There are 10 courses/knowledge areas that are important, and each year the Project Management Leadership Group selects eight courses that will be offered for that particular year based on the project needs and requirements (MnDOT 2018a).

The courses within this training are grouped by knowledge areas covering what a PM needs to know in order to successfully manage Minnesota DOT projects. Courses identified as base courses provide a general overview of the skills needed and are provided by outside vendors. These courses may be sponsored by Minnesota DOT or can be taken directly by contacting the provider. Courses identified as *Learning On Demand* provide a general overview of the skills needed and are generally provided by outside vendors; they are available only for a limited time. Courses identified as *How We Manage Projects at Minnesota DOT* provide information on the processes, procedures, and tools available at Minnesota DOT. Table 17 provides the 10 knowledge areas for PM training in the Minnesota DOT, and Figure 33 shows the online courses for the Minnesota DOT PM training (MnDOT 2018a).

Table 17 Ten Knowledge Areas for Project Manager Training in Minnesota DOT

Topic	Description
Integration Management	Establish a framework to accomplish project objectives. This includes developing a project management plan and a project charter.
Scope Management	Establish a framework to accomplish project objectives. This includes developing a project management plan and a project charter.
Schedule Management	Examine processes required for the timely completion of the project. This includes the development and control of the project schedule.
Cost Management	Plan, estimate, budget, and control costs to ensure that the project can be completed within the approved budget.
Quality Management	Identify which quality standards are relevant to the project objectives to ensure that the project achieves its goals. This includes quality planning assurance and control.
Resource Management	Establish a process that involves resource planning and ensuring that all resources are used efficiently. This includes forming, developing, and managing the project team.
Communications Management	Communicate direction and decisions on all project-related issues. This includes performance tracking, issue escalation, and managing internal and external stakeholders.
Risk Management	Increase the probability and impact of positive events and decreasing negative events. These are updated throughout the project. This includes qualitative and quantitative risk analysis.
Procurement Management	Follow the process to purchase/acquire the products, services, or results needed to perform the project work. This includes contract management and change control.
Stakeholder Management	Engage stakeholders during project decisions and execution effectively by analyzing stakeholder expectations and developing management strategies.

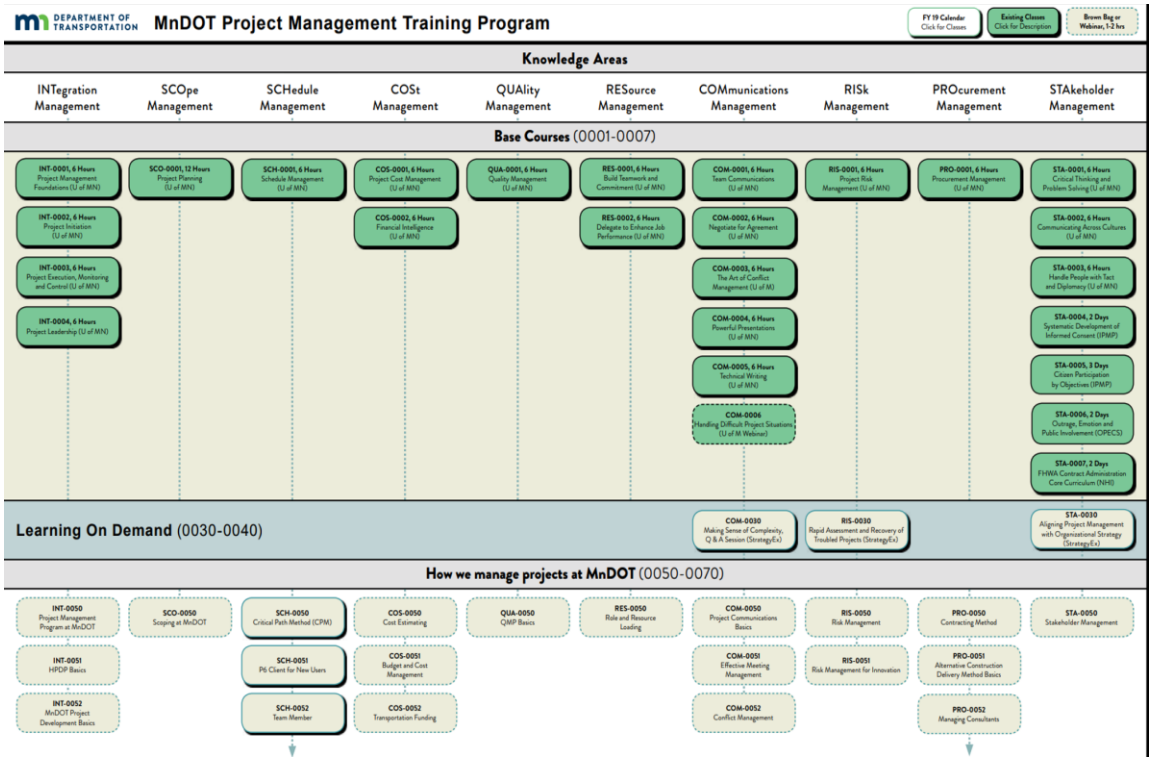


Figure 33 Project Management Training Courses in Minnesota DOT (MnDOT 2018b)

4.8. Project Issue Resolution Practice

The successful completion of the project requires collaboration and cooperation among the various functional offices (e.g., Right of Way, Environmental, and Design), project managers, and other project stakeholders. Because of the complex nature of the projects, issues are certain to arise during the life of the project. A well-defined and standard approach to address and resolve the issues becomes very important to avoid or minimize the adverse impacts of those issues on project cost and schedule. Therefore, several state DOTs, such as the Nevada and Utah DOTs, have developed a standard approach to efficiently manage the issues that arise on a project and effectively address them within the established time frame for the project.

4.8.1. Nevada DOT's Project Issue Resolution Process (PIRP)

The Nevada DOT has established a project issue resolution process to manage and resolve issues/conflicts between project participants (e.g., functional divisions, in-house technical staff, consultant staff, and project managers). The issues are divided into four levels based on the severity of the issues (NDOT 2010):

- Level 1 – Technical issues
- Level 2 – Cost, scope, quality, and contractual issues
- Level 3 – Technical, cost, scope, schedule, quality, and contractual issues
- Level 4 – Policy issues

The severity of the issues is measured based on the effects on cost, schedule, quality, and scope of the project. The PIRP helps establish a fixed timeline within which the issue must be resolved. Table 18 provides the project issue resolution process in the Nevada DOT. The PM is always included in any issues regarding cost, schedule, scope, and/or quality of the project. All the issues of Level 2 and higher must be documented and the PM should track the issue resolution documentation. All the issues should be resolved in the time frame agreed upon in the project management plan. If necessary, Level 1 and Level 2 issues can be included in the project meeting minutes. If the issue is not resolved within the established timeline, the PM is required to elevate the issue to a higher level (NDOT 2010).

Table 18 Project Issue Resolution Process Levels

Level of Issue	Type of Issues and Resolution Method
Level 1: Technical Issues	• Level 1 of the PIRP is the lowest level. • Generally, this type of issue takes place between functional units and/or with consultant staff. • Discussions between affected parties should commence immediately once an issue is discovered, and the issue should be resolved according to the project management plan. • Most issues can and should be resolved at this level and generally without input from the PM.
Level 2: Cost, Scope, Schedule, Quality, and Contractual Issues	• Level 2 is intended to resolve issues elevated from Level 1 because of potential cost, scope, schedule, quality, and/or contractual (local agency, consultants, etc.) issues. • The PM will be contacted and asked for an opinion on the issue and proposed resolution. • If the PM agrees with the proposed resolution, no further action is necessary. • If the PM does not agree or proposes a different solution due to cost, scope, schedule, quality, or contractual issues, discussions should commence immediately, and the issue be resolved according to the project management plan or referred to Level 3, if necessary.
Level 3: Technical, Cost, Scope, Schedule and Quality, and Contractual Issues	• Level 3 is utilized upon failure to resolve an issue among project team members. • At this level, the PM shall be informed of the issue and will take an active role in coordinating a resolution. • Functional managers (assistant division head, division head, etc. as per division procedures) from the respective functional units will communicate directly, and in cases where cost, scope, schedule, and quality are affected, the PM will take part in those communications. • The recommended time frame to resolve critical issues for this level is three days. • If a functional manager is not available during the three-day time frame, the issue should be moved up to Level 4.
Level 4: Policy Issues	• Level 4 of the PIRP is the last step and generally should only be used in those cases when departmental policy or questions of legality are concerned, or when staffs associated with Level 3 resolutions are not available. • In those rare instances when an issue cannot be resolved by the respective divisions at the division head level, issues may be elevated to the appropriate assistant director or directors if the issue is between divisions not under a single assistant director. • The PM will coordinate a resolution and make the assistant director(s) aware of any CSSQ concerns. If a resolution cannot be reached between two assistant directors or a departmental policy is involved, then the director or deputy director may be asked to participate in the resolution. • If a legal matter is at the core of the issue, the assistant attorney general may review the matter and render a recommendation. • The recommended time frame for this level is 1 week. In the event an assistant director is unavailable, the director or deputy director can be involved, but generally only in matters that require immediate attention.

Note:

CSSQ: Cost, Scope, Schedule, and Quality

4.8.2. Utah DOT's MITAR Approach for Project Issue Resolution

The Utah DOT uses the concept of Monitor, Investigate, Take Action, and Report (MITAR) for handling and resolving the issues and disputes that arise during the different phases of a project. The MITAR principle provides uniform information to avoid miscommunication and delays. The project manager role changes as the project progresses from the definition stage to the execution stage of the project, and PMs are required to use the concept of MITAR throughout the different phases of the project to handle the issues that arise. MITAR enables the PM to carry out the project management plan to resolve the issues, and it contains the following processes:

- Monitor: Track and compare project progress to the baseline project plan
- Investigate: Explore the causes and possible resolutions to changes in scope, schedule, budget, and team
- Take Action: Manage and record the changes, issues, and risks that emerge as the project progresses
- Report: Communicate actual performance, progress, variances, and actions taken to the appropriate members of the organization

In the Utah DOT, the management principle of MITAR is one of the core aspects to the functioning of the PMs (UDOT 2013). The MITAR approach is used extensively for the following four main areas of project management (UDOT 2013):

- Project scope
- Project schedule
- Project budget

- Project team

The MITAR approach provides uniform information to avoid miscommunication and delays. MITAR also helps avoid overbudgeting by tracking the budget and preparing strategies to bring the project back on track. The MITAR approach also aids the PM in carrying out the project management plan. Table 19 shows examples of use of the MITAR principle for resolving issues in the four project areas previously mentioned (UDOT 2013).

4.9. Risk Management

A detailed risk management plan is critical for project managers to effectively address project issues during various phases of the project development process. Highway projects are complex and exposed to various kinds of uncertain events (i.e., risk factors), and a well-thought-out strategy for risk management becomes an important aspect of the project management. A carefully developed risk management strategy can help significantly reduce the adverse impact of risk on the project and mitigate it to successfully complete the project. Several DOTs, such as the Nevada and Washington State DOTs, have developed their own risk management processes to enhance their project delivery practices.

Table 19 Examples of Utah DOT's MITAR Approach to Issue Resolution

Type	Scope MITAR	Schedule MITAR	Budget MITAR	Team MITAR
Monitor	During a weekly team meeting, the PM discovers that the designer has added the replacement of all the small drainage culverts that cross the road. This was not in the original scope of the project.	During a review of the project schedule, the PM discovers that the utility coordinator has extended completion of a critical path activity by three weeks.	The lead designer sends the PM the latest construction estimate based on the plan-in-hand design package. The PM notices that the utility relocation estimate has increased significantly. This has caused the engineer's estimate to be greater than the project value.	While discussing your project with the design leader, she states that the structures lead will not return her calls or emails about some key elevation information that is needed to complete the plan-in-hand review package.
Investigate	The PM questions the designer and finds that the maintenance engineer requested that he add these culvert replacements to the project. The PM follows up with the maintenance engineer and finds that a recent inspection revealed that most of the culverts were partially collapsed.	The PM talks with the utility coordinator and finds that the utility coordinator has been assigned to a large project and can only work half-time on the other region projects. This will delay all of the utility coordinator's project work.	The PM talks to the lead designer. The lead designer states that recent utility information indicates a large, high-pressure gas line is too shallow and has to be lowered.	The PM promptly sets up a meeting with the structures lead. The structures lead states that he was extremely offended by some comments made by the design leader at the last meeting. He doesn't think the plan set needs the requested information and does not want to talk to the design leader, so he has ignored her information requests.
Take Action	The PM meets with the designer, the maintenance engineer, and region management to decide if this additional scope should be added to the project. If so, the PM will have to determine if the project has sufficient funds or if additional funds are required.	The PM meets with the utility coordinator and region management to brainstorm solutions. They decide to hire a consultant to work for the utility coordinator to help relieve the utility coordinator's workload.	The PM holds a brainstorming session with the appropriate team members to develop and select a shallower pavement design that avoids the gas line. This alternative design costs more than the original design but is much less than relocating the gas line. The new engineer's estimate is now less than the project value.	The PM sets up a meeting with the design leader and the structures lead. The PM should make certain that the atmosphere in this meeting is nonthreatening and open. It is important to elicit solutions for this issue from the two contending team members. Team members resolve this conflict by agreeing to certain rules of communication. They also agree to treat each other professionally and respectfully.
Report	The PM communicates to all team members the actions taken and consequences of this resolved issue.	The PM reports the resolution to the delivery team.	The PM will report this new pavement design solution to the project team and region management.	This resolution should be reported to leadership and those team members affected by this conflict. There is no need to inform other team members who are unaware of this conflict.

4.9.1. Nevada DOT's Risk-Based Project Management

To control or monitor the use of project contingency or risk reserve, the Nevada DOT uses a strategy of project controls. Project controls can be set as a percent of the project contingency or risks that can be utilized without prior approvals. The Nevada DOT terms this control as project allowances. Allowances allow flexibility to the project team in managing project risk and uncertainties. In addition, allowances allow use of project reserves to deal with the realized risks without going through a formal approval process. That being said, the project team should make all efforts to deliver the project within the established cost and schedule baseline. Project teams should avoid use of the reserves from the onset. The project team should try to avoid risk as far as possible and focus on opportunities, and if risk avoidance is not possible then the team should use the reserve to reduce the impact of the risk. Three types of allowances are defined and apply to all projects in the Nevada DOT (NDOT 2010):

- Project team's allowance—Use of this allowance is at the discretion of project team.
- Project manager's allowance—Use of this allowance is at the discretion of the PM and does not require approval from the program manager. The project team's allowance must be exhausted prior to the use of the PM's allowance.
- Program manager's allowance—Use of this allowance is at the discretion of program manager and does not require approval from the director's office. The project team's and project manager's allowances must be exhausted prior to use of the program manager's allowance. For cost or schedule increases exceeding the program manager's allowance, the program manager must follow the

Nevada DOT's formal change order process and seek approval from the director's office.

Figure 34 depicts the cumulative probability chart for project allowances. Table 20 provides three types of allowances for project-based risk planning.

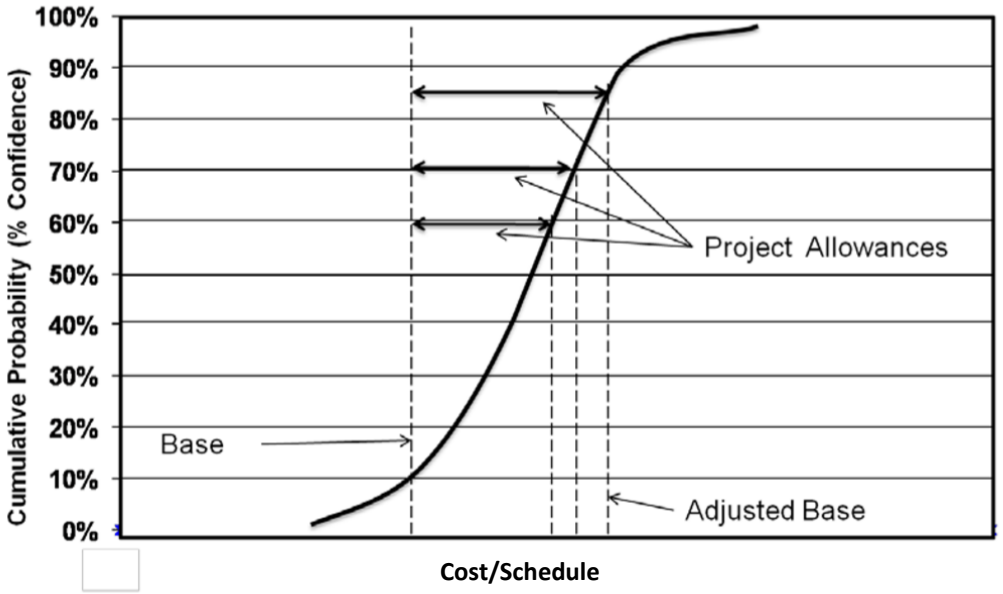


Figure 34 Cumulative Probability Chart for Project Allowances at Nevada DOT (NDOT 2010)

Table 20 Three Types of Allowances for Project-Based Risk Planning at Nevada DOT

Allowance	Schedule		Budget	
	Contingency-based Schedule	Risk-based Schedule	Contingency-based Budget	Risk-based Budget
Project Team's Allowance	Base Duration × 0.15	Base Duration 60% confidence level	Contingency × 0.60	60% confidence level
Project Manager's Allowance	Base Duration × 0.20	Base Duration 70% confidence level	Contingency × 0.10	70% confidence level
Program Manager's Allowance	Base Duration × 0.30	Base Duration 85% confidence level	Contingency × 0.15	85% confidence level

For all Nevada DOT projects, the preparation of a risk management plan is compulsory. The Nevada DOT proposes the use of both qualitative and quantitative risk analysis to prepare a risk management plan. However, the department uses distinct procedures that project teams need to follow to prepare a risk management plan based on the project value, needs, and complexity.

- For projects that have total value less than $100 million, a risk management spreadsheet is used for preparing the risk management plan. The spreadsheet provides a simpler way to identify, analyze, and develop risk response, and monitor and control project risks. The spreadsheet uses qualitative risk analysis that provides a prioritized list of risks.
- For projects above $100 million, the project team is required to use the "NDOT Risk Tracking Analysis Tool for Small and Medium Size Projects." This tool enables the team to create and maintain 24 major project risks. The project team is also required to implement a facilitated probabilistic, risk-based, integrated cost and schedule model. This approach for risk management is known as the cost estimate validation process (CEVP), which was originally developed at the Washington State DOT.
- When performing risk analysis, the project team should remove any conservatism and contingencies from the project schedule and cost baselines, as those will be accounted for in the risk management process and the adjusted project baselines.
- Quantitative techniques used for risk management generate a probability distribution of the project cost and schedule based on risk effects. The results of

this graph are the cost and schedule estimates with 70% confidence and a prioritized list of quantified risks. The analysis should be conducted several times at various phases in the project.

The project team identifies the risks and opportunities through the risk management planning process and develops actions to deal with each risk and opportunity. This process helps the Nevada DOT project team decide where to concentrate, whether on risks or opportunities or a combination of both.

4.9.2. Washington State DOT's Risk Management Process

The Washington State DOT has developed a detailed project risk management plan to assess and mitigate the risk on different project sizes. Table 21 provides project categorization for risk management based on the project size. The project risk management helps align the project team with steps required for effective risk management on the projects. The risk management plan also helps assign the required resources to the project. The Washington State DOT's project risk management plan helps establish an estimate range based on the risk associated with the project. A single number for the project masks the critical uncertainty inherent in the project. The accurate estimate is determined by dividing the estimate into two components, i.e., the base cost and the risk component. The base cost is the cost of the project if a specific risk materializes as planned without any contingencies. The risk contingency is defined based on all the risks associated with the project defined in the risk register. Based on the type of the project, risk assessment is applied to replace the general contingency with project-specific contingency with explicitly

defined risk events. The risk events are characterized in terms of probability of occurrence and the consequences of each potential risk event (WSDOT 2018).

Table 21 Project Categorization for Risk Assessment at Washington State DOT

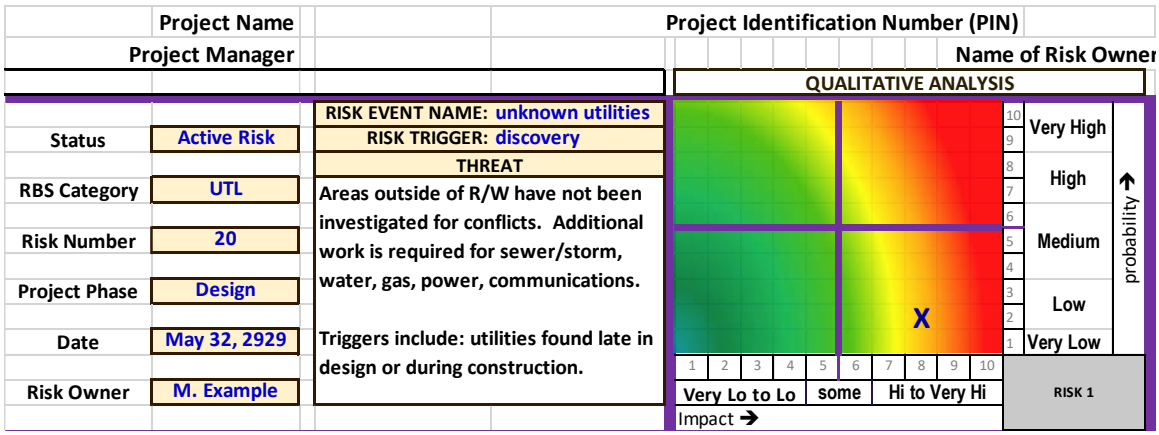
	Project Size ($M)	Risk Assessment Level	Notes
Less Formal Risk Assessment	**0–10**	**Qualitative Spreadsheet**	The project team assesses each identified risk for its probability of occurrence and its impact on project objectives. Project teams may request assistance from SMEs or functional units to assess the risks in their respective fields. The self-modeling spreadsheet can be used for any project.
	10–25	**Self-modeling Spreadsheet**	
More Formal Risk Assessment	**25–100**	**Cost Risk Assessment (CRA)**	The team, working collaboratively with independent SMEs, reviews and/or validates cost and schedule estimating and identifies, characterizes, and analyzes risks. Workshops are accomplished in a structured setting. Modeling can be accomplished with off-the-shelf software or using the self-modeling spreadsheet.
	> 100	**Cost Estimate Validation Process (CEVP)**	

Based on the type of risk assessment method used for the project, the schedule is modified to add risk management milestones in the project schedule to account for the risk and monitor the risk at regular intervals. Table 22 provides the milestones for risk management. The defined milestones for risk management allow for the incorporation of the risk management activities into the project schedule, which minimizes the impact of risk on cost and schedule during project delivery.

Table 22 Milestones That Need to be Added in the Project Schedule for Risk Management

Less Formal Risk Assessment		Formal Workshop	
Qualitative Spreadsheet	**Self-modeling Spreadsheet**	**CRA**	**CEVP**
Milestones to be included in the schedule: • **Project scope, schedule, and estimate are complete (appropriate to the level of development)** • **Prep meeting (initial review of areas of concern; determine tool: qualitative or self-modeling)** • **Risk meeting (risks are identified and characterized)** • **Risk response actions developed** • **Risk response actions implemented**		**Milestones to be included in the schedule:** • Workshop request form submitted • Project scope, schedule, and estimate are complete (appropriate to the level of development) • Prep session (flowchart project; determine SMEs; additional prep items) • Workshop • Preliminary results presented • Draft report • Final report	

Figure 35 shows an example of the qualitative risk assessment spreadsheet for a project less than $10 million (WSDOT 2018). The qualitative risk assessment enhances the capability of project management by characterizing the risk in terms of probability (i.e., very high, high, medium, low, and very low) of a risk occurring and its consequence, which is provided in the "THREAT" section of Figure 35. Figure 36 shows the template of the CEVP Workshop with key information from the workshop, such as key project risks, probabilistic analysis, and benefits of risk response actions. As project risk management is an integral component of project management, the CEVP Workshop allows the PM and the project team to increase the satisfaction of time, cost, performance, quality, scope, and client of a project by proactively managing risks (e.g., assessing uncertainty and risk, quantifying uncertainty in the project cost and schedule, conducting probabilistic analysis and documentation, and providing actionable information on the risks) (WSDOT 2018).



Note:

RBS: Risk Breakdown Structure

Figure 35 Example of Qualitative Risk Assessment Spreadsheet for Project at Washington State DOT (WSDOT 2018)

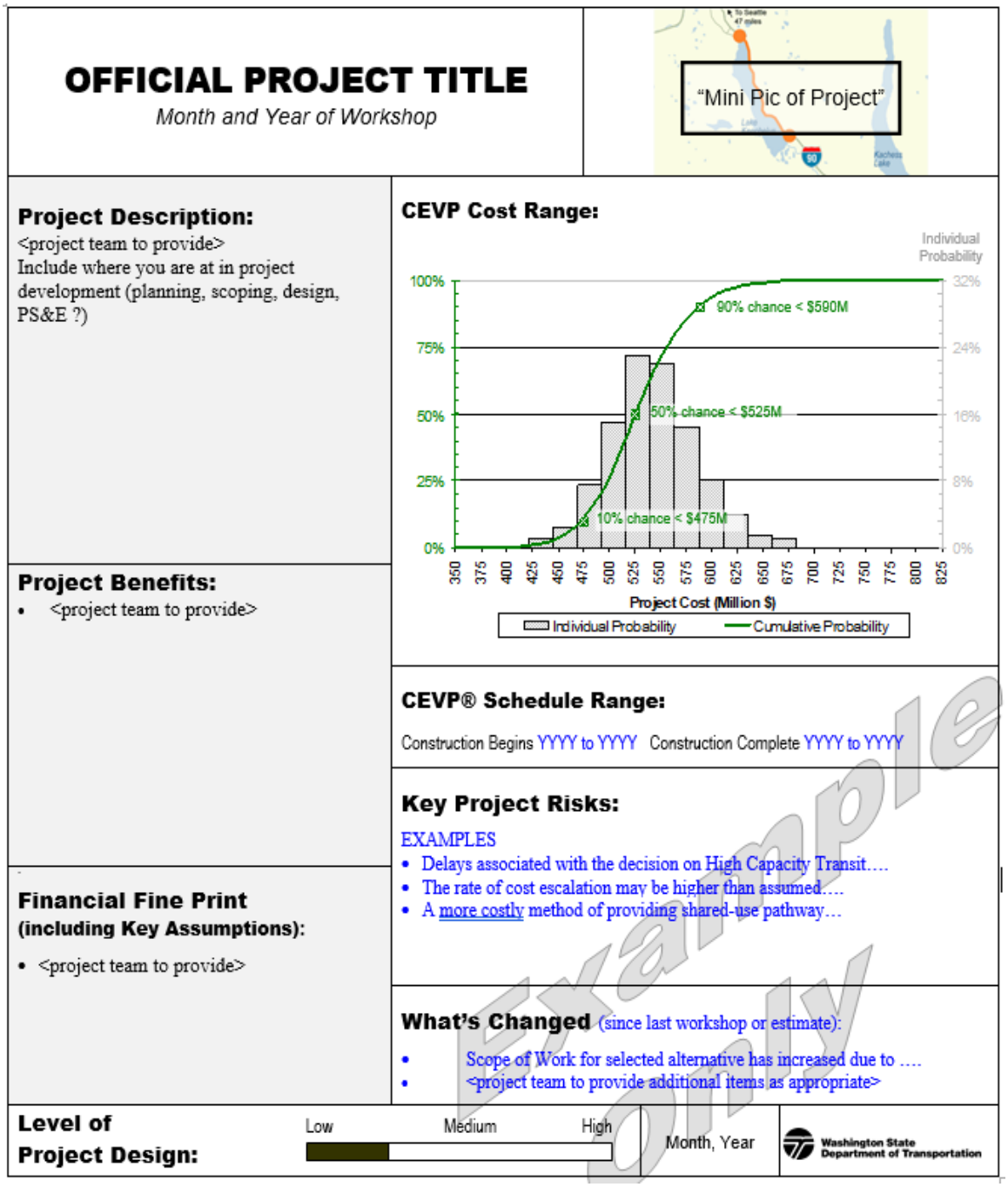


Figure 36 Washington State DOT CEVP Project Workshop Template (WSDOT 2019)

4.10. Project Resource Selection

As transportation agencies are investing in more and more projects, there is an increasing trend to shift some of the preconstruction services, such as design, environmental analysis, ROW acquisition, and utilities to consulting firms. For example, Hannon and Ashuri (2014) and Hannon et al. (2014) identified best practices for environmental planning and permitting to expedite project delivery. Some state DOTs, such as the Utah, Florida, and Iowa DOTs, have developed systematic approaches to hire consultants for their projects. Furthermore, consultants are hired to aid the functional offices if they are overloaded with work. The current practices of these state DOTs for the hiring and selection of the consultants are described in this section.

4.10.1. Utah DOT's Project Resource Selection

In the Utah DOT, about 65% of the total projects are done in-house, which in dollar value equates to about 80% of the Utah DOT's budget every fiscal year. The rest of the work is done by consultants. Project managers in the Utah DOT can hire consultants directly if the functional offices in the Utah DOT do not have adequate resources for the project; however, PMs should always give first preference to in-house resources. The functional offices should also make sure that the consultants are able to deliver work of the prescribed quality and within the established schedule and budget. If the PM feels that the functional offices are not able to deliver or are struggling to meet the project objectives and goals, then the PM can hire project consultants to avoid delays and going over budget on the project.

4.10.2 Florida DOT's Project Resource Selection

The Florida DOT uses consultants for about 90% its total projects each year. Consultants are used in all disciplines for Florida DOT projects, and the department also uses the concept of consultant project manager. The assignment of the consultant PMs depends upon the workload of the in-house PMs. The district director makes the decision for the assignment of consultant PMs on the project based on the project needs. The Florida DOT PM leads the project team that is responsible for the project. Figure 37 shows the typical structure of the project team for Florida DOT projects.

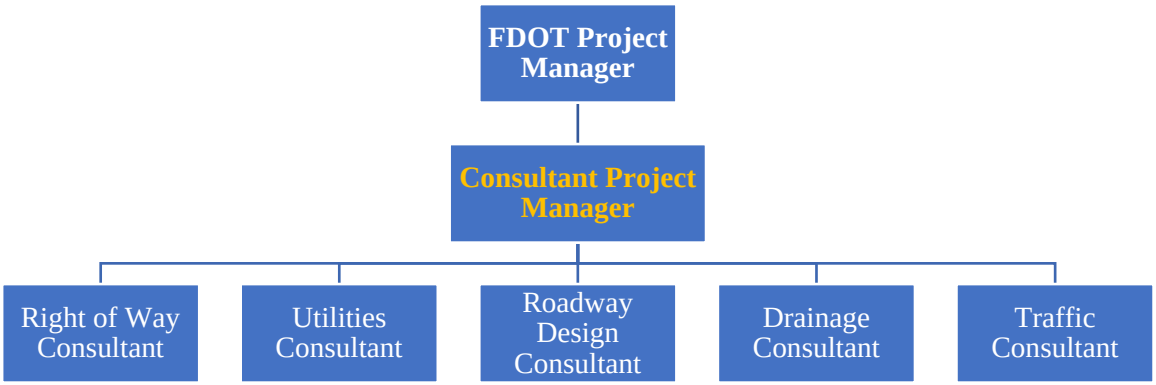


Figure 37 Typical Structure of Project Team for Florida DOT Projects

The Florida DOT uses a two-layered process for the assignment of consultants. Initially, the technical review committee (TRC) develops the initial list of consultants, which then goes to the selection committee. The Florida DOT PM is usually the chair of the TRC. Personnel should not accept membership to the TRC if they are not able to efficiently do the job or have any kind of conflict of interest with a firm that has submitted a letter of interest for the project. The selection committee is responsible for shortlisting and finalizing the selection of consultants for the Florida DOT's projects. The selection

committee consists of district secretary (serves as chairperson) and district directors or their designees. The PM may or may not be a part of the selection committee. Table 23 shows the proposal requirements for the consultants based on the type and complexities of the project.

Table 23 Proposal Requirements for Florida DOT Consultants Based on Project Types and Complexities

Type of Project	Type of Proposal Required
Simple or Relatively Simple Projects	Interviews are appropriate for simple projects or district-wide projects.
Projects Involving Public Participation	Oral technical presentations are most appropriate for Project Development and Environment (PD&E) studies (i.e. FDOT's procedure for complying with the NEPA process) and other projects involving public participation because they provide some insight into the consultant's presentation skills.
Large Projects	Written technical proposals are appropriate for large projects.
Large and Complex Projects	Technical proposals, oral and written, may both be appropriate for large and complex projects.

4.10.3 Iowa DOT's Project Resource Selection

The Iowa DOT established its Project Management Office (PMO) in 2016 to improve the project management practices on its projects. The PMO, located in the central office, administers contracts for consultants for the project tasks beyond the staffing limits of the internal staff. The PMO decides whether to keep the project in-house or assign consultants on the project once the project is 40% complete in the development phase. The consultants are required to report the project progress to the PMs and senior PMs in the PMO. The PMO is tasked with handling the following functions with respect to consultants (Iowa DOT 2018).

- QA/QC scope and budgets (to compare to typical levels of efforts for similar work)
- General contract administration—invoicing, contract execution, monitoring reports, audits, etc.
- Monitoring contracts for duplication of duties, untimely tasks, unneeded work, and fair prices
- Negotiating appropriate changes to consultant scope and fees, or in consultation with the functional office, and assist as needed

4.11. Environmental Coordination

There is a recent trend in some of the transportation agencies to establish a coordination unit within their project development structure, especially for environmental analysis tasks. Since timely environmental reviews during project development process play a critical role in establishing and maintaining an overall project schedule (An et al. 2018), establishing environmental coordination unit aids PMs and project teams in delivering projects successfully and timely. The main goal for establishing the environmental coordination unit is to elevate the importance of environmental assessment in the dynamic project environment, enhance the understanding of the project management team about environmental permitting issues and related procedures, and help coordinate the efforts of the project development team and the environmental office for the success of the project. The following state DOTs established an environmental coordination unit within their project development groups:

- Connecticut DOT: The Connecticut DOT established the Environmental Coordination Unit under the engineering unit in its organization. The main purpose

for establishing the Environmental Coordination Unit was to communicate and coordinate the efforts between the Environmental Planning Office and Preconstruction Project Management group.

- Alabama DOT: The Alabama DOT established the Environmental Technical Office within its design bureau. The main purpose of establishing the Environmental Technical Office was to facilitate communication and promote awareness within the organization of the activities conducted by various Alabama DOT offices.
- Minnesota DOT: The Minnesota DOT established the Environmental Coordination Unit in the district offices. The aim for establishing the Environmental Coordination Unit was to facilitate coordination between the project development team at the district level and the Environmental Stewardship Unit in the headquarters, which is responsible for environmental permits, regulations, and policy and procedures for all Minnesota DOT projects.

4.12. Trust Between State Legislature and State DOTs

The Utah DOT's annual budget on an average is $1 billion; of that, $370 million comes from the federal government, with the rest being funded by the state legislature. It is very important to have a fostering relationship with the state legislature for meeting the funding requirements to fulfill the requirements of the constituents (Ashuri et al. 2018c; Jallan et al. 2018). The Utah DOT has established a robust relationship with the state legislature based on trust that has developed because of the Utah DOT's consistent performance in delivering projects over the years, due to a focus on completing projects within the established schedule and budget baselines. To achieve this, the Utah DOT has

focused on defining the scope of the project early in the project phase, which helps the agency assign the funding clearly to the scope of the project. This extra focus has resulted in gaining trust and support from the Utah state legislature in the Utah DOT's project delivery performance.

This established trust has helped the state legislature understand clearly where the allocated funds for the project are being used and how they are being used. There have been several instances when the Utah DOT has gained an advantage because of its exemplary and consistent performance, for example, increased funding and passing critical bills. To maintain this established trust, the Utah DOT makes sure that its projects are completed on schedule and within budget, using all the available resources. This is a unique example where the ever-perceived image of not performing efficiently on the part of the state department of transportation has been changed to foster a healthy relationship with the state legislature.

4.13. Project Management Leadership Group

The Minnesota DOT holds project management leadership group sessions every two months for the project managers from all eight districts to provide and share innovative and effective project management practices. The project management leadership group session is led by a PM lead from one of the district offices. There is a rotating-chair policy for leading each session of the project management leadership group meetings. The group session is also attended by members of executive management and the heads of the functional offices. The major advantages of the project management leadership group are as follows:

- Provide the district office with an opportunity to discuss its issues and problems in an open forum
- Provide the opportunity to adopt best practices from other district offices for better project management
- Provide knowledge dissemination opportunities and encourage creative and innovative thinking

4.14. Improving Coordination and Promoting a Collaborative Environment

The Arizona DOT uses a unique but soft approach to improve project management and project delivery. All the departments associated with the project must attend the mandatory project meetings. The department head or middle-level or higher-level authority represents each department at the meeting. Along with attending, all participants are expected to contribute to the meetings. The chief engineer or senior project manager attends the meeting randomly to make sure everyone is participating in the meetings and adding value to the organization. The Arizona DOT believes that discussing issues face to face can have much better results than occasional virtual meetings, as face-to-face meetings help speed the resolution process. Better communication strategies such as gathering all the people in the same physical space (i.e., a face to face meeting) has proven to be an effective communication tool as it helps everyone understand the other's position on the project (Kingsley et al. 2017).

Recently, the Arizona DOT has made great efforts to transform the attitudes of project participants in the organization. If a project fails, it is not because of a specific department or a particular person, but the project team as a whole is expected to accept

responsibility for the failure of the project as a whole. In such manner, the traditional silos mentality can be broken down and a more collaborative environment created. In addition, the Arizona DOT promotes finding solutions for problems at the lowest level possible to reduce delay and cost escalation. With this strategy, the Arizona DOT resolves around 50% of project issues at the field level, which saves a lot of time and effort for the project team.

The Arizona DOT also established a critical policy regarding limiting project scope change in line with design completion. For example, before the design is 50% completed, the PM or SMEs in functional offices can work together to change some aspects of the project scope. However, after 50% design completion a senior PM or higher management needs to approve the project scope change. The project is typically well defined by the time design is 50% complete and, thus, there will not be a surprise element in the project. Furthermore, the Arizona DOT has implemented a new policy where any incomplete submittals would not be processed. The department believes that while it is very important to meet deadlines—if somebody misses a deadline, then he or she needs to be held accountable—there is also no need to waste time processing incomplete submittals.

4.15. Enterprise Project Management Initiative

Some DOTs, such as the Iowa DOT, have established the Enterprise Project Management Initiative (EPMI) to move from a weak matrix to a balanced matrix to improve project delivery and performance. The initiative helps improve existing project management and create opportunities to grow better through leveraging staff knowledge, skills, and abilities in the principles and practice of project management. As a part of the EPMI, the Highway Project Management Office (PMO) was created to help improve

project management capabilities in the highway division. The major objectives of the EPMI and PMO are provided in Table 24. The mission behind the development of the PMO in the Iowa DOT is to improve the capability of the organization and its ability to consistently deliver quality projects within the prescribed time and cost through the use of sound project management principles. For this initiative, specialized staff was needed that was not readily available under the previous organizational structure. This was the main reason for introducing the change in the organizational structure for project management. The PMO is responsible for two categories of project management tasks, including complex project management tasks and portfolio-wide management tasks (Iowa DOT 2018).

The PMO has the roles and responsibilities of project management for complex projects, such as interstate reconstruction projects, new urban corridor or reconstruction project, and other projects (complexity jointly determined by the project delivery bureau director and district engineer). For complex projects, the PMO will assign a PM for the development phase of the project, which extends from the traditional planning to the letting process. If requested by the district based on the need, the PM will aid also during a later phase (i.e., construction). The PM is expected to coordinate among the various functional offices to make sure that the project meets the success criteria (Iowa DOT 2018).

In the portfolio-wide management tasks, the Iowa DOT PMO takes on functions or support roles for all types of projects, both complex and routine (e.g., new alignment and projects that have minimal realignment and right of requirements). For the routine project, the heads of the functional offices assign engineers from the functional offices for the roles and responsibilities of project management. For instance, the head of the Location and Environment Office, located in the central office, assigns engineers from the Location and

Environment Office to new alignment projects for the project management and project development. Moreover, if the projects have minimal realignment and right of way, the head of the Design Office, located in the central office, assigns engineers from the Design Office to the projects for the project management and development (Iowa DOT 2013; Iowa DOT 2018).

Table 24 Objectives of Enterprise Project Management Initiative and Project Management Office

Objectives for the Creation of EPMI and PMO
• Better transparency and accountability to meet project success criteria
• Improved decision making and information flow
• Better controls and mechanisms for reporting project cost, schedule, and quality
• More comprehensive and risk-based approach for management of large and complex projects
• Improving the process of development and management of small to medium sized projects with different levels of complexity
• Collect data and provide tools, insight, and recommendations that will help higher management create clarity and consistency in prioritizing and managing a portfolio of projects for programming and development

Regarding enterprise project management initiative activities, the PMO will serve as the highway division's representative and liaison. The highway division as an integral part of EPMI will collaborate with information technology project managers and project managers from other functional offices to advance the state of project management in the department through developing and implementing tools, practices, templates, informational resources, and training activities for project management (Iowa DOT 2018).

4.16. Establishing Project Classification for Customizable Project Management Practices

State DOTs handle projects that vary in size, complexity, and risk. A single approach to such diversity of projects is not a suitable option. The categorization of projects helps implement a state-wide approach of scheduling provisions and maintain schedule control on projects. For instance, the VDOT has developed a ranking system to classify projects into six categories based on complexity of projects. Figure 38 shows six categories of the VDOT projects. Level M projects are the simplest projects (e.g., maintenance projects) with much less risk associated to the project, while the projects on Level V represent the highest risk projects (e.g., very costly complex construction projects) **(**VDOT 2012). Table 25 provides a summary of criteria and scheduling requirements of the six categories of projects.

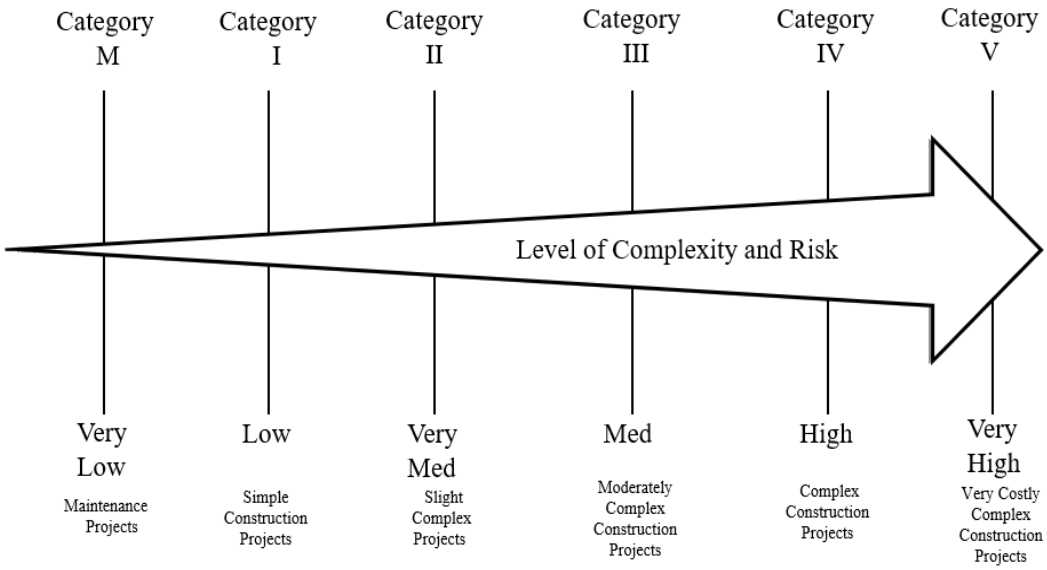


Figure 38 Project Category Based on Complexity (VDOT 2012)

Table 25 Criteria and Scheduling Requirements for Projects

Category	Criteria	Scheduling Requirements
Category M	• Typical seasonal maintenance and schedule type work generally with contract duration of one construction season or less (Time is not a major constraint) • Simple repairs or straight-forward maintenance work • Minimal traffic impact or limitations to the Work • No involvement with other major construction or improvement projects	• A written narrative describing the project plan and sequence • Prepare initial schedule in tabular format, showing the details of activities. • Every week, submit a two-week, look-ahead schedule.
Category I	• Contract duration of one construction season or less (typically short durations) • Estimated contract value of $1 million or less • Limited items of work • Simple operations in familiar and favorable conditions • Minimal traffic impact or limitations to the Work • Does not include utility adjustments or relocations • Contract does not contain any Special Provisions for special time-related conditions, such as Interim Contract Milestones, A+B Bidding, Incentives/Disincentive, or Lane Rental. • Project has no major materials delivery restrictions, environmental impacts, delayed right-of-way acquisitions or access, or other similar constraints and restrictions.	• A written narrative describing the project plan and sequence • Prepare initial schedule in tabular format showing the details of activities. • Progress earning schedule to show progress each month in terms of percentage complete • Every week, submit a two-week, look-ahead schedule. • Revision of baseline when the schedule is significantly affected
Category II	• Contract duration of one construction season or less (may be two construction seasons, but involve simple linear or repetitive operations) • Estimated contract value generally less than $3 million • Limited number of straightforward contiguous or linear operations • Low to medium traffic impact • Typical conditions and limitations to the work • May include minimal utility adjustments • Contract does not contain Special Provisions for special time-related conditions, such as Contract interim milestones, Incentives/Disincentives, A+B bidding, or Lane Rental, etc. • Project has no major materials delivery restrictions, environmental impacts, right-of-way acquisitions, or other similar constraints and restrictions.	• A written narrative describing the project plan and sequence • Prepare initial schedule in tabular format showing the details of activities. • Progress earning schedule to show progress each month in terms of percentage complete • A monthly update on the project schedule and progress earnings schedule to show the actual progress and the current plan to complete the remaining work • Revision of baseline when the schedule is significantly affected

Category	Criteria	Scheduling Requirements
Category III	• Medium-size projects with contract duration generally spanning 2-3 construction seasons • Estimated contract value generally between $3M and $10M • Limited number of concurrent work-paths • Medium limitations to the work and traffic impact • Limited number of utility adjustments • Contract does not contain Special Provisions for special time-related conditions, such as Contract interim milestones, Incentives/Disincentives, A+B bidding, or Lane Rental, etc. • Project has no major materials delivery restrictions, environmental impacts, right-of-way acquisitions, or other similar constraints and restrictions.	• Preliminary project schedule to provide a startup schedule and monitor work for the first 60 days • A written narrative describing the project plan and sequence • Baseline project schedule showing times within which individual activities will be accomplished • Baseline project earning schedule showing planned progress each month • Monthly update of the project schedule and progress earning schedule and plan forward • Revision of baseline plan schedule when schedule significantly affected by change
Category IV	• Medium to large size projects with contract duration generally spanning 3 or more construction seasons • Estimated contract value generally between $10M and $75M • Contract contains Special Provisions for special time-related conditions, such as Contract interim milestones, Incentives/Disincentives, A+B bidding, or Lane Rental, etc. • Multiple concurrent work-paths • Complex construction staging, phasing, or MOT issues • Complex constructability issues • Substantial traffic impact and limitations to the work • May include major utility relocation/adjustments • Project has no major materials delivery restrictions, environmental impacts, right-of-way acquisitions, or other similar constraints and restrictions.	• Preliminary project schedule to provide a startup schedule and monitor work for the first 90 days • A written narrative describing the project plan and sequence • A cost-loaded baseline progress schedule in CPM format. Cost-loaded Schedule used to prepare time distributed cost data • 30-day, look-ahead schedule • Monthly update of the project schedule and Progress earning schedule and plan forward • Revision of baseline plan schedule when schedule significantly affected by change

Category	Criteria	Scheduling Requirements
Category V	• Very large projects with contract duration generally spanning 3 or more construction seasons • Estimated contract value generally greater than $75M • Contract contains Special Provisions for special time-related conditions, such as Contract interim milestones, Incentives/Disincentives, A+B bidding, or Lane Rental, etc. • Considerable number of concurrent work-paths • Complex construction staging, phasing, or MOT issues • Complex constructability issues • Substantial traffic impact and limitations to the work • Substantial number of right-of-way acquisitions and/or relocations • Major material delivery restrictions • Significant utility relocation/adjustments • Major environmental or community impact	• Qualified and dedicated project scheduler/coordinator to coordinate all scheduling meetings and issues • Contractors working on such projects need to develop and maintain their schedule in a collaborative environment. • Preliminary project schedule to provide a startup schedule and monitor work for the first 120 days • A written narrative describing the project plan and sequence • A cost-loaded baseline progress schedule in CPM format. Cost-loaded schedule used to prepare time distributed cost data. • A baseline progress earning schedule based on time distributed cost data to show planned progress for each month • Weekly submit a four-week, look-ahead schedule. • A community progress report to show progress of selected items of work • A monthly update of project schedule to show actual progress and plan forward • Revision of baseline plan schedule when schedule significantly affected by change

Note:

CPM: Critical Path Method MOT: Maintenance-of-Traffic

CHAPTER 5 CONCLUSIONS

Delivering highway projects within budget and on time is a great challenge for state DOTs because of the increased level of project complexity, environmental regulations, and intense public interest and involvement. To enhance the efficiency in managing design–bid–build projects, a better understanding of the state of practice in organizational structure models and project management used by other state DOTs is essential. Thus, the primary objective of this research is to identify best management practices in other state DOTs regarding the organizational structure of design–bid–build project delivery for highway projects. Through surveys and interviews with the subject-matter experts and content analysis on documents from other state DOTs, this research classified different state DOTs' organizational structure models into groups with similar characteristics (e.g., the position of the dedicated project management unit and functional units) and identified best practices for project management that help highway agencies efficiently deliver transportation projects.

The research identified 13 organizational structure models for project management, which are seven organizational structure models with the centralized organization and six organizational structure models with the decentralized organization, respectively. The identified organizational structure models for state DOT project management are characterized as follows:

- Centralized Organizational Structure Models
    - Centralized Organizational Structure Model C1 (Division of Program Delivery Parallel to Division of Engineering Reporting to Chief Engineer)

- Centralized Organizational Structure Model C2 (Project Development Office over Project Management, Design, Right of Way (ROW), Bridge, and Utilities Units)
- Centralized Organizational Structure Model C3 (Project Delivery Bureau over Project Management, Design, Location and Environmental, ROW, Bridge and Structures, and Utilities Units)
- Centralized Organizational Structure Model C4 (Project Development Bureau over Bridge, Project Management, Design, ROW, Utilities, and Construction Units)
- Centralized Organizational Structure Model C5 (Director of Highway Operations over Project Management, Roadway Design, Environmental, Structures, ROW, Utilities, and Construction Units)
- Centralized Organizational Structure Model C6 (Engineering Division over Highway Design, Bridges, Environmental Coordination, ROW and Utilities, and Asset Management Units; Project Management Within the Asset Management Division)
- Centralized Organizational Structure Model C7 (Chief Engineer over Project Management, Highway Design, ROW and Assets Management, Bridge and Infrastructure, and Construction and Materials Units)

- Decentralized Organizational Structure Models
  - Decentralized Organizational Structure Model D1 (Project Management, Construction, Environmental, ROW (Utilities), and Design Offices under District Director)

- Decentralized Organizational Structure Model D2 (Project Development Office in the District over Project Management and Design Units)
- Decentralized Organizational Structure Model D3 (Program Management Office in the District over Project Engineering, Environmental, Design, Hydraulics, Planning, ROW and Utilities, and Construction Units)
- Decentralized Organizational Structure Model D4 (Program Management Office in the District Office over Roadway Design, Advanced Project Development, Bridge Design, Project Delivery, Right of Way, and Utilities Offices; Engineers from Different Functional Offices Acting as Project Managers During the Various Phases of Project Development)
- Decentralized Organizational Structure Model D5 (District Design Engineer over Drainage Design, Roadway Design, Surveying and Mapping, Consultant Project Management, and Structures Design Offices)
- Decentralized Organizational Structure Model D6 (District Engineer over Project Management, Construction, ROW, and Design Units)

With regard to innovative and best practices in the project management for design–bid–build highway projects, the research examined the state of the practice in other state DOTs in the following areas: (1) establishing the Project Delivery Bureau, (2) leadership and accountability, (3) uniform letting schedule throughout the fiscal year, (4) performance evaluation dashboard for highway program development and delivery, (5) a blended approach to assign a project manager to a project, (6) training program for project managers, (7) project issue resolution practice, (8) risk management, (9) project resource selection,

(10) environmental coordination, (11) trust between state legislature and state DOTs, (12) project management leadership group, (13) improving coordination and promoting collaborative environment, (14) enterprise project management initiative, and (15) establishing project classification for customizable project management practices.

This research summarized the following recommendations from the identified best practices:

- The Bureau of Project Development/Project Delivery enables the department to streamline its project development process and develop a project-centered culture in the organization.
- Active engagement of the headquarters (HQ) and district leadership in reviewing the project progress improves accountability in project development and delivery.
- Uniform letting plan throughout the year enables the agency to have better planning of the resources for the projects.
- A customized, scalable, and flexible performance dashboard provides management with an effective tool to track the trends of specific measures and monitor the progress of the projects. Moreover, the dashboard enhances transparency in communicating internally and with the public.
- Assignment of project managers based on the size, complexity, and risks of the project enables the department to efficiently utilize the knowledge and experience of project managers.
- The project manager's training helps create common knowledge base for project managers and project team and meet the agency's goals and objectives.

- The practice of project issue resolution enables the department to manage and resolve issues/conflicts between project participants at the lowest level.
- A systematic approach for risk identification, assessment, and mitigation enhances the program delivery.
- Establishment of environmental coordination unit within the Project Development Division improves coordination between the functional and project management services, and environmental office during the project development process of the project.
- The timely delivery of highway program is essential to establish trust between state DOTs and state legislatures.

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