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Identification of Best Practices to Aid Streamline the Transportation Project Development Process: A Study of the States Department of Transportation

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IDENTIFICATION OF BEST PRACTICES TO AID STREAMLINE THE TRANSPORTATION PROJECT DEVELOPMENT PROCESS

A STUDY OF THE STATES DEPARTMENT OF TRANSPORTATION

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ABSTRACT

In the United States, federal, state, and local governments are responsible for addressing their residents' transportation infrastructure needs. Similar to most States Department of Transportation (State DOTs), the South Carolina Department of Transportation (SCDOT) is responsible for owning, operating, and maintaining a large transportation system for the state. The SCDOT has the 5th largest highway system in the United States, and like most states, the state of South Carolina's (SC) transportation system needs have continued to expand. SCDOT is under growing pressure for efficient and effective transportation project delivery to address the need and continued expansion. The pressure is due to high demand, limited funding sources, stakeholders' concerns, federal and state policies, and intense public involvement. Due to increasing demand and pressure to meet its key strategic goals, SCDOT is taking initiatives to deliver projects as efficiently and expeditiously as possible.

One of the efforts undertaken by SCDOT is streamlining its preconstruction Project Development Process (PDP). The PDP is a core function of state DOTs and is strategically crucial for highway projects because it assures adequate selection and planning phases. This research study aims to streamline the SCDOT PDP to enhance, streamline, and improve project delivery by identifying PDP best practices that are applicable for a state DOT comparable to SCDOT's organizational structure and transportation program from the literature review, delivery partners' input, and the practices utilized by other state DOTs.

An Explanatory Sequential Design is used to meet the research's goal. Preliminary semi-structured interviews are conducted with SCDOT to identify the

agency's current PDP practices and suggestions for improvement. An administrative questionnaire is utilized to obtain input from state DOTs and SCDOT's delivery partners to gain insight regarding PDP best practices. Structured interviews with comparable state DOTs are conducted to probe PDP concepts, gain an in-depth understanding of PDP best practices, and identify PDP best practices.

The identified PDP Best Practices are assembled based on the data, analysis, and findings supported by five different data sources, National PDP Survey, Comparable State DOTs Interview, Secondary State DOTs Documentation, SCDOT SMEs Interview, and ACEC-SC Survey. The analysis of all data sources is used to assemble twelve (12) PDP Best Practices, which are numbered and categorized into five categories. Finally, this research study provides a 'Model' for the methodology used by other State DOTs to systematically assess their current practices and obtain input/suggestions for process improvement from the agency's own SME's and their external delivery partners that are providing professional services.

DEDICATION

Dedicated to my parents, who, entire their lives, during many conflicts and wars, as refugees, sacrificed their career and life choices so I could get an education, as they believed gaining knowledge is the only means to acquire wisdom and be a kind human being. I hope that my work will carry their legacy forward.

To my mother, Nafisa Shoaibi, for all the love, support, and guidance she has provided throughout my life. To my father, Qasim Haidary, who taught me hopefulness and humbleness, so in remaining hopeful, I know that the road towards success can always be constructed, and in remaining humble, I know that no matter how many roads I construct, there will always be more.

Dedicated to my siblings, Shabbir Haidary, Muqadas Haidary, and Mudaser Haidary, for the inspiration and support and for being with me in the moments of happiness and sorrow. To my U.S family, Danny Rhodes, Rosemary Rhodes, Kelly Cushman, and Kevin Rhodes, for their encouragement and support during my studies far away from home. Finally, to my friends and loved ones, specially Mursal Saba, whose inspiration, motivation, and support helped strengthen my confidence in times I doubted myself,

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LIST OF ABBREVIATION

ABBREVIATION	EXPLANATION
AASHTO	American Association of State Highway and Transportation Officials
AHP	Analytical Hierarchy Process
ASCE	American Society of Civil Engineers
CE	Categorical Exclusion
COG	Council of Government
CPM	Critical Path Method
CSS/CSD	Context-Sensitive Solution/Design
DOT	Department of Transportation
E.O	Executive Order
EA	Environmental Assessment
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
LPA	Local Public Agency
LRTP	Long-Range Transportation Plan
MPO	Metropolitan Planning Organization
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
PCE/PA	Programmatic Agreement
PDDM	Project Development and Design Manual
PDP	Project Development Process
PDT	Project Development Team
PS&E	Plans, Specifications, and Estimate
PSP	Project Scoping Process
ROD	Record of Decision
ROW	Right-of-Way
SCDOT	South Carolina Department of Transportation
SME	Subject Matter Experts
STA	State Transportation Agencies
STIP	Statewide Transportation Improvement Program
TRB	Transportation Research Board

CHAPTER ONE

INTRODUCTION

1.1. Research Scope

In the United States, federal, state, and local governments are responsible for addressing their citizens' infrastructure needs. State and local governments often receive federal aid that obliges them to invest funding in transportation infrastructure such as highways, bridges, roadways, etc. Federal funding accounts for 60% of all capital expenditures on infrastructure and 90% of the operational cost to maintain roadways (Bausman et al., 2014). Federal, local, state, and multi-governmental transportation planning entities and agencies such as Departments of Transportation (DOT), Council of Governments (COG), and Metropolitan Planning Organizations (MPO) are responsible for Long-Range Transportation Planning (LRTP) and investing public resources in funding, developing, managing, and operating many of the nation's significant transportation assets (Sperling & Ross, 2018).

Historically, transportation planning and engineering have been a cost-conscious, flexible, forward-thinking, and innovative discipline that has led transportation agencies to construct robust transportation systems (Hillis et al., 2016). Due to these criteria and the involvement of a broad spectrum of stakeholders, state DOTs have embraced a cooperative and knowledge-based philosophy for planning, managing, design, constructing, and operating transportation infrastructure (Crossett & Oldham, 2005). Also, state DOTs have relied on well-defined guidelines, standards, and engineering processes for planning, developing, designing, constructing, and managing

the highway systems to shape the roadway geometrics and design details (Hillis et al., 2016).

State DOTs are under growing pressure to deliver projects timely, cost-effectively, and improve their programs and projects' performance to meet constituents' needs (The Louis Berger Group Inc., 2005; McMinimee et al., 2009). The pressure is due to high infrastructure demand, environmental policies, limited funding and revenue sources, stakeholder concerns, federal and state policies, and intense public interest and involvement (McMinimee et al., 2009). The planning, design, environmental stewardship, and construction of highway projects are complicated and complex, and contingent on uncertainties that result in the difficulty of accurately predicting project performance (Wood et al., 2014). These uncertainties stem from the lack of information in developing project scope and estimates, unidentified risks that arise as projects develop, and the needs of a wide-ranging spectrum of stakeholders concerned with community, environmental, historic, scenic, aesthetic, and social values (Wood et al., 2014; Crossett & Oldham, 2005).

Due to rising demand and pressure to reduce transportation project delivery time, state DOTs are seeking initiatives to develop and deliver projects as efficiently and expeditiously as possible (McMinimee et al., 2009). Many initiatives have been designed to streamline the practices and processes used in delivering the projects efficiently and timely. Hillis et al. (2016) list these initiatives in their study, which include expanding the modal solutions, increasing public involvement, streamlining the Project Development Process (PDP), using innovative engineering techniques in construction, establishing a focus on performance management over strict engineering procedures, and using new

technologies to expedite location and design decision-making. Although these initiatives influence quality, cost, and timeliness, which are the three dimensions that guide effective project delivery, state DOTs are challenged to find a balance among the uncertainties of community, project development, environmental compatibility, project scoping, unidentified risks, and fiscal constraints (Hillis et al., 2016; Wood et al., 2014).

STAs, including state DOTs, MPOs, and COGs, have initiated different programs to tackle increasing pressure and achieve a balance between project uncertainties (Hillis et al., 2016). Among these initiatives is streamlining their PDP to improve the performance of their programs. The PDP is a core function of state DOTs and is a discipline of project management. State DOTs have largely ignored the PDP and its importance due to other management priorities such as funding, labor issues, maintenance, and public relations (Wood et al., 2011). The PDP is strategically crucial for highway projects because it assures adequate planning of project phases and aids in selecting the right project (Le et al., 2009). The PDP requires cautious and distinctive coordination between all phases of a project. These project phases include but are not limited to; planning, scoping, programming, preliminary and final design, utility and railroad coordination and adjustment, environmental assessment, right-of-way acquisition, Plans, Specifications, and Estimates (PS&E), schedule development, construction, and maintenance (Le et al., 2009; FHWA, 2007).

Considering the rising need for all state DOTs to have an effective and efficient PDP, this research study scope is to:

a) Identify a state transportation agency's (SCDOT) current practice(s),

b) Collect input and suggestions from the agency's internal Subject Matter Experts (SME),

c) Obtain feedback and suggestions for improvement from external delivery partners,

d) Collect input from other DOTs to identify effective and efficient practices, e) identify PDP best practices, and

e) Compare best practices to a state transportation agency's current practice and develop recommendations for improving their PDP.

The State DOT examined in this study is the South Carolina Department of Transportation (SCDOT); however, the methodology utilized and the best practices identified are applicable for other State DOT's that desire to evaluate and improve their PDP.

1.2. Problem Statement

With the Federal Highway Administration (FHWA) support, SCDOT provided funding for this research project. The agency desired to update and streamline SCDOT's Project Development Process (PDP) to enhance and improve project development performance by identifying for implementation of PDP best practices. Like all state DOTs, the SCDOT PDP serves as the baseline process for developing and delivering transportation projects for the spectrum of projects and programs assigned to the Preconstruction Division within SCDOT. The PDP was last updated in December 2011 and is currently published as a written process with a complimentary flowchart. SCDOT delivers projects based upon numerous programmatic guidelines. The PDP is currently written to be an all-inclusive process for application to a variety of programs and

projects. This all-inclusive process provides general guidelines but does not specify the steps that must be added, or eliminated, based upon a specific program or project type.

Similar to most state DOTs, the SCDOT is responsible for owning, operating, and maintaining a large transportation system for the state. The SCDOT has the 5th largest highway system in the United States, and like most states, South Carolina's transportation system needs have continued to expand (Reason Foundation Report, 2019). SCDOT's operating budget has increased by more than ten percent per year in response to SC's expanding transportation demands. As of 2018, it reached approximately 1.4 billion to fund the needed transportation programs and associated administrative responsibilities.

Like other states, South Carolina is continually seeking additional funding sources to meet the rising demand for transportation infrastructure improvements. The SCDOT's expansion of its transportation program in the coming years will be partially fueled by the 'Roads Bill' passed by the SC General Assembly and in effect as of July 1, 2017. This bill increased gas tax revenue each year over six years, and by 2024 SC's gas tax will generate an additional $800 million/year for transportation funding. This continued expansion of state transportation programs places increasing pressure on personnel responsible for the efficient and effective delivery of transportation projects for SCDOT, which is also a challenge for almost every other State Transportation Agencies (STA) (Infrastructure, S. C. 2017)

State DOTs typically develop strategic plans that establish the long-range focus and priorities for the agency. SCDOT's Strategic Plan (2018-2020) was developed 'to reflect the department's current priorities, align the entire organization towards those

priorities, and instill accountability for achieving mission-critical goals.' Key strategies identified in the plan to meet the agency's strategic goals include increasing SCDOT's reliability of developing and delivering projects on-time and on-budget, expediting the environmental permitting process, and interagency coordination. Like other state DOTs, South Carolina's strategic plan for transportation recognized the agency's need to expedite project development and delivery and improve the process's reliability.

In addition to increasing demand, the SCDOT faces the additional challenge of a deteriorating state highway system. The 24th Annual Highway Report by Reason Foundation ranked South Carolina's highway system 20th in highway performance in the US in overall cost-effectiveness and condition. The Reason Foundation Report (2019) ranks the performance of states' highway systems by measuring performance indicators in 13 categories, including highway expenditures per mile, Interstate and primary road pavement conditions, urbanized area congestion, bridge conditions, and fatality rates. South Carolina has experienced a 15-spot decrease from its prior ranking. This rating reduction was due to worsened interstate pavement conditions, rural arterial pavement conditions, and a significant increase in deficient bridges across the state. This has placed additional pressure on the state's need to improve its PDP to facilitate an effective and timely response to its deteriorating transportation system.

SCDOT's current PDP was last updated in 2011, which is almost a decade ago. An initial literature review by the researcher found that SC is not an isolated case. Approximately 52.5% of STAs have a PDP process that is more than five years old or no documentation at all (Jin, Haidary, Bausman, & Chowdhury, 2020). Considering SCDOT's expanding transportation program, the agency's strategic objectives, and its

deteriorating highway system, the agency must ensure that its program and PDP are current, effective, efficient, and project/program-specific. With increasing demands placed on SCDOT (and other state DOTs) personnel, the state's PDP must reflect best practices to enhance the effectiveness and efficiency of transportation agency personnel and the agency's program/project development and delivery partners.

1.3. Research Objectives

The purpose of this research study is to streamline the South Carolina Department of Transportation's (SCDOT) Project Development Process (PDP) to enhance and improve project delivery by identifying PDP best practices that are applicable for a DOT comparable to SCDOT's organizational structure and transportation program. This research will provide SCDOT and other state DOTs, the methodology, and needed insight regarding best practices to help the agency streamline and update their PDP leading to an increase in efficiency of critical task initiation, execution, and coordination.

Identification, development, and implementation of best practices will help state DOTs develop and deliver projects faster and improve project delivery effectiveness and efficiency. Most state DOTs face increasing transportation needs, scarcity of funding, growing pressure to reduce the time of project development, and an increasing need to enhance the effectiveness and efficiency of their PDP. This study will provide a 'Model,' the methodology, for state DOTs to systematically assess their current practices and obtain input/suggestions for process improvement from the agency's own SMEs, other comparable state DOTs, and the external development and delivery partners providing professional services.

1.4. Primary Research Questions

As mentioned in the previous section, this research aims to provide SCDOT, and other state DOTs, the methodology and needed insight regarding best practices to help the agency streamline and update their PDP leading to an increase in efficiency of critical task initiation, execution, and coordination. Thus, this research study and the methodology discussed later will answer the following primary research questions.

1. What are the Project Development Process (PDP) best practices utilized by State Departments of Transportation to improve and streamline the South Carolina Department of Transportation's Project Development Process?
2. What PDP best practices distinguish the top-performing state DOTs from Poor-performing state DOTs, and how do these PDP best practices affect the PDP timeline among top-performing and poor-performing state DOTs?

The abovementioned primary research questions are a refined form of management question or problem statement discussed earlier in this chapter. The primary questions have led the researcher to develop the secondary research questions, which will be discussed later in Chapter 2: Literature Review. The primary questions with the comprehensive literature review on PDP have also led the researcher to develop investigative and measurement questions for data gathering purposes, which will be discussed later.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This research study's first task is reviewing the literature on PDP and its related best practices. The literature review entails a comprehensive review of federal and state laws and policies, peer-reviewed publications, research papers, and studies concerning PDP and its related best practices for transportation projects. Particular emphasis is placed on federal and state policies, studies and publications from State DOTs, and peer-reviewed journal articles from industry and professional organizations such as Federal Highway Administration (FHWA), American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB), American Society of Civil Engineers (ASCE), and National Cooperative Highway Research Program (NCHRP). State DOTs websites are also examined to obtain relevant information on project development best practices, processes, organization, and execution.

This literature review aims to understand and identify studies concerning PDP best practices and explore the gaps or areas related to this research study's objective. Another purpose of the comprehensive literature review is to understand the transportation development processes, review specific problems and concerns, review best practices identified by prior studies, develop investigative questions, and refine this study's objectives. The review process helped to establish the body of knowledge and isolate areas needing further inquiry. The literature review aided the development of the specific research design for this study and the investigative format and approach for data

collection. Considering the importance of transportation PDP, it is surprising that there were limited scholarly publications during a preliminary literature review. Most of the literature addressed various PDP phases and components individually, but few studies and publications addressed the entire PDP.

2.1.1. Literature Review Map

Figure 2.1 shows the literature review methodology and bodies of knowledge for this study. The literature review map represents the methodology utilized for a comprehensive review of federal policies, regulations, acts, initiatives, state DOTs PDP and best practices, peer-reviewed journal articles, studies, and reports from FHWA, TRB, AASHTO, ASCE, NHCRP, and other relevant databases. The comprehensive review of the literature related to PDP and process best practices provided the foundation for identifying and understanding the process elements and issues, knowledge gaps, and current best practices in state DOTs. The literature review provided the insight necessary to refine the specific objectives and questions to be addressed with this research effort. What follows is a summary of the literature review and a detailed description, along with the methodology for the literature review based on Figure 2.1.

2.2. Project Development Process (PDP)

2.2.1. PDP and Best Practices Definitions

IGI Global (2020) defines transportation project development as “the process to take a transportation improvement from concept through construction." The project development process includes planning, organizing, coordinating, and controlling-

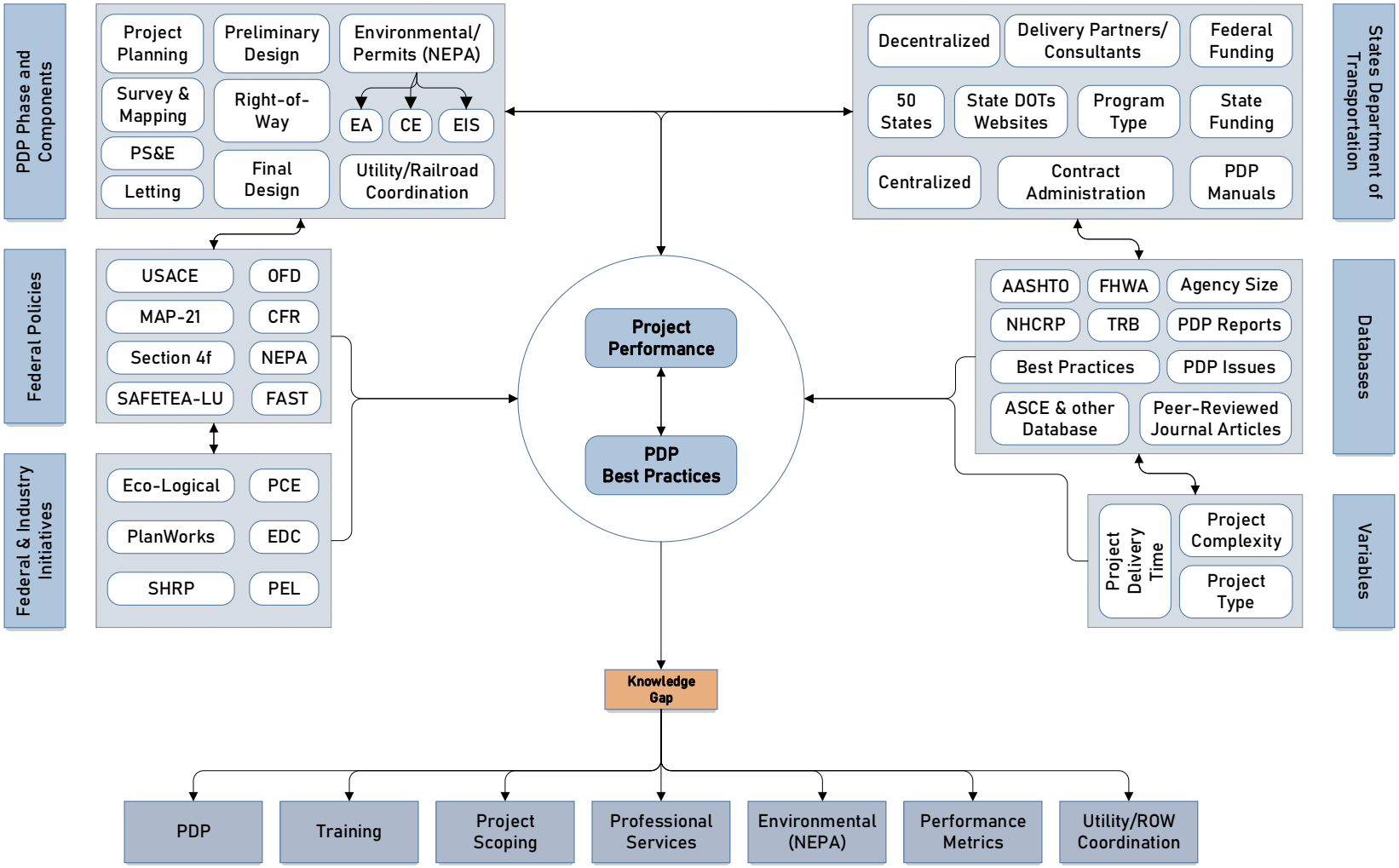


Figure 2.1: Literature Review Map and Bodies of Knowledge

-resources to meet specific goals. It has six phases; initiation, definition, design, development, implementation, and follow-up phases (IGI Global, 2020). Virginia DOT (VDOT) defines PDP as “the use of concurrent multidisciplinary efforts to develop transportation projects from inception to construction." The term “Project Delivery” is also used frequently in the literature to address some or all phases of PDP, which refer to all stages of the project development process, from initial planning to final commissioning (Wood et al., 2011).

Minimee et al. (2009) defined PDP best practices as “strategies and project-delivery applications that contribute to a state’s success in delivering projects." Gransberg et al. (2017), in their study, defined best practices as “a method or technique that has consistently shown results superior to those achieved with other means, and that is used as a benchmark (Stacks, 2011).” According to Gransberg et al. (2017), a best practice is distinguished from other practices by the term “superior to other means” and “used as a benchmark.” Best practice should not be confused with effective practice; a research-based practice identified through a high-quality quantitative study is not used as a benchmark. Benchmark is the criterion that distinguishes between effective practice and best practice (Gransberg et al., 2017).

According to Bausman et al. (2014), best practices apply to related organizations and can be simple or complex depending on an organization’s objective, goals, priorities, and capabilities. The implementation of best practices may require staged execution in an organization, and the development of best practices is accomplished by (Bausman et al., 2014):

1. “Identifying related practices from similar organizations

2. Evaluating the outcome(s) of each practice
3. Analyzing and comparing the results of each practice and
4. Identifying the practice that most consistently optimizes outcome"

2.2.2. PDP Phases, Tasks, and Activities

Transportation PDP consists of several phases. These phases are "environmental analysis and permitting, engineering design, right-of-way acquisition, construction, and maintenance" for every project to be implemented (Barberio et al., 2008). When a new transportation project is developed, it typically includes tasks such as "defining the project, conducting preliminary design studies, completing the environmental process, conducting final design, completing right-of-way engineering and right-of-way appraisal and acquisition, obtaining required project permits, preparing cost estimates, advertising and awarding construction of the project and proceeding with project construction" (Hecht & Niemeier, 2002).

FHWA identifies PDP, phases, gates, tasks, and activities in their flow chart shown in Figure 2.2, which simplifies and outlines the Federal Highway Administration's project development process. The chart provides major tasks, milestones (phases or gates), and detailed activities of PDP based on guidelines, processes, and policies. The PDP flowchart can be modified to fit individual state DOT and local transportation projects. The FHWA PDP flowchart's detailed activities define the milestones and activities that structure the PDP alongside their process documentation and timeline. Several peer-reviewed studies, federal guidelines, and state DOTs document activities or tasks that constitute the PDP.

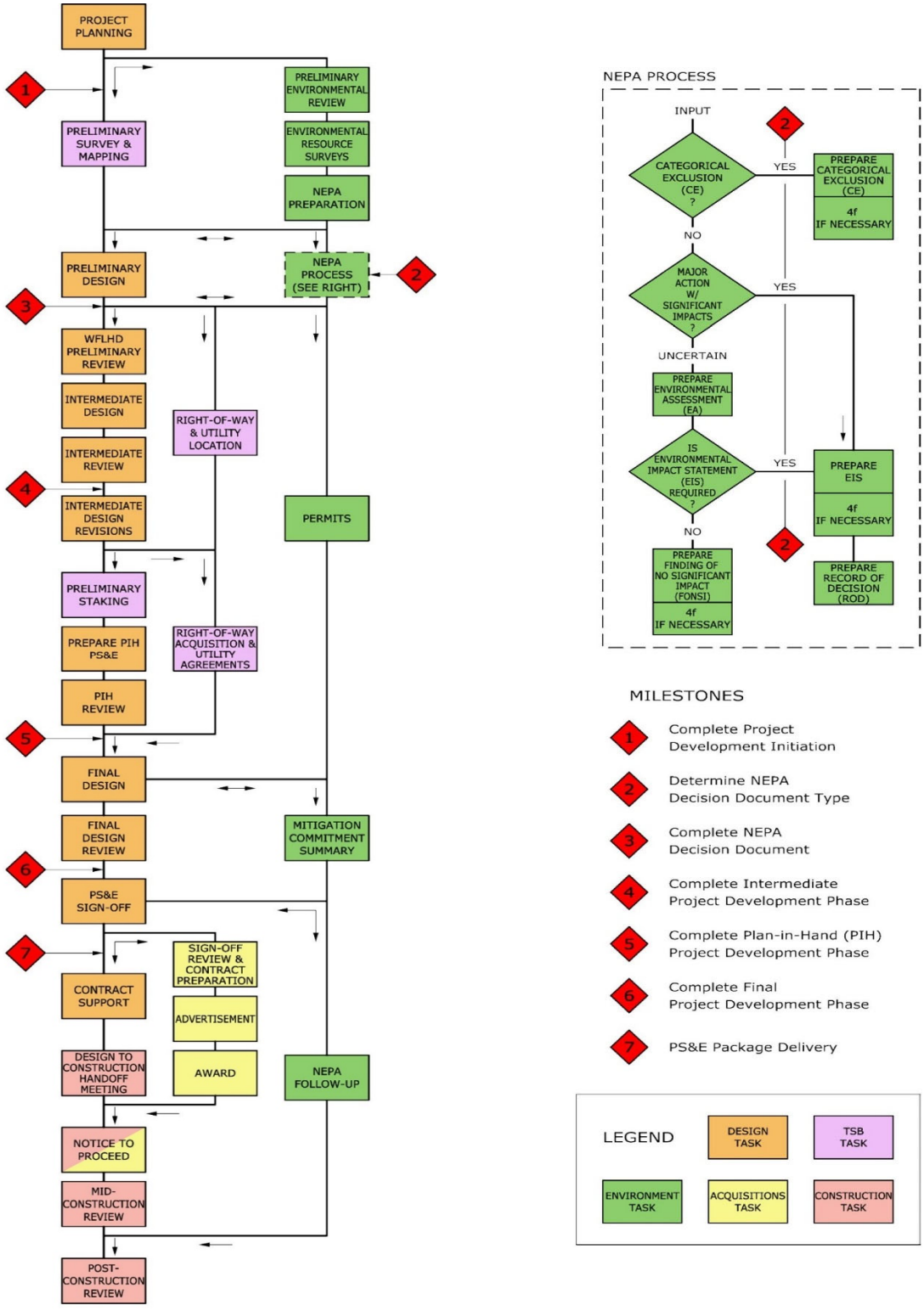


Figure 2.2: FHWA Project Development Process Flowchart (FHWA 2007; PPDM 2018)

Based on (Le et al., 2009), highway project development has six phases, shown in Figure 2.3. Four out of six phases are covered by PDP: needs assessment, feasibility scoping, preliminary design, and detailed design (final design). Figure 2.3 shows six phases and six gates (milestones). "A phase is a period in which several relevant steps need to be conducted to complete a set of tasks" (Caldas et al. 2007). A phase gate can be defined as a milestone that indicates the beginning or completion of a significant phase length. Commonly mentioned PDP tasks and activities include the following:

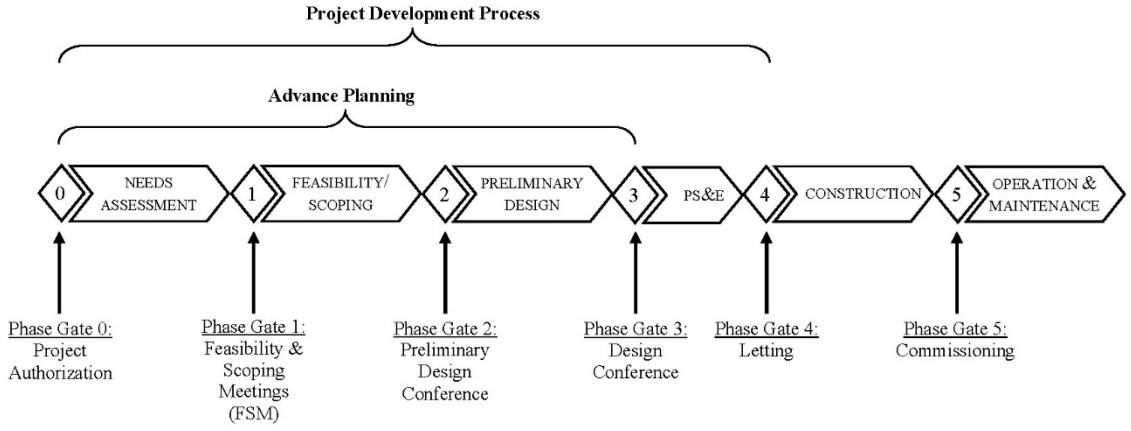


Figure 2.3: PDP Phases and Milestones (Le et al. 2009; Caldas et al. 2007)

2.2.2.1. Planning

The planning process is the first task or activity of most every PDP. The purpose of this task is to identify the conceptual development of a project plan. The activities involved in reaching this milestone address planning assumptions, planning decisions, facilitation of communication among the stakeholders, and preparation of approved documentation of scope, cost, and schedule baseline. This task also provides an

assessment of transportation deficiencies and determines a project's need (Wood et al., 2011).

In planning task, the scope of a project is developed by field review and early involvement of related departments and project stakeholders. The scoping document developed in this task addresses the purpose and need of a project. In addition to scoping, this task determines the roles and responsibilities of partner agencies and stakeholders, identifies the Project Development Team (PDT), lists reasonable project alternatives, develops a preliminary schedule and estimates, and identifies the environmental impact level (PDDM, 2018; Wood et al., 2011). The information provides the foundation for the determination of funding and the preliminary design of the project.

2.2.2.2. Programming

In this task, state DOTs rank the need for a project based on the planning process and initiate programming for funding purposes (Wood et al., 2011).

2.2.2.3. Preliminary Design

This task's definition varies among state DOTs and is often known as Preliminary Engineering (PE) or 30% Design. In this task, preliminary design parameters such as typical sections, horizontal and vertical alignments, pavement structures, and design speeds are developed to analyze different alternatives or preferred National Environment Policy Act (NEPA) alternatives (Wood et al., 2011; PDDM, 2018). In addition, design criteria are developed based on the scoping document, and environmental impacts are analyzed for each environmental alternative. According to (Wood et al., 2011),

it is better to start risk management applications in this task as the scope of work, size, and cost of project and location decisions begin to emerge.

2.2.2.4. Environmental Assessment and Documents (NEPA)

In this task, state DOTs obtain The National Environment Policy Act (NEPA) approval regarding assessing the environmental impacts of a transportation project. The purpose of this task is to prepare documentation of the state DOT's studies and analysis of alternatives to evaluate the environmental impact of the project and obtain NEPA approval for the alternative recommended by the DOT (Wood et al., 2014; PDDM, 2018). There are three NEPA decision documents, which are: Categorical Exclusion (CE), Environmental Assessment (EA), and Environmental Impact Statement (EIS), and each has a unique NEPA process. Many state DOTs have their environmental department to address NEPA requirements and other environmental regulations because they are often quite extensive and a detailed process instrumental to the PDP.

2.2.2.5. Final Design

Defined by 23 CFR 636.103, the final design follows the preliminary design and "expressly includes the preparation of final construction plans and detailed specifications for the performance of construction work." This task advances the Plans, Specifications, and Estimates (PS&E) package to 95%, including all design plans, a complete set of SCRs, and a CPM schedule (Wood et al., 2011; PDDM, 2018). The purpose of this task is to achieve the completion of the final PS&E package. The PS&E package includes all detailed: plans, designs, quantities, estimates, a complete set of Special

Contract Requirements (SCR), and a comprehensive Critical Path Method (CPM) schedule.

2.2.2.6. Environmental Permitting

This task is part of the NEPA process to obtain the required permits for the project being developed. These permits typically include a Clean Water Act Permit, Storm Water Permit, and State permits for stream protection and stream alteration. Most of the requirements for these permits are addressed with the NEPA documentation and require sufficient project design development to obtain the permits (Wood et al., 2011; PDDM, 2018).

2.2.2.7. Right-of-Way (ROW)

The purpose of this task is to identify the necessary right-of-way acquisitions for project construction. It also includes any necessary railroad impact coordination for the project. In some state DOTs, the railroad impact coordination is handled in the Utility Coordination task. In this task, the right-of-way specialist obtains and examines existing right-of-way plans, documents, and permits and then coordinates with various parties to negotiate and develop acquisition agreements (Wood et al., 2011; PDDM, 2018).

2.2.2.8. Utility Coordination and Relocation/Adjustment

The purpose of this task is to coordinate utility conflicts with highway projects right-of-way such as overhead and underground power, communications, fuel, and water lines, irrigation ditches, and canals with private owners and government entities. This task's relocation aspect is normally performed in the construction phase, but the coordination and agreement with related parties are performed during the PDP (Wood et

al., 2011; PDDM, 2018). Utility coordination can be a costly, time-consuming, and intensive process that involves the resolution of utility conflicts, utility records research, onsite location of utilities, and utility agreement document preparation (Kraus et al., 2008). These activities can involve intensive coordination among the state DOTs, utility companies, stakeholders, consultants, and contractors (Kraus et al., 2008).

2.2.2.9. Letting and Construction

The purpose of this task is to prepare the contract documents for competitive pricing and deliver the PS&E package to acquisitions, which facilitates advertisement of the project, receipt of bids, and selection of a contractor for the construction of a project. The task requires a complete PS&E package and a project schedule (Wood et al., 2011; PDDM, 2018).

2.3. PDP from Federal and State Perspectives

The transportation Project Development Process (PDP) is alike based on federal and state perspectives. The only difference is that states tailor the process based on their policies, laws, geography, funding sources, project/program type, environmental laws, and public involvement. Federal policies, laws, and regulations are the same for all states, but states' policies, laws, and regulations are different across each state. Since state laws and regulations differ, many factors play crucial roles in transportation PDP. From the Federal perspective, transportation project development can be defined as "the process to take a transportation improvement from concept through construction."

State DOTs PDP is different from one state to another. Some state DOTs have their PDP aligned based on project type, and some have aligned their PDP based on

management authority and organization structure. State DOTs PDP depends on several factors, such as state policies, laws, regulations, management style, funding sources, public engagement, federal policies, geography, and location. Table 2.1 lists transportation project types that state DOTs have in common when developing transportation projects. These project types range from smaller projects such as bicycle lanes to bigger projects such as interstate widening. These project types also have different development timelines and costs associated with them, which vary from one state to another based on how a state is developing and managing a specific project type. State DOTs PDP does not vary significantly based on project type. State DOTs categorize different projects based on other factors such as funding source, environmental impacts, federal policies, and their management style.

State DOTs Transportation Project Types			
Roadway Projects	Bridge	Locally Funded Projects	County Sales Tax
Resurfacing Restoration Rehabilitation Widening Reconstruction New Location Intersection Improvement Complex Maintenance Repair/Replacements Safety	Rehabilitation Low Volume Off-System Federal-Aid Replacement Repair	CTC LPA TAP ARC CMAC	Managed Locally Managed by DOT MPO/COG Emergency Projects

Table 2.1: State DOTs Transportation Project Types for Development Process

As mentioned, PDP does not significantly differ based on project types because state DOTs categorize different project types based on factors such as funding sources,

environmental impact, federal policy, and management style or authority. The only difference that project types make in PDP is their timeline and the cost associated with them. Funding source also plays an important role in PDP. PDP generally differs based on who is funding the project. There are many funding sources, but generally, it is categorized into three sources: Federally Funded Projects, State Funded Projects, and Locally Funded Projects. Other sources of funding are mainly categorized under the three mentioned sources. If the federal government funds a project (FHWA), states have to abide by federal policies, laws, and regulations. Federal policies impact the state PDP because of their requirements, such as consideration of environmental impacts, wetlands, forest lands, and the United States Army Corps of Engineers (USACE) permitting. State DOTs follow the federal procedures while developing a transportation project if it is fully or partially funded by the federal government, which affects a state's PDP.

If a project is funded by the state or local government, then the PDP process differs based on state policies, and as mentioned before, state policies are different from one to another. State and local funded projects follow state policies and might ignore federal policies since federal dollars are not involved. This scenario changes state transportation PDP and gives state DOTs flexibility in developing their projects. The state-funded transportation projects differ in PDP from federally funded depending on each state. It depends on the state because one state can follow a general guideline based on federal guidelines and implement the same policy for state and locally funded projects. For example, considering environmental impacts and alternatives, which is an important factor and necessary guideline to abide by for the federally funded projects, a state can

choose to abide by or ignore federal guidelines for considering environmental impacts on their PDP regardless of its funding source. Another state considers federal environmental guidelines for federally funded projects and ignores when the state or local counties fund a project. There are some exceptions, such as considering wetlands or forest lands, which, regardless of where the funds come from, states have to follow the federal guidelines.

The state DOTs' PDP also differs based on how a state DOT is organized and manages its projects. Not all state DOTs are alike based on their management authority or organization structure and style. Some state DOTs are Centralized, some are Decentralized, and some use a mixed organizational structure; let's call them 'Hybrid.' Centralized state DOTs are also different because they are centralized based on either geography or discipline. The same goes for decentralized state DOTs, and they are also different based on geography, project type, or discipline. The organizational structure and management authority affect how state DOTs develop their projects and bring changes and differences in PDP. Some decentralized state DOTs have districts that handle a big portion of project development, but the overall PDP does not change because it does not matter who is doing the job, whether district or central DOT; the process is the same.

To conclude, how state DOTs' PDP differ based on project type, funding source, or management and organization structure, there is not only one factor that changes the entire development process of transportation projects. It is a combination of all these factors discussed above, which considers all policies, laws, guidelines, funding sources, and management styles. State PDP may not significantly change generally based on project type only or management structure. Combining all these factors creates different

categories and affects the development process, which changes the state DOTs' PDP. In the PDP, a combination of different project types, programs, and funding sources can significantly impact the development process. As a result, these variables must be considered in the PDP to address the economic, social, environmental, and transportation differences and the varying federal and state legal requirements (Caltrans, 2018). In some states (Caltrans, 2018; WDOT, 2019; IDOT, 2017; NYSDOT, 2017; ODOT, 2017; MDOT, 2018), project development categories have been established to ensure that these project-related differences meet varying state and federal requirements.

2.4. Federal and State Governments PDP Policies, Regulations, and Acts

Federal policies and initiatives influence the timeline, budget, and environmental aspects of almost every transportation project under development. Federal guidance or directives significantly influence state DOTs' activities, especially in the PDP (Barrella et al., 2010). According to Hecht & Niemeier (2002), state and federal acts, policies, and regulations significantly influence the PDP timeline. Hecht & Niemeier (2002) gives Caltrans PDP as an example to prove their argument. According to Hecht & Niemeier (2002), three decades ago, Caltrans PDP timeline for major transportation projects was in 3 to 5 years. Due to state and federal policies, laws, regulations, and acts, the average time of PDP has increased to eight years from the inception of need to project completion. Below are some of the federal and state governments' policies, acts, and regulations that affect transportation PDP.

2.4.1. Code of Federal Regulations – Title 23: Highways (CFR 23)

23 CFR is the United States Code of Regulations that contains a set of rules and regulations pertaining to FHWA and state DOTs. State DOTs and the FHWA operate according to 23 CFR. The purpose of this code is to regulate and establish a set of rules for DOT transportation projects.

2.4.2. National Environmental Policy Act (NEPA)

The National Environment Policy Act (NEPA), passed in 1969, establishes a national environmental policy. NEPA provides a system for environmental planning and decision-making by federal agencies. NEPA requires Federal agencies and state projects with federal funding to conduct environmental reviews when planning projects, issuing permits, and considering a project's impacts on the environment. NEPA also requires federal agencies to identify significant environmental impacts and make them available to the public for comment before implementation. The Council on Environmental Quality (CEQ) is responsible for addressing the NEPA regulations and laws as a form of guidance (FHWA NEPA Toolkit, 2019).

NEPA aims to protect the environment from the potential consequences of infrastructure projects such as highways, railroads, and interstates. These projects are subjected to interdisciplinary and interagency review processes to establish the impacts on the environment and analyze alternatives to mitigate or minimize the impacts. One of the functions of FHWA is to recognize and avoid potential environmental impacts on the social and natural environment when approving transportation projects. According to NEPA, DOTs are required to partner with natural, cultural, and historic resource agencies

to determine a practical time frame for review of the environmental impacts of a transportation project.

In PDP, three basic classes of action and documentation are required to address NEPA requirements. These classes of action are Environmental Impact Assessment (EIS), Environmental Assessment (EA), and Categorical Exclusion (CE).

2.4.3. Moving Ahead for Progress in the 21st Century Act (MAP-21)

The Moving Ahead for Progress in the 21st Century Act (MAP-21) was signed into law by President Obama in July. 6, 2012. The purpose of the MAP-21 act is to create streamlined and performance-based surface transportation programs, promote accelerated project delivery, and encourage innovations for highways, transit, bicycle, and pedestrian use. State DOT's were not required to develop and demonstrate performance progress to FHWA before this act. MAP-21 requires all state DOTs to emphasize performance-based and data-driven transportation decisions. In addition, the state DOTs are required by the MAP-21 act to use national-level performance measures for safety and infrastructure and system-level performance measures across state DOTs to develop a risk-based management system for their national highway system (Amekudzi & Meyer, 2006; Maurer et al., 2013; Venner, 2003; Sperling & Ross, 2018).

2.4.4. One Federal Decision (OFD)

The Executive Order (E.O) 13807, Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects, was issued on August 15, 2017. Under the OFD, federal agencies are expected to process environmental review documents and authorization decisions for infrastructure projects.

As per this executive order, the OFD sets a goal of two years from Notice of Intent (NOI) to EIS preparation. It also requires federal authorization decisions to be formulated within 90 days of ROD issuance. To conclude, the OFD (2017) directs the federal agencies to:

- Develop a schedule for environmental review documents and authorization decisions
- Prepare an EIS under NEPA
- Sign a Record of Decision (ROD)
- Issue all necessary authorizations within 90 days of ROD issuance

In order to accomplish these steps, the federal order notes the following three points in the environmental review process that should be identified (OFD, 2017).

- Purpose and need (prior to issuance of NOI)
- Reasonable Alternatives Evaluation
- Identification of preferred alternative (prior to final EIS)

Federal agencies such as DOTs, FHWA, Office of Planning, Environment and Realty, U.S. Coast Guard, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Services have developed process charts according to the E.O to outline their process.

2.5. PDP Initiatives and Current Practices

This section provides information and discusses the initiatives and current practices developed by FHWA, DOTs, and STAs to expedite, streamline, and improve the PDP. Below is the description of some of the PDP initiatives and current practices developed to streamline and expedite PDP in state DOTs.

2.5.1. Planning and Environmental Linkages (PEL)

Planning and Environment Linkages (PEL) is a cohesive approach to transportation development decision-making. PEL incorporates the economic, environmental, and community goals in the early phase of the project development process. As a result of the process, PEL generates a set of information, analysis, and products to help state DOTs with project scope development and the environmental review process. It has four steps, which are as follows.

- Implementation
- Effective Practices
- Publications
- Training and Workshops

Implementation of PEL includes identifying project stakeholders and their involvement and responsibilities in the planning and environmental process, effective coordination and communication, and a process for collection and analysis of project data. PEL effective practices include integrated planning, process guidelines, partnering agreements, and collaboration. These effective practices and implementation tools and techniques are driven from the experience of state and metropolitan case studies (FHWA NEPA Toolkit, 2019).

In their study, Barberio et al. (2008) summarized the planning and environmental linkage (PEL) approach alongside federal legislation to present the PEL approach's benefits in the PDP. The PEL approach is designed to streamline the PDP and provides approaches, strategies, practices, and tools to link planning with NEPA requirements. (Barberio et al., 2008) argues that the effective and successful implementation of PEL

improves the PDP and streamlines its components by enhancing coordination among stakeholders. According to (Barberio et al., 2008), the PEL processes that link planning and environment are; change management, data and analysis tools, inter-agency and intra-agency coordination, process improvements, corridor, and system-level activities. PEL can be used by state DOTs, MPOs, COGs, and STAs by successfully implementing its approaches to streamline the PDP.

2.5.2. Programmatic Categorical Exclusion Agreement (PCE or PA)

Programmatic Categorical Exclusion Agreement (PCE) is an established agreement between the FHWA and state DOTs that identifies a list of projects, and associated criteria, to allow state DOTs to approve CEs action without federal approval. A programmatic agreement (PA) aims to streamline the project development process for handling routine environmental requirements for commonly encountered project types.

2.5.3. Strategic Highway Research Program (SHRP2) – C19

Expediting Project Delivery (C19) is a second Strategic Highway Research Program (SHRP2) that provides a capacity solution to accelerate planning and environmental review of transportation projects. The SHRP2-C19 addresses 16 constraints by 24 strategies and best practices to expedite project delivery (Table 2.2). The initiative is developed by TRB and explained in their report Expedited Planning and Environmental Review of Highway Projects. The 24 strategies (shown in Table 2.2) are grouped into six expediting themes, which are as following (Andrle & Heilman, 2012):

- "Improve public involvement and support;
- Improve resource agency involvement and collaboration;

- Demonstrate real commitment to the project;
- Improve internal communication and coordination;
- Streamline decision making; and
- Integrate across all phases of project delivery."

2.5.4. Everyday Counts (EDC)

This initiative collaborates between FHWA and AASHTO to expedite highway projects' delivery and address the funding challenges. EDC facilitates sharing of specifications, best practices, lesson learned, and relevant data among stakeholders, which result in the rapid technology transfer and accelerates the development of innovation across the U.S. Currently, EDC has two innovations which are Implementing Quality Environmental Documentation (IQED) and Programmatic Agreements (PAs). IQED's (2006) report focuses on "improving the quality of NEPA documents and represents FHWA's and the state DOTs' current thinking regarding the use of different formats and alternative approaches to NEPA documentation."

2.5.5. PlanWorks

PlanWorks is a web-based program developed by FHWA for state DOTs to efficiently plan project delivery and improve project delivery. This program is part of the Ecological Initiative by FHWA. This web-based program scopes the project development process, decisions, and project delivery methods. It is built on state DOTs and stakeholders' experiences in PDP. PlanWorks streamlines the transportation project development process by systematically building an interagency collaborative approach. PlanWorks uses PDP successful practice examples and input from state DOTs.

Recommended Strategies	Constraints														
	Avoiding policy decisions through continual analysis	Conflicting resource values	Difficulty agreeing on impacts and mitigation	Inability to maintain an agreement	Ineffective internal communication	Inefficient Section 106 consultation with State Historic Preservation Officer	The inordinate focus on a single issue	Insufficient public engagement or support	Issues arising late cause project change	Lack of dedicated staff	Lengthy review and revision cycles	Negative or critical coverage from the media	Relocation process delays construction	Slow decision making	Stakeholder controversy and opposition	The unusually large scale of and/or complex project or program
Change-control practices									X							
Consolidated decision council	X			X	X		X							X		
Context-sensitive design and solutions		X							X						X	
Coordinated and responsive agency involvement											X			X		
Dispute-resolution process	X	X	X	X			X		X							
DOT-funded resource agency liaisons				X						X				X		
Early commitment of construction funding				X						X				X		X
Expedited internal review and decision making	X				X					X						X
Facilitation to align expectations upfront	X		X	X			X		X						X	
Highly responsive public engagement				X				X	X			X	X		X	
Incentive payments to expedite relocations													X			
Media relations manager				X				X				X	X		X	
Performance standards		X														X
Planning and environmental linkages		X	X	X		X			X		X			X		
Planning-level environmental screening criteria	X	X	X	X		X	X		X		X					
Programmatic agreement for Section 106						X										
Programmatic or batched permitting	X		X	X						X	X					X
Real-time collaborative interagency reviews					X		X		X		X			X		
Regional environmental analysis framework	X		X				X								X	x
Risk management	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Strategic oversight and readiness assessment				X	X					X				X		X
Team co-location					X						X			X		X
Tiered NEPA process				X					X							
Up-front environmental commitments	X	X	X													X

Table 2.2: Constraints and Practices to Expedite PDP (Andrle & Heilman, 2012)

2.6. PDP Issues and Literature Gaps

This section discusses the state DOT PDP issues, knowledge gaps, improvement areas, and best practices based on peer-reviewed journal articles, studies, and reports (see Figure 2.1). The purpose of this section is to explore current PDP best practices and knowledge gaps or areas in the literature from peer-reviewed studies related to the objective of this study. In addition, the literature review has provided the insight necessary for refinement identification of the specific objectives and questions to be addressed with this research effort.

What follows is a summary of the literature review and knowledge gaps focusing on PDP and its key phases and tasks, which are NEPA, Professional Services Consultants, Performance Measurement, Project Scoping, and Utility Coordination.

2.6.1. PDP

A well-defined and current Project Development Process (PDP) is crucial for any state DOT to effectively meet its transportation needs. PDP ensures that the right transportation project is selected, properly planned, and delivered per governing regulations. For a project, a properly executed PDP is one that has well-coordinated elements, including planning and programming, schedule, design, environmental assessment, right-of-way acquisition, permits, utility and railroad coordination, PS&E, construction, and maintenance (Le et al., 2009).

Several peer-reviewed studies have discussed issues in PDP and its phases. These studies have also developed strategies, tools, and frameworks to tackle PDP issues. The problem is that most of these peer-reviewed studies address various PDP stages and components and rarely focus on the entire PDP. In addition, most of these

studies are outdated by a decade. Below is a description of some of the findings of these studies.

In their study, Redd & McDowell (2013) identified PDP uncertainties and problems that influence highway project delivery for the Wyoming Department of Transportation (WYDOT). These uncertainties include scope growth, design times, labor and material price volatility, environmental and right-of-way issues, unplanned political priorities, and construction cost inflation (Redd & McDowell, 2013). This study's objective was to present a process improvement effort and strategies to manage the mentioned uncertainties and their impacts, deliver projects on-time, on-budget, and enhance the delivery of highway projects in the WYDOT. The strategies recommended by Redd & McDowell (2013) addressed some elements of PDP rather than the entire PDP. Besides, Redd & McDowell's (2013) strategies are limited to transportation projects planned six to eight years in advance, which does not involve all types of projects.

The Texas Transportation Institute (Beaty et al., 2016) also identified two issues that can result in project delay, notably an absence of documentation and poor project definition. State DOTs struggle with the variation, the lack of details, and insufficient documentation corresponding to PDP, leading to delays and cost increases (Beaty et al., 2016; Kermanshachi et al., 2017). PDP documents provide written processes that guide project managers, traffic engineers, and stakeholders during the project development and delivery process. A defined process also provides information regarding the essential components of the PDP. Surprisingly, not many studies have addressed the variation and insufficient documentation of PDP and their relationships to delays and cost increase.

Another study, Brown & Marston (1999), focused on reengineering the Tennessee Department of Transportation's (TDOT) PDP. Due to stakeholders' pressure on TDOT and its technological advancement, the TDOT executives decided to change their business process and management. TDOT mainly focused on PDP for new constructions. In order to become a more processed-based organization, TDOT applied business process reengineering's (BPR) disciplines. According to the study, the reasons TDOT turned to BPR's disciplines were to have cross-functional access to information, time-in-service of the PDP leaders, and filling the transportation knowledge gap (Brown & Marston, 1999).

TDOT started with analyzing its current PDP by developing a detailed process map. The mapping helped the team understand the current PDP's activity flows, organizational responsibilities, and process. The analysis helped identify problems such as performance, process, and staffing deficiencies. Considering BPR disciplines, the TDOT's PDP redesign focused on human resources, organizational structure, and information technology by benchmarking other state DOTs (Brown & Marston, 1999). However, this study is two decades old.

Furthermore, Crossett & Oldham (2005) proposed a framework based on Context-Sensitive Solution (CSS) for state DOTs to govern the planning, design, construction, maintenance, and operation of transportation systems. The framework addresses practices for PDP and its outcomes. The concept used by Crossett & Oldham (2005) focuses on PDP issues and challenges. The proposed framework is based on creating a set of measures for both project-level and organizational-level to address the implementation of CSS-based PDP practices and performance measurement as a management tool. In their study, Crossett & Oldham (2005) argued that using a balanced

set of project-specific and organizational measures in state DOTs would help improve PDP. Crossett & Oldham (2005) focused only on CSS measures, which is an element of PDP. Besides, the study is outdated, and the identified measures may not apply to the current PDP. These measures, according to Crossett & Oldham (2005), focuses on the following areas of PDP:

- "Project Level: multidisciplinary teams, public engagement, project problems and needs, project vision or goals, alternatives analysis, stakeholder satisfaction, construction and maintenance, and quality assurance review
- Organizational Level: training, manuals, policies, staff motivation strategies, time frame and budget, and stakeholder satisfaction"

In addition, the NCHRP report by McMinimee et al. (2009) analyzed six states' DOT practices and identified best practices that contributed to a state's success in delivering projects. In this study, the state DOTs were selected based on a history of project development innovations and management in 2009, which may not be the same case currently in 2020. Criteria such as program size, work complexity, metrics system, and performance metrics were also considered in selecting the state DOTs. McMinimee et al. (2009) categorized the four major criteria into subcategories (see Table 2.3) to assign each PDP best practice to a narrow subject area to create a manageable focus. The study's identified best practices are based on the analysis of only six state DOTs and do not include the remaining state DOTs.

In identifying the best practices, McMinimee et al. (2009) proposed that tailored and modified best practices from this study's findings will help state DOTs develop and deliver projects on-time, on-budget, and improve efficiency of planning and

environmental processes with successful public involvement. The identified best practices can be implemented at the federal, state, and local levels to advance innovative practices to streamline and improve project development and delivery process (McMinimee et al., 2009).

PDP Focus Area	Best Practices Categories
Project Management	Project Management Structure Shared Leadership Risk Management Use of Consultants Investment in GIS and Data Management Tools Maintaining Core Competencies
Performance Measures	Performance Management Systems Contemporary Public Accountability
Contracting Practices	Innovative Construction Contracting
Community Involvement	Early Involvement External Relationships

Table 2.3: PDP Focus Areas and Best Practices Categories (McMinimee et al., 2009)

In another study, to promote consistency in the nation's procurement system, Gransberg et al. (2017) proposed a ranking framework to identify and analyze best practices for Alternative Contracting Method (ACM) for transportation agencies. Gransberg et al. (2017) claimed that there is no uniform agreement among agencies as to what constitutes a best practice. By proposing the ranking framework, Gransberg et al. (2017) identified 24 candidates (see Table2.2) from six NCHRP Synthesis reports on

ACM that met the criteria of a best practice and found out that only four of these practices can be defined as best practices.

The candidate best practices identified by Gransberg et al. (2017) are to formalize and institutionalize the ACM policies of agencies, using two-step best-value award procedures, the appointment of an agency ACM champion, and stipends for unsuccessful competitors (Gransberg et al., 2017). The practices identified in the study were categorized into organizational structure, the process of project delivery method selection, and contracting practices. Gransberg et al. (2017) argued that transportation agencies would be able to tailor their PDP by using these tested best practices summarized in the study. The methodology can also be a guide for transportation agencies that are new to ACM.

Likewise, Andrle & Heilman (2012) identified 16 common constraints of expediting project development and delivery (see Table 2.2). These constraints are encountered by STAs and state DOTs during the PDP when trying to meet the objectives such as meeting schedules, risk management, and building collaborative processes. The program offers 24 proven and tested strategies to address and tackle these common constraints and expedite project development. Table 2.2 summarizes the constraints and proven and tested strategies to accelerate a transportation project's development process.

The strategies identified by Andrle & Heilman (2012) are focused on the planning, environmental, and permitting phases of the PDP. Andrle & Heilman (2012) recommends these strategies to save time, reduce rework, reduce the risk of anticipated environmental and permitting costs, and present a framework for resolving disputes. According to Andrle & Heilman (2012), STAs and state DOTs can adopt and implement

these proven strategies based on their needs, goals, and organizational objectives. FHWA and AASHTO, through their implementation assistant program, have helped 12 STAs in 10 states to implement these strategies to expedite their PDP, as shown in Figure 2.4.

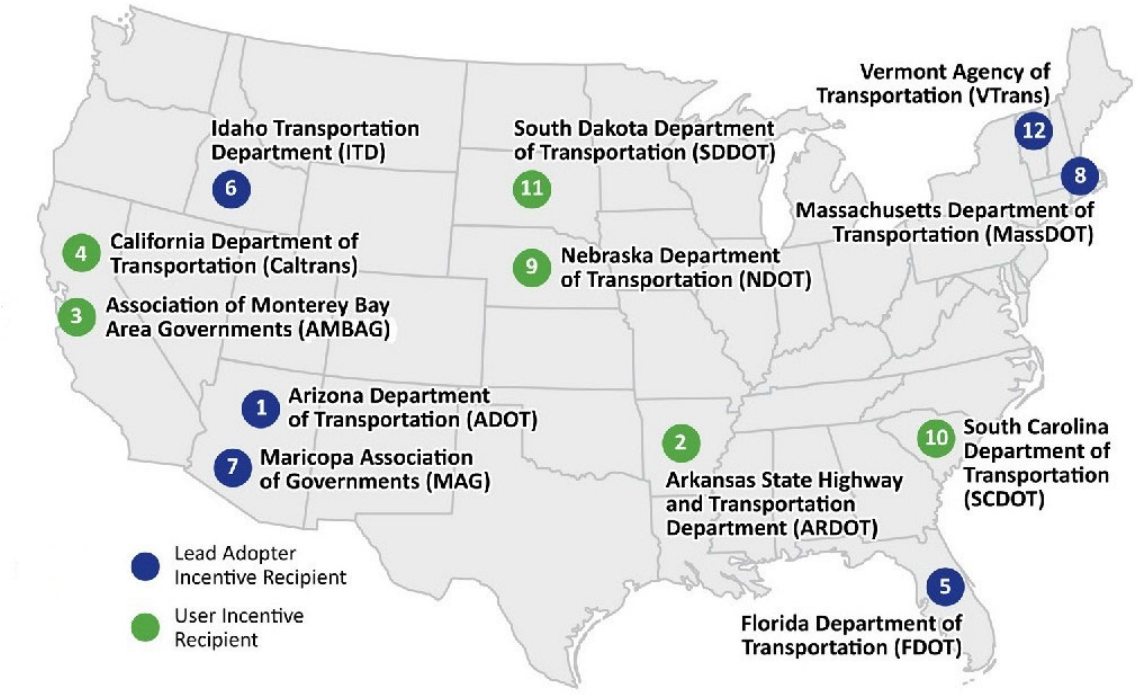


Figure 2.4 - FHWA and AASHTO PDP Strategies Map Area (Andrle & Heilman 2012)

Lastly, Hillis et al. (2016) recommended implementing the national and state-level PDP initiatives developed by FHWA and AASHTO to address the quality, cost, and timeliness of PDP. The national initiatives are Value Engineering (VE), FHWA's EDC, and Context-Sensitive Design/Solutions (CSD/CSS). The state initiative discussed in the study is practical design and improvement. In addition, the NCHRP report by Hillis et al. (2016) focused on practical design performance measures and argues that the implementation of these metrics will help state DOTs understand their accountability and transparency

and avoid inefficient scope and cost overruns. The NCHRP report focuses on one element of PDP and lacks sufficient details to address PDP best practices.

2.6.2. Environmental Assessment and Impacts (NEPA)

NEPA has been involved in transportation project development for decades (Wood et al., 2011). The NEPA process and documentation were historically managed separately from the PDP but, in the 1970s, this changed along with evolving federal regulations. The state DOTs now integrate NEPA with the PDP (Wood et al., 2011). According to (Wood et al., 2011), NEPA integration with the PDP did not simplify the process but reduce the risks of delay and cost overruns in the last decade. Figure 2.5 shows the impact of NEPA on PDP in terms of timeline.

Figure 2.5 represents FHWA initiatives' impact on PDP time, such as planning and environmental linkage. The FHWA initiatives have decreased the NEPA timeline by 40% - 50% in the last decade, which is, on average, 45 months. The NEPA timeline still needs a reduction by another 50% due to the increasing demand and pressure on DOTs to deliver transportation projects. Besides, the 50% reduction of the NEPA timeline is based on the Executive Order (E.O) 13807 issued in 2017 that sets a goal of 24 months for the NEPA timeline. The FHWA NEPA Project Development Process is an approach to balance transportation decision-making, which considers potential environmental impacts.

Additionally, documentation is an essential part of NEPA project development. NEPA requires federal agencies to document the process to promote public participation and coordination among agencies. The purpose of NEPA documentation is to provide complete disclosure to the public, allowing the public to comment on proposals and alternatives and provide appropriate information regarding the alternatives' impacts to

the decision-makers. In PDP, three different classes of action are required to address NEPA requirements, and each has a different process. These different classes are Environmental Impact Assessment (EIS), Environmental Assessment (EA), and Categorical Exclusion (CE) (PDDM, 2018).

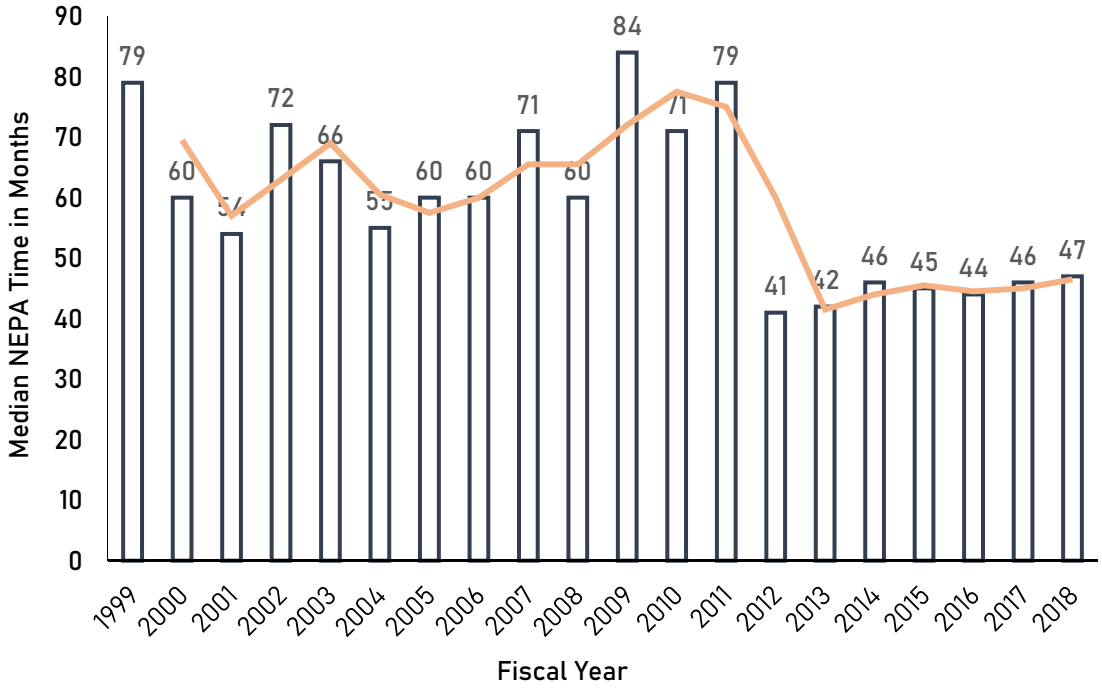


Figure 2.5: Estimated NEPA Process Time (Retrieved from FHWA Website, https://www.environment.fhwa.dot.gov/nepa/timeliness_of_nepa.aspx)

2.6.2.1. Environmental Impact Assessment (EIS)

For transportation projects that significantly impact the environment, NEPA requires federal agencies to prepare an EIS. An EIS document includes project purpose and need, alternative analysis, environmental significances, and record of decision.

According to the FHWA NEPA Toolkit (2020), an EIS is a full disclosure document that describes the following in detail.

- The development process for an EIS transportation project
- Development of the range of reasonable alternatives for a transportation project
- Analysis of potential impacts of the alternatives for a project
- Compliance with other environmental regulations, laws, and orders

2.6.2.2. Environmental Assessment (EA)

For a transportation project to qualify for only an Environmental Assessment (EA), the state DOT must provide sufficient evidence and analysis to prepare an EA that supports a Finding of No Significant Impact (FONSI). A FONSI is a conclusion of the EA process, which documents the decision based on their analysis of a project's environmental impact. It reflects all reviews, comments, and the project sponsor's preferred alternative. In addition, an EA document assists state DOTs when a project's environmental impact is uncertain. The FHWA must approve an EA document before it is made available to the public.

2.6.2.3. Categorical Exclusion (CE)

CE is defined as the "Category of actions that do not individually or cumulatively have a significant effect on the human environment and for which, therefore, neither an environmental assessment nor an environmental impact statement is required" (40 CFR 1508.4). In transportation projects, CE actions are those actions that do not cause significant impacts to land use, relocation of a large number of people, natural, cultural,

historical, recreational resources. In addition, CE actions do not cause a significant impact on air, noise, or water quality.

All state DOTs aim to streamline the NEPA and FHWA's transportation planning process, which is also a presidential goal and directive (Executive Order 13274) (Smith & Butler, 2005). Several peer-reviewed studies have discussed issues in PDP NEPA Process. These studies have also developed strategies, tools, and frameworks for the NEPA Process during PDP. Below is a description of some of the findings of these studies.

The study Amekudzi & Meyer (2006) examined the practice of involving and considering environmental factors such as air quality, land use, socio-economic, wetlands, cultural resources, water quality, and human health in the early phases of PDP. The study argued that environmental concerns could create significant PDP delays if considered in the later stage of transportation decision-making. By evaluating state DOTs and MPOs' experience through a survey, Amekudzi & Meyer (2006) identified tools, actions, and strategies to implement environmental concerns in PDP's early stage. The study's findings by Amekudzi & Meyer (2006) indicated that early consideration of environmental impacts in the PDP leads to better decisions, faster project implementation, better PDP, intensive public involvement in the decision-making process, and reduction of the level of resources needed in planning.

In another study, Bejleri et al. (2003) discussed the development of an Efficient Transportation Decision-Making Process (ETDM) to streamline the transportation planning and environmental review for the Florida Department of Transportation (FDOT). The study's objective in streamlining the environmental reviews is to improve

interagency coordination, reduce cost and schedule of project development, and address environmental concerns. The development and implementation of EDTM are argued to improve project development decision making, reduce cost and schedule delays, timely permit applications, and efficient project and environmental reviews (Bejleri et al., 2003).

Furthermore, Malley & Dusenbury (2002) assessed and provided information related to NEPA tiering to examine its benefits and drawbacks in highway projects. As defined by Malley & Dusenbury (2002), tiering NEPA is a two-step process that starts with preparing an Environmental Impact Statement (EIS) and then preparing NEPA documentation. Malley & Dusenbury (2002) proposed using tiering techniques in state DOTs and STAs by presenting federal rules and regulations related to highway projects' environmental aspects to improve transportation development and streamline the NEPA process.

Additionally, Venner et al. (2007) examined state DOTs' developments and practices regarding environmental management system integration in their PDP. According to Venner et al. (2007), effective and vigorous environmental management systems benefit state DOTs in monitoring, improving, expediting, and streamlining their PDP effectively. By examining different state DOTs' environmental management and information system and PDP, Venner et al. (2007) portrayed the relationship between integrating these processes in effectively improving and streamlining the PDP process. Figure 2.6 shows the relationship of Caltrans's environmental system to their PDP. Besides, Venner et al. (2007) proposed that using information technology tools to track schedules, budgets, and metrics can enhance environmental management systems, improving and streamlining the environmental and project development process.

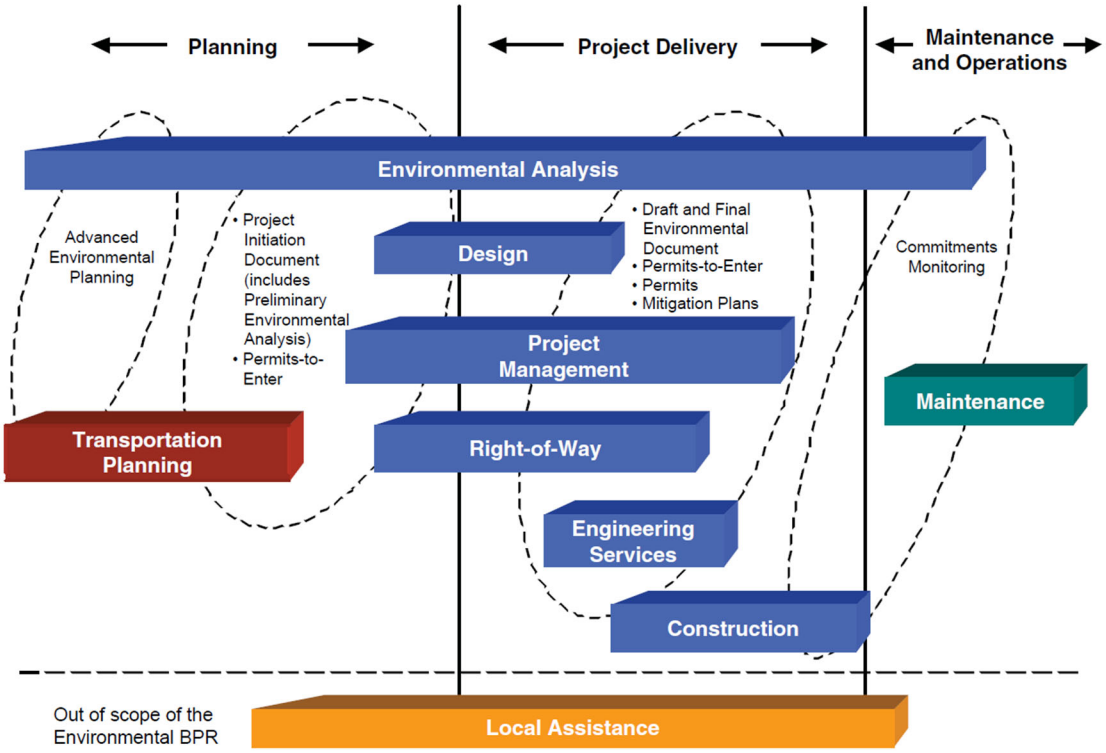


Figure 2.6: Caltrans Environmental Assessment Integration in PDP (Venner et al., 2007)

Lastly, in the study by Smith & Butler (2005), successful integration of GIS tools and early and continuous stakeholders' involvement is presented as practices to streamline and expedite NEPA in PDP. The project discussed in this study is the Arkansas State Highway and Transportation Department (AHTD) Interstate 69 Connector. This study's four-phase approach demonstrated that early coordination with state and federal agencies and public and Native American tribes expedite the NEPA process, resulting in streamlining PDP. The four-phase proposed in the study by Smith & Butler (2005) as effective practices are scoping process and purpose and need assessment, corridor study, alignment study, and environmental documentation (Smith & Butler, 2005).

Smith & Butler (2005) also argued that integrating project-specific GIS tools and stakeholder outreach streamlines the PDP, fosters a cooperative project atmosphere among all stakeholders, and addresses the needs and environmental concerns. Besides, it is claimed that the study's approach has been widely accepted by several other state DOTs and STAs such as Louisiana, Texas, and Mississippi, which has shortened project schedules and reduced project costs (Smith & Butler, 2005).

2.6.3. Professional Services Consultants

Professional Services Consultants play a significant role in streamlining state DOTs' PDP and enhancing project delivery as they are part of the Project Development Team (PDT). Bausman et al. (2014) identified and investigated state DOTs' procurement and contracting management practices to develop best practices for improving their professional procurement services. Bausman et al. (2014) argued that implementing the practices identified in their study would help state DOTs improve their performance, effectiveness, and efficiency.

Cochran et al. (2004) also examined state DOTs best practices in consultant procurement management through structured interviews of subject matter experts. The study's finding is argued to improve state DOTs consultant procurement and management, resulting in enhanced project development and delivery. Major issues found by Cochran et al. (2004) related to professional services procurement are"

- "strategic planning and management,
- resource allocation for consultant programs,
- development of technology and information systems to support consultant management, training, and recruiting,

- development of in-house program management capabilities,
- performance management systems,
- consultant evaluation systems and audit activities, and
- use of project managers and contract managers."

By summarizing initial best practices areas from state DOTs documentation and documenting best practices from state DOT interviews, Cochran et al. (2004) found that successful consultant procurement management programs have common characteristics such as consistency, transparency, regularity, and independence. Although Cochran et al.'s (2004) findings contributed to addressing consultants' issues during PDP, the study is outdated, and its findings' application may not be applicable in the current state DOTs environment. Because increasing project development demands have forced state DOTs to focus more on professional services procurement to assist in PDP.

2.6.4. Performance Measurement

Performance measurement is a process of gathering information to help state DOTs and STAs make well-informed decisions when developing transportation projects (Boadi & Amekudzi, 2013). According to Boadi & Amekudzi (2013) and NCHRP Report 551, many state DOTs have developed system-level performance measures to track their development efforts and management performance, such as investments, maintenance, and operational improvements.

Performance measurement has emerged as a best practice among state DOTs to measure and track their efforts and gather information to make well-informed decisions to influence the desired outcome. However, many state DOTs lack a formal or

comprehensive system for tracking measures or performance metrics (Barrella et al., 2010). State DOTs are responsible for ensuring that their transportation systems meet the needs of the public. Thus, state DOTs establish goals and objectives that are measurable to track and address the need (Compin, 2008).

State DOTs have to comply with Federal Law to measure their performance and state their progress to demonstrate their national targets' progress. Due to this compliance, state DOTs measure their progress and performance on both the organizational and project levels. Also, state DOTs use performance measurement as a tool and indicator of their performance by creating a robust performance measurement system. The result of their progress portrays how much the state DOTs are behind or ahead of their national targets, which in result, shape their practices of planning, designing, delivering, operating, and maintenance. State DOTs have their national performance targets in their Long-range Transportation Plan (LRTP) and State Transportation Improvement Programs (STIP).

Besides, according to Baird & Stammer (2000), state DOTs measure their performance due to "implementation of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), movements within the federal and state governments to reinvent the government, especially to focus on results and to increase accountability, increased use of private-sector management concepts and techniques within public agencies, greater competition for limited dollars requiring STAs to have convincing, credible, and timely information to justify budgets and dedicated taxes, and increased scope and complexity of STA responsibilities" (Baird & Stammer 2000).

Several peer-reviewed studies such as Sperling & Ross (2018), Baird & Stammer (2000), Compin (2008), Pei et al. (2010), Bremmer et al. (2005), Barrella et al. (2010), and Boadi & Amekudzi (2013) have focused on performance metrics and measurement and their influence on decision-making for PDP in state DOTs. The finding of the mentioned studies varies depending on the scope of their research. Their findings concluded that performance metrics and measurement had influenced state DOTs to make better decisions during PDP phases. In addition, the findings concluded that the trend of measuring performance in state DOTs is increasing. Also suggested by these studies is that performance metrics and measurement play a crucial role in decision-making during PDP, which influences the practices of state DOTs in achieving their goals and objectives.

What follows is a detailed discussion of what performance measurement is, what metrics are being used in state DOTs that can be incorporated in developing the PDP best practices, how do these metrics and performance measurement influence state DOTs' decision-making, and how does performance measurement affect state DOTs practices during PDP.

Compin (2008) defined performance measurement as “using observed evidence to determine progress toward specific defined organizational objectives." The U.S. General Accounting Office has defined performance measurement “as an assessment of an organization’s performance," which Venner (2003) lists as following:

- “Productivity, which quantifies the outputs and inputs of an organization and expresses the two as a ratio, generally of output to input (e.g., inspections per staff day);

- Effectiveness, which determines the relationship of an organization's outputs to what an organization intends to accomplish;
- Quality, which examines an output or the process by which an output is produced and is indicated by attributes such as accuracy (or error rate), thoroughness, and complexity; and
- Timeliness, which evaluates the time involved in producing an appropriate output (National Center for Public Productivity. A Brief Guide for Performance Measurement in Local Government. Rutgers University, Newark, N.J., 1997)."

The term performance measure in transportation planning is used to present the level of use and condition of transportation facilities and services (Baird & Stammer, 2000). It addresses transportation planning components, such as design, planning, construction, maintenance, and operation. According to Baird & Stammer (2000), there are three dimensions of transportation performance measurement. These dimensions are physical conditions of facilities, stakeholder and user satisfaction, and efficiency and effectiveness.

Baird & Stammer (2000) argued that the last dimension is given less attention, related to performance measurement of STAs and state DOTs as a unit or organization. Also, the reason to measure performance in most literature is to analyze and evaluate service and facilities to identify needs and determine the investment's efficiency, which is important to transportation decision-making (Baird & Stammer, 2000).

According to Wood et al. (2011), there are four primary categories of project performance are described as following:

1. “Budget: the relationship between the cost of construction and the project's estimated cost at various development phases.
2. Schedule: the deviation between the date of construction completion versus the estimated schedule at various project development phases.
3. Quality: refers to the project's suitability to meet its stated purpose in terms of functionality and sensitivity to context.
4. Agency reputation: the public perception of an agency's ability to deliver a project or program of projects on schedule and budget. When an agency's reputation for project delivery suffers, there can be consequences in increased legislative oversight or staff changes.”

In their study, Sperling & Ross (2018) examined and explored the state DOT's transportation performance status in compliance with federal reporting requirements. State DOTs are required to report their transportation performance target in a Long-Range Transportation Plan (LRTP) and the State Transportation Improvement Program (STIP). The study also measured state DOTs' interest in performance measurement. This study's findings are that state DOTs are moving toward a performance-based approach and using metrics and tracking systems for better decision-making (Sperling & Ross, 2018). The findings also discussed the need for a performance-based decision analysis framework to align state DOTs' PDP in meeting their STIP target and objectives.

In another study, Baird & Stammer (2000) examined ten state DOTs' performance measurement systems from different disciplines and perspectives. The disciplines examined in this study are transportation planning, business management, and public administration. Baird & Stammer (2000) proposed the perspective of performance

measurement in state DOTs to demonstrate that it improves project development performance. STAs have adopted, and required performance measures application on their transportation systems and facilities based on their organizational objectives, goals, guidelines, and standards (Baird & Stammer, 2000). The study Baird & Stammer (2000) lacks sufficient detail in proposing specific PDP performance metrics. In addition, the study is outdated, which the findings may not be applicable due to changes in state DOTs objectives, goals, and policies.

Additionally, Venner (2003) examined the environmental process's performance measurement (NEPA) in STAs and presented tools and measures to track related environmental characteristics. By proposing and examining several types of performance measurements from state DOTs, Venner (2003) argued that performance measurement drives operational improvement by identifying and assessing areas that need improvement, especially in the NEPA process. The study, Venner (2003), focused only on environmental performance measurement, which is an element of PDP.

Furthermore, Bremmer et al. (2005), in their study, summarized the trends and driving factors of performance measurement management in state DOTs. Also, the study recommended performance measurement practices to state DOTs for implementation. With performance measurement being an evolving practice, Bremmer et al. (2005) concluded that all state DOTs implement some type of performance measurement to tackle the pressure from leadership changes, funding, policies, mandated benchmarks, and reporting. Bremmer et al. (2005) argued that the developed performance measurement practices within state DOTs would enhance programs' development and demonstrate transparency and accountability if implemented with the driving framework.

Lastly, Compin (2008) presented evidence from five state DOTs (California, Florida, Maryland, Minnesota, and Washington) across the United States concerning their performance measurement programs. The mentioned state DOTs were chosen based on their advanced performance measurement programs and the extent of the provided information. In analyzing state DOTs' performance measurement programs, Compin (2008) found that many states have established such programs, but they failed to implement them in their transportation decision-making processes. Depending on the goals and objectives of state DOTs, Compin (2008) provided general insight and best practices to DOTs on how their performance measurement programs can be tailored to help their transportation decision-making processes, planning, and advance their goals and objectives.

To conclude, performance measurement is an evolving practice. As implied by the peer-reviewed studies mentioned above, it is best to shape other organization practices during PDP. Tracking progress in state DOTs facilitates and identifies needs in processes and determines decision-making efficiency, leading to the shaping of PDP best practices. Besides, performance-based decision analysis will help state DOTs align their PDP and develop best practices to meet their STIP and LRTP targets and objectives. Best practices developed based on performance measurement within a state DOT will enhance and improve program and performance development if implemented with a driving framework.

2.6.5. Project Scoping

Project Scoping is one of the main tasks mainly executed in the early phases of the development process in state DOTs. The Project Scoping Process (PSP) is defined by

Kermanshachi et al. (2017) as “a series of project-focused activities that develop key design parameters and other project requirements to a sufficient level of definition such that scope discovery is complete and a budget and letting date can be firmly established before programming the project in the STIP to minimize the risk of change and project overruns during detailed design."

Kermanshachi et al. (2017) discussed the project scoping improvements to achieve on-time and on-budget project development and transportation project delivery. The delays in schedule and the increase in highway projects' costs are due to an increase or change in scope (Bejleri et al., 2003). Kermanshachi et al. (2017) argued that the lack of adequate scope definition in state DOTs causes delays and increases cost once the project is programmed in TIP or STIP. Mismatches between projected and actual funding cause delays and increase cost and may not be addressed due to lack of funding in the scoping phase of PDP (Redd & McDowell, 2013).

The challenges identified by Kermanshachi et al. (2017) in developing transportation project scope are “time to prepare project scopes, cost or funding for project scoping activities, training on the project scoping process, communication of project scoping issues, clarity of expected outcomes of the project scoping, framing or understanding the project itself, qualified personnel to prepare project scopes, and formally documented scoping process."

To tackle the mentioned challenges and develop a project scope, Kermanshachi et al. (2017) recommended the following practices:

- “Identification of project purpose and needs
- Execution of improvement and requirement studies

- Right-of-way considerations
- The proposition of project limits and rough schematics
- Execution of project benefit-to-cost and feasibility studies
- Consideration of environmental issues
- Creation of public involvement and participation plan and
- Integrity conditions (i.e., quality and serviceability of the physical transportation infrastructure)"

In their evaluation of PSP's current practices in the highway industry, Kermanshachi et al. (2019) developed a multi-level project scoping model for transportation projects. Specifically, the study methodology used resources from the literature to assess current industry practices to develop alternative scoping processes. Kermanshachi et al. (2019) then used the integrated definition modeling technique to develop these scoping processes. The proposed scoping model consisted of four levels, composed of 20 activities and 84 sub-activities. Indeed, the development of such a comprehensive and detailed project scoping process model led to adopting appropriate best practices and strategies, which reduced costly scope changes and prevented unnecessary project delays (Kermanshachi et al., 2019).

2.6.6. Utility Coordination

Identification of utility issues in the early phase of PDP is critical to PDP's timeline and delivering highway projects because it accommodates enough time during PDP to accommodate changes (Kraus et al., 2008). Utility conflict is defined as the interference of utility facilities that occupy the space needed for highway expansion (Kraus et al., 2008). In their study, Kraus et al. (2008) addressed the state DOTs issue of utility

coordination and conflict management during the PDP. They proposed a tool for effectively managing utility conflicts in the early phase of PDP.

Utility conflict can be interference of utilities in space needed for highway expansion or interference of planned facilities with existing utilities. Utility conflict management activities are time-consuming, costly, and complex depending on project type, project development phase and timeframe, state DOTs staffing, utility companies' interest, and state policies. In state DOTs, right-of-way and design groups manage utility conflicts with the following strategies (Kraus et al., 2008):

- "Introducing a change to the horizontal or vertical alignment of the proposed highway facility;
- Removing, relocating, or otherwise adjusting the utilities in conflict;
- Implementing an appropriate engineering countermeasure other than a roadway design change or utility adjustment; and
- Accepting an exception to the policy"

2.7. Conclusion

To conclude, the literature review entailed a comprehensive review of federal and state laws and policies, peer-reviewed publications, research papers from federal, state, and industry databases, and studies concerning PDP and its related best practices for transportation projects. The literature review also summarized literature and knowledge gaps focusing on PDP key elements: NEPA, Professional Services Consultants, Performance Measurement, Project Scoping, and Utility Coordination. Considering the importance of transportation PDP, most of the literature addressed various PDP phases, tasks, and components. Still, there were few studies and publications that addressed the

entirety of the Project Development Process. In addition, most of the studies focused on PDP and its elements are outdated, which makes their applications arguable due to changes in state DOTs' goals, objectives, and policies throughout time.

The purpose of this comprehensive literature review was to understand and identify studies concerning PDP and its best practices and explore the gaps or areas related to the objective of this research study. The literature also helped the researcher understand and identify specific problems, issues, primary and secondary research questions, and current PDP best practices. The Literature Review Map and Bodies of Knowledge (see Figure 2.1) presented the literature review methodology and how these issues, knowledge gaps, initiatives, laws, policies, acts, and PDP alongside its best practices are explored.

The literature review context is also used to identify investigative and measurement questions related to major dimensions of PDP to develop an administrative questionnaire (Survey/Interview) to gather information from state DOTs as part of the research design of this study, which will be discussed in Chapter 4. The following concepts and PDP dimensions present the literature review summary related to PDP and its phases and components. These concepts will be used to explore the relationship between PDP best practices and streamlining project performance of state DOTs to identify best practices.

The development of survey questionnaires and interview questions to gather data will be based on these concepts, validated by several studies discussed in the literature review. The literature validates that developed best practices of the following concepts

improve project performance, such as streamlining and expediting project delivery and making PDP on-time and on-budget.

- PDP Phases, Tasks, and Activities
- Project Management
- Project Scoping
- Performance Measurement
- Professional Services Consultants Procurement and Management
- Environmental Assessments and Impacts (NEPA)
- Utility and Right-of-Way Coordination

CHAPTER THREE

CONCEPTUALIZATION AND MEASUREMENT

Chapter 2, Literature Review, entailed a comprehensive review of federal and state laws and policies, peer-reviewed publications, research papers from federal, state, and industry databases, and studies concerning PDP and its related best practices for transportation projects. The literature review also discussed the exploration of knowledge gaps focusing on PDP key elements, such as NEPA, Professional Services Consultants, Performance Measurement, Project Scoping, and Utility Coordination. In addition, the literature review provided the researcher with the information to explore various theoretical foundations and structure of systematic relationships concerning PDP and its Best Practices, such as various dimensions, concepts, variables, and measures.

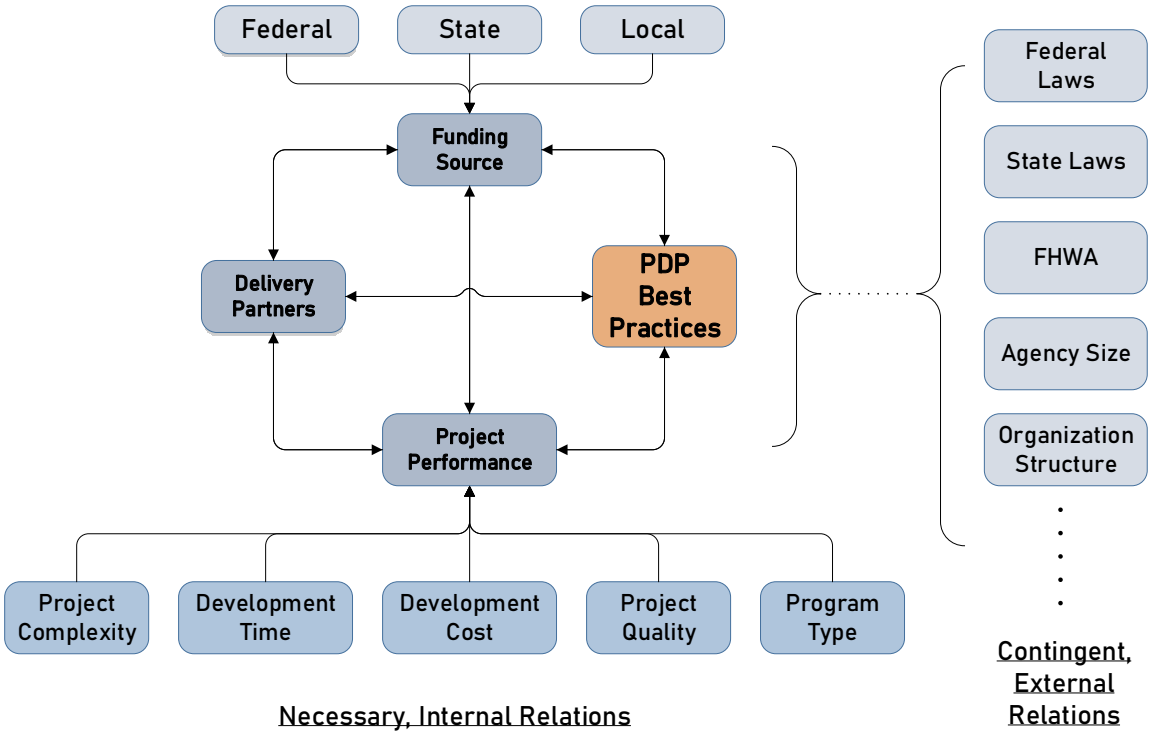
In this chapter, following the information gathered from the literature review, the researcher discusses the structure of systematic relationships and theoretical foundation concerning this research study's objective. The structure of systematic relationship and theoretical foundations are used to explore the relationship between PDP best practices and streamlining project performance of state DOTs to identify best practices. Besides, the concepts explored through the systematic structure of relationships have helped the researcher in the development of survey questionnaires and interview questions for data gathering purposes.

3.1. Structure of Systematic Relationships

Figure 3.1 shows the structure of this study's systematic relationship, including necessary (internal) and contingent (external) relationships, concepts, dimensions, variables, and measures. In this study, the researcher seeks to identify the PDP best practices and develop recommendations to enhance project development performance and streamline PDP in a state DOT. Streamlining Project Development Process by identifying PDP Best Practice for implementation is the concept that this study will explore and measure to characterize the unit of analysis, which is the State Department of Transportation (DOT). PDP Best Practices is one of this study's concepts, which is defined as "strategies and project delivery applications that contribute to a state's success in delivering projects".

The relationship between the PDP Best Practices and project performance presupposes other relationships such as performance metrics, delivery partners, funding sources, etc. They form the structure (see Figure 3.1). External relationships such as Federal and State laws, centralized or decentralized agency type, and agency size are also explored.

Figure 3.1 also represents a conceptual data gathering and measuring plan to measure PDP Best Practices' characteristics and dimensions. For example, the 'performance metrics' (i.e., project development time) are measured to determine the performance measurement characteristics. The measure 'project development time' in this study is "months," which will be measured via a computer-assisted self-administered questionnaire and structured interviews with state DOTs, which is discussed in the methodology section.



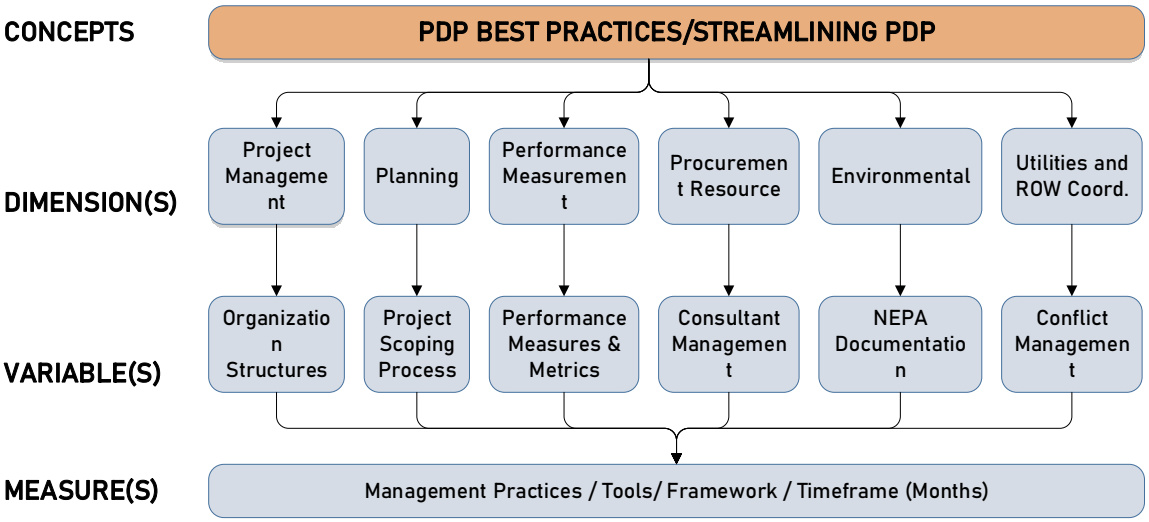


Figure 3.1: The Structure of Systematic Relationships

3.2. Theoretical Framework

The theoretical framework explored for this research study to support and explain the research problem is Context-Sensitive-Design (CSD) framework, also called Context-Sensitive Solutions (CSS). "CSD/CSS is a theoretical approach to transportation decision-making and a cohesive philosophy embodied in basic principles that address PDP and its outcomes" (TransTech Management, Inc., 2004). TransTech Management. Inc. (2004) developed the concept and principles of CSD/CSS first in 1998 at the national "Thinking Beyond the Pavement" conference held in Maryland. CSD/CSS considers many aspects of a transportation project. These aspects are but not limited to:

- problem identification,
- determination of purpose and need,
- collaborative design by an interdisciplinary team,
- involvement of regulatory agencies and stakeholder,
- supporting community values and preserving scenic, aesthetic, historical,
- preserving environmental resources and social values while maintaining safety and mobility (TransTech Management. Inc., 2004; Crossett & Oldham, 2005; Paiewonsky et al., 2007).

State DOTs are successfully embracing this holistic philosophy in their PDP. By an interdisciplinary collaborative approach, state DOTs use CSD/CSS to govern their transportation planning, design, construction, and operation (TransTech Management, Inc., 2004; Crossett & Oldham, 2005). In their study, Crossett & Oldham (2005) claimed that empirical evidence indicates the adoption of CSD/CSS-based PDP approaches and principles in state DOTs and the use of performance measurement as a management

tool. CSD/CSS is a theoretical approach that can be applied to every kind of transportation project and its PDP phases and elements.

Figure 3.2 shows the CSD/CSS framework in determining the right balance between all-inclusive PDP stages, components, interdisciplinary teams, and collaborations. The framework is based on two parameters to understand what to measure and clarify the complexity of transportation project development. The parameters shown in Figure 3.2 are the measurement of project-level versus organization-wide factors and measurement of processes versus outcomes. Balancing these parameters creates a measurement framework that helps establish PDP best practices and improve project performance.

Application of CSD/CSS principles at the project and organizational level determines the root of project planning, design, construction, and maintenance. These principles can be applied across all project development stages and milestones to provide initiatives and best practices to address time, budget, and outcome issues. Besides, on the process side, principles such as involvement of stakeholders early in the development phase, multidisciplinary input, public involvement, and environmental assessment help state DOTs to achieve outcomes that reflect community values that are sensitive to scenic, aesthetic, historical and natural resources; and are safe and financially feasible (Crossett & Oldham, 2005; TransTech Management. Inc., 2004; Neuman et al., 2002). CSD/CSS principles and process emphasize outcome-related, project, and organizational levels, enhancing state DOTs PDP and project delivery performance.

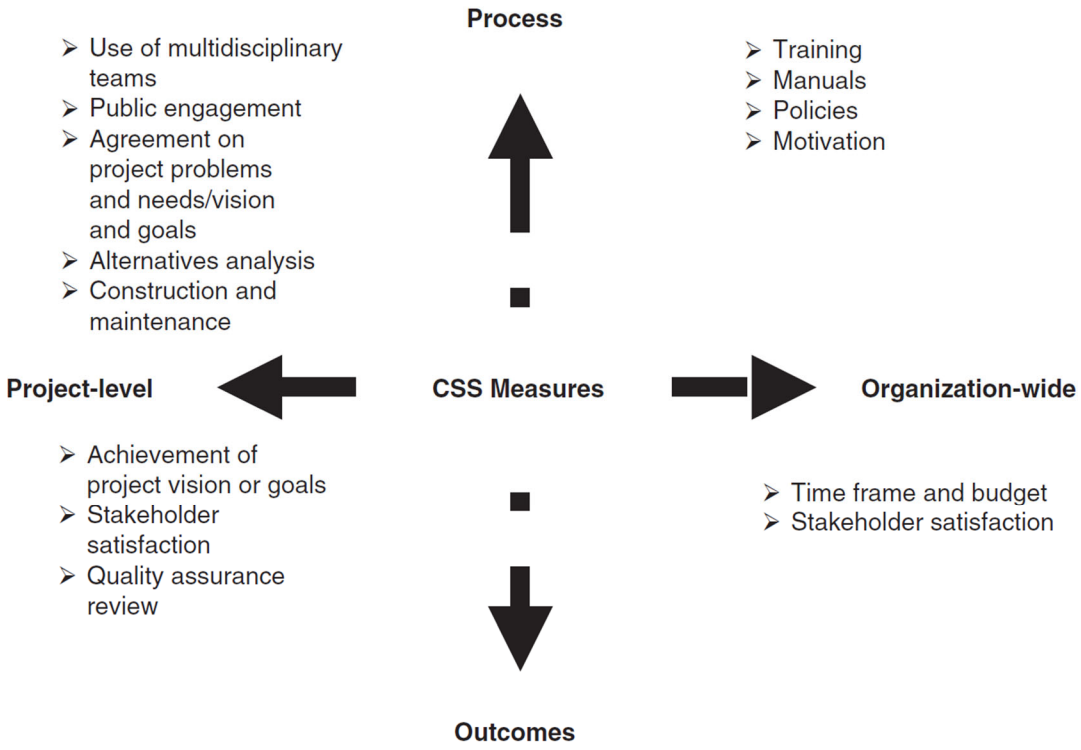


Figure 3.2: CSD/CSS Framework (Crossett & Oldham, 2005)

For many state DOTs, enhancing the project delivery process is an important task to apply CSD/CSS principles. CSD/CSS's application takes care that its approach and framework are adopted as part of the agency business style. The CSD/CSS principles that state DOTs are using are based on the quality of excellence and in transportation design and characteristics of the PDP that yields this excellence. According to Crossett & Oldham (2005); TransTech Management, Inc., (2004); and Neuman et al. (2002), these principles are:

- "Identification and satisfying of the purpose and needs agreed to by a full range of stakeholders and that this agreement is forged in the earliest phase of the project and amended as warranted,

- The project is a safe facility for both the user and the community,
- The project is in harmony with the community and preserves environmental, scenic, aesthetic, historical, and natural resource values of the area,
- The project exceeds the expectations of designers and stakeholders and achieves a level of excellence in people's minds,
- The project involves the efficient and effective use of resources (time, budget, community) of all involved parties,
- The project is designed and built with minimal disruption to the community,
- The project is seen as having added lasting value to the community,
- Communication with all stakeholders is open, honest, early, and continuous,
- A multidisciplinary team is established early, with disciplines based on the needs of the specific project and with the inclusion of the public,
- A full range of stakeholders is involved with transportation officials in the scoping phase; the purposes of the project are clearly defined, and consensus on the scope is forged before proceeding,
- The PDP is tailored to meet the circumstances; a process is employed that examines multiple alternatives and results in consensus on approaches,
- A commitment to the process from top agency officials and local leaders is secured,
- The public involvement process, which includes informal meetings, is tailored to the project,
- The landscape, community, and valued resources are understood before the design starts,

- A full range of tools for communication about project alternatives is used (Crossett & Oldham, 2005; TransTech Management, Inc., 2004; and Neuman et al., 2002)"

In terms of the PDP, Neuman et al. (2002) identified six key themes within the CSD/CSS framework that defined complex projects in state DOTs and discussed implementing the PDP framework to improve project performance. These key themes, according to Neuman et al. (2002), are as follows:

- "Effective Decision Making
- Overall management structure, including organization and project management
- Reflecting Community Values
- Achieving Environmental Sensitivity
- Ensuring Safe and Feasible Solutions
- Organizational Needs (Neuman et al., 2002)"

To conclude, CSD/CSS "asks questions first about the need and purpose of the transportation project, and then equally addresses safety, mobility, and the preservation of scenic, aesthetic, historical, environmental, and other community values. Context-Sensitive-Design and Context-Sensitive Solutions (CSS) involves a collaborative, interdisciplinary approach in which citizens are part of the design (Neuman et al., 2002)." The CSD/CSS framework and its principles provide a theoretical approach and decision-making philosophy based on the principles to address all-inclusive transportation PDP.

CHAPTER FOUR

RESEARCH DESIGN AND METHODOLOGY

4.1. General Research Strategy

The purpose of this research study is to streamline the South Carolina Department of Transportation's (SCDOT) Project Development Process (PDP) to enhance and improve project development and delivery by identifying PDP best practices that are applicable for a state DOT comparable to SCDOT's organizational structure and transportation program.

As mentioned in the previous chapters, this research also aims to provide SCDOT, and other state DOTs, the methodology and needed insight regarding best practices to help the agency streamline and update their PDP leading to an increase in efficient development programs. The methodology will also enable state DOTs to systematically assess their current practices and obtain input/suggestions for process improvement from the agency's own SMEs, other comparable state DOTs, and the external development and delivery partners providing professional services.

This chapter discusses the methodology of the research study (Research Design) and how it is conducted. This research study is categorized as explanatory because it seeks to identify PDP best practices to streamline a State DOT's PDP to improve project development performance. Figure 4.1 shows the Research Design and Methodology Map for this research study, discussed in detail in the following sections. The proposed methodology (Figure 4.1) for this research study is completed in four phases comprising ten tasks.

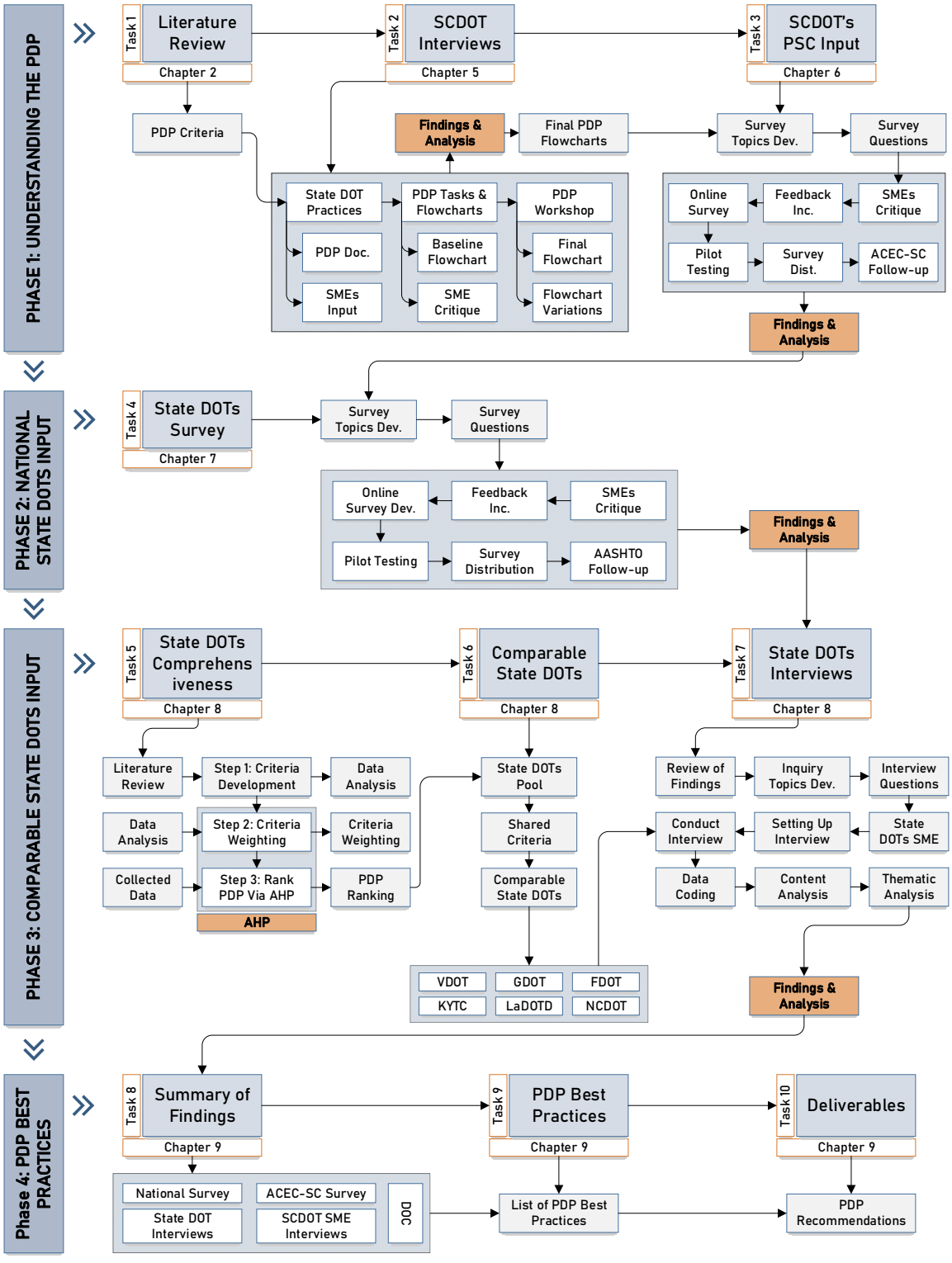


Figure 4.1: Research Design and Methodology Map

4.2. Specific Research Questions

The primary purpose of the comprehensive literature review (see Chapter 2) of the PDP for transportation projects was to gain an understanding of the development process to review specific problems, and current PDP practices identified by prior studies, refine primary research questions, develop secondary research questions, develop investigative and measurement questions, and refine the objectives of this study. The review process helped establish the body of knowledge and isolate areas needing further inquiry.

The Literature Review aided the development of the specific research design for this study and the investigative format and approach for data collection. The development of measurement questions for data gathering will be discussed in later chapters. The following specific primary and secondary research questions were developed to address the knowledge gap and this study's objective. The below research questions are a refined form of management question or problem statement, which have led the researcher to develop measurement questions for data gathering purposes.

4.2.1. Primary Research Questions

3. What are the Project Development Process (PDP) best practices utilized by State Departments of Transportation that could improve and streamline the South Carolina Department of Transportation's PDP?
4. What PDP best practices distinguish the top-performing state DOTs from Poor-performing state DOTs?
5. How do these PDP best practices affect the PDP timeline among top-performing and poor-performing state DOTs?

4.2.2. Secondary Research Questions

- What are the phases and milestones within a state DOT's PDP, and how do they vary based on the project/program type?
- What are the Project Development Process (PDP) best practices for comparable State DOTs?
- How does the PDP vary based on state DOTs project/program types, funding sources, organizational structures, and environmental impacts?
- What are best practices for the primary PDP phases and tasks, including initial project scoping, utility and railroad coordination, environmental requirements, design development, and right-of-way acquisition?
- What are the best practices regarding the use and procurement of professional services consultants?
- What performance metrics are state DOTs using to track PDP milestones, and how does it affect project delivery performance?

4.3. Specific Research Design

This research study utilized an Explanatory Sequential Design, as shown in Figure 4.1 (Mixed Method Research Design). This design was selected to facilitate a qualitative analysis to aid and enhance the quantitative findings. The Mixed-Method Research Design for this study is discussed in detail in the following sections, representing the whole research design layout or map (see Figure 4.1). The proposed methodology for this research study is completed in four phases comprising a total of ten tasks.

During Phase 1 of this research (Figure 4.1), secondary data from state DOTs, past studies, and scholarly publications from organizations involved with transportation

(discussed in the literature review) is collected to evaluate the current state of practice in PDP and identify PDP criteria and best practices. Furthermore, preliminary semi-structured exploratory interviews are conducted face-to-face with SCDOT's Subject Matter Experts (SME) of each department and functional unit involved in PDP to identify its current PDP as well as its issues. In addition, input from SCDOT's delivery partners (Professional Services Consultants) is solicited via a self-administered computer-assisted questionnaire to identify strengths and weaknesses in the current SCDOT PDP and obtain suggestions for improvement.

During Phase 2, a computer-assisted self-administered questionnaire is administered to identify PDP best practices concerning project development performance in all state DOTs across the US. During Phase 3, structured interviews with comparable state DOTs to SCDOT are selected to probe deeper in identifying and explaining PDP best practices and their relation to project development performance. Besides, secondary documentation received from the comparable state DOTs is analyzed to support the development of PDP best practices. Lastly, in Phase 4, the PDP Best Practices list and Recommendations are discussed from the summary of findings and analysis from secondary documentation, surveys, and interviews.

A detailed description of each phase and task of the research methodology and design is discussed below (Figure 4.1).

4.3.1. Phase 1: Understanding the PDP (SCDOT PDP)

Figure 4.2 shows the research methodology, Phase 1, the SCDOT Project Development Process (PDP). Phase 1 of the research methodology includes three tasks:

literature review, SCDOT preliminary interviews, and obtaining input from SCDOT's professional services delivery partners concerning the agency's current PDP.

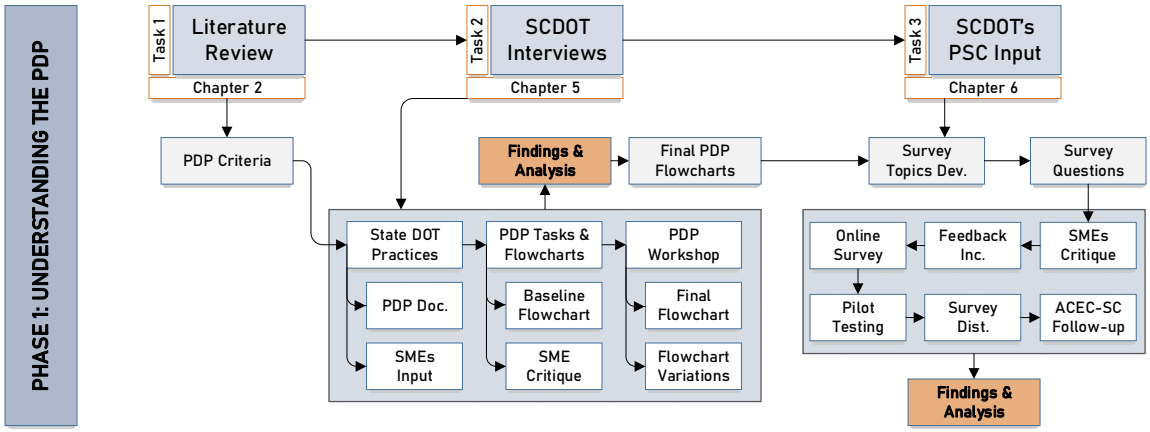


Figure 4.2: Research Methodology Phase 1: SCDOT PDP

4.3.1.1. Task 1: Literature Review

The literature review is summarized in detail in Chapter 2. The comprehensive literature review (see Figure 2.1) in PDP and its related gaps and best practices helped understand and identify specific problems, issues, research questions, and current best practices for this study's objective. Another purpose was to develop a specific research design based on the summarized information to develop a survey questionnaire and interview questions for state DOTs to gather data.

The literature review also provided theoretical foundations, concepts, and dimensions related to PDP and its phases and components. These concepts are used to explore the knowledge gap related to PDP best practices and streamlining project performance of state DOTs to identify best practices for SCDOT and other state DOTs. Lastly, the literature review provided the peer-reviewed PDP criteria used to determine

the state DOTs' PDP comprehensiveness and determine investigating and measurement questions for different dimensions and variables of PDP.

4.3.1.2. Task 2: SCDOT Exploratory Interviews

Preliminary exploratory semi-structured interviews were conducted face-to-face with SCDOT's Subject Matter Experts (SME) from each department and functional unit involved in PDP to identify the current PDP practices and suggested areas of improvement of the process. Forty-four (44) SCDOT SMEs from twenty-two (22) different departments functional units were interviewed. These departments and functional units are, Pre-construction, Environmental, Traffic, Utility and Railroad, Right-of-Way, Planning, Design, Letting and Construction, Professional Services, Project Management, Project Control, Scheduling, Program Management, Local Public Agency (LPA), and C-Program administration. The interviews were semi-structured with open-ended questions. The primary objectives of the preliminary interviews with the SCDOT SMEs are to:

- Identify and document the agency's current PDP
- Map the agency's PDP
- Obtain documentation regarding current PDP tasks and subtasks
- Identify each department's or functional unit's PDP role(s), responsibilities, and activities
- Collect and examine PDP practices, policies, reports, studies, and other relevant material
- Identify how the PDP varies based on project type, program type, environmental; impact, and funding source

- Collect information regarding SCDOT's organization structure, personnel responsibilities, critical tasks, control activities, interagency communication, coordination, and reporting.
- Identify key drivers for the PDP
- Solicit suggested areas for improvement from the SMEs
- Identifying current performance measures and suggestions for changes and additions to the performance metrics collected by the agency

The preliminary interviews with SCDOT SMEs resulted in the identification of all the objectives noted above. SMEs validated the interview transcripts, summaries, and findings. The preliminary interviews identified the primary issues and factors influencing project performance in SCDOT, which aligns with the summarized concepts from the literature review. Detailed findings and analysis alongside the PDP flowcharts are discussed in Chapter 5.

4.3.1.3. Task 3: SCDOT Professional Services Consultants Input

Professional Services Consultants (PSCs) are significant and vital to the PDP of most state DOTs (Bausman et al., 2014). The use of consultants in the project development process in state DOTs is increasing due to several factors, including increased funding and corresponding state DOT workload, insufficient in-house resources or technical ability, and project complexity. PSCs are the state DOT's delivery partners, and their input is essential to help evaluate current practices and identify change(s) that could drive improvement in the development process.

The researcher solicited input from SCDOT delivery partners (PSCs) involved in the PDP to identify strengths and weaknesses in the current PDP and obtain suggestions

for improvement via a computer-assisted self-administered questionnaire. The administrative questionnaire focused on the effectiveness and efficiency of SCDOT's PDP related to the PSC's interaction and execution. Consultants were asked to provide suggestions for improvement of the PDP. The input from SCDOT's delivery partners is analyzed, and findings are summarized for use in developing survey and interview questions for state DOTs.

The unit of analysis for this survey was "organization," which is a SCDOT Professional Services Consultant (PSC). The target population was SCDOTs PSCs that have been or currently are, involved in the project development process. This survey's sampling frame was the professional services planners and project developers that are members of the South Carolina American Council of Engineering Companies (SCACEC). The survey design for SCDOT PSCs input was cross-sectional.

Computer-Assisted Self-Administered Survey was chosen due to lower cost, ease, timeliness of respondent input, coverage area (geographically), and questionnaire design flexibility. The survey questionnaire was pilot tested to enhance validity and reliability, and feedback was incorporated into the questionnaire's final design. Subsequent to distribution, a follow-up email was sent to enhance the response rate. Detailed survey development and findings and analysis of the SCDOT professional services consultant's survey are discussed in Chapter 6.

4.3.2. Phase 2: National State DOTs Input

Figure 4.3 shows the research methodology, Phase 2, National State Departments of Transportation Input. Phase 2 of the research methodology includes one task: the

national state DOTs data collection concerning the Project Development Process (PDP) via a self-administered computer-assisted questionnaire.

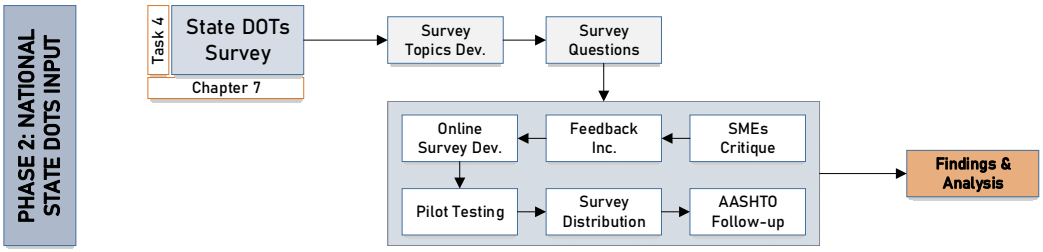


Figure 4.3: Research Methodology Phase 2: National State DOTs Input

4.3.2.1. Task 4: State DOTs Survey

Task 4 is developing, distributing, and collecting data from all state DOTs utilizing a computer-assisted self-administered questionnaire. The targeted population is the States Department of Transportation. The population number is 50 states of the US. The sampling frame is a list of all 50 state DOTs. The targeted respondent(s) for each state DOT is an individual(s) with knowledge and agency responsibility for the project development process and professional services procurement. The computer-assisted self-administered questionnaire was pretested to enhance the validity and reliability of the questionnaire. Pilot testing feedback was incorporated prior to the distribution of the survey. Follow-up emails were sent approximately two weeks after distribution to increase the state DOTs response rate,

Information obtained from the literature review concerning PDP criteria, dimensions, and practices formed the basis of the measurement questions in the survey. The computer-assisted self-administered questionnaire was developed and sent to all 50 states via an online service. The questionnaire predominately contained five-point

Likert Scale interval data. Several questions, such as background information, were open-ended and short answers (nominal data). Anonymity was offered to the respondents.

Detailed findings and analysis of the national state DOTs survey are discussed in Chapter 7.

4.3.3. Phase 3: Comparable State DOTs Input

Figure 4.4 shows the research methodology, Phase 3, Comparable State DOTs Input. Phase 3 of the research methodology includes three tasks: evaluation of state DOTs' PDP comprehensiveness, identification of comparable state DOTs, and obtaining input from comparable state DOTs via structured interviews concerning the PDP.

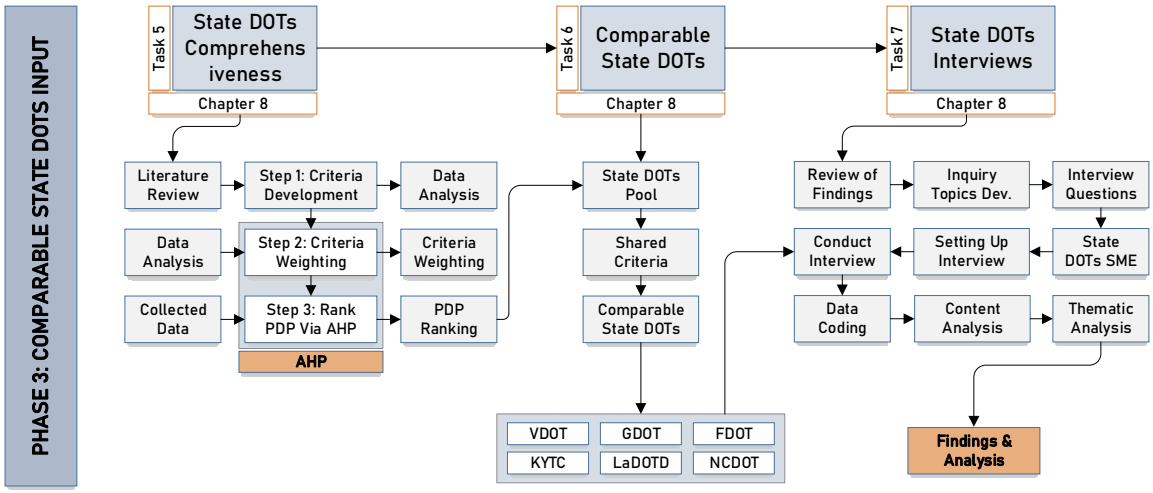


Figure 4.4: Research Methodology Phase 3: Comparable State DOTs Input

State DOTs have different organizational structures, missions, state laws and regulations, resources, culture, and management approaches. Still, they all have common responsibilities regarding planning, design, construction, operation, and

maintenance of state transportation systems (Cochran et al., 2004). These shared responsibilities provide opportunities for state DOTs to share their experiences to aid the improvement of their project development processes. Identification of peer or comparable states is valuable for identifying PDP best practices that are effective and applicable to a state DOT (Bausman et al., 2014). Best practices are intended to apply to related or comparable organizations (Cochran et al., 2004).

A two-tiered systematic approach to identify comparable state DOTs to SCDOT is proposed: 'Evaluation of State DOTs PDP Comprehensiveness' and 'Identification of Comparable State DOTs.' What follows is a brief description of this two-tiered systematic approach (task 5 and task 6, see figure 4.4) with their steps. This evaluation process resulted in selecting six state DOTs that have: 1) a well-defined, current project development process, and 2) an organizational structure, approach, and transportation responsibilities comparable to SCDOT. Detailed identification of comparable state DOTs and findings and analysis of the interviews of comparable state DOTs are discussed in Chapter 8.

4.3.3.1. Task 5: Evaluation of State DOTs PDP Comprehensiveness

The goal in task 5 was to evaluate the PDP comprehensiveness of state DOTs. This evaluation enabled the researcher to rank each state DOT's PDP comprehensiveness by identifying their PDP elements and evaluating them utilizing a systematic weighing system. The weighting assessment was accomplished using the Analytical Hierarchy Process (AHP). AHP is a multi-criteria decision-making technique to formulate weighing scales from the pair-wise comparison. AHP was chosen for its unique ability to include both data information and human judgment. The step-by-step approach followed to

achieve the goal in this task is shown in Figure 4.5. A brief explanation of this process (Figure 4.5) is described in the steps outlined below.

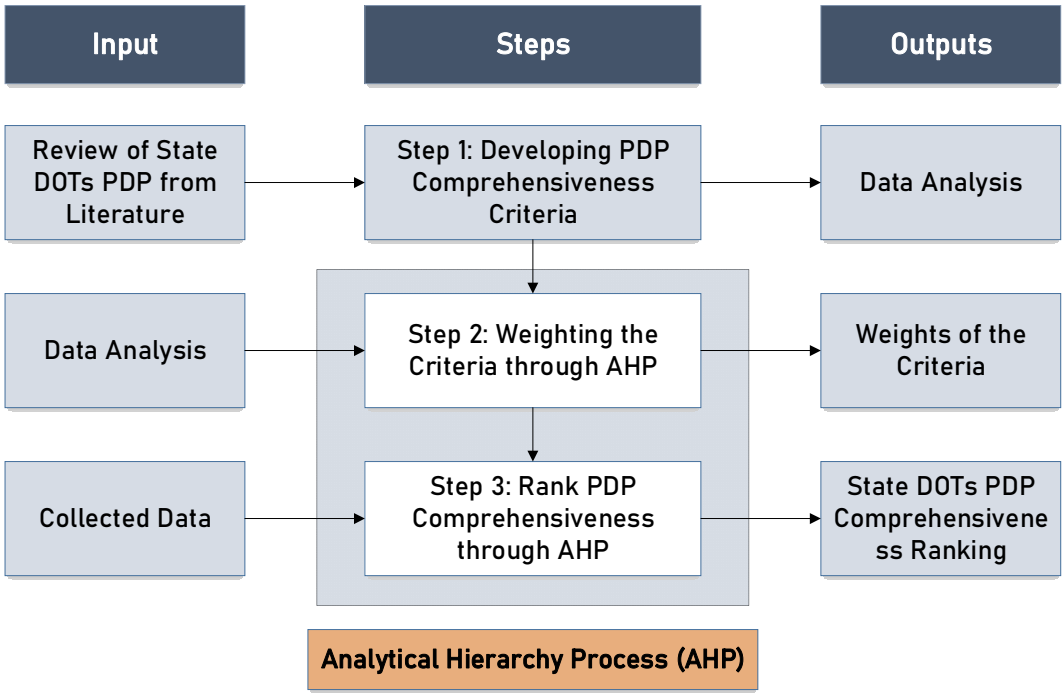


Figure 4.5: Evaluation of State DOTs PDP Comprehensiveness Methodology

4.3.3.1.1. Step 1: Developing PDP Comprehensiveness Criteria

As shown in Figure 4.5, the first step in the AHP was to identify the components that should be incorporated into a comprehensive PDP. A comprehensive list of PDP criteria and components is identified during the literature review from an investigation of the PDP process utilized by state DOTs. In addition, states PDP manuals were reviewed using relevant research databases, search engines, and the state DOTs' websites to identify these criteria.

4.3.3.1.2. Step 2: Weighting the Criteria through AHP

Once the criteria were developed in Step 1, the second step was to weigh these criteria (see Figure 4.5). Although all criteria can be assumed to be critical to evaluating the PDP comprehensiveness, they have different relative weights. Criterion with higher weight has a more significant impact on the evaluation results. If each criterion's weight were not correctly determined, the evaluation results would not represent the state PDP's current comprehensiveness.

Empirically, it isn't easy to decide the importance of some criteria over other criteria. Therefore, to establish a logical and empirical ground to the weighting process and consider both the underlying data and human judgment, AHP was selected as the most suitable way to weigh the criteria. The advantage of the AHP is that both the underlying data information and human judgment can be considered for the evaluation process. AHP allows varying and incommensurable criteria to be compared to one another rationally and consistently. This advantage distinguishes AHP from other decision-making techniques.

4.3.3.1.3. Step 3: PDP Comprehensiveness Ranking through AHP

The last step in developing the evaluation method was to rank the state DOTs' PDP comprehensiveness using the AHP (see Figure 4.5). The primary task in Step 3 was to determine how much one state's PDP is more or less comprehensive than another. After defining the weights of PDP criteria, each criterion was scored to calculate the criterion weighting. This weighted score created a ranked list of states based on PDP comprehensiveness using a 100-point scale score rating in 'R Software.'

4.3.3.2. Task 6: Identification of Comparable State DOTs

In this task, state DOTs comparable to SCDOT are identified after evaluating state PDP comprehensiveness in Task 5, as shown in Figure 4.4. To identify the comparable state DOTs, the researcher first evaluated the pool of states ranked higher than SCDOT (from Task 5: Step 3). This pool of states was further reduced using criteria including organization type (centralized, decentralized, hybrid), state geography, state-owned/maintained highway miles, and highway statistics (NHS/interstate mileage owned and maintained by a state, federal and state highways length by the functional system to improve comparability with SCDOT). This evaluation process resulted in selecting six state DOTs that have: 1) a well-defined, current project development process, and 2) an organizational structure, approach, and transportation responsibilities comparable to SCDOT.

4.3.3.3. Task 7: Comparable State DOTs Interviews

Structured interviews were conducted with the comparable state DOTs identified in Task 5 and 6 to further identify and probe best practices and project development processes and performance concepts. Structured interviews were chosen to gather in-depth information on the topics related to addressing the research objectives. The national state DOTs computer-assisted self-administered questionnaire (Task 4) provided limited data from a broad sample. In contrast, the in-depth interviews permitted a deeper level of understanding of selected topics.

4.3.4. Phase 4: PDP Best Practices

Figure 4.6 shows the research methodology, Phase 4, PDP Best Practices. Phase 4 of the research methodology includes three tasks: summarizing the findings and analysis from the previous phases, developing PDP best practices, and the deliverables, which is the establishment of PDP recommendations. Detailed description and development of PDP best practices are discussed in Chapter 9.

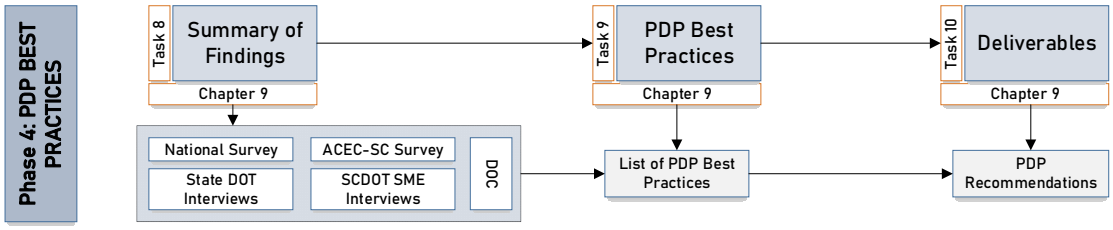


Figure 4.6: Research Methodology Phase 4: PDP Best Practices

4.3.4.1. Task 8: Summary of Findings and Analysis

As shown in Figure 4.1, the data analysis has occurred at several points in this study. First, analyzing the qualitative data collected from semi-structured SCDOT SMEs, and second, analyzing quantitative data collected from professional services consultants via a structured survey. Third, analyzing the quantitative data collected by computer-assisted self-administered questionnaires from national state DOTs and analyzing the qualitative data collected via structured interviews and secondary data from comparable state DOTs.

Task 8 discusses the summary of these findings and analysis and how it supports the development of PDP best practices (see Figure 4.6). The analyses from the quantitative results are connected to the qualitative phase, and subsequently, the

qualitative results are used to understand the quantitative results. The qualitative results have provided a deeper understanding of the relationships and statistical findings of the quantitative results.

For the quantitative analysis, a test of statistical significance is conducted to determine the significance of the explored concepts related to PDP best practices and project development performance from the data collected via survey instrumentation from the sample. The survey instrumentation's measurement scale is mainly nominal and interval data; thus, both parametric and nonparametric tests are conducted. The statistical test results are presented by probability values (p-value).

For the qualitative analysis, data collected from interviews are analyzed by content analysis and thematic analysis. Through content analysis, the qualitative data is systematically transformed into a concise and organized summary. Besides, the data is coded, organized by category, and analyzed to identify central themes. Via thematic analysis, by moving through the data back and forward, the association's patterns and descriptions are searched and explored across the interview transcripts. The final analysis presents a quantitative section, followed by a qualitative section, to provide a clear understanding of the relationship between the study variables.

4.3.4.2. Task 9: Development of PDP Best Practices

Based on the data assembled and analyzed in the previous phases and tasks, a listing of PDP Best Practices for optimizing PDP flowchart(s), organizational structure, operational procedures, and project development practices are identified. Task 9 discusses the development of PDP best practices from the assembled and analyzed data

that has occurred in several points of this study. In addition, task 9 discusses how the findings and analysis support these PDP best practices.

4.3.4.3. Task 10: Deliverables

In task 10, the PDP best practices are compared to SCDOT's current Project Development Process to generate a list of recommendations to enhance and streamline SCDOT's PDP. The recommendations and research deliverables are focused on project and program-specific needs and aid in developing and implementing a streamlined and updated PDP permitting SCDOT to more effectively and efficiently manage the Project Development Process. A detailed description of the deliverables is discussed in Chapter 9.

4.4. Conclusion

This chapter discussed the methodology of the research study (Research Design) and how it is conducted. This research study is categorized as explanatory because it seeks to identify PDP best practices to streamline a State DOT's PDP to improve project development performance. Figure 4.1 shows the Research Design and Methodology Map for this research study, discussed in detail in this chapter. The proposed methodology (Figure 4.1) for this research study is completed in four phases comprising ten tasks. A detailed description of each phase of the research methodology's findings and analysis are discussed in the next chapters.

CHAPTER FIVE

PHASE 1: UNDERSTANDING THE TRANSPORTATION PROJECT DEVELOPMENT PROCESS (PDP)

This chapter discusses, describes, and presents the research methodology, Phase 1, the South Carolina Department of Transportation's Project Development Process (SCDOT PDP), alongside its findings and analysis. As shown in Figure 4.1 and discussed in Chapter 4, Phase 1 of the methodology includes three main tasks: literature review, SCDOT preliminary exploratory interviews, and obtaining input from SCDOT's professional services delivery partners concerning the agency's current PDP. In this chapter, the researcher has only focused on SCDOT preliminary interviews (Phase 1: Task 2). The SCDOT's professional services consultants' input concerning PDP is discussed later in Chapter 6.

5.1. Introduction

Preliminary Exploratory Interviews with SCDOT SMEs aimed to investigate, understand, and map SCDOT's preconstruction PDP activities and development sequence to document current PDP practices and identify areas for improvement. It provided guidance to determine key PDP tasks, sub-tasks, and activity sequences for the agency's various program/project types, funding source(s), and environmental impacts. Ultimately, the goal of the preliminary interviews with SCDOT SMEs was to:

a. Understand, identify, and document the current SCDOT PDP phases, activities, and practices.

b. Identify and map the SCDOT PDP based on different impacting factors such as project/program type, funding source, and environmental impact.
c. Identify PDP areas for improvement to pave the way for improving and streamlining SCDOT PDP, which is the ultimate goal of this research study.

A five-step methodology was developed to guide the mapping process of PDP, shown in Figure 5.1. The initial step was a thorough review of state DOTs' PDP and related literature. The next step involved developing topics of inquiry for the key components/tasks in PDP. These inquiry topics were then used to guide interviews with the SMEs from departments and functional units of the SCDOT, serving as the focus of this study. Data were collected, coded to gather necessary information, and analyzed to prepare PDP flowcharts for the agency. These flowchart tasks were then validated through a two-day focus group with a SCDOT leadership team. After incorporating the workshop's input, the researcher mapped PDP flowcharts for the SCDOT based on program/project type, funding source, and environmental requirements.

5.2. Methodology

As mentioned, the objective of this chapter is to investigate and determine SCDOT's current PDP comprehensively. In essence, its goal is to provide insight into SCDOT leadership's approach and the researcher to investigate and document PDP's current preconstruction processes and practices for transportation projects. Ultimately, the SCDOT's objective was to improve their PDP. To achieve that goal, the agency recognized that the establishment (documentation) of its current process and practices was an essential first step to improve its PDP. The methodology utilized to accomplish

this research objective incorporated five steps and associated sub-steps, as shown in Figure 5.1.

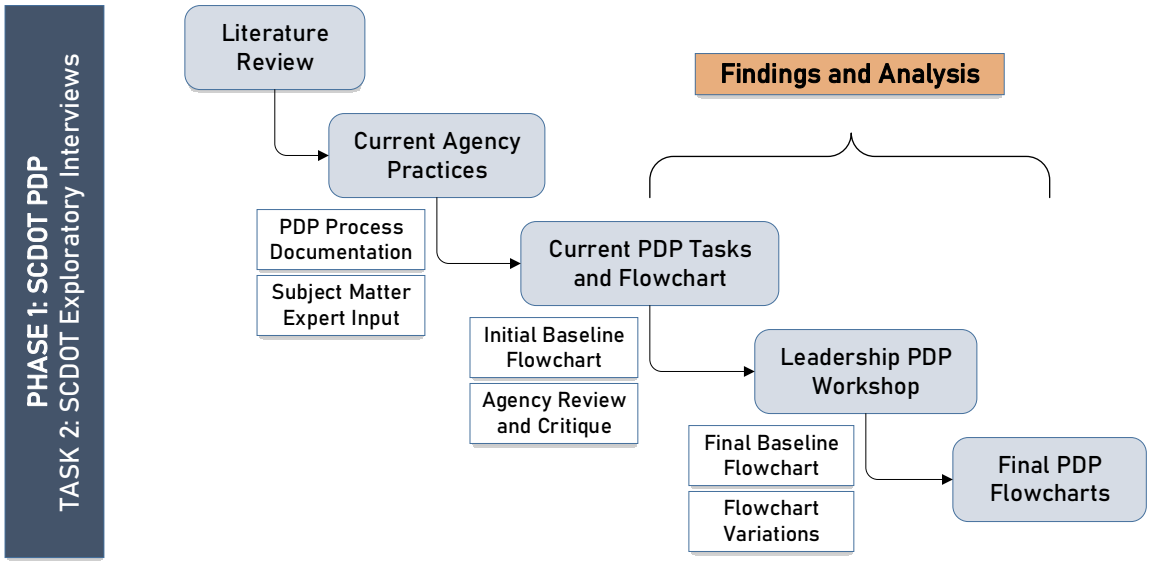


Figure 5.1: SCDOT PDP Mapping Process Methodology

It is anticipated that the methodology utilized is applicable for use by other STAs and State DOTs as a guide to identifying project development current practices, document their PDP, and utilize the insight they gained through the process to improve their agency's future performance in the delivery of the state's infrastructure projects. A detailed summary of each step taken in Figure 5.1 is provided as follows.

5.2.1. Literature Review

The first step was to complete a thorough review of publications, research papers, and studies concerning the PDP for transportation projects to gain a comprehensive understanding of the PDP. Special emphasis was placed on studies and publications from state DOTs and related industry and professional organizations,

including FHWA, AASHTO, TRB, and the NCHRP. The research team also examined state DOTs' websites to obtain relevant information on the agency's project development process, organization, training, and execution.

Online data relating to the PDP from forty (40) state DOTs were collected and reviewed to identify PDP components, tasks, sub-tasks, and the flow/sequence of activities (flowchart). The remaining ten (10) states did not have substantive information relating to their PDP available online. The researcher also explored the extent of the state's system, the agency's organizational structure, gained insight into the impact that the funding source had on the state DOT's process, and sought to identify any pending modifications to SCDOT's PDP.

5.2.2. Current Agency PDP Practices

The identification of current PDP practices utilized by the SCDOT for this study entailed two sequential activities: a) review of the SCDOT's PDP documented processes and practices, and b) gain insight from the SMEs of each functional unit regarding their role in the PDP and the unit's relationship with other functional units and departments. An overview of the investigative process for each activity is as follows:

5.2.2.1. PDP Documentation

Subsequent to the literature search, the next step in the research process was to investigate the state agency's development process that serves as the 'case study' – hereafter referred to as the 'SCDOT.' The researcher collected and examined SCDOT's PDP documentation regarding practices, policies, reports, studies, and other relevant material for each program and project type of project development. The researcher

examined information and documentation regarding the SCDOT organization structure, personnel responsibilities, critical tasks, control activities, communication/coordination, and reporting. SCDOT's approach and scheduling software utilized for PDP planning and management were identified and investigated. The researcher then examined SCDOT's organizational structure and identified its functional departments in preparation for the next step of the investigative process.

5.2.2.2. State DOT Subject Matter Experts (SMEs)

This step involved developing a detailed listing of topics for the inquiry to understand the activities and process flow of the SCDOT. The topics were developed after studying PDP components, tasks, and activities of SCDOT and other state DOTs and identifying important components relevant to this study. Subsequent to the identification of the major PDP components, a list of questions was prepared for each functional unit regarding: a) their role and activities in the PDP, b) the unit's interaction with other functional units, c) the timing and sequence of their PDP activities, d) steps taken to monitor and track their performance, and e) the impact that various projects and program type and funding source had on the PDP activities. The topics of inquiry alongside the SCDOT SME interview questions are attached in Appendix A.

The researcher then met with SCDOT's leadership team to review the agency's organizational structure and functional departments to identify the most appropriate SMEs to provide the department's PDP activities, roles, responsibilities, and suggestions for improving the process. Forty-four (44) SMEs from twenty-two (22) functional units were identified as candidates for the interview process.

Over the course of approximately two months, semi-structured interviews were conducted with the forty-four SMEs (Table 5.1). Prior to each session with the SME(s), an interview outline was developed that was tailored to the interviewee's functional unit, as previously noted. However, consistent general themes addressed during all the interviews included:

- Introduction and review of the purpose of the PDP research and the interviews to gain their understanding and support
- PDP role(s), responsibilities, and execution timing
- Functional department organization and involvement in the PDP
- Interaction with other functional departments during the PDP
- How their role(s) was impacted by project type, program type, and funding source
- Performance metrics tracked
- Suggestions for improvement of the PDP
- Collection of any additional process documentation

Each interview lasted approximately 1½ to 2 hours. With the interviewee's permission (s), each session was recorded to ensure comprehensive capture of their input and efficiently utilize the interviewee's time (s). Additional PDP documentation was identified and noted for collection after the interview process. Following each interview, a complete transcript was developed that was subsequently analyzed and summarized by theme/category using Content and Thematic forms of Analysis. The content and thematic analysis led the researcher to organize and map the SME input by flowchart task to supplement and clarify the PDP information previously assembled during an examination of the agency's PDP documentation.

Department/Functional Unit	Number of SME(s)	Title
Preconstruction-Surveys/SUE	1	Sr. Management
Environmental Management	1	Director
Traffic Engineering	1	Director
Right of Way-Utilities/RR	3	Sr. Management
Planning	1	Director
Program Management (Senior)	4	Program Managers
Preconstruction Bridge Design	1	Bridge Designer
Right of Way	1	Director
Preconstruction VE and Risk Assessment	2	Sr. Management
Preconstruction Road Design	2	Road Design
Design-Build	2	Sr. Management
Project Management (Junior)	4	Program Managers
C-Program Administration	1	Director
Construction Materials Research	2	Sr. Management
Professional Services Procurement	2	Sr. Management
Project Controls	1	Department Head
Project Scheduling	1	Department Head
Program Managers	4	Program Managers
Regional Project Groups (RPG)	4	RPG Leaderships
Design Managers	4	Sr. Management
LPA	1	Federal Grants Admin
Construction	1	Director
Total Interviewed	**44**	

Table 5.1: SCDOT Interviewed Subject Matter Experts

5.2.3. Findings and Analysis: Current PDP Tasks and Flowchart

5.2.3.1. Develop Initial Baseline Flowchart.

Once the SCDOT process documentation and SMEs input were summarized, analyzed, organized, and evaluated, the researcher then developed a 'baseline' PDP flowchart. This flowchart reflected the SCDOT's current tasks and sequence (flow) for the PDP for projects classified as an EA FONSI (for more information on EA FONSI, see Chapter 2). The researcher also identified suggested milestones for the development

process. This 'baseline' flowchart contained fifty-nine tasks and eight milestones, shown in Figure 5.2.

5.2.3.2. Agency Review & Critique

Once the flowchart development was completed, the researcher conducted a review session with key SCDOT personnel and SMEs to gain their initial comments and critique. Subsequently, the 'baseline' flowchart was updated to address their input.

5.2.4. Findings and Analysis: SCDOT Leadership PDP Workshop

5.2.4.1. Finalize Baseline Flowchart

A two-day workshop was held to finalize PDP flowchart development and establish the 'subtasks' for each flowchart task. The researcher and the attendees included the preconstruction support leadership, senior regional leadership responsible for project development, senior design management, project management, FHWA representatives, and the research team members. The workshop was held at a location remote from the main office to minimize distractions. Prior to the meeting, each attendee was provided a digital copy of the baseline flowchart and a listing of the tasks with all of the sub-tasks that had been uncovered during a review of the documents and the SME(s) interviews.

The workshop's first day was primarily devoted to reviewing, amending, and finalizing the EA FONSI project development flowchart. Each task, flowchart sequence, and milestone were reviewed and edited as necessary. During the evaluation process, improvements to the process were discussed, but modifications were limited to those process adjustments that best conveyed the SCDOT's intended practice. The participants

appropriately thought it best to first document and stabilized current practices prior to initiating improvement.

5.2.4.2. Flowchart Variations for Program/Project Type

The second day of the workshop focused on three key elements: a) determining how the EA FONSI flowchart varied based on project type, environmental classification, and funding source, b) review and finalize the subtasks for each flowchart task; and c) consideration of the suggestions for improvement of the PDP offered by SMEs during the interview process.

With the EA FONSI flowchart serving as the baseline, each major program, project type, and funding source was evaluated to determine what, if any, flowchart tasks or sequences needed to be added, changed, or eliminated. The key decisions reached during this review were:

- SCDOT leadership decided to limit PDP flowcharts' development to project/program 'types' that comprised the majority of the agency's work. The leadership decided to develop and define their 'core' PDP program(s). They wanted to support the development effort for what comprised the majority of their current and future projects.
- SCDOT's projects that required an EIS were few in number and typically large and complicated with an extended development period. These projects often required resources that exceeded the agency's capacity. Also, the preconstruction development activities were typically subject to completion timelines that required dedicated resources. As a result, EIS projects were typically contracted out to engineering consultant firms to plan and execute the development

activities. For these reasons, the agency elected not to create a PDP flowchart for an EIS project.

- Each of the remaining project/program and funding types was examined. Three additional flowcharts were identified for development: CE (including both programmatic and non-programmatic), Non-Federally Funded with the United States Army Corps of Engineers (USACE) Permit required, and Non-Federally Funded and No USACE Permit.

Once the remaining flowcharts were determined, the workshop participants identified the modifications to the baseline flowchart sequence, tasks, and sub-tasks required for each.

5.2.5. Findings and Analysis: Final PDP Flowcharts and Sub-Tasks

After the workshop, the EA FONSI baseline flowchart and the three additional flowcharts based on varying environmental and permit requirements were finalized. The 'EA FONSI' baseline flowchart is shown in Figure 5.2. The flowcharts based on varying environmental and permit requirements are shown in Figure 5.3, Figure 5.4, and Figure 5.5. Besides, the key sub-tasks for each task on the flowcharts were linked to their corresponding task. These completed documents were then distributed to the leadership team for final critique/comments before wider agency distribution via the agency's internet website. The next planned step was to host the flowcharts, tasks, and linked sub-tasks on the agency's website for broad use by each project manager, department, and functional unit.

5.2.6. PDP Areas for Improvement

The preliminary interviews with SCDOT SMEs also resulted in exploring and identifying areas that needed improvement concerning PDP. The identified PDP areas for improvement explored in this phase helped identify investigative topics to gather data from other state DOTs to identify best practices for implementation to streamline SCDOT PDP. The PDP areas for improvement are listed in Table 5.2. The preliminary interviews identified the primary issues and areas for improvement, influencing project development performance in SCDOT, aligning with the literature review's summarized concepts.

PDP Areas for Improvement Explored from SCDOT SMEs Interviews	
PDP Areas	Sub-Areas and Components
Project Scoping	Responsibility, Level of Design, Documentation, Process
Organizational Structure	Organization Style, Process Standardization, Process Consistency, Documentation
Performance Measurement	Performance Metrics, Responsibility, Measurement Impact, and Use
Professional Services Consultants	Use of Consultants, Procurement Process, Procurement Metrics, Consultant Performance Measurement, Contracting Type
PDP	Level of Detail and Development, Program Types, Process Consistency
PDP Training	Responsibility, Level of Detail, Amount of Training, Methods of Delivery
Project Scheduling	Responsibility, Level of Detail, Tracking, and Use
Utilities and ROW Coordination	Procurement, Conflict Management, Responsibility, Tracking

Table 5.2: PDP Areas for Improvement

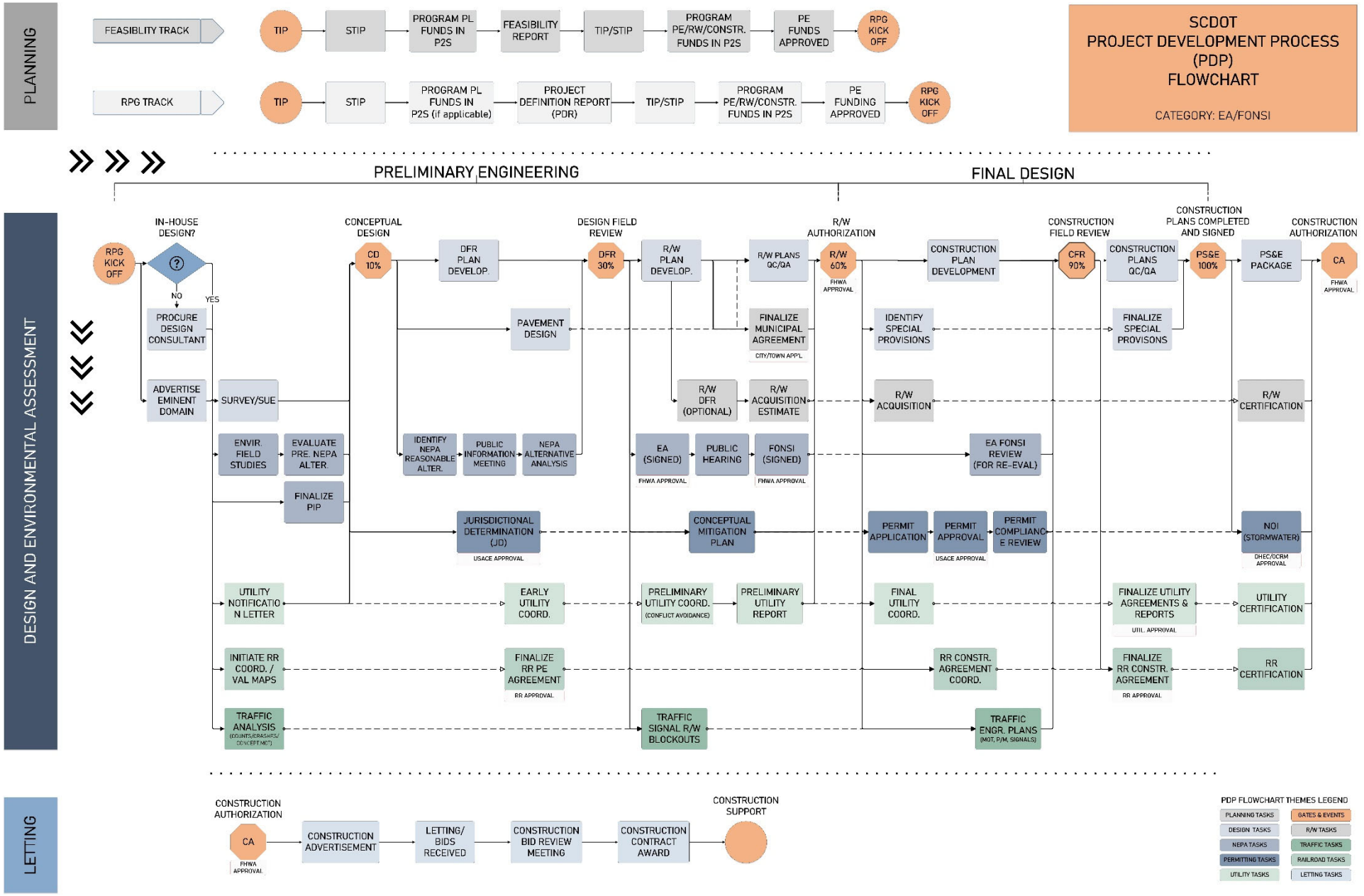


Figure 5.2: SCDOT 'EA FONSI' Baseline PDP Flowchart

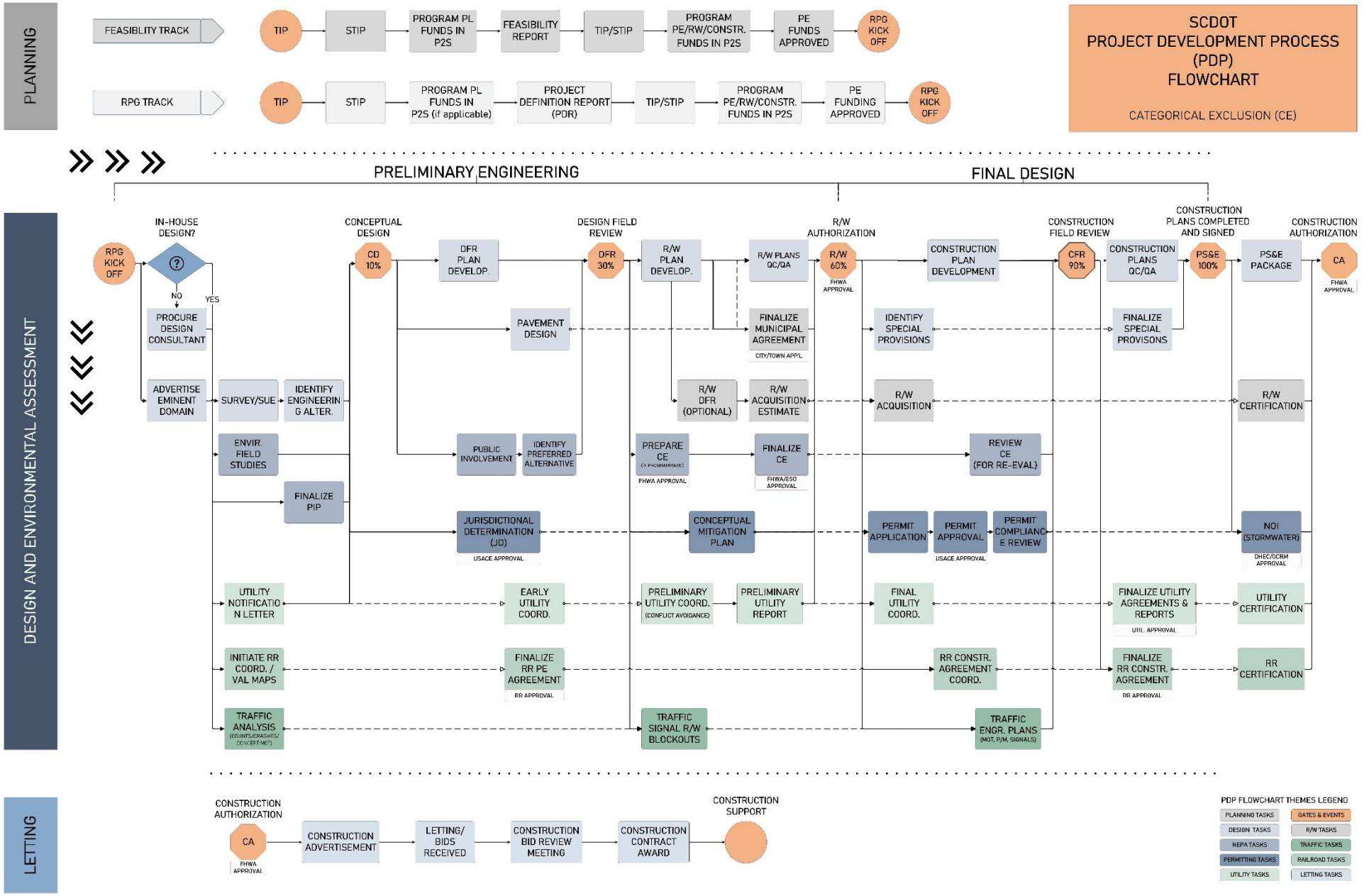


Figure 5.3: SCDOT 'CE Programmatic and Non-Programmatic' PDP Flowchart

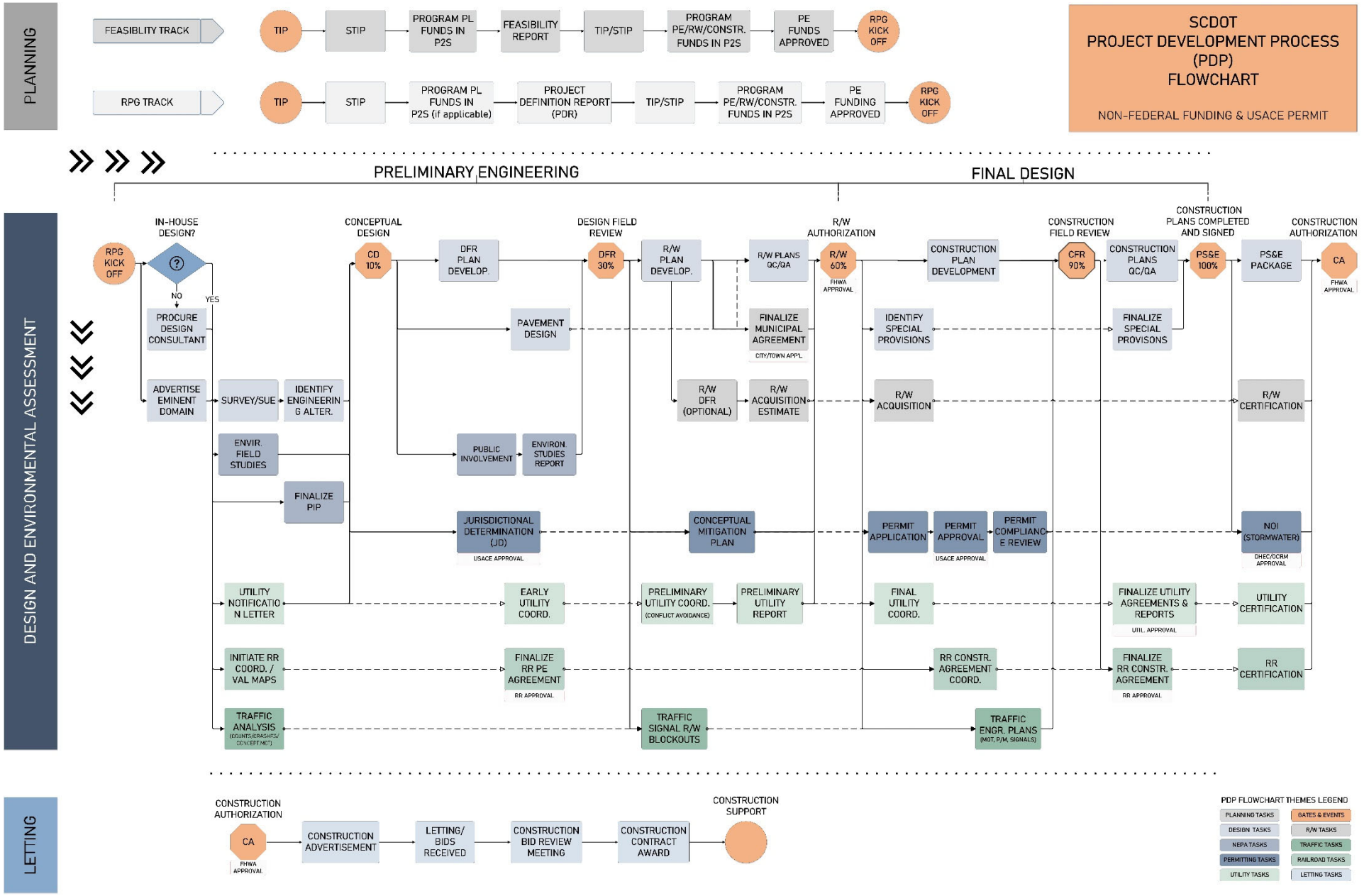


Figure 5.4: SCDOT 'Non-Federal Funding and USACE Permit' PDP Flowchart

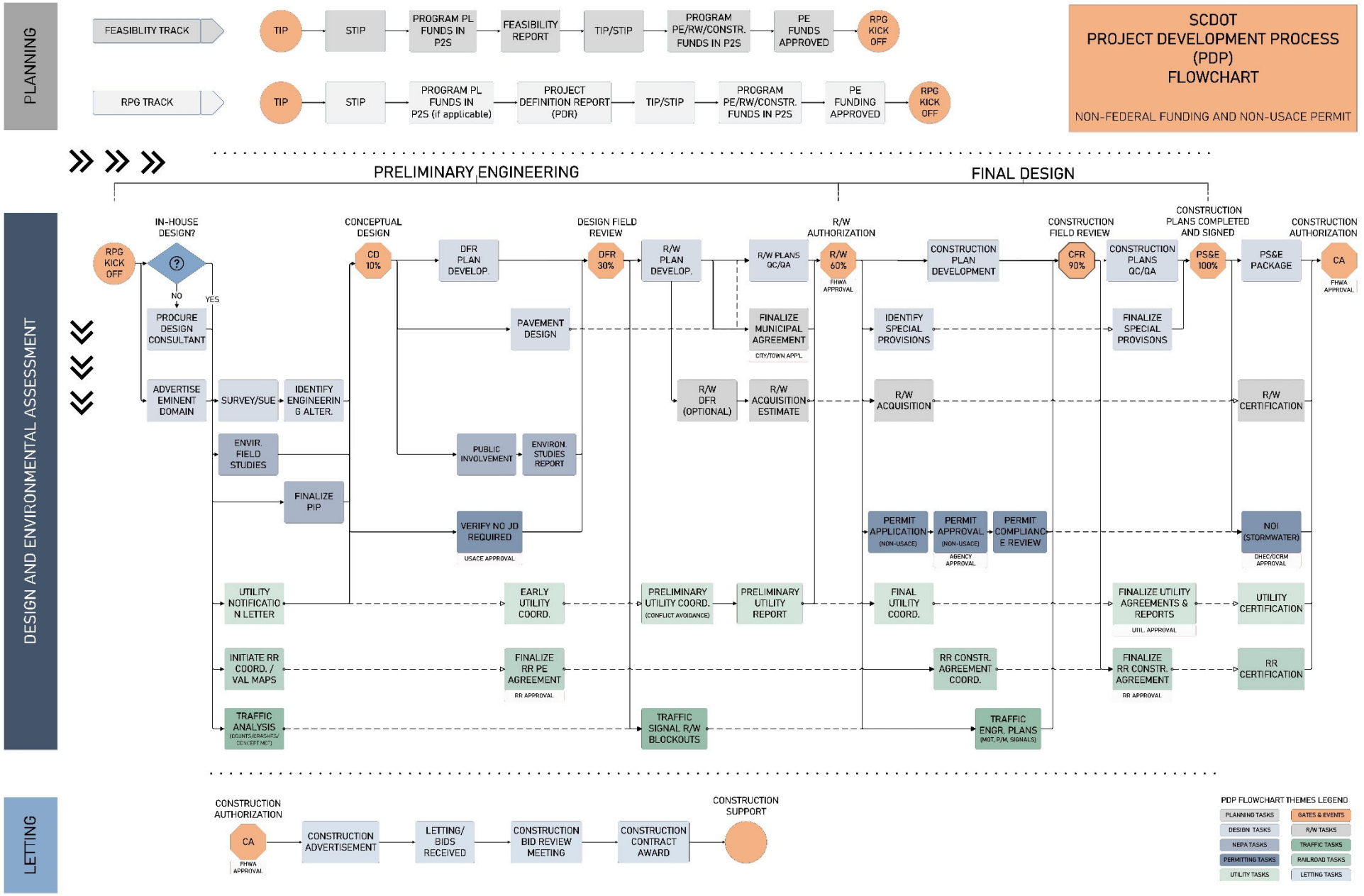


Figure 5.5: SCDOT 'Non-Federal Funding and Non-USACE Permit' PDP Flowchart

5.3. Conclusions

The knowledge gained and the lessons learned by agency leadership and the researcher during the execution of this phase of research methodology were extensive. This review of the study methodology (steps) and the lessons learned should be valuable to any state DOT planning to evaluate its own approach to project development. The lessons learned include the following:

- DOT leadership's commitment and involvement are essential: Self-evaluation of the agency process can be a fearful and intimidating experience, especially for those currently engaged in performing the activities. It is vital to have state DOT leadership involved with the project steering committee and committed to encouraging broad support for agency self-evaluation of the development process. It is also essential for state DOT leadership to signal their continuing support of the self-evaluation effort by actively staying engaged in the process.
- Agency self-evaluation of their PDP requires departmental and functional leadership's active support: A state DOT's PDP is executed at the departmental/functional level. It is vital to have functional leadership supportive and actively engaged in the effort to gain valid insight regarding current practice and substantive input to improve the process. Essential steps to gain support include an initial briefing concerning project objectives, the team's approach to gathering information on current practice, assurance of the confidentiality of input, and an earnest solicitation for their input.
- A research team with agency knowledge and experience is critical: The PDP is complex and spans multiple agency functional departments. In addition, during

the project, the researcher needs to interact with multiple SMEs with a number of demands on their time. The research team needs to have prior agency experience and functional knowledge. For this research effort, SCDOT leadership and the steering committee selected lead researchers who successfully completed prior research efforts spanning multiple agency functions. Committee leadership had the foresight to encourage the researcher to include a practicing transportation engineer with prior DOT experience in the team.

- Process execution often varies: Even with documented processes, the actions of agency personnel can vary. Additionally, variation can increase if the agency is decentralized or its departments and functional units operate in a vacuum. On multiple levels of the organization, information and process knowledge 'gaps' are often filled in at the direction or guidance of an individual's supervisor. It was enlightening to see the execution variations in gaining input on process and agency interaction from SMEs. These variations in executions reinforced the need for departmental/functional involvement and input to the project.
- Performance metrics are important: During the interview process with agency SMEs, the researcher received input from personnel at both ends of the spectrum concerning performance measurement. Some SMEs (department/functional units) opposed performance measurement for reasons ranging from the inability to predict and control PDP performance to concerns with the metrics' application. At the other end of the spectrum were SMEs that welcomed performance metrics. Some noted that 'measurement promotes action.' These functional groups typically had more predictable performance and a keener understanding of key

PDP tasks and process improvement. The collection and evaluation of appropriate performance metrics are essential for process improvement.

- PDP Flowchart(s) is an initial step: The development and documentation of an agency's PDP tasks, sub-tasks, and activity sequence is a vital first step. However, detailed supporting documentation (operations manual) is needed to promote consistent execution throughout an agency. This need is intensified as workload increases and experienced personnel retire or leave the agency. In either case, organizations are often faced with addressing their resource needs by utilizing personnel with limited industry or organizational experience. Documentation of agency PDP practice and process is essential to ensure consistent delivery of projects by personnel with varying experience levels.

To conclude, the preliminary interviews with SCDOT SMEs resulted in identifying all the objectives noted in this chapter. SCDOT SMEs validated the interview transcripts, summaries, and findings. The preliminary interviews identified the primary issues and factors influencing project development performance in SCDOT, aligning with the literature review's summarized concepts.

CHAPTER SIX

SCDOT PROFESSIONAL SERVICES CONSULTANTS INPUT

This chapter discusses, describes, and presents the research methodology, Phase 1-Task 3, the South Carolina Department of Transportation's Professional Services Consultants' Input (SCDOT PSC) concerning Project Development Process, alongside its findings and analysis (see Figure 4.1).

Professional Services Consultants (PSCs) are significant and vital to the PDP of most state DOTs (Bausman et al., 2014). The use of consultants in the PDP in state DOTs is increasing due to several factors, including increased funding and corresponding state DOT workload, insufficient in-house resources or technical ability, and project complexity. PSCs are the state DOT's delivery partners, and their input is essential to help evaluate current practices and identify change(s) that could drive improvement in the development process.

In this task, input from SCDOT delivery partners (PSCs) involved in the PDP was solicited to identify strengths and weaknesses in the current PDP and obtain suggestions for improvement via a computer-assisted self-administered questionnaire. The questionnaire focused on the effectiveness and efficiency of SCDOT's PDP related to the PSC's interaction and execution. Consultants were asked to provide suggestions for improvement of the PDP. What follows is the input from SCDOT's delivery partners along with its findings and analysis.

6.1. Introduction

State DOTs' development and delivery of transportation projects are complicated and complex processes that can take an agency several years to develop a project. State DOTs are faced with developing various project types that demand a wide range of agency expertise for project delivery. During project development, state DOTs must address a spectrum of federal regulations that vary based on project type, size, location, and public interest. Governmental regulations frequently limit the project development approach and often require a detailed evaluation of possible alternatives to minimize environmental impact, conserve wetlands, protect endangered species, and limit the project's impact on individuals and communities (Berger 2005, McMinimeeet.al. 2009).

Compounding the project development challenges that State DOTs face include key variables such as population growth that drives rising demand for transportation infrastructure, increasing expectations from the public for faster project completion, a continuing agency challenge to attract, train, and retain experienced professional staff, and the unremitting pressure resulting from state and federal budget constraints. As a result, state DOTs seek ways to more efficiently, effectively, and expeditiously deliver projects. To reach that objective, state DOTs are taking steps to streamline their project development and delivery processes and approach (Capers 2009).

State DOTs' initiatives include expanding contracting options to include delivery methods such as Design-Build and Construction Management. Besides, several state DOTs have focused on implementing Best Practices to develop transportation projects that have been identified by recent industry studies (Capers 2009). Several of these studies have addressed the significant role that professional services consultants have

in streamlining a state DOTs project development to enhance the agency's project delivery process (Bausman et al. 2014; Cochran et al. 2004).

The focus on professional services consultants' role is especially relevant, considering the national state DOTs survey findings discussed later in Chapter 7. Thirty-six state DOTs, representing 72% of all state DOTs in the US, participated in the study. The study's objective was to investigate the preconstruction project development process of state DOTs and the agency's procurement and utilization of professional service consultants.

The national state DOTs survey found that state DOTs contract an average of fifty-four percent (54%) of their agency's preconstruction project design and engineering activities to professional services consultants. In addition, more than a third (37%) of the state DOTs participating in the study indicated that their use of consultants was increasing. In comparison, the remaining 63% noted that their use of consultants was steady. None of the state DOTs indicated that their contracting of professional services consultants was decreasing.

A number of state DOTs were even using professional services consultants as 'general' managers to manage other consultants that were delivering project-related services. State DOTs were also focused on reducing the procurement timeline for professional services consultants to support consultants' efficient procurement. Interestingly, the primary driver for state DOTs' use of professional services consultants was not to reduce project cost or increase production efficiency but in response to the agency's increased workload, the lack of staff availability, and the absence of agency expertise.

The increased involvement of professional services consultants for project delivery does not eliminate the need for agencies to streamline the process and enhance project delivery effectiveness and efficiency. On the contrary, it may necessitate a renewed focus through a collaborative effort with professional services consultants (Fischer et al., 2017).

The father of the current quality management structure is Edward Deming. One of Deming's 14 principles for delivering quality services centered on the spirit of collaboration between team members to foster the exchange of ideas. An application of Deming's Total Quality Management theme is that the improvement of the project delivery process would require consultant input and involvement (Levy 2018). Lending support to Deming's philosophy is one of Stephen Covey's The 7 Habits of Highly Effective People: "Seek first to understand, then to be understood." It is essential to reach out and gain insight from the agency's delivery partners to effectively enhance the development process (Covey 2004).

Global feedback from team members that addresses performance, areas for improvement, process impediments, and suggestions to enhance team member efficiency and effectiveness are essential for overall state DOTs improvement. Feedback from state DOTs delivery partners is important, but the agency's feedback to those delivery partners is equally important for system improvement (Santorella 2011). To effectively evaluate an agency's project development process, it is essential to periodically survey organizations (consultants) that provide professional services to the agency to gain insight into enhancing process performance (Schaufelberger 2009).

SCDOT leadership recognized the benefit of obtaining feedback from consultants that have, or currently are, providing professional services to the agency. The researcher worked closely with leadership and the Steering Committee to develop the survey and identify the consultants to be solicited for participation. The study objective, research methodology, findings, and conclusions are presented in the following sections.

6.2. Methodology

6.2.1. Objective

Gathering input was an essential step (see Figure 6.1) in this research effort to gain feedback on the SCDOT's process from professional services consultants providing engineering and consultant services to the agency during project development. The objective for this task of the research was to seek the input of SCDOT's delivery partners, the professional services consultants, to help the agency improve and streamline its PDP.

The PSC survey's primary topics of interest were to gain insight regarding the agency's: a) project development process before construction, and b) procurement and utilization of professional service consultants.

6.2.2. Population and Sampling Frame

The unit of analysis for this consultant survey was "organizations" that were professional services consultants. The target population was professional service consultants that have been, or currently are, providing consultant services for SCDOT's project development process (PDP). The sampling frame for this survey was professional service planners and project developers that are members of the American

Council of Engineering Companies of South Carolina (ACEC-SC). The survey design for SCDOT professional services input was cross-sectional.

Nationally, ACEC represents engineers, architects, land surveyors, and other specialists. This national organization has state chapters across the U.S. To gain membership in the ACEC-SC, firms must be certified by the SC State Board of Registration for Professional Engineers and Surveyors. Firms in ACEC-SC are classified into two different categories: Member firms and Affiliate Members. At the time of this survey, there were 82 Member firms and 17 Affiliate Members.

It was anticipated that many of the firms in the selected population have multiple engineers from the company that have provided services or who are currently engaged to provide PDP services to the agency. Therefore, SC-ACEC member firms were asked to: a) limit their survey response to one per firm and b) provide a survey response that was representative of the collective experience and insight of the firm.

6.2.3. Survey Development and Distribution

Data collection for this task was obtained from a computer-assisted self-administered online survey. A detailed questionnaire containing thirty-three (33) questions were developed for the survey. The questionnaire was subdivided into six primary topics. The first section involved general questions addressing services the firm provides SCDOT, the firm's primary area(s) of operation, number of full-time professional employees, percentage of the firm's annual volume in transportation services (federal/state/local), and the percentage of their transportation services for SCDOT.

The remaining two sections of the questionnaire addressed: a) the state DOT's procurement of professional services consultants, and b) the issues faced after the

award, including execution, expectations, performance, and management of the project development process. PSCs were also asked for suggestions for improvement concerning both sections. The professional services consultant's questionnaire is shown in Table 6.1.

The development of the individual questions was an eight-step process. Similar to the national state DOT survey discussed in Chapter 7, it was developed subsequent to a comprehensive literature review and the SCDOT Exploratory Interviews with forty-four (44) SMEs from twenty-two (22) different functional units within the SCDOT (Figure 6.1).

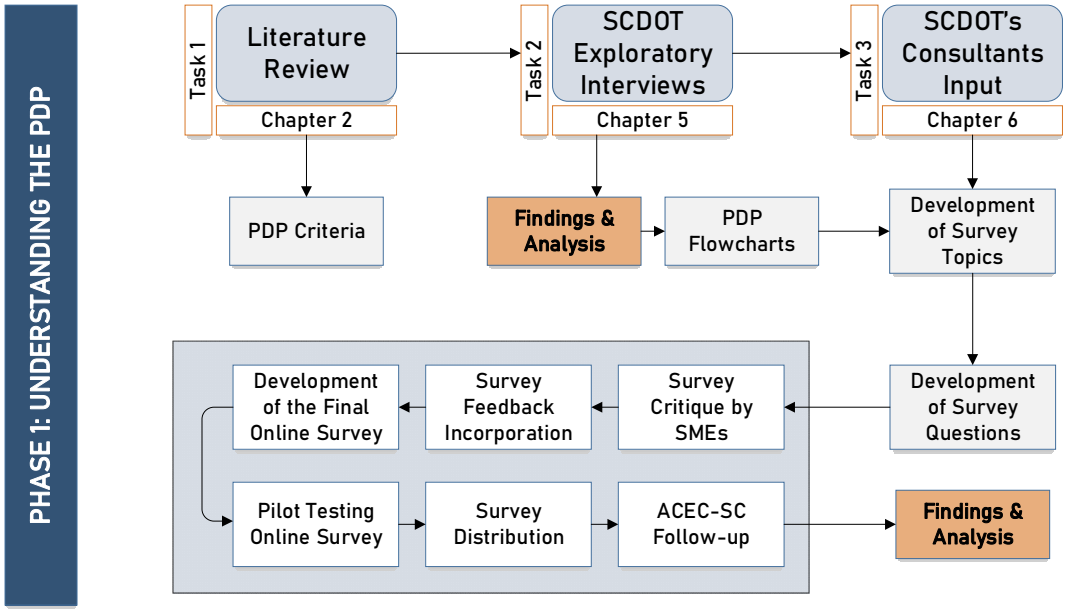


Figure 6.1: Research Methodology Phase 1, Task 3

Once the preceding data was collected, organized, and analyzed, the survey topics and individual questions were developed. This first draft of the questionnaire developed was then subjected to three rounds of critique by subject matter experts from academic,

consulting, and practicing transportation professionals. Comments and suggested edits received during each pass were addressed and incorporated as necessary before each succeeding review. The final draft of the questionnaire was then formatted on an online survey site, and pilot tested. A group of academic professionals, SMEs from the industry, and SCDOT department/functional leaders pilot tested the online survey, and their feedback was addressed before finalizing the online survey.

6.2.3.1. Survey Distribution

A request to distribute the survey was sent to the state chapter of the ACEC by SCDOT's preconstruction department head. The email solicitation provided a brief overview of the survey, the primary topics of interest, approximate time to complete, and the survey link. The initial request, and subsequent distribution by ACEC to their membership, was in March 2020. Additional requests to ACEC members to encourage survey participation were sent in April and early May 2020.

6.3. Findings and Analysis

Most of the survey questions were structured with Likert scale response options to provide interval data for testing. Statistical tests incorporated a confidence level of 95% and t-tests with an $\alpha = .05$, assuming unequal variances were conducted between respondent groupings when appropriate. Table 6.1 shows the survey questions and responses coding that is used for the analysis.

Questions	Code	Response Code				
Type of Services Provided for PDP	Q1	Engineering Design (1)	Specialty Services (2)		Other (3)	
Primary Area of Operation	Q2	National (1)	Southeast Region (2)		South Carolina (3)	
Primary Areas of Operation (Regionally)	Q3		State Name			
Number of Full-time Employees	Q4	1-50 (1)	51-200 (2)	201-500 (3)	501-1000 (4)	>1000 (5)
Annual Volume in Transportation	Q5		Percentage (%)			
Annual Volume of Transportation Work with SCDOT	Q6		Percentage (%)			
		Likert Scale: Level of Frequency (Almost Never-Almost Always)				
Plan development review & comment is prompt.	Q8a	1	2	3	4	5
Review & comment on plan development is effective & efficient.	Q8b	1	2	3	4	5
DOT receptive to deviations in design standards that reduce cost	Q8c	1	2	3	4	5
Interim project milestones are clearly defined.	Q8d	1	2	3	4	5
Payment for services is timely.	Q8e	1	2	3	4	5
Clear and consistent direction is provided during design.	Q9a	1	2	3	4	5
Performance expectations (metrics) are clearly defined.	Q9b	1	2	3	4	5
PDP is transparent & clearly communicated.	Q9c	1	2	3	4	5
Consultants are given regular feedback on performance.	Q9d	1	2	3	4	5
The PDP is consistently administered (managed) from PM to PM.	Q9e	1	2	3	4	5
RFPs are well advertised.	Q12a	1	2	3	4	5
Proposal requirements (level of effort) are reasonable.	Q12b	1	2	3	4	5
Project scope well defined at award.	Q12c	1	2	3	4	5
Project goals/objectives are clearly conveyed prior to award.	Q12d	1	2	3	4	5
Contract negotiations are completed timely.	Q12e	1	2	3	4	5
Project deliverables are consistent from project to project.	Q12f	1	2	3	4	5
		Likert Scale: Level of Agreement/Disagreement (Strongly Disagree–Strongly Agree)				
Preconstruction timelines are appropriate for the services	Q7a	1	2	3	4	5
Preconstruction schedules are regularly monitored and enforced	Q7b	1	2	3	4	5
PSCs are provided with adequate PDP training	Q7c	1	2	3	4	5
Design standards are organized and easily accessible	Q7d	1	2	3	4	5
DOT's file-sharing management system is efficient and user friendly	Q7e	1	2	3	4	5
DOT's schedule software is effectively utilized to plan activities	Q7f	1	2	3	4	5
DOT has sufficient project staff to permit timely response to PSCs	Q7g	1	2	3	4	5
Bundling design advertisements promote procurement efficiency.	Q11a	1	2	3	4	5
Lump-sum contracting would improve efficiency of the delivery.	Q11b	1	2	3	4	5
Prequalification of PSCs for procurement would be beneficial.	Q11c	1	2	3	4	5

Table 6.1: PSCs Survey Questions and Responses Coding for Analysis

6.3.1. Survey Response Rate

Forty-three (43) firms responded to the survey. Ten of the participants provided input for only the 'general' section of the survey. The remaining thirty-three (33) firms substantially completed the questionnaire and provided input regarding the procurement and execution of professional services consultants yielding a 40% response rate for questions structured to permit statistical testing.

6.3.2. Responding Firms Characteristics

Forty-four percent (44%) of the responding firms indicated that they operated nationally, 35% were Southeast regional firms, and 21% limited their area of operation to the SC (Figure 6.2).

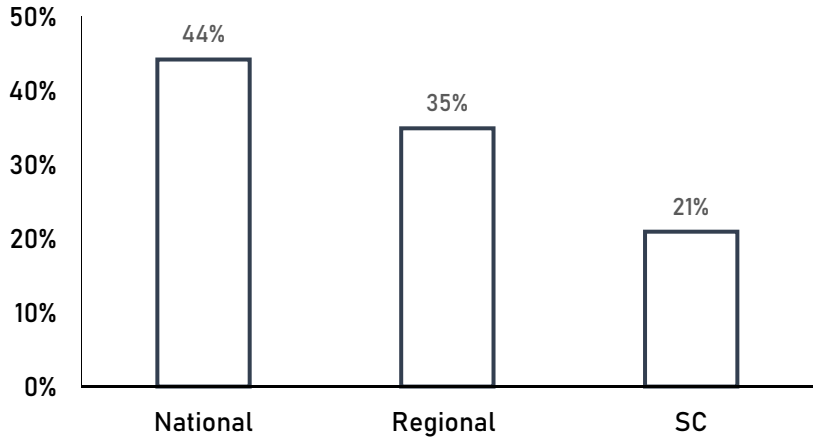


Figure 6.2: PSCs Area of Operation (%)

Eighty-nine percent (89%) of the firms indicating their operation area were national or state offered engineering design services. In comparison, eighty percent (80%) of the regional firms provided engineering design services. Combined, 86% of the respondents performed engineering design services (Table 6.2). Sixteen percent (16.2%)

of the firms providing engineering services also provided 'specialty' services to support design. The vast majority (84%) of the national firms had five hundred or more full-time professional employees, whereas the majority (67%) of state firms had fifty or fewer employees. Regional firms averaged 200 or more professional employees (Table 6.2).

	Firms Percentage (%)			
Type of Services	Combined (Total)	National	Regional	State
Engineering Design	86%	89%	80%	89%
Specialty Services to Support Design	23%	11%	40%	22%
Other	19%	26%	20%	0%
Only Specialty Services to Support Design	9%			
Only Other	5%			
Firm Size				
1-50	17%		7.7%	66.7%
51-200	20%		38.5%	33.3%
201-500	15%	15.8%	23.1%	0%
501-1000	24%	36.8%	23.1%	0%
>1000	24%	47.4%	7.7%	0%
Annual Volume in Transportation	**Average**			
Total (federal, state, local)	63%	56%	79%	62%
South Carolina	25%	13%	61%	26%

Table 6.2: PSCs Type of Services, Firm Size, and Annual Transportation Volume

Respondents were asked to provide the approximate percentage of the firm's annual volume for transportation services on federal, state, or local projects. All of the respondent groups indicated that transportation was their largest market segment. Transportation was 56% of annual volume for national firms, regional 79%, and for state

firms, transportation services averaged 62% of their volume. Respondents were then asked to provide the percentage of their transportation work with SCDOT, and the percentage of their annual volume with the state averaged 25% for all respondents. However, each group's annual transportation work with the state ranged from 13% for national firms to 61% for state firms, with regional firms averaging 26% (Table 6.1).

Survey participants were then asked a series of questions concerning both the SCDOT's procurement of professional services and the agency's management of the project development process post-award. The findings are addressed as follows:

6.3.3. Professional Services Consultants - Procurement (Pre-Award)

The questionnaire asked a series of questions (nine) that focused on professional services consultants' procurement. The investigation topics ranged from the Request for Proposal (RFP) advertisement to contract negotiation and contracting. The first grouping of questions and its descriptive statistics are presented in Table 6.3 and Table 6.4. Table 6.4 provides response options addressing the frequency of the concept or action noted in the question.

Approximately half (48%) of the consultant firms responding to the survey indicated that project RFPs were often or almost always well-advertised. However, greater than half (52%) of the firms indicated that practice was not consistent. They felt that RFPs were well advertised only sometimes, seldom, or almost never.

Consultant opinions regarding proposal requirements (level of effort) were divided into three camps. About a third (35%) felt that the required level of effort for proposal response was often or almost always reasonable. Another third of the respondents thought that requirements were reasonable only sometimes. The remaining

third (32%) felt that the required level of effort for a response was seldom or almost never reasonable.

Question	Descriptive Statistics													
	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Sum	Count	Confidence Level (95%)
	Frequency (respondent)													
Q12a	3.42	0.17	3	3	0.92	0.85	0.43	-0.43	4	1	5	106	31	0.34
Q12b	3.00	0.18	3	4	1.00	1.00	-0.64	-0.21	4	1	5	93	31	0.37
Q12c	3.45	0.14	3	4	0.77	0.59	-0.21	-0.06	3	2	5	107	31	0.28
Q12d	3.45	0.15	4	4	0.81	0.66	-0.39	-0.24	3	2	5	107	31	0.29
Q12e	2.29	0.18	2	2	1.01	1.01	0.56	0.83	4	1	5	71	31	0.37
Q12f	3.32	0.14	3	3	0.79	0.62	1.44	-0.66	4	1	5	103	31	0.29
	Level of Agreement/Disagreement													
Q11a	4.13	0.18	4	5	0.99	0.98	1.54	-1.15	4	1	5	128	31	0.36
Q11b	4.16	0.17	4	5	0.97	0.94	2.10	-1.28	4	1	5	129	31	0.36
Q11c	4.13	0.18	4	5	1.02	1.05	1.02	-1.07	4	1	5	128	31	0.34

Table 6.3: PSCs Procurement Responses Descriptive Statistics

Approximately half of the responding firms thought that project scope and objectives were clearly defined before award. However, many of the firms indicated that project scope and objective were sometimes well-defined (42% and 36%, respectively). A similar disparity was noted for project deliverables. Approximately 42% noted that project deliverables were consistent, whereas almost half indicated that was the case only 'sometimes.'

The procurement question with 'frequency' response options addressed the timeliness of contract negotiations. Two-thirds (68%) of respondents noted that contract negotiations were seldom or almost never completed timely.

Question	Frequency (respondent %)					
	Mean	Almost Never	Seldom	Sometimes	Often	Almost Always
RFPs are well advertised.	3.42	3.2%	9.7%	38.7%	38.7%	9.7%
Proposal requirements (level of effort) are reasonable.	3.00	6.5%	25.8%	32.3%	32.3%	3.2%
Project scope well defined at award.	3.45	0%	9.7%	41.9%	41.9%	6.5%
Project goals/objectives are clearly conveyed prior to award.	3.45	0%	12.9%	35.5%	45.2%	6.5%
Contract negotiations are completed timely.	2.29	19.4%	48.4%	19.4%	9.7%	3.2%
Project deliverables are consistent from project to project.	3.32	3.2%	6.5%	48.4%	38.7%	3.2%
	Level of Agreement/Disagreement (%)					
	Mean	Strongly Disagree	Disagree	Neither Agree or DA	Agree	Strongly Agree
Bundling design advertisements promote procurement efficiency.	4.13	3.2%	0%	22.6%	29.0%	45.2%
Lump-sum contracting would improve efficiency of the delivery.	4.16	3.2%	0%	19.4%	32.3%	45.2%
Prequalification of PSCs for procurement would be beneficial.	4.13	3.2%	0%	25.8%	22.6%	48.4%

Table 6.4: PSCs Procurement Questions and Frequency of Responses

The second grouping of questions presented in Table 6.4 provides response options addressing the level of agreement or disagreement with the question/statement. As summarized in Table 6.4, professional services consultant firms strongly believe that bundling design RFPs would promote procurement efficiency. Almost three-quarters (74%) of the firms agree or strongly agree with this assertion. An even larger percentage of respondents (78%) agree or strongly agree that lump sum contracting would improve the efficiency of the delivery of services. Lastly, close to three-quarters (71%) of the responding firms submit (agree or strongly agree) that the prequalification of Professional Services Consultants for procurement would be beneficial.

6.3.4. Project Development Process – Post Award

The next series of questions on the survey focused on the delivery of professional services and the SCDOTs management of the project development process. Table 6.5 and Table 6.6 summarizes the descriptive statistics, questions, mean response, and the associated consistency (frequency) of agency response and action as viewed by the responding firms.

Approximately one-third (36%) of professional services consultants consider the agency's plan development review & comment as prompt. The remaining two-thirds of the respondents asserted that review and comment were prompt sometimes or seldom. A similar response distribution was provided for consultant assessment of the agency's review's effectiveness and efficiency and comment on plan development. Only one-quarter (25%) of the respondents felt the process was often or almost always effective and efficient. The remaining consultants (75%) submitted that it was effective and efficient only sometimes, seldom, or almost never. Most of the consultant firms (70%) felt that the

agency was sometimes, seldom, or almost never receptive to deviations in design standards that reduced the cost or the impact of the project.

Question	Descriptive Statistics													
	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Sum	Count	Confidence Level (95%)
	Frequency (respondent)													
Q8a	3.33	0.14	3	3	0.82	0.67	-0.1	0.39	3	2	5	110	33	0.29
Q8b	2.88	0.18	3	3	1.01	1.01	-0.24	0.26	4	1	5	92	32	0.36
Q8c	3.06	0.17	3	3	0.97	0.93	0.08	-0.13	4	1	5	101	33	0.34
Q8d	3.48	0.12	4	4	0.71	0.51	-0.13	-0.49	3	2	5	115	33	0.25
Q8e	3.52	0.19	4	4	1.09	1.19	0.03	-0.56	4	1	5	116	33	0.39
Q9a	3.44	0.14	3	3	0.80	0.64	-0.23	0.22	3	2	5	110	32	0.29
Q9b	3.25	0.17	3	3	0.95	0.90	0.86	-0.30	4	1	5	104	32	0.34
Q9c	3.31	0.18	3	3	1.00	1.00	0.36	-0.48	4	1	5	106	32	0.36
Q9d	3.19	0.15	3	3	0.86	0.74	0.71	-0.06	4	1	5	102	32	0.31
Q9e	2.81	0.16	3	3	0.90	0.80	0.24	0.11	4	1	5	90	32	0.32
	Level of Agreement/Disagreement													
Q7a	3.69	0.13	4	4	0.74	0.54	0.89	-0.96	3	2	5	118	32	0.27
Q7b	3.61	0.14	4	4	0.83	0.68	-0.12	-0.54	3	2	5	119	33	0.29
Q7c	2.82	0.18	3	2	1.01	1.03	-0.29	0.39	4	1	5	93	33	0.36
Q7d	3.94	0.15	4	4	0.86	0.74	0.47	-0.81	3	2	5	130	33	0.31
Q7e	3.79	0.16	4	4	0.89	0.79	0.01	-0.68	3	2	5	125	33	0.32
Q7f	3.00	0.16	3	3	0.90	0.81	-0.45	0	4	1	5	99	33	0.32
Q7g	3.21	0.20	3	4	1.17	1.36	-0.65	-0.31	4	1	5	106	33	0.41

Table 6.5: PSCs PDP Responses Descriptive Statistics

A majority (55%) of the consultants supported the assertion that interim project milestones were clearly defined. A smaller number (44%) of the consulting firms felt that

clear and consistent direction during design was often or almost always provided. A similar percentage (44%) of participating firms thought the preconstruction development process was transparent and clearly communicated to professional services consultants. However, for transparency/consistency of the process and clear/consistent direction during design, the remaining (56%) consultants indicated the situation only sometimes, seldom, or almost never.

A majority (55%) of the consulting firms considered payment for their professional services to be often or almost always timely. However, close to one-third (30%) of the consultants submitted that payment was timely, sometimes, with the remaining firms (15%) noting that payment was seldom or almost never timely.

For both the clarity of performance expectations and the regularity of feedback regarding their performance, consulting firms had a similar response distribution. Approximately one-third of the respondents felt that performance expectations were clearly defined, and they were provided regular feedback, often or almost always. However, greater than half (53%) of the firms indicated that was the case just sometimes, and the remaining (13%-16%) advised it happened seldom or almost never.

The last question in Table 6.6 addressed the project development process's consistency of Project Manager (PM) administration (management). The feedback was that less than one-fifth (19%) of the consultant firms felt that the PDP was consistently managed from PM to PM. Almost one-half (47%) indicated that was their experience sometimes. The remaining one-third (34%) noted that the consistency of PDP management PM to PM was seldom or almost never their experience.

Question	Frequency (respondent %)					
	Mean	Almost Never	Seldom	Sometimes	Often	Almost Always
Plan development review & comment is prompt.	3.33	0%	12.1%	51.5%	27.3%	9.1%
Review & comment on plan development is effective & efficient.	2.88	6.3%	31.3%	37.5%	18.8%	6.3%
DOT receptive to deviations in design standards that reduce cost & impact;	3.06	6.1%	18.2%	45.5%	24.2%	6.1%
Interim project milestones are clearly defined.	3.48	0%	9.1%	36.4%	51.5%	3.0%
Payments for services are timely.	3.52	6.1%	9.1%	30.3%	36.4%	18.2%
Clear and consistent direction is provided during design.	3.44	0%	9.4%	46.9%	34.4%	9.4%
Performance expectations (metrics) are clearly defined.	3.25	6.3%	6.3%	53.1%	25.0%	9.4%
Preconstruction development process is transparent & clearly communicated.	3.31	6.3%	9.4%	40.6%	34.4%	9.4%
Consultants are given regular feedback on performance (> than semi-annually).	3.19	3.1%	12.5%	53.1%	25.0%	6.3%
The PDP is consistently administered (managed) from PM to PM.	2.81	6.3%	28.1%	46.9%	15.6%	3.1%

Table 6.6: PSCs PDP Questions and Frequency of Responses

The next series of survey questions that also focused on post-award activities had response options requesting the respondent to indicate their level of agreement/disagreement with a statement (Table 6.7). The first three questions centered on preconstruction schedules.

Consultants overwhelmingly agreed or strongly agreed (75%) with the statement that 'preconstruction timelines are appropriate for the services provided. In addition,

almost two-thirds (64%) felt that preconstruction schedules were regularly monitored and enforced. However, only 30% of consultants thought that the agency's scheduling software was effectively utilized to plan preconstruction activities. Conversely, a similar percentage of respondents (27%) indicated that the software was ineffective while the remaining participants were undecided.

Question	Level of Agreement/Disagreement (%)					
	Mean	Strongly Disagree	Disagree	Neither Agree or DA	Agree	Strongly Agree
Preconstruction timelines are appropriate for the services	3.69	0%	9.4%	15.6%	68.8%	6.3%
Preconstruction schedules are regularly monitored and enforced	3.61	0%	12.1%	24.2%	54.5%	9.1%
PSCs are provided with adequate PDP training	2.82	6.1%	39.4%	30.3%	18.2%	6.1%
Design standards are organized and easily accessible	3.94	0%	9.1%	12.1%	54.5%	24.2%
DOT's file sharing management system is efficient and user friendly	3.79	0%	12.1 %	15.2%	54.5%	18.2%
DOT's schedule software is effectively utilized to plan preconstruction activities	3.00	3.0%	24.3%	42.3%	27.3%	3.0%
DOT has sufficient project staff to permit timely response to consultants	3.21	9.1%	18.2%	33.3%	36.4%	12.1%

Table 6.7: PSCs PDP Questions and Level of Agreement/Disagreement of Responses

One quarter (24%) of the participating professional services consultant firms felt they were provided adequate training regarding the agency's PDP. However, close to half (46%) of the firms felt that training was insufficient. There was strong support (79%) that design standards were organized and easily accessible. In addition, almost three-

quarters (73%) of the consultants submit that the agency's file-sharing management system was efficient and user-friendly.

The last question addressed agency resources. Almost half (49%) of the consultant firms agreed (or strongly agreed) that the agency had sufficient project staff to permit timely response to consultants. However, more than a quarter (27%) felt staffing was insufficient, and the remaining one-third of respondents were undecided.

The online survey also asked respondents for suggestions to improve the state DOT's project development process. The following is a summary of the comments received.

6.3.5. Statistical Significance

For all the variables (questions) in the PSCs questionnaire, a t-test was conducted to determine if there is a significant difference between the means of National operating and Regional/Local operating consultants. For many variables, the t-test for two samples assuming unequal variances resulted in no significant difference between the means of National and Regional/Local PSCs (not enough evidence to reject the null hypothesis). However, Table 6.8 presents the variables that the t-test resulted in determining a significant difference between the two groups' means. The distributions of these variables are shown in Figure 6.3.

The t-test concluded a significant difference among national and regional/local PSC firms concerning questions (variables) Q8a, Q8b, Q8c, and Q11c. The t-test concluded that national professional services consultants' firms more frequently view that SCDOT's review and comment on plan development are prompt. It was also concluded that national PSC firms more frequently view that SCDOT's review and comment on plan

development are efficient and effective. The national PSC firms also more frequently view that SCDOT is receptive regarding deviations to design standards, which can reduce cost and reduce impact. Finally, the national PSC firms more strongly believe that a prequalification process for procurement of professional services would be beneficial.

Variable	Level	Count (N)	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
		Means and Standard Deviations					
Q8a	N	15	3.60	0.91	0.24	3.10	4.10
	R/L	18	3.11	0.68	0.16	2.77	3.45
Q8b	N	15	3.20	1.08	0.28	2.60	3.80
	R/L	17	2.59	0.87	0.21	2.14	3.04
Q8c	N	15	3.40	0.91	0.24	2.90	3.90
	R/L	18	2.78	0.94	0.22	2.31	3.25
Q11c	N	14	4.50	0.85	0.23	4.01	4.99
	R/L	17	3.82	1.07	0.26	3.27	4.38

t-Test: National – Regional/Local (assuming unequal variances)							
Q8a				Q8b			
Difference	-0.49	t Ratio	-1.72	Difference	-0.61	t Ratio	-1.75
Std Err Dif	0.28	DF	25	Std Err Dif	0.35	DF	27
Upper CL Dif	0.096	Prob > |t|	0.0973	Upper CL Dif	0.107	Prob > |t|	0.0921
Lower CL Dif	-1.073	Prob > t	0.9513	Lower CL Dif	-1.33	Prob > t	0.9540
Confidence	0.95	Prob < t	0.0487	Confidence	0.95	Prob < t	0.0460
Q8c				Q11c			
Difference	-0.62	t Ratio	-1.92	Difference	-0.68	t Ratio	-1.95
Std Err Dif	0.32	DF	30	Std Err Dif	0.35	DF	29
Upper CL Dif	0.038	Prob > |t|	0.0638	Upper CL Dif	0.032	Prob > |t|	0.0607
Lower CL Dif	-1.283	Prob > t	0.9681	Lower CL Dif	-1.385	Prob > t	0.9697
Confidence	0.95	Prob < t	0.0319	Confidence	0.95	Prob < t	0.0303

Table 6.8: t-Test, PSCs National and Regional/Local Means

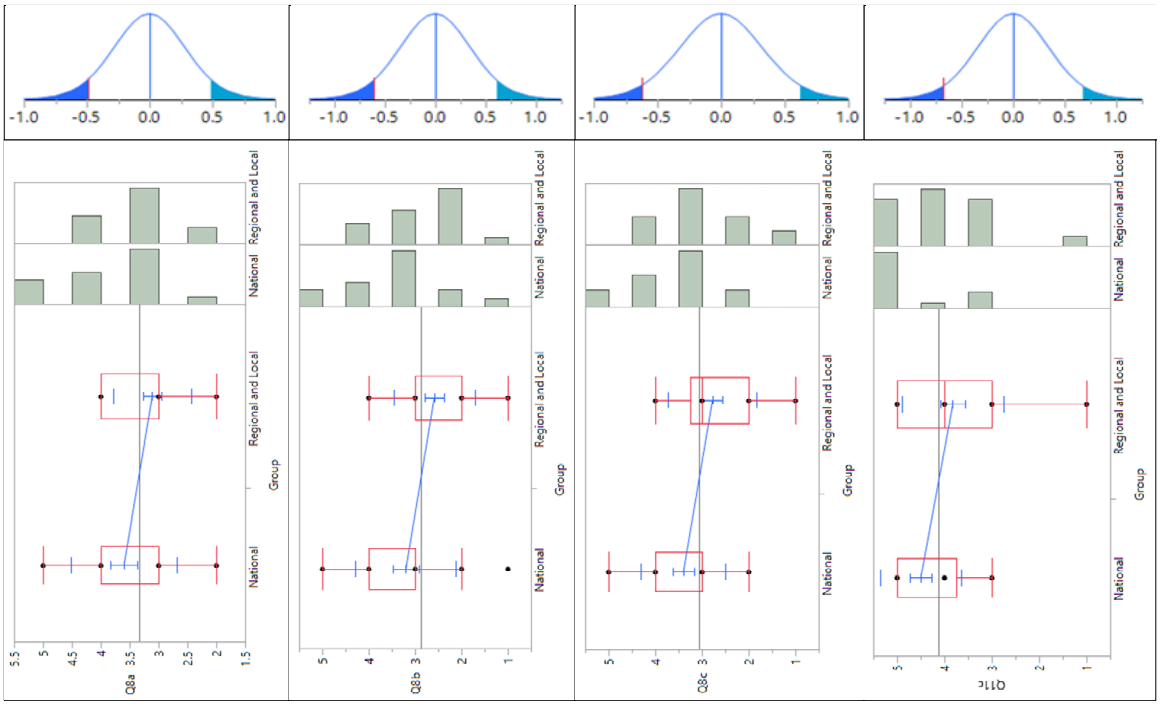


Figure 6.3: PSC Variables (Groups) t-test Distribution

6.3.6. Areas for Improvement

6.3.6.1. Design Standards and Plan Review

- Better communication is needed between Preconstruction Support and Preconstruction. Decisions made by Program Managers (PM) and design staff in the Regional Program Groups that affect design and deliverables are often not communicated to Preconstruction Support, resulting in many unnecessary review comments.
- The quality Assurance (QA) process needs to be streamlined and made less cumbersome. QA process needs refinement and consistency across the board.
- When plans are submitted for review to SCDOT, the PM should consolidate all comments from every department, vet each comment for consistency, and

provide one combined comment matrix for the consultant to address. In the event that comments from SCDOT conflict with one another, the PM should determine the correct course of action before forwarding said comments to the consultant.

- Review comments are not consistent as new reviewers are of different opinions and do not read back through old comments and resolutions. This causes a lot of wasted time by the consultant.
- The agency needs to allow for more engineering judgment and innovation from the consultant engineers performing the design.
- Hold projects completed by consultants to the same standard of care and completeness as those prepared by state DOT.
- Address design intent: if the notes or message conveyed by the plans is clear enough to be built by a contractor, the consultant should not be required to match exactly plans prepared by the department.
- Design memos are difficult to keep up with mid-stream in design.

6.3.6.2. Procurement

- The procurement timeframe for PSCs is too long.
- Project budget restraints encourage procurement to manipulate scope and fee to get to a fee number that could be approved by leadership. Some of these budget expectations are unrealistic and will eventually require a contract modification.
- The two-tier selection process being implemented appears to be disingenuous and is used to protect the department from scrutiny and is an unfair penalty for more qualified teams.

- The average overhead provision being implemented penalizes specialty and smaller companies that have larger overhead. This practice discourages the use of small and medium-sized businesses.
- A small fixed fee coupled with a cost-plus max contract and scope/fee manipulation leads to a tough business model that is difficult to maintain.
- PMs should be prepared to identify if the low-volume design criteria apply to the project when the scoping meeting is held. Currently, most projects are being scoped based upon typical design criteria as a worst-case approach, and then less scope is performed when and if the PM makes the low volume determination.
- The extent of budget detail required leads to excessive micro-management of the project budget during execution.

6.3.6.3. Management of the PDP

- Inconsistency between Regional Program Groups & PMs regarding how contract modifications for performing out of scope work is addressed. Some RPG contract modifications for performing out-of-scope work are unacceptable/unfair.
- Sometimes it feels like the PM doesn't quite know the PDP. They struggle in making decisions without getting advice from upper management, which slows the process and affects the timely delivery of the project. Now that the "One Decision" environmental process has been initiated, this action needs to be included in the process.
- A project development process manual, if it exists, needs to be shared with consultants.

- Lack of agency standards and training yields inconsistencies between Regional Program Groups.
- Need to improve the consistency between Regional Program Groups and project managers for consultant performance evaluation.

6.4. Conclusions

Conclusions supported by the survey data received from Professional Services Consultant firms for both procurements of PSCs and management of the project development process include the following:

6.4.1. Procurement of Professional Services Consultants (PSC)

Professional Services Consulting firms thought that the agency's Requests for Proposal (RFP) were not consistently well-advertised. Besides, only about one-third (35%) of the consulting firms felt that the level of effort required for proposal response was typically (often) reasonable. The majority of consultants believed that the project scope and goals were well-defined. However, they considered project deliverables to be inconsistent from project to project. In addition, one of the strongest assertions shared by consulting firms was that the procurement timeframe was too long.

There was strong support from PSCs for the bundling of design RFPs to promote procurement efficiency. Also, most consulting firms suggest that prequalification of PSCs would be beneficial to reduce the timeframe of the procurement process. Also, a majority of professional services consultants believe that lump sum contracting improves the efficiency of professional services delivery.

6.4.2. Management of the Project Development Process

Approximately one-third (36%) of the consultants considered plan review and comment during design development to be prompt (often). Similarly, one quarter (25%) of all consultants thought the review process was often effective and efficient. However, consultants felt that agency staffing was sufficient for a timely response. Also, PSCs thought that agency design standards were organized and accessible and considered the agency's file-sharing system to be efficient and user-friendly. Preconstruction timelines were considered appropriate, but performance expectations were viewed as inconsistent.

There was agreement among PSCs that project schedules were regularly monitored. Conversely, they thought that the agency's software application was ineffective for the management of the preconstruction activities. Besides, PSCs considered PDP training for consultants to be inadequate. Lastly, a consistent and recurring theme from professional services consulting firms was that the PDP management was inconsistent from project manager to project manager.

CHAPTER SEVEN

PHASE 2: NATIONAL STATES' DEPARTMENT OF TRANSPORTATION INPUT

This chapter discusses, describes, and presents the research methodology, Phase 2-Task 4, the States' Department of Transportation input concerning Project Development Process (PDP), alongside its findings and analysis (see Figure 4.1).

7.1. Introduction

This research phase's primary objectives were to gain insight concerning the state DOTs' preconstruction PDP and the use of Professional Services Consultants (PSC). This phase presents the methodology, findings, and analysis of a national state DOT survey to gain insight concerning a) the preconstruction PDP of state DOTs, b) state DOTs input on PDP to identify effective and efficient practices, c) the trend of PDP practices among state DOTs to improve their performance, and d) state DOTs professional services consultants procurement and utilization.

Phase 3-Task 4 (Figure 4.1) presents the developing, distributing, and collecting data from all state DOTs utilizing a computer-assisted self-administered questionnaire. The targeted population is the States Department of Transportation. The targeted respondent(s) for each state DOT is an individual(s) with knowledge and agency responsibility for the PDP and PSC. Information obtained from the literature review, previous phase, and tasks of this research concerning PDP criteria, dimensions, and practices formed the basis of the questions in the questionnaire. The computer-assisted self-administered questionnaire was developed and sent to all 50 states via an online service. The questionnaire predominately contained a five-point Likert Scale (interval

data). Several questions, such as background information, were open-ended and short answers (nominal data). Anonymity was offered to the respondents.

A detailed description of the methodology, findings, and analysis of the national state DOTs survey is discussed below.

7.2. Methodology

7.2.1. Objective

The primary objectives of this phase (survey) were to gain insight concerning: a) the preconstruction PDP of state DOTs, b) state DOTs input on PDP to identify effective and efficient practices, c) the trend of PDP practices among state DOTs to improve their performance, and d) state DOTs professional services consultants procurement and utilization.

7.2.2. Population and Sampling Frame

The population selected for this survey was all 50 state DOTs throughout the US. Specifically, the targeted participation was department leadership and Subject Matter Experts (SMEs) within each state DOT involved in, and knowledgeable of, the agency's preconstruction PDP and their utilization of PSCs. Because of this survey's scope, state DOTs were advised that two or more respondents (SMEs) from their agency may be necessary to complete the investigative survey.

7.2.3. Survey Development and Distribution

This phase's data collection was from a self-administered online survey containing forty-eight (48) questions that were subdivided into six primary topics. The

first section involved general questions concerning the state DOT, such as location, organizational structure, overall use of professional service consultants, and agency's responsibility for preconstruction development activities. Additional sections addressed scheduling/planning, project scope, performance evaluation, development activities and timeframes, and professional service consultants' utilization and management. The state DOTs survey questionnaire is shown in Table 7.1.

The development of the individual questions was a multi-step process (Figure 7.1). To gain insight into project development for transportation projects, the researcher initiated the process by conducting a comprehensive literature search. Subsequent to that investigation, the researcher interviewed forty-four (44) SMEs from twenty-two (22) different functional units from the SCDOT.

Once the knowledge base was established, the questionnaire topics and individual questions were developed. This initial questionnaire was reviewed and critiqued by academics and transportation professionals. Subsequently, the comments/suggestions were addressed, and the updated questionnaire was posted to an online survey site. This questionnaire was then pilot tested by six state DOT department/functional leaders, four SMEs, an industry consultant, and four academic professionals with transportation experience and PDP knowledge. Feedback received was incorporated, and the final survey was posted online.

7.2.3.1. Survey Distribution

A request to complete the survey was then sent from the SCDOT research department to each of the 50 state DOTs contact individuals, as noted in the AASHTO RAC membership listing. The email solicitation provided a brief overview of the survey, the

primary topics of interest, approximate time to complete, and the survey link. The initial distribution was late March 2020, with a follow-up sent approximately five weeks later and a third solicitation distributed in early May.

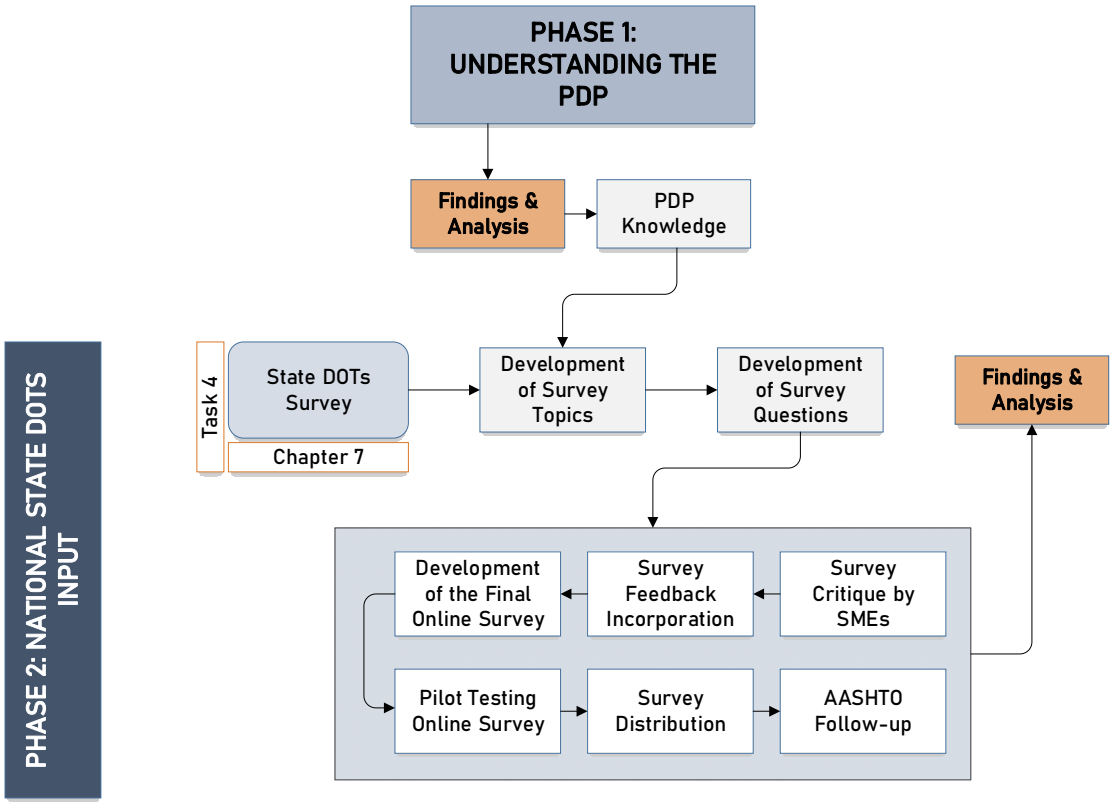


Figure 7.1: Research Methodology Phase 2, Task 4

7.3. Findings and Analysis

The general information and open-ended questions of the survey typically provided nominal data. However, most of the remaining questions were structured to provide interval data using a Likert Scale. When the data type permitted, responses were subjected to statistical means testing using a confidence level of 95%. In addition, t-tests with an $\alpha = .05$ assuming unequal variances were conducted between various respondent

groupings. Table 7.1 presents the survey questions and responses coding used for the analysis.

Questions	Code	Response Code					
State DOT	Q1	State Name					
Respondent role and responsibility	Q2	Preconstruction Director (1)	Project Manager (2)	Project Control (3)	Design Manager (4)	PSP Manager (5)	Other (6)
State DOT preconstruction organizational structure	Q3	Centralized (1)		Decentralized (2)		Hybrid (3)	
State DOT organization to manage individual projects	Q4	Discipline (1)	Project Type (2)	Geo/Region (3)	Funding Source (4)	Other (5)	
Overall responsibility of PDP activities timely delivery in state DOT	Q5	Preconstruction Director (1)	Design Manager (2)	Program/Project Manager (3)	Other (4)		
Percentage of transportation projects developed by PSCs	Q6	Percentage (%)					
The trend of use of Professional Services Consultants	Q7	Decreasing (1)		Steady (2)		Increasing (3)	
Variation of PSCs use based on project type	Q8	YES (1)			NO (2)		
Development of State Environmental Process (SEPA)	Q10	YES (1)			NO (2)		
Utilization of management consultants	Q24	YES (1)			NO (2)		
		Likert Scale: Level of Agreement/Disagreement (Strongly Disagree–Strongly Agree)					
Preconstruction schedules are developed once PE is approved	Q11a	1	2	3	4	5	
Preconstruction schedules are regularly monitored and updated	Q11b	1	2	3	4	5	
Preconstruction project milestones are clearly defined	Q11c	1	2	3	4	5	
Tracking project performance metrics reduce PDP timeline	Q15	1	2	3	4	5	
Adequate PDP training for PSC is provided	Q21a	1	2	3	4	5	
Design standards are well organized and easily accessible	Q21b	1	2	3	4	5	
Use of PSCs are more cost-effective than in-house design services	Q21c	1	2	3	4	5	
Use of PSCs reduces the preconstruction PDP timeframe of projects	Q21d	1	2	3	4	5	
		Likert Scale: Level of Frequency (Almost Never-Almost Always)					
Project scopes are developed by a cross-functional team of SMEs	Q12a	1	2	3	4	5	
Project scope is clearly defined when PE funds are added to STIP	Q12b	1	2	3	4	5	
Changes in initial scope to the extent that STIP needs revision	Q12c	1	2	3	4	5	
Development of a formal project scoping document prior to placement of the project PE funds in the STIP	Q12d	1	2	3	4	5	

Table 7.1: State DOTs' Survey Questions and Responses Coding for Analysis

Questions	Code	Response Code				
		Likert Scale: Level of Frequency (Almost Never-Almost Always)				
Suggestions for deviations to design standards that could reduce cost and impact	Q12e	1	2	3	4	5
How frequently is each of the following activities the primary factor controlling the schedule between R/W & Construction Authorization	Q18					
Completion of Project Design/Plan Development	Q18a	1	2	3	4	5
Right of Way Acquisition	Q18b	1	2	3	4	5
Utility Relocation	Q18c	1	2	3	4	5
Permitting	Q18d	1	2	3	4	5
Compare and evaluate PSCs vs in-house schedule performance	Q23a	1	2	3	4	5
Compare and evaluate the cost of PSCs services vs in-house	Q23b	1	2	3	4	5
PSCs interim and final milestones are clearly defined	Q23c	1	2	3	4	5
Bundling of design advertisements for selection of multiple PSCs	Q23d	1	2	3	4	5
Lumpsum contracting for design services	Q23e	1	2	3	4	5
Prequalification of design consultants	Q23f	1	2	3	4	5
Use of 'On-call/IDIQ/Continuing' PSCs for project design services	Q23g	1	2	3	4	5
PSCs selection, negotiation, and contracting is completely timely	Q23h	1	2	3	4	5
Precon. project deliverables are similar for both in-house and PSCs	Q23i	1	2	3	4	5
Frequency of state DOT's utilization of Management Consultants	Q25	1	2	3	4	5
		Likert Scale: Level of Effectiveness (Not Effective-Extremely Effective)				
How effective are the following actions in reducing the time required for Design consultant procurement?	Q26					
Development of a well-defined project scope prior to advertisement	Q26a	1	2	3	4	5
Prequalification of consultants	Q26b	1	2	3	4	5
Standardized estimating/scoping templates	Q26c	1	2	3	4	5
Tracking key performance milestones of the procurement process	Q26d	1	2	3	4	5
Reduction of the number and time required for internal approvals	Q26e	1	2	3	4	5
Contracting with the consultant lumpsum	Q26f	1	2	3	4	5
Tacking of Preconstruction PDP performance metrics/milestones	Q13	List of Multiple Selection Choices				
Freq. Compare actual vs. baseline (schedule) project performance	Q14	Never (1)	Yearly (2)	Quarterly (3)	Monthly (4)	Other (5)
Average PDP activities timeframe from PE to R/W for CE projects	Q16	Bridge Replacement (1)		Roadway Widening (2)		Interstate Improvement (3)
Average PDP activities timeframe from PE to R/W for EA projects	Q17	Bridge Replacement (1)		Roadway Widening (2)		Interstate Improvement (3)
Avg. Timeframe between 100% Construction Plans and Bids Received	Q19	Time (Months)				
Avg. Timeframe from Advertisement to NTP for PSCs' procurement	Q22	Time (Months)				

Table 7.1 (Continued): State DOTs' Survey Questions and Responses Coding for Analysis

7.3.1. Survey Response

Thirty-six (36) of the fifty state DOTs responded to the survey yielding a response rate of 72%. The distribution of state DOTs participating in the survey provides support for a broad national representation (Figure 7.2).

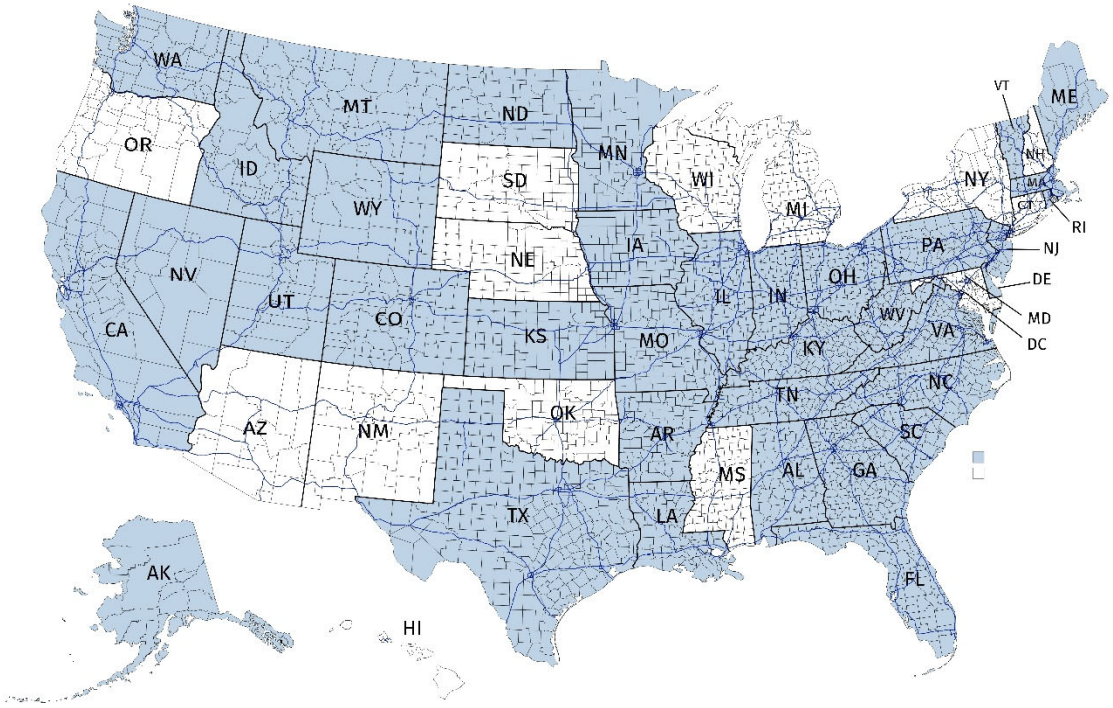


Figure 7.2: State DOTs Participating in the Survey

Forty (40%) of the respondents were a preconstruction director, five (14%) were from project management, six (17%) design managers, one (3%) from project controls, one (3%) was a PSP manager, and nine (25%) indicated other. The 'other' group included senior agency managers classified as chief engineer, district engineer, director of program delivery, manager of project delivery, and project management director (Figure 7.3).

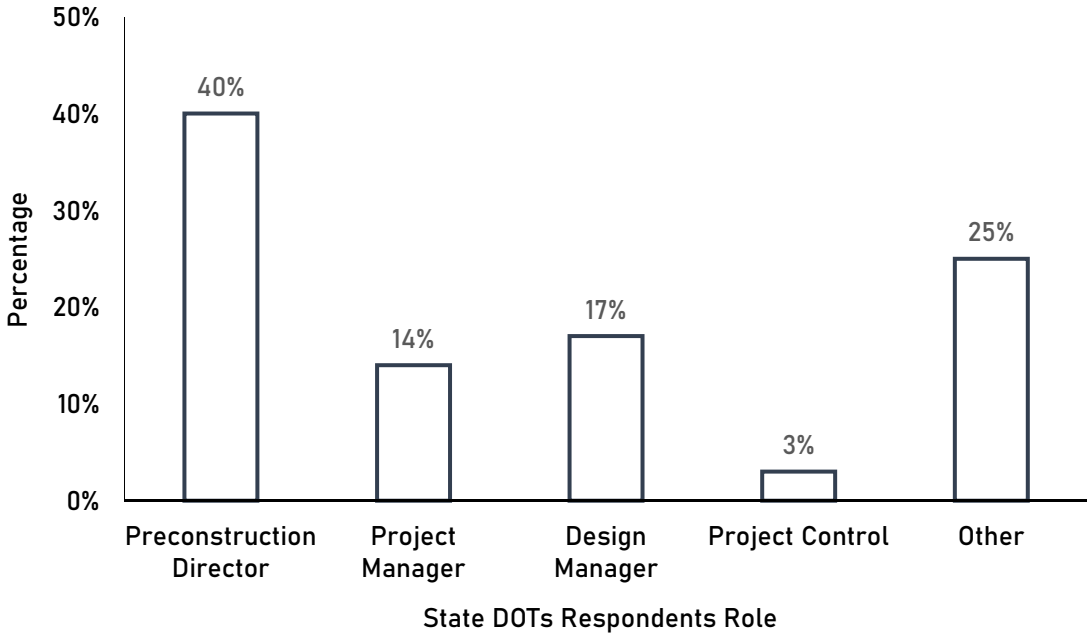


Figure 7.3: Survey Respondents Roles and Responsibilities (%)

7.3.2. General State DOTs Information

7.3.2.1. Organizational Structure

Survey participants were asked if centralized, decentralized, or hybrid best described their general state DOT preconstruction organizational structure (Figure 7.4). Forty percent (40%) selected centralized, 20% decentralized, and 40% selected hybrid. Probing deeper, respondents were then asked to identify how the state DOT was organized to manage individual projects. The most frequent response was by geography/region at 43%. About a quarter (26%) of the state DOTs selected by 'discipline,' and 14% noted by 'project type.' None of the respondents selected 'funding source.' The remaining 17% of the state DOTs provided various options, with most noting a combination of factors, including project type and complexity.

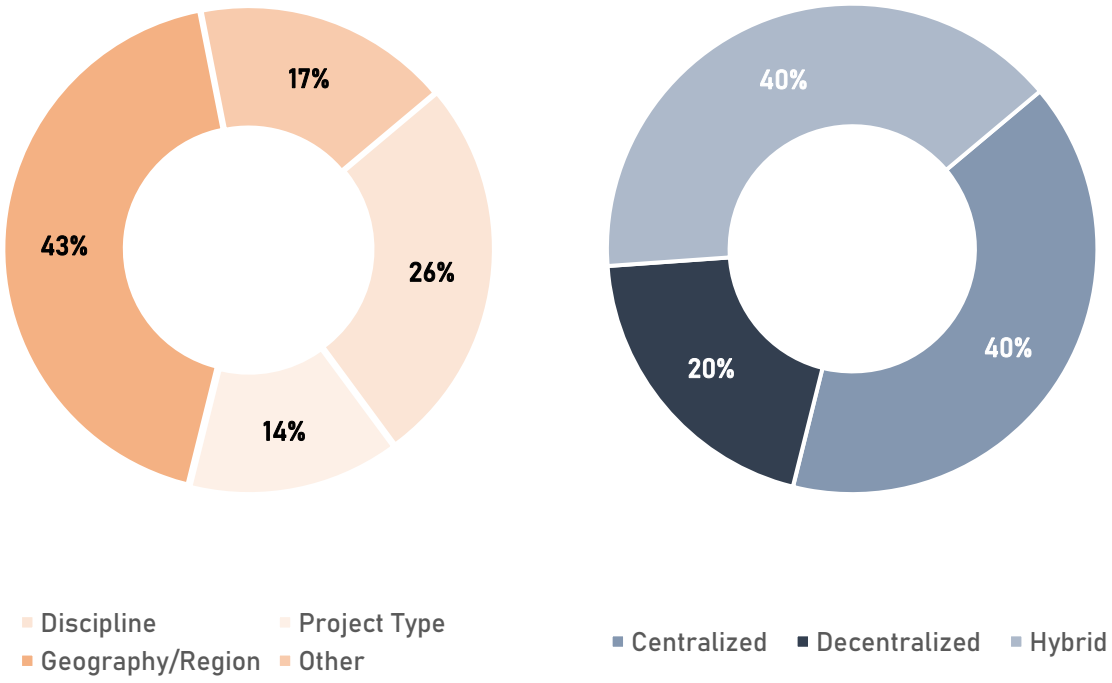


Figure 7.4: State DOTs Preconstruction Department and Management Organization

7.3.2.2. Timely completion

One-half (50%) of the state DOTs indicated that their project manager had overall responsibility for the timely delivery of preconstruction activities. Fourteen percent (14%) noted that responsibility rested with their preconstruction head, but only one state DOT selected design management. The remaining state DOTs (28%) provided responses, including regional engineer(s), district engineer(s), director of program delivery, district director, and technical services division.

7.3.2.3. Use of Design Consultants

State DOTs were asked the percentage of their transportation projects that had design development performed by professional services consultants. Responses ranged

from 20% to 95%, with an average of 54% of their design contracted to design consultants. The distribution of responses is shown in Figure 7.5. In addition, 37% of the state DOTs indicated their use of consultants was increasing, and 63% noted their use of consultants was steady. None of the state DOTs indicated their consultant use was decreasing.

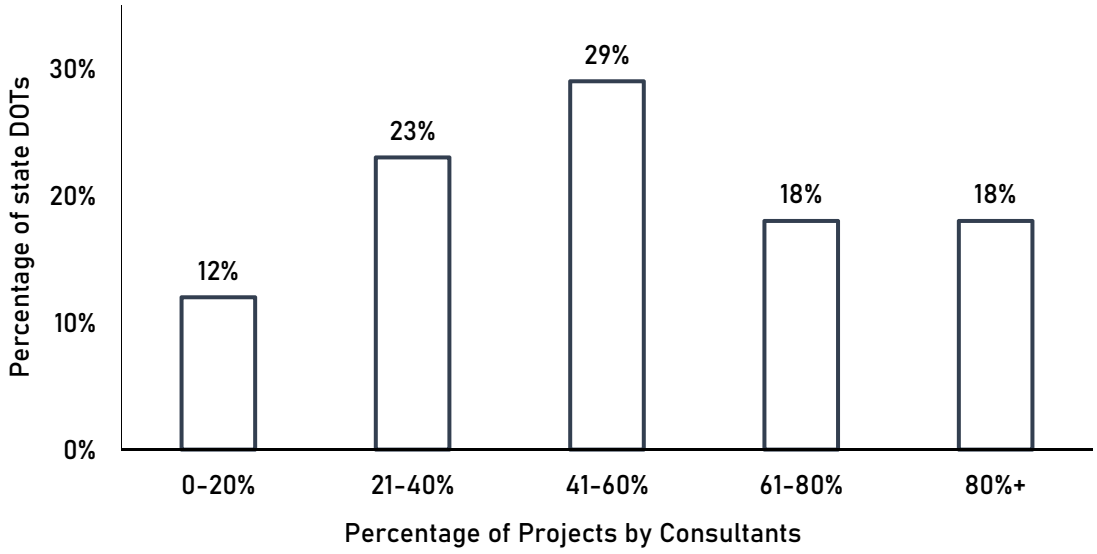


Figure 7.5: State DOTs Percentage of Projects by PSCs

Respondents were also asked if their use of design consultants varied based upon the project type, and fifty-three percent (53%) answered affirmatively. When asked why, most noted that complex, large, unique, and specialty projects were primarily contracted out to consultants. Many remarked that as the complexity of the project increased, the use of consultants correspondingly increased. Another common response was that use was necessary when the agency did not have the in-house expertise or the resource capacity needed for timely completion of the project.

7.3.3. Project Scheduling

This section of the survey asked questions concerning when project schedules were prepared, if they were regularly monitored, and if milestones were clearly identified. Response options were provided on a 5-point interval scale ranging from strongly disagree to strongly agree.

A strong majority of respondents indicated that their agency developed preconstruction schedules once Preliminary Engineering (PE) funds were approved, that schedules were regularly monitored, and they had clearly defined milestones. The mean response for all three questions was greater than 4 (out of 5). Eighty-three percent (83%) selected agree or strongly agree with the statements that they developed detailed schedules once PE funds were approved and that schedules were regularly monitored and updated. Nearly all the respondents (86%) noted that milestones were clearly identified in their project schedules. Table 7.2 shows the descriptive statistics and percentages of responses concerning project schedules.

7.3.4. Project Scoping Process

Survey participants were presented with a series of questions concerning their project scoping practices. Table 7.3 identifies each question's theme, the mean response, descriptive statistics, and the frequency of each response. As noted in Table 7.3, response options ranged from 'almost never' to 'almost always.'

Two-thirds (67%) of state DOTs participating in the study often, or almost always, developed project scopes with a cross-functional team of the agency's SMEs. Similarly, two-thirds indicated that they often or always clearly defined project scope when PE funds were added to the State Transportation Improvement Plan (STIP). However, less

than half (47%) of the responding state DOTs developed a formal project scoping document prior to placement of funding requirements for PE in the STIP. Twenty-two percent (22%) of the state DOTs had to revise the STIP 'often' because of project scope change(s), and 31% needed to revise their STIP 'sometimes.'

Question	Descriptive Statistics												
	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Sum	Count
	Level of Agreement/Disagreement												
Q11a	4.14	0.15	4	4	0.90	0.81	3.48	-1.53	4	1	5	149	36
Q11b	4.22	0.12	4	4	0.72	0.52	-0.95	-0.37	2	3	5	152	36
Q11c	4.22	0.13	4	4	0.76	0.58	0.63	-0.82	3	2	5	152	36
	Respondent (%)												
	Strongly Disagree		Disagree		Neither Agree or DA		Agree		Strongly Agree				
Q11a	2.8%		5.6%		8.3%		47.2%		36.1%				
Q11b	0%		0%		16.7%		44.4%		38.9%				
Q11c	0%		5.6%		8.3%		47.2%		38.9%				

Table 7.2: Project Scheduling Responses Descriptive Statistics and Percentages

A comparative analysis of the responses yielded additional insight. Eighty percent (80%) of the state DOTs that 'almost always' develop a formal scoping document also submit that their agency clearly defines project scope often or almost always when PE funding is added to their STIP. A corresponding high percentage (62%) of state DOTs that seldom or almost never develop a formal scoping document also believe that their state

DOT clearly defines project scope (often or always) when PE funding is added to their STIP. However, when considering the frequency of STIP revision, there is some disparity. Only 12% of the state DOTs that almost always developed a formal scoping document needed to revise their STIP often because of a project scope change. However, almost half (46%) of the state DOTs that seldom or almost never developed a formal scoping document often had to revise their STIP.

Question	Descriptive Statistics												
	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Sum	Count
	Level of Frequency												
Q12a	4.00	0.16	4	5	0.96	0.91	-1.00	-0.42	3	2	5	144	36
Q12b	3.83	0.17	4	4	1.03	1.06	1.35	-0.98	4	1	5	136	36
Q12c	2.64	0.16	3	2	0.96	0.92	-0.94	-0.01	3	1	4	95	36
Q12d	3.31	0.23	3	2	1.37	1.88	-1.37	-0.10	4	1	5	119	36
Q12e	3.36	0.15	4	4	0.90	0.81	-0.95	-0.31	3	2	5	121	36
	Respondent (%)												
	Almost Never		Seldom		Sometimes		Often		Almost Always				
Q12a	0%		6%		28%		28%		39%				
Q12b	6%		0%		28%		39%		28%				
Q12c	11%		36%		31%		22%		0%				
Q12d	8%		28%		17%		19%		28%				
Q12e	0%		25%		22%		47%		6%				

Table 7.3: Project Scoping Responses Descriptive Statistics and Percentages

7.3.5. Performance Evaluation

The next section of the questionnaire investigated PDP performance evaluation. The initial question asked if their state DOT regularly tracked the preconstruction project performance metrics/milestones noted in Figure 7.6. The metrics/milestones that 75% or more state DOTs tracked included Approval of Project Funding, FHWA FONSI Approval, ROW Authorization, ROW Certification, Utility Certification, Railroad Certification, and Construction Authorization. The milestones tracked by less than 50% of state DOTs included Advertisement of Eminent Domain, Conceptual Design (10%), and Notice of Intent.

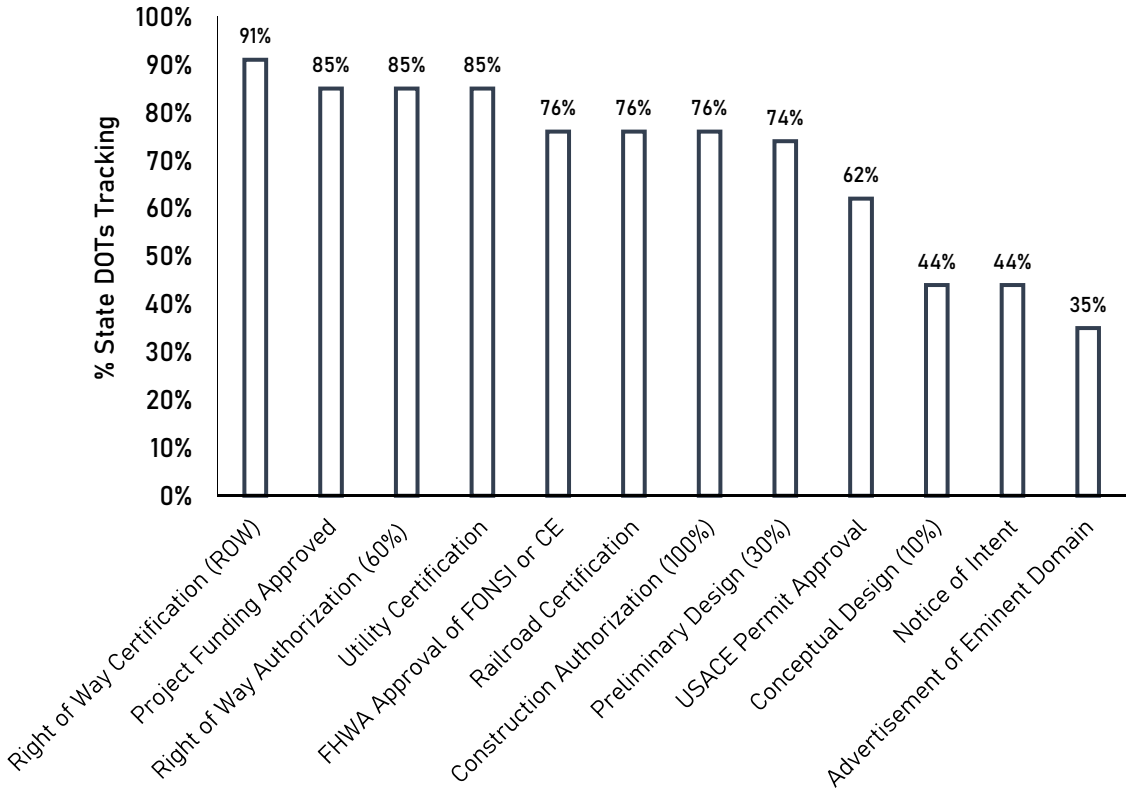


Figure 7.6: PDP Metrics/Milestones Tracked by State DOTs

When asked how frequently their state DOT compared actual project performance with the initial schedule (baseline) for preconstruction activities on a project, almost two-thirds indicated often or almost always, 45% and 19% (Table 7.4), respectively. This level of tracking frequency is likely supported by the finding that three-quarters of the state DOTs either agree (44%) or strongly agree (31%) with the statement 'tracking preconstruction project performance metrics improves and reduces the preconstruction project development timeline' (Table 7.4).

Question	Descriptive Statistics												
	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Sum	Count
	Level of Frequency												
Q14	3.39	0.23	4	4	1.38	1.90	-0.84	-0.69	4	1	5	122	36
	Level of Agreement/Disagreement												
Q15	4.06	0.13	4	4	0.75	0.57	-1.18	-0.09	2	3	5	146	36
	Respondent (%)												
	Never		Yearly		Quarterly		Monthly		Other				
Q14	17%		11%		9%		44%		19%				
	Strongly Disagree		Disagree		Neither Agree or DA		Agree		Strongly Agree				
Q15	0%		0%		25%		44%		31%				

Table 7.4: Project Performance Responses Descriptive Statistics and Percentages

The survey participants were then asked to identify their agency's average timeframe (in months) for the preconstruction activities from the start of PE to Right of Way (ROW) Authorization for three types of Categorical Exclusion (CE) projects – bridge replacement, intersection improvement/roadway widening, and interstate/interchange improvement. Similarly, duration data by project type was solicited for EA/FONSI projects. The findings are summarized in Table 7.5 and Figure 7.7.

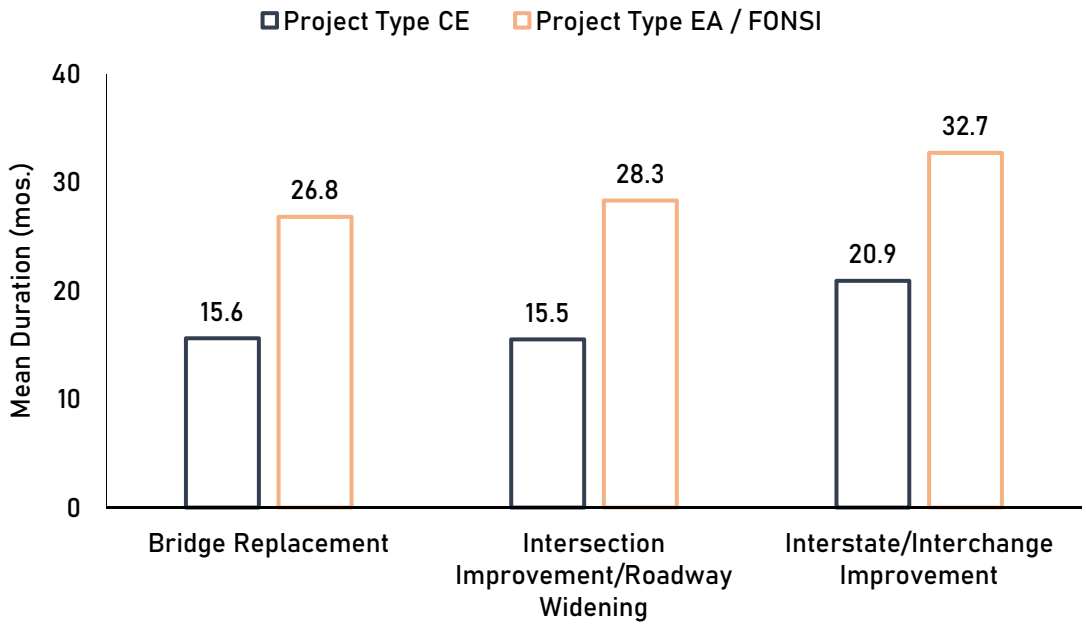


Figure 7.7: PDP Duration based on Project Type and Environmental Impact

The mean duration for all CE project types ranged from 15.5 to 20.9 months. The mean duration for EA/FONSI projects ranged from 26.9 to 32.7 months. Respondents also advised that the approximate timeframe from 100% construction plans to receipt of construction bids for state DOTs ranged from 1-6 months with an average of 3.3 months.

Respondents were also asked how frequently each of four identified preconstruction activities were the primary factor controlling the project development schedule between ROW Authorization and Construction Authorization.

	Descriptive Statistics												
Question	Mean and Average Timeframe (months)												
	Bridge Replacement		Road Widening		Interstate Improvement		Average						
Q16	15.6		15.5		20.9		17.3						
Q17	26.8		28.3		32.7		28.8						
Q19	3.30 months												
Q22	5.1 months												
	Level of Frequency (respondents %)												
	Almost Never		Seldom		Sometimes		Often		Almost Always				
Q18a	5.6%		27.8%		41.7%		19.4%		5.6%				
Q18b	0%		8.3%		22.2%		33.3%		36.1%				
Q18c	5.6%		11.1%		19.4%		47.2%		16.7%				
Q18d	5.6%		13.9%		55.6%		25%		0%				
	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Sum	Count
Q18a	2.92	0.16	3	3	0.97	0.94	-0.12	0.17	4	1	5	105	36
Q18b	3.97	0.16	4	5	0.97	0.94	-0.71	-0.54	3	2	5	143	36
Q18c	3.56	0.18	4	4	1.08	1.17	0.11	-0.73	4	1	5	128	36
Q18d	3.00	0.13	3	3	0.79	0.63	0.67	-0.73	3	1	4	108	36

Table 7.5: PDP Duration Responses Descriptive Statistics and Percentages

The two activities identified as frequently the controlling factors in the PDP were ROW acquisition and Utility Relocation (Table 7.5). ROW was the controlling factor often

or almost always greater than two-thirds (69%) of the time. In comparison, Utility Relocation was often or almost always the primary control factor on 64% of the project development efforts. Both Completion of Project Design and Permitting were often or almost always the primary controlling factor, only approximately 25% of the time. Table 7.5 concludes the average PDP phases' timeframe across the state DOTs derived from survey responses based on different project types, project complexity, and environmental impact.

Survey participants were then asked to share the actions that their DOT has taken or was considering for improvement of the agency's PDP. This open-ended question resulted in a broad spectrum of actions that DOTs have or were taking to improve their development process. They have been summarized by general topic in the following listing:

7.3.5.1. Project Management

- Created a statewide project management office
- Expanded project manager development training
- Added construction staff to the project development team to accelerate project development and design activities
- Contracted with project management consultants to help accelerate large projects and projects on aggressive timelines
- Initiated a comprehensive training program for new/inexperienced preconstruction staff

7.3.5.2. Project Development Process (PDP)

- Updated the Project Development manual
- Reduced the review and comment duration during the development of the design
- Streamlined forms and databases
- Utilize Design Build on major projects to facilitate the overlap of environmental, procurement, and other development processes to expedite delivery
- Enhanced procurement activities and incorporate consultant disincentives in contracts
- Development or improvement of the agency's cost estimating and bidding processes
- Implementation of an Integrated Project Delivery Process
- Expedited the environmental process by the development of an electronic system for the process
- Shifted Erosion & Sediment (E&S) and Maintenance of Traffic (MOT) design to the contractor
- Continued to look for innovations and efficiencies in processes and procedures. Continuous improvement

7.3.5.3. ROW & Utilities

- Advanced the timeframe of utility relocations
- Increased the use of conditional ROW certificates for projects
- Advertised projects with limitations based on ROW acquisition and include a schedule of acquisition for each outstanding parcel in the bid documents

7.3.5.4. Project Scoping

- Expanded the project scoping team to include a comprehensive departmental representation
- Implemented a "pre-design" process prior to PE to provide earlier data-driven decision making to improve alignment with the agency's practical design process

7.3.5.5. Performance Metrics Evaluation

- Expanded the collection and evaluation of time and cost performance metrics
- Held divisions accountable for performance indicators
- Developed performance dashboards for preconstruction metrics
- Increased the use and frequency of schedule updates
- Expanded the distribution of PDP performance data

7.3.6. Professional Services Consultants

For state DOTs participating in the survey, the time required from advertisement to Notice to Proceed for the procurement of Design Consultants ranged from 2 to 12 months. Collectively, the respondent average (mean) was 5.1 months (Table 7.5). It should be noted that most of the state DOTs were at opposite ends of the spectrum. The procurement time for forty-one percent (41%) of the state DOTs was three months or less, while it took a similarly sized group of state DOTs (44%) 6 months or more to procure professional services consultants. The procurement time for the remaining 15% was 4-5 months.

The next question set regarding professional services consultants addressed consultant training, the organization and accessibility of the agency's design standards,

and consultant impact on development time and cost for the project. The response means, descriptive statistics, and percentage of state DOT level of agreement or disagreement with each statement are summarized in Table 7.6. The highest mean response (4.06) was to the statement that 'our DOT design standards are well organized and easily accessible to consultants.' Eighty percent (80%) of the state DOTs agree or strongly agree with this statement. In addition, a majority (53%) of the state DOTs participating believe they provide adequate training for their consultants.

Question	Descriptive Statistics												
	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Sum	Count
	Level of Agreement												
Q21a	3.38	0.15	4	4	0.89	0.79	-0.85	-0.31	3	2	5	115	34
Q21b	4.09	0.13	4	4	0.74	0.55	0.51	-0.60	3	2	5	143	35
Q21c	2.34	0.14	2	2	0.84	0.70	1.62	0.53	4	1	5	82	35
Q21d	3.03	0.13	3	3	0.75	0.56	1.41	0.85	3	2	5	106	35
	Respondent (%)												
	Strongly Disagree		Disagree		Neither Agree or DA		Agree		Strongly Agree				
Q21a	0%		21%		27%		50%		3%				
Q21b	0%		3%		17%		51%		29%				
Q21c	14%		43%		40%		0%		3%				
Q21d	0%		20%		57%		9%		14%				

Table 7.6: PSCs Training and Value Responses Descriptive Statistics and Percentages

Conversely, a majority (57%) of the agencies disagree or strongly disagree with the statement that 'the use of consultants is typically more cost-effective than in-house design services.' Additionally, less than a quarter (23%) of respondents agreed or strongly agreed that the use of design consultants reduced the timeframe for preconstruction.

The next series of survey questions addressed the state DOT's frequency of using certain activities concerning consultant procurement and its impact on PDP time and cost. A summary of the findings is presented in Table 7.7. The frequency response options ranged from almost never to almost always, as noted in Table 7.7.

The first seven questions noted in Table 7.7 addressed consultant procurement activities. The findings were that almost three-quarters (74%) of the state DOTs often or almost always prequalify design consultants. Only 17% of the state DOTs seldom or never prequalify. In addition, close to three-quarters (73%) of the state DOTs use on-call/IDIQ/continuing consultants for project design often or almost always. Conversely, lumpsum contracting for consultants is seldom or never used by a majority (60%) of the state DOTs.

Similarly, bundling consultant procurement is used frequently (often or almost always) by only 22% of state DOTs. However, there is a high level of frequency (often or almost always) for state DOTs to clearly define contractual milestones (88%) and establish consultant deliverables that are similar to those utilized for in-house design teams (91%). Lastly, more than three-quarters (76%) of the state DOTs believe that their professional services consultants' procurement is accomplished in a timely fashion. This

is interesting compared with the finding from an earlier question, which found close to half (44%) of the state DOTs averaged six months or more for consultant procurement.

Question	Descriptive Statistics												
	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Sum	Count
	Level of Frequency												
Q23c	4.32	0.13	4	5	0.77	0.58	1.09	-1.07	3	2	5	147	34
Q23d	2.77	0.21	3	3	1.24	1.53	-0.62	0.17	4	1	5	97	35
Q23e	2.29	0.22	2	1	1.27	1.62	-0.76	0.60	4	1	5	80	35
Q23f	3.94	0.24	5	5	1.41	2.00	-0.15	-1.09	4	1	5	138	35
Q23g	3.82	0.17	4	4	1.00	1.00	2.04	-1.17	4	1	5	130	34
Q23h	3.89	0.14	4	4	0.83	0.69	-0.85	-0.10	3	2	5	136	35
Q23i	4.4	0.12	5	5	0.74	0.54	1.93	-1.28	3	2	5	154	35
Q23a	2.17	0.16	2	2	1.10	1.21	0.68	0.91	4	1	5	76	35
Q23b	2.49	0.21	2	3	1.22	1.49	-0.44	0.50	4	1	5	87	35
	Respondent (%)												
	Almost Never		Seldom		Sometimes		Often		Almost Always				
Q23c	0%		3%		9%		41%		47%				
Q23d	20%		17%		40%		11%		11%				
Q23e	40%		20%		20%		14%		6%				
Q23f	11%		6%		11%		15%		57%				
Q23g	6%		0%		24%		47%		24%				
Q23h	0%		6%		28%		40%		26%				
Q23i	0%		3%		6%		40%		51%				
Q23a	31%		34%		26%		3%		6%				
Q23b	26%		26%		31%		0%		9%				

Table 7.7: PSCs Procurement Responses Descriptive Statistics and Percentages

The last two questions shown in Table 7.7 focused on tracking and evaluation of consultant performance. State DOTs were asked how frequently they compared and

evaluated consultant vs. in-house schedule and cost performance on similar scope projects. The majority of state DOTs seldom or almost never compared and evaluated either schedule (65%) or cost (52%) performance. Only 9% of the state DOTs often or always compared and evaluated each of the performance metrics.

Survey participants were also asked if their state DOT utilized Management Consultants to manage design consultants. Only a third (33%) of the state DOTs answered affirmatively. The remainder (67%) did not utilize Management Consultants. Those state DOTs indicating the use of Management Consultants were then asked to indicate their level of frequency. The finding was that only 19% of those DOTs indicated that they often used Management Consultants.

Conversely, half of the agencies (50%) seldom or almost never used this approach. The balance of state DOTs (31%) utilized Management Consultants sometimes. In summary, Management Consultants are utilized often or almost always by only 19% of the state DOTs that use consultant managers, and those state DOTs are only 33% of all DOTs. As a result, Management Consultants are often or almost always utilized by only 6.3% (0.19 x 33%) of the state DOTs.

The most effective procurement action was the development of a well-defined project scope prior to advertisement. Seventy-nine percent (79%) of the state DOTs indicated that this activity was very or extremely effective for reducing the procurement time period. The activity ranked second (based on the mean) was the use of standardized estimating/scoping templates, with 70% of the respondents submitting that it was very or extremely effective. Combined with moderate effectiveness, the total for all three levels of effectiveness rating for this activity rises to 100%. Prequalification of consultants

was viewed as moderately effective, with 63% of state DOTs indicating that it is very or extremely effective. Reduction of the number and time required for internal approvals and tracking procurement milestones were also viewed as very or extremely effective by a majority of 61% and 51%, respectively. The only action with a mean response of less than 3.0 was using lumpsum contracts for consultants.

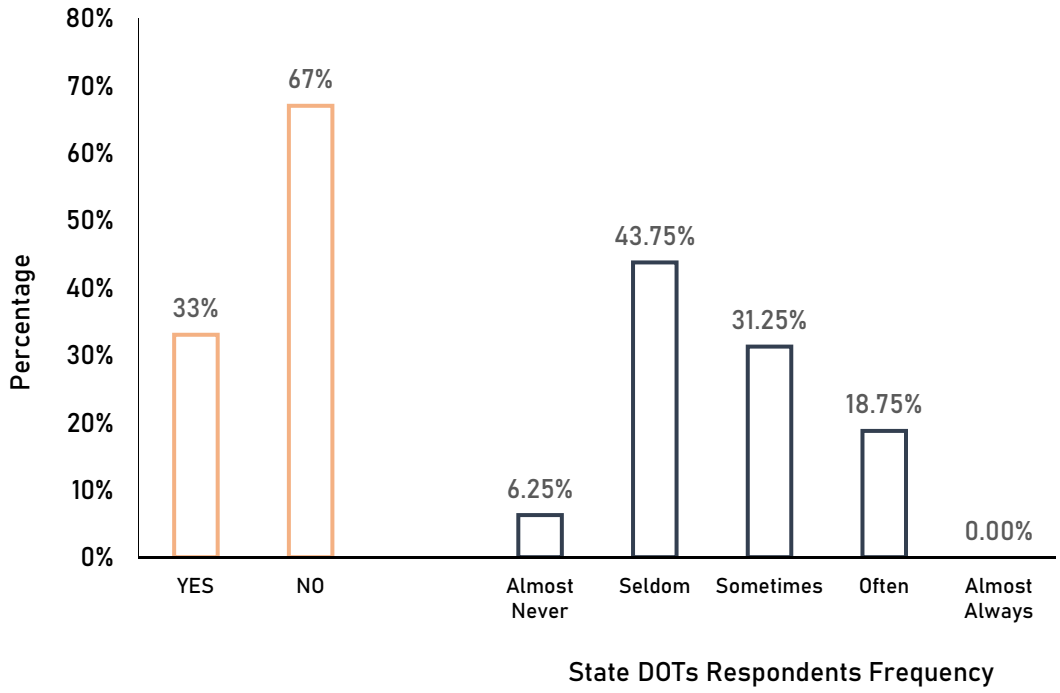


Figure 7.8: State DOTs Use of Management Consultants Frequency

The last portion of the questionnaire addressed the level of effectiveness that certain actions had on reducing the time required for the procurement of design consultants. The actions investigated and the effectiveness of each is tabulated in Table 7.8.

Question	Descriptive Statistics												
	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Sum	Count
	Level of Frequency												
Q26a	4.06	0.14	4	4	0.79	0.62	-0.04	-0.52	3	2	5	134	33
Q26b	3.66	0.24	4	5	1.36	1.85	-0.79	-0.64	4	1	5	117	32
Q26c	3.91	0.13	4	4	0.72	0.52	-1.00	0.14	2	3	5	129	33
Q26d	3.61	0.17	4	3	1.00	1.00	0.03	-0.31	4	1	5	119	33
Q26e	3.61	0.17	4	4	1.00	1.00	0.13	-0.51	4	1	5	119	33
Q26f	2.52	0.18	3	3	1.03	1.06	-1.07	-0.05	3	1	4	78	31
	Respondent (%)												
	Not Effective		Slightly Effective		Moderately Effective		Very Effective		Extremely Effective				
Q26a	0%		3%		18%		49%		30%				
Q26b	9%		14%		16%		25%		38%				
Q26c	0%		0%		30%		49%		21%				
Q26d	3%		6%		40%		30%		21%				
Q26e	3%		9%		27%		43%		18%				
Q26f	19%		32%		29%		20%		0%				

Table 7.8: Actions Reducing PDP Timeline Descriptive Statistics and Percentages

7.3.7. Statistical Significance

For all the variables (questions) in the state DOTs questionnaire, a t-test was conducted to determine if there is a significant difference between the means of different groupings. The detailed statistical analysis data (t-test) for all variables (questions) is presented in Table 7.9. Table 7.9 presents the detailed statistical test results for statistically significant variables based on the survey data's different comparison groupings. For some variables, the t-test for two samples assuming unequal variances

resulted in no significant difference between the different groups' means (not enough evidence to reject the null hypothesis). The variables that the t-test resulted in determining a significant difference between the two groups' means are discussed below.

The project development durations for each state DOT were summarized to facilitate comparative analysis. To assemble the listing, the average durations for Categorical Exclusion (CE) and Environmental Assessment (EA) projects were calculated for each state DOT. In addition, the average combined duration for CE + EA projects was determined. A sort of data yielded the duration performance results for the top and bottom half of the state DOTs, as shown in Figure 7.9.

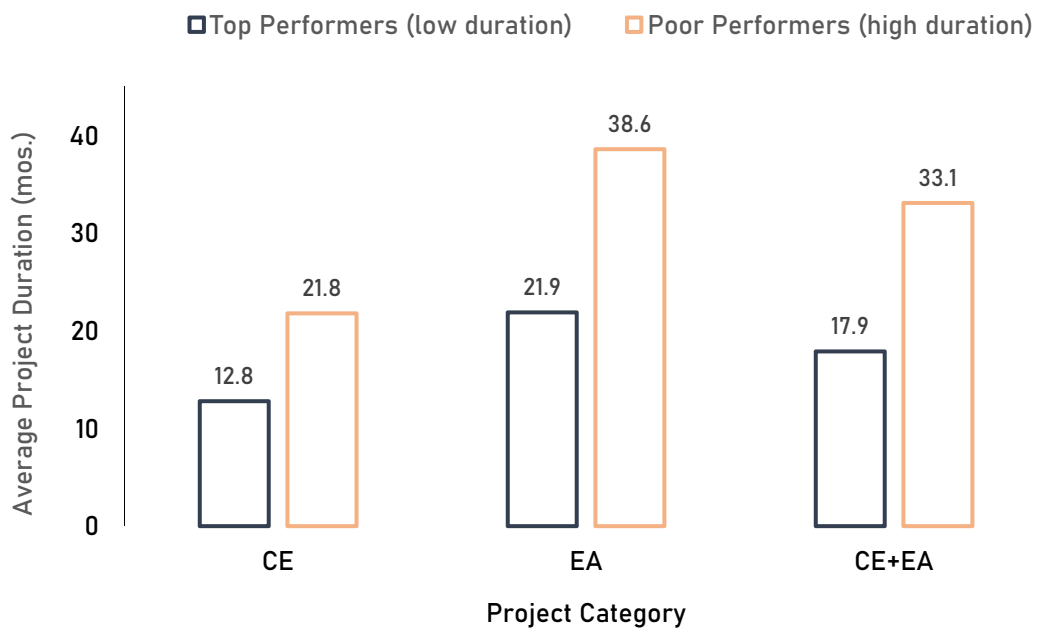


Figure 7.9: PDP Duration based on Project Category and Environmental Impact

	T-Test – CE - Top and Poor Performing State DOTs				T-Test – EA - Top and Poor Performing State DOTs			
	Q5		Q19		Q12e		Q21b	
	>mean	<mean	>mean	<mean	>mean	<mean	>mean	<mean
Mean	1.75	2.92	3.50	2.42	3.75	3.17	4.42	3.92
Standard Err Dif.	0.38		0.34		0.30		0.27	
Observations	12	12	12	12	12	12	12	12
Hypothesized Mean	0		0		0		0	
Confidence Level	0.95		0.95		0.95		0.95	
DF	17		21		22		22	
t Ratio	-3.06		2.94		1.94		1.83	
Prob > |t|	0.0071		0.0078		0.0652		0.0805	
Prob > t	0.9964		0.0039		0.0326		0.0403	
Prob < t	0.0036		0.9961		0.9674		0.9597	

	T-Test – CE+EA - Top and Poor Performing State DOTs				T-Test – CE, EA, and CE+EA State DOT Organization			
	Q19		Q26b		Q3-CE		Q3-CE+EA	
	>mean	<mean	>mean	<mean	C	D & H	C	D & H
Mean	3.33	2.58	3.42	4.33	20.14	15.11	29.86	22.31
Standard Err Dif.	0.40		0.52		3.20		3.98	
Observations	12	12	12	12	9	14	10	14
Hypothesized Mean	0		0		0		0	
Confidence Level	0.95		0.95		0.95		0.95	
DF	19		22		13		19	
t Ratio	1.85		-1.77		-1.57		-1.90	
Prob > |t|	0.0788		0.0914		0.1398		0.0734	
Prob > t	0.0394		0.9543		0.9301		0.9633	
Prob < t	0.9606		0.0457		0.0699		0.0367	

	Top and Poor Performing State DOTs					
	CE		EA		CE+EA	
	Top	Poor	Top	Poor	Top	Poor
Mean	12.80	21.75	21.94	38.61	17.87	33.05
Standard Err Dif.	2.43		3.14		2.64	
Observations	12	11	12	12	12	12
Hypothesized Mean	0		0		0	
Confidence Level	0.95		0.95		0.95	
DF	18		16		16	
t Ratio	-3.67		-5.32		-5.75	
Prob > |t|	0.0017		<0.0001		<0.0001	
Prob > t	0.9991		1.0000		1.0000	
Prob < t	0.0009		<0.0001		<0.0001	

Table 7.9: Survey Questions Statistical Test Results

The Top Performers in Figure 7.9 represent the average duration of those state DOTs in the top half with an average project development duration that was substantially less than the Poor Performing state DOTs. For all three project categories, the average project development duration for the top performers was nearly half the project duration of the poor-performing state DOTs. Statistical testing found the duration differential for all three categories (CE, EA, CE+EA) to be statistically significant (Table 7.9).

Comparative analysis utilizing project duration indicators (CE, EA & CE+EA) was used to analyze the survey data's various response groupings. Additionally, statistical analysis (t-test with an $\alpha = 0.05$ assuming unequal variances) was conducted when appropriate. However, statistically significant findings were somewhat limited, largely because of the small sample (36 total), which provided eighteen or less in each statistical pairing. The findings are summarized in the following paragraphs.

Preconstruction Department Structure: The survey question addressing the organizational structure of the state DOT's preconstruction department offered three response options – centralized, decentralized, and hybrid. Three-quarters of the top performers represented in Figure 7.9 had a decentralized or hybrid organization. Conversely, a majority (58%) of the Poor Performers had a centralized structure. Statistical testing of the project development duration for the response groupings resulted in two statistically significant findings.

- For CE projects, state DOTs with a centralized preconstruction department had a statistically significant longer project development duration than state DOTs with a decentralized or hybrid preconstruction department.

- The average combined project development duration for CE & EA projects for state DOTs with a centralized preconstruction department was a statistically significant longer project development duration than state DOTs with a decentralized or hybrid preconstruction department.

Combined, the findings indicate that the PDP is significantly longer for both CE projects and the overall combined average duration of CE+EA projects for state DOTs with a centralized preconstruction department.

Preconstruction Department Organization for Projects: State DOTs were also asked to identify how their preconstruction department was organized to manage individual projects. The response options included discipline, project type, geography/region, and other. Almost two-thirds (66%) of the Poor Performers were organized by project type or discipline. Conversely, a majority (58%) of the Top Performers were organized by geography/region. For all three project classifications (CE, EA, & CE+EA), the mean project development duration for preconstruction departments organized by geography/region had a lower project development duration than departments organized by discipline or project type, with variances equal to 31%, 18%, and 13% respectively. However, statistical testing resulted in no statistically significant difference with t-tests using an $\alpha = .05$. With t-tests using an $\alpha = .10$, there was a statistically significant finding supporting a lower duration on CE projects for departments organized by geography/region.

State Environmental Process: Ninety-two percent (92%) of the Top Performing DOTs had a State Environmental Policy Act (SEPA), whereas only 50% of the Poor Performing state DOTs had a SEPA.

STIP Revisions: Fifty-eight percent (58%) of the Top Performers almost never or seldom had to revise their STIP for a change to the project's initial scope. Conversely, two-thirds (67%) of the Poor Performing state DOTs had to revise the STIP sometimes or often. The difference was statistically significant with an $\alpha = 0.10$.

Prequalification of Design Consultants: Ninety-two percent (92%) of Top Performers often or almost always prequalify design consultants, while only 58% of Poor Performers often or almost always prequalify. This difference was statistically significant using an $\alpha = 0.10$. A similar disparity between the two groups exists regarding the perceived effectiveness of prequalification to reduce the time required for consultant procurement. The difference is statistically significant (t-test $\alpha = 0.05$.). Top Performers view prequalification of design consultants as more effective than Poor Performers for reducing the time for consultant procurement.

7.4. Conclusions

The transportation infrastructure needs of states across the U.S. continue to expand, and funding remains limited. In this environment, state DOTs are under increasing pressure to design and develop projects within a shorter timeframe and deliver projects more cost-effectively. To reach those performance objectives, most agencies view it essential to improve their PDP. State DOTs have a keen interest in improving their PDP, as evidenced by their support and widespread participation in this study. Conclusions supported by the findings of this survey include the following.

Organizational structure has an impact on performance: The project development duration for state DOTs with a centralized preconstruction department was longer than the development duration for state DOTs with a decentralized or hybrid preconstruction

department. In addition, there was support that preconstruction departments organized by region/geography out-performed state agencies with preconstruction organized by discipline or project type for CE projects. The preconstruction organizational structure has an impact on the duration of the PDP.

Project scope documentation reduces the need for STIP revision: Developing a formal scoping document with a cross-functional project team in the planning stage reduces the need for project scope changes and STIP revisions. State DOTs documentation of project scope early in the development process is important.

Project development performance of state DOTs varies significantly: Most state DOTs participating in this survey place a high value on performance tracking and evaluation. There were limited differences between the participating state DOTs in the other performance indicators investigated during this study. However, the difference in actual performance was significant. The average project development duration for the best (top) performing state DOTs for CE and EA projects was 13mos and 22mos, respectively. Conversely, the average development duration for the poorer performing state DOTs for CE and EA was 22mos and 39mos, respectively. The PDP for the poor-performing state DOTs was almost twice as long for project development. While most state DOTs indicated that they have similar processes, top performers have a more effective execution of their project development activities. It is important for a state DOT to expand its focus beyond just 'what' the agency does to 'how effectively' it performs each step of the development process.

Timely procurement of Professional Service Consultants is key: Collectively, state DOTs indicated that on greater than fifty percent of their projects, the design is completed

by professional services consultants. Also, the involvement of consultants in the development process was expanding. Therefore, effective procurement of consultants is essential for timely and efficient project development. The average procurement timeframe for consultants ranged from two to twelve months, with a mean duration of five months. With this wide range of procurement duration, some state DOTs have a need and an opportunity to reduce their procurement timeframe. To reduce procurement duration, almost all of the top-performing state DOTs have implemented a prequalification process for consultants. Top performers view the prequalification of design consultants as an effective action to reduce the procurement duration. In addition, many state DOTs have increased their use of on-call/IDIQ/continuing consultants for project design to reduce procurement time.

Performance evaluation of Professional Services Consultants is needed: The majority of state DOTs do not believe the use of consultants is more cost-effective than using in-house design services or that their use reduces the timeframe for preconstruction. However, the majority of the state DOTs do not compare and evaluate either consultant schedule or cost performance with their in-house design services. With consultant use widespread and increasing, it may be prudent for agencies to consider initiating a comparative analysis to evaluate the use of in-house versus consultant design services effectively.

PDP evaluation and improvement are a continuing process: To effectively and efficiently meet their states' infrastructure needs, state DOTs are continually evaluating their PDP and taking steps to improve performance. Some of the initiatives that were noted by state DOTs for performance improvement included: expanded training, updating

their PDP, expanded use of consultants, utilization of design-build, improved procurement processes, shifting design responsibilities to the contractor, implementation of technology, the use of conditional ROW certificates, the improved scoping process, and the enhancement of their performance monitoring and evaluation processes. An agency's PDP is regularly impacted by changing regulations, funding sources, organization realignment, state priorities, technology, and environmental demands. As a result, a state DOT's PDP is continually evolving.

CHAPTER EIGHT

PHASE 3: COMPARABLE STATES' DEPARTMENT OF TRANSPORTATION INPUT

This chapter discusses, describes, and presents the research methodology, Phase 3, the Comparable States' Department of Transportation input concerning Project Development Process (PDP), alongside its findings and analysis. As shown in Figure 4.1 and discussed in Chapter 4, Phase 3 of the methodology includes three main interrelated tasks: evaluation of state DOTs' PDP comprehensiveness, identification of comparable state DOTs based on PDP comprehensiveness, and finally, obtaining input from identified comparable state DOTs via structured interviews concerning transportation PDP and best practices.

8.1. Introduction

Subsequent to the national state DOTs survey (chapter 7), Phase 3 of the research methodology aims to obtain input from the comparable or peer state DOTs to SCDOT. Phase 3 aims to identify PDP best practices by further probing and gathering in-depth information on PDP concepts explored in previous phases of this research. Besides, gathering in-depth input from comparable state DOTs helped establish support for PDP best practices and findings explored through the national state DOTs survey discussed in chapter 7.

There were mainly two reasons for choosing the methodology for identifying comparable state DOTs and gathering input from them to develop PDP best practices. First, state DOTs have different organizational structures, missions, state laws and regulations, resources, culture, and management approaches. Still, they all have

common responsibilities regarding planning, design, construction, operation, and maintenance of state transportation systems (Cochran et al., 2004). These shared responsibilities provide opportunities for state DOTs to share their experiences to aid improve their project development processes. Identification of peer or comparable states is valuable for identifying PDP best practices that are effective and applicable to a state DOT (Bausman et al., 2014). Best practices are intended to apply to related or comparable organizations (Cochran et al., 2004).

Second, a perfect methodology to develop PDP best practices would have been interviewing all 50 state DOTs. But this is impossible due to limited resources such as time and money. Interviewing all 50 state DOTs would have taken a significant amount of time and required a vast amount of money. The aim was to select a small sample of state DOTs (based on available resources) comparable to SCDOT, which could best address the objective of this research. This methodology of identifying and selecting comparable state DOTs and gathering input from them was established based on these limitations.

The methodology chosen for this phase of the research is a systematic process. To summarize, first, all state DOTs' PDP were evaluated based on shared and established criteria from the literature and state DOTs' PDP documentation. Second, all state DOTs were ranked based on these criteria to identify their PDP comprehensiveness. Third, a pool of state DOTs was generated by this ranking that ranked higher than SCDOT. The pool of higher-ranked state DOTs was chosen because it does not make any logical sense to gather input (via interviews) from the state DOTs with less comprehensive PDP than SCDOT. Then, comparable state DOTs to SCDOT were identified based on state DOTs'

shared criteria, characteristics, and statistics with SCDOT to minimize the number of state DOTs from the pool generated in the first step.

8.2. Methodology

Obtaining input from comparable state DOTs is accomplished via three tasks, which are shown in Figure 8.1. These three tasks are also shown in Figure 4.1 which are, a two-tiered systematic approach to identify comparable state DOTs to SCDOT, 'Evaluation of State DOTs PDP Comprehensiveness (Task 5)' and 'Identification of Comparable State DOTs (Task 6),' and finally, obtaining input from identified comparable state DOTs (Task 7) via structured interviews concerning transportation PDP and best practices. What follows is a detailed description of these tasks with their steps (Figure 8.1).

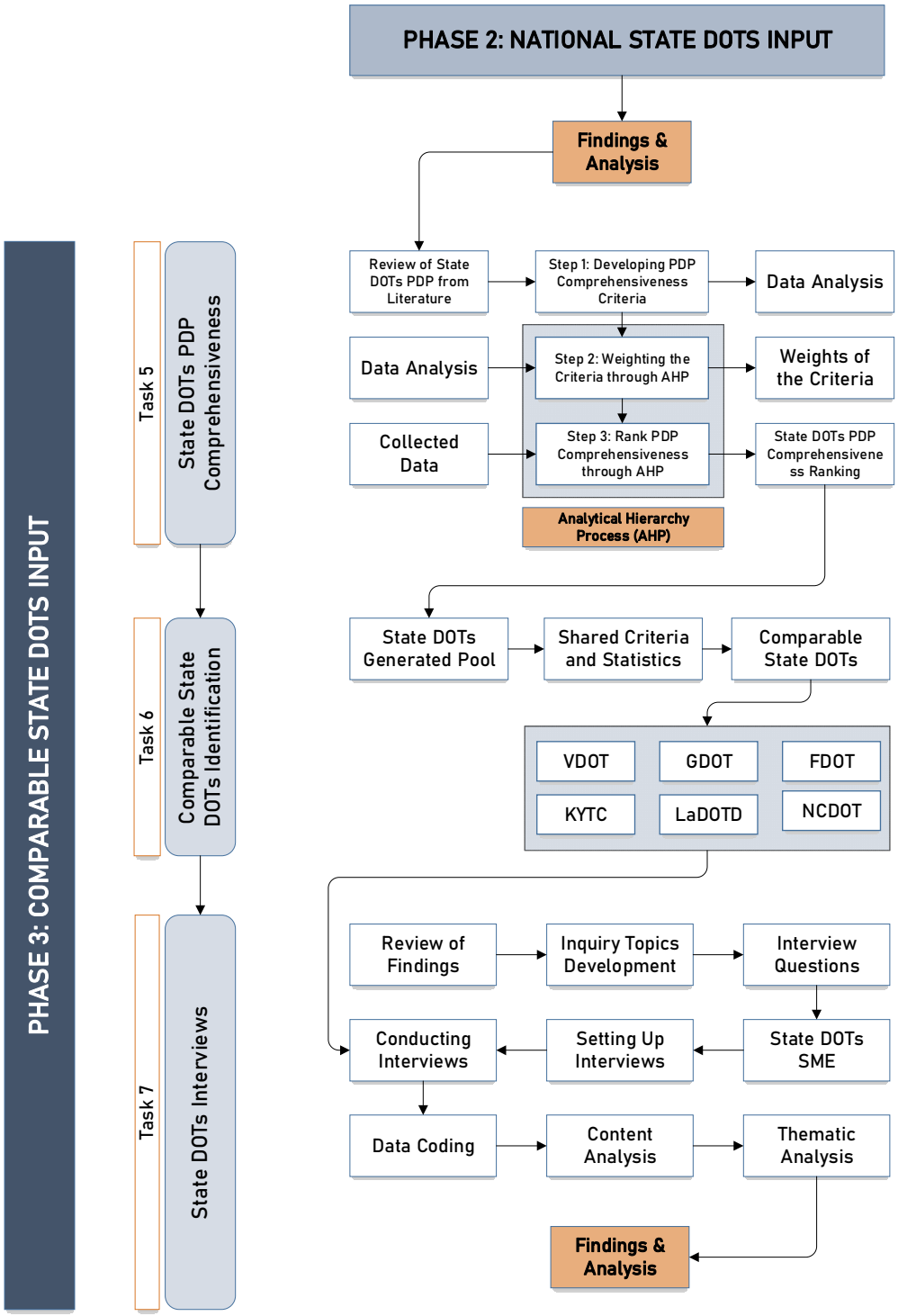


Figure 8.1: Research Methodology Phase 3

8.2.1. Task 5: Evaluation of State DOTs PDP Comprehensiveness

A three-step method was used to develop the evaluation procedure of PDP, as shown in Figure 8.1. The goal in task 5 was to evaluate the PDP comprehensiveness of state DOTs. This evaluation enabled the researcher to rank each state DOT's PDP comprehensiveness by identifying their PDP elements and evaluating them utilizing a systematic weighing system. The weighting assessment was accomplished using the Analytical Hierarchy Process (AHP). AHP is a multi-criteria decision-making technique to formulate weighing scales from the pairwise comparison. AHP was chosen for its unique ability to include both data information and human judgment. The step-by-step approach followed to achieve the goal in this task is shown in Figure 8.2. A brief explanation of this process (Figure 8.2) is described in the steps outlined below.

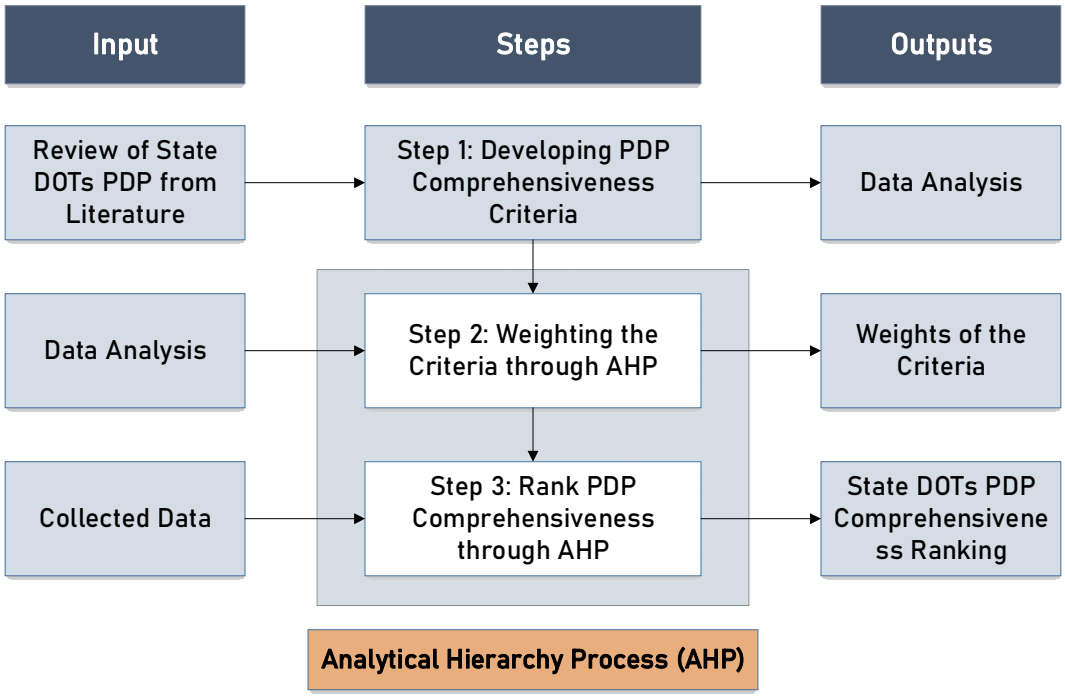


Figure 8.2: Task 5 – Evaluation of State DOTs' PDP Comprehensiveness

8.2.1.1. Step 1: Developing PDP Comprehensiveness Criteria

The first step in developing the evaluation method was to identify the components that should be incorporated into a comprehensive PDP. A comprehensive list of criteria was identified during the literature review from peer-reviewed studies, FHWA guidelines, and published state DOTs PDP documentation (Table 8.1).

The literature review identified 19 criteria from an investigation of the process utilized by state DOTs. State DOTs' PDP manuals were reviewed using relevant research databases, search engines, and the state DOTs' websites. PDP documentation for forty (40) state DOTs was found on the agency's website. The remaining ten state DOTs did not have PDP documentation available on their websites. These states are Tennessee, Hawaii, Montana, New Hampshire, New Mexico, North Dakota, Rhode Island, South Dakota, West Virginia, and Wyoming, thus excluded from the evaluation.

Ten essential PDP components were initially identified during the literature review process. These criteria are Project Planning, Survey, Mapping, Preliminary Design, Right of Way, Utility/Railroad Coordination, Plans Specification & Estimates (PS&E), Final Design, Contract Administration, Construction, and Environmental Studies/Documentation/Permits (Dyke et al., 2017; Molenaar, 2010).

The researcher also identified the following additional criteria by reviewing published State DOT's PDP and literature related to the PDP. Although some criteria were not documented in some State DOT's PDP documentation, they were highly recommended as initiatives by other studies to potentially improve PDP's efficiency. These criteria were included for evaluating the relevancy and comprehensiveness of a state DOTs' PDP.

#	State (DOTs)	PDP Manual	Year of Publication	PDP Flowchart	Number of Flowcharts	Number of Tasks (Activities)	PDP Components	Project Planning	Survey & Mapping	Preliminary Design	Right-of-Way	PS&E	Final Design	Contract Administration	NEPA/Permit	Utility/Railroad Coordination	Construction	Milestones	Project Management (PM)	PDP Steps	Value Engineering (VE)	Risk Management	Quality Management	PDP Content Pages	Year of Update
1	**Alabama**	Yes	2018	No	0	0	Full	5	2	1	1	9	2	1	5	3	5	14	0	1	0	0	0	138	2018
2	**Alaska**	Yes	2018	Yes	2	19	Full	2	1	6	2	1	1	3	6	3	0	0	2	4	0	0	0	74	2018
3	**Arizona**	Yes	2015	No	0	0	Full	43	5	4	15	2	10	30	30	16	1	0	3	1	0	0	0	215	2015
4	**Arkansas**	Yes	2015	No	0	0	Full	1	1	1	1	1	9	4	5	1	2	0	0	1	1	3	0	139	2015
5	**California**	Yes	2018	Yes	1	62	Full	21	3	9	8	5	4	3	30	13	10	8	3	6	31	0	0	832	2018
6	**Colorado**	Yes	2013	No	0	0	N/A	1	3	1	9	3	1	10	46	6	3	2	3	1	8	0	0	496	N/A
7	**Connecticut**	Yes	2012	Yes	2	6	Full	1	1	40	1	3	25	1	11	5	2	9	0	3	1	0	0	159	2018
8	**Delaware**	Yes	2015	No	0	0	Full	10	3	3	1	1	3	4	7	2	5	1	1	1	1	0	0	56	2015
9	**Florida**	Yes	2018	No	0	0	Full	10	5	10	10	5	10	10	10	5	2	0	20	1	20	20	20	N/A	2018
10	**Georgia**	Yes	2019	Yes	3	100	Full	9	2	31	6	3	15	2	6	3	8	1	2	1	3	1	0	253	2019
11	**Idaho**	Yes	2014	Yes	1	137	Full	8	4	80	14	19	58	20	12	3	0	0	0	1	1	0	0	678	2014
12	**Illinois**	Yes	2017	Yes	2	33	Full	2	2	2	1	1	3	1	2	6	0	0	0	2	1	0	0	98	2017
13	**Indiana**	Yes	2007	No	0	0	Full	2	4	1	10	1	20	4	20	6	0	2	0	3	2	0	0	141	2007
14	**Iowa**	Yes	2013	Yes	2	96	Full	17	1	1	1	1	1	1	3	4	0	0	1	3	0	0	0	253	2013
15	**Kansas**	Yes	2011	No	0	0	Full	14	2	4	54	4	7	3	5	1	2	0	0	1	0	0	0	231	2011
16	**Kentucky**	Yes	2016	Yes	1	0	Partial	1	52	14	20	2	18	8	16	10	2	1	0	1	1	0	0	473	2016
17	**Louisiana**	Yes	2013	Yes	1	33	Full	14	1	3	1	0	11	7	14	4	15	1	13	4	1	1	0	148	2013
18	**Maine**	Yes	2016	No	0	0	Full	2	1	2	2	1	1	2	1	4	2	1	0	1	0	0	0	19	2016
19	**Maryland**	Yes	2016	No	0	0	Full	1	1	7	5	1	4	3	11	7	16	0	0	1	1	0	0	424	2016
20	**Massachusetts**	Yes	2006	Yes	1	56	Full	16	2	2	2	3	3	6	7	3	2	0	0	1	0	0	0	1069	2006
21	**Michigan**	Yes	2018	Yes	1	104	Full	33	94	196	27	2	44	7	94	35	0	9	0	2	0	0	0	414	2018
22	**Minnesota**	Yes	2019	No	0	0	Partial	0	0	0	7	0	0	0	9	7	0	0	0	1	0	0	0	N/A	N/A
23	**Mississippi**	Yes	2019	No	0	0	Partial	0	0	0	6	15	0	5	3	3	14	0	0	1	0	0	0	64	2019
24	**Missouri**	Yes	2018	No	0	0	Partial	6	4	40	17	0	0	10	12	10	4	0	0	1	10	0	0	N/A	N/A
25	**Nebraska**	Yes	2006	No	0	0	Full	2	2	1	2	2	1	0	4	0	0	0	0	1	0	0	0	24	2006

Table 8.1: List of state DOTs' PDP Comprehensiveness Criteria

#	State (DOTs)	PDP Manual	Year of Publication	PDP Flowchart	Number of Flowcharts	Number of Tasks (Activities)	PDP Components	Project Planning	Survey & Mapping	Preliminary Design	Right-of-Way	PS&E	Final Design	Contract Administration	NEPA/Permit	Utility/Railroad Coordination	Construction	Milestones	Project Management (PM)	PDP Steps	Value Engineering (VE)	Risk Management	Quality Management	PDP Content Pages	Year of Update
26	**Nevada**	Yes	2010	No	0	0	Full	1	1	2	1	1	2	1	3	1	3	1	18	1	1	1	0	116	2010
27	**New Jersey**	Yes	2017	Yes	1	43	Partial	0	0	0	1	1	2	0	2	1	0	2	0	3	0	0	0	7	2017
28	**New York**	Yes	2017	Yes	1	40	Partial	4	0	3	0	1	1	1	7	1	0	0	0	6	16	90	25	145	2017
29	**North Carolina**	Yes	2019	Yes	1	230	N/A	1	1	1	1	1	1	1	2	2	1	0	14	1	0	1	2	61	2019
30	**Ohio**	Yes	2018	Yes	1	36	Full	13	1	10	11	2	11	3	9	4	10	0	0	5	2	0	0	79	2018
31	**Oklahoma**	Yes	2019	No	0	0	Full	1	4	2	5	1	3	1	2	5	0	0	0	2	0	0	0	58	2019
32	**Oregon**	Yes	2017	No	0	0	Full	5	5	1	4	51	3	5	10	4	1	2	0	2	0	0	0	129	2017
33	**Pennsylvania**	Yes	2002	No	0	0	Full	2	2	7	2	0	5	2	4	1	0	0	0	1	0	0	0	119	2002
34	**South Carolina**	Yes	2011	Yes	1	20	Full	1	1	1	3	1	1	1	2	1	1	1	0	1	1	0	0	15	2011
35	**Tennessee**	Yes	2012	No	0	0	Partial	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	21	2012
36	**Texas**	Yes	2017	No	0	0	Full	47	14	75	30	84	45	15	40	29	0	0	0	1	0	0	0	314	2017
37	**Utah**	Yes	2015	No	0	0	Partial	0	0	0	8	0	0	0	6	2	5	0	0	1	0	0	1	58	N/A
38	**Vermont**	Yes	1995	Yes	1	17	Partial	2	2	2	1	1	3	1	3	1	4	0	0	1	0	0	0	71	1995
39	**Hawaii**	No	N/A	No	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
40	**Montana**	No	N/A	No	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
41	**New Hampshire**	No	N/A	No	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
42	**New Mexico**	No	N/A	Yes	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
43	**Virginia**	Yes	2016	Yes	2	39	Full	1	0	10	3	1	11	1	3	2	1	0	0	1	1	5	0	78	N/A
44	**North Dakota**	No	N/A	No	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
45	**Rhode Island**	No	N/A	No	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
46	**South Dakota**	No	N/A	No	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
47	**Washington**	Yes	2019	Yes	1	23	Full	1	1	1	1	1	1	1	1	0	0	1	5	1	0	0	0	N/A	N/A
48	**West Virginia**	No	N/A	No	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
49	**Wisconsin**	Yes	2019	Yes	1	36	Full	5	80	60	15	40	60	25	50	80	0	4	30	4	2	0	0	871	2019
50	**Wyoming**	No	N/A	No	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

Continued Table 8.1: List of state DOTs' PDP Comprehensiveness Criteria

8.2.1.1.1. PDP Document Year of Publication and Update

The evolution of PDP regulations, delivery methods, and development processes require the regular update of a state DOTs' PDP. It needs to ensure an efficient process that conforms with current needs and regulations. Therefore, including the year of publication and update was considered an important criterion for evaluating a state DOTs' PDP's relevancy.

8.2.1.1.2. Project Management

Several states (Caltrans, 2018; Ohio DOT, 2018) discussed project management to improve the project delivery process. Indeed, one such NCHRP report (Keck, 2010) indicated project management as one of the best practices that characterize successful project delivery. Excellent project management is essential to facilitate the successful delivery of a project with a properly defined scope that meets the project's quality, time, and cost constraints. Conversely, poorly documented project management procedures result in inconsistency and inefficiency in the development of projects. Thus, documentation of project management's role and responsibilities was added to the evaluation criterion for determining the comprehensiveness of a state DOTs' PDP.

8.2.1.1.3. PDP Difference based on Project/Program Types

In the PDP, different project types, programs, and funding sources can significantly impact the development process. As a result, these variables must be considered in the PDP to address the economic, social, environmental, and transportation differences and the changing federal and state legal requirements (Caltrans, 2018). In some state DOTs (Caltrans, 2018; WDOT, 2019; IDOT, 2017; NYSDOT,

2017; ODOT, 2017; MDOT, 2018), project development categories have been established to ensure that these project-related differences meet varying state and federal requirements. Recognition and documentation of these variances in the development process are essential to ensure the proper adjustment of individual state DOTs' processes to meet these varying criteria.

8.2.1.1.4. PDP Flowchart

A flowchart is an effective method that a number of state DOTs (Caltrans, 2018; LaDOTD, 2013; ODOT, 2018; IDOT, 2017; NYSDOT, 2017; IDAHODOT, 2014; IOWADOT, 2013; MDOT, 2018; AlaskaDOT, 2018; GDOT, 2019) have incorporated in their PDP documentation to convey the development process graphically. Three criteria were identified in the PDP flowchart to assess the degree of flowchart development. These criteria were the number of project-specific flowcharts, the number of control points (milestones) in the flowcharts, and the level of detail (number of tasks) in the flowchart(s).

8.2.1.1.5. Other Criteria

Past studies proposed other strategies and criteria to improve the efficiency of PDP. These criteria included Value Engineering (VE), risk assessment/management, and quality management. A VE study's primary objective is to minimize total costs (life cycle and construction), reduce construction time, make the project easier to construct, improve quality, and ensure safe operations and environmental goals (NYSDOT, 2017). Based on the literature review findings, half of the state DOTs do VE on their projects. In June 2013, Florida DOT initiated a VE study of the project development and environmental process to streamline most of their projects' development processes.

Additionally, some state DOTs (GDOT, 2019; FDOT, 2019) have incorporated risk management into project delivery. In one NCHRP report (Keck, 2010), risk management is considered one of the best practices during project delivery. Risk management is a valuable tool for better ensuring that desired project outcomes were achieved within scope, cost, schedule, and quality (NYSDOT, 2017). Furthermore, quality management typically includes quality control and quality assurance. Quality control is performed to ensure conformance with stringent requirements. Quality assurance is a continuous improvement of the entire project delivery process to enhance quality, productivity, and customer satisfaction (NYSDOT, 2017). Although risk management and quality management are not widely documented in the PDP, they are still accounted for as the criteria since having them in the PDP can improve the project development process.

8.2.1.2. Step 2: Weighting the PDP Comprehensiveness Criteria through AHP

Once the PDP comprehensiveness criteria were developed in Step 1 (Table 8.1), the second step was to weigh them. Although all criteria were critical to evaluating the comprehensiveness of the PDP, they have different relative weights. Criterion with higher weight has a more significant impact on the evaluation results. If each criterion's weight were not correctly determined, the evaluation results would not represent the current comprehensiveness of the PDP. Therefore, attention was paid to determine the weights of each criterion.

The relative weights of some criteria could not be determined directly since some of the criteria were incommensurable. Empirically, it was difficult to decide the importance of some criteria over other criteria. For example, how much the

'documentation year of publication and update' is more or less important than 'project management.'

Therefore, to establish a logical and empirical ground to the weighting process, it needed to take into account both the underlying data as well as human judgment. To achieve that objective, it was determined that AHP would be the most suitable way to weigh the criteria (10, 11, 34). The advantage of the AHP is that both the underlying data and human judgment can be considered for the evaluation process. AHP allows varying and incommensurable criteria to be compared to one another rationally and consistently. This advantage distinguished AHP from other decision-making techniques.

The researcher followed the AHP's typical steps and developed a process for weighting the criteria. Nineteen (19) criteria for PDP comprehensiveness were developed as discussed in Step 1 (Table 8.1). Keeping in mind that the comparison of the PDP comprehensiveness criteria through AHP is pair-wised, combining a pair of criteria over the range 19 criteria ($^{19}C_2$) is 171, which is a large pool of numbers to weight. Therefore, to simplify the process, the researcher then grouped the 19 criteria into the six categories and subcomponents representing a hierarchy shown in Figure 8.3.

Having decided the six categories and subcomponents (hierarchy), each category's weights were determined using judgment based on Subject Matter Experts' input (preliminary interviews with SCDOT) and the knowledge/support from the literature review. The weighting process was accomplished systematically by evaluating various criteria by comparing them to each other two at a time, concerning their impact on a criterion above them in the hierarchy. For example, project planning weight could be determined by being compared with other criteria such as survey and mapping,

preliminary design, right of way, utility/railroad coordination, PS&E, final design, contract administration, construction, environmental studies and documentation, and permits.

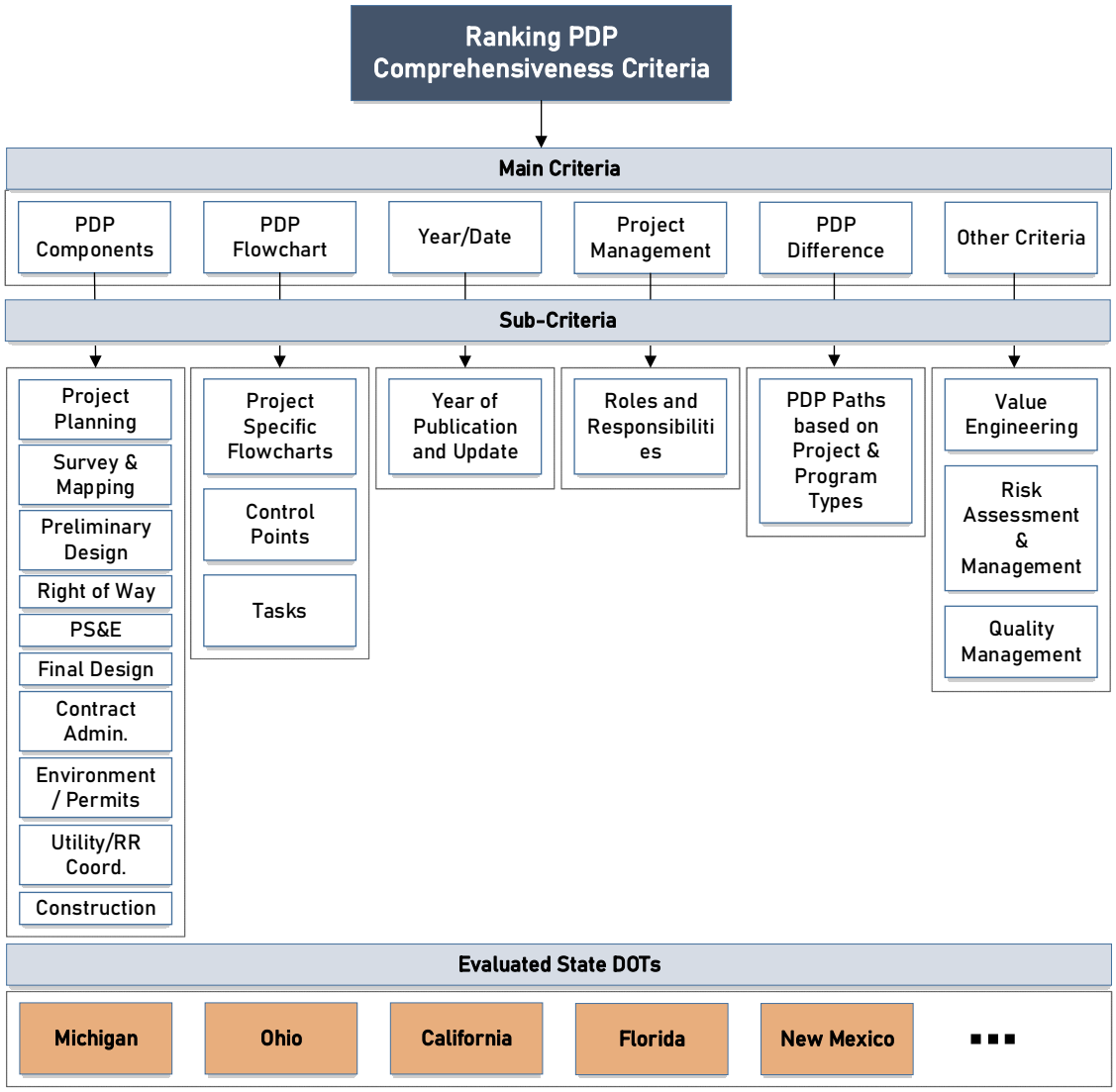


Figure 8.3: PDP Comprehensiveness Criteria Categories for AHP

Data collected (Table 8.1), such as the number of pages in the document and frequency of occurrence relating to each criterion, were used to determine a criterion's

weight. For example, the higher the number of pages in a state DOT PDP document relating to the criterion, the more weights should be put on the criterion. Through the pairwise comparison procedure (AHP), the researcher obtained all comparison results to develop the set of pairwise comparison matrices. Multiple comparison results were synthesized by using their geometric mean. Table 8.2 presents the weights of the PDP comprehensiveness criteria and sub-criteria using AHP.

Criterion	Weight	Sub-Criterion	Weight
Documentation Year	9.8%	Documentation year of publication and update	9.8%
PDP Flowchart	13.8%	The number of project-specific flowcharts	3.5%
		The number of control points/milestones	3.5%
		The number of tasks	6.9%
PDP Components	42.2%	Project Planning	4.3%
		Survey & Mapping	4.1%
		Preliminary Design	4.3%
		Right of Way	4.6%
		PS&E	4.2%
		Final Design	4.3%
		Contract administration	4.3%
		Environmental Studies/Documentation/Permits	4.8%
		Utility/Railroad Coordination	4.6%
		Construction	2.7%
Project Management	9.8%	Project management's role and responsibilities	9.8%
PDP Difference - Project/Program Types	14.7%	The number of PDP paths	14.7%
Other Criteria	9.8%	Value Engineering	4.9%
		Risk Assessment/Management	2.5%
		Quality Management	2.5%
Sum	100%	Sum	100%

Table 8.2: PDP Comprehensiveness Criteria and Sub-Criteria Weights Using AHP

As shown in Table 8.2, the weight of each criterion was identified through the AHP. The importance of the criteria was that PDP Components (42.2%)> PDP Difference based on Project/Program Types (14.7%)> PDP Flowchart (13.8%)> Project Management (9.8%) = Documentation Year of Publication and Update (9.8%) = Other Improvements (9.8%). The most important criterion was the PDP Components. The result is intuitive since the PDP components occupy most of the PDP, and most of the state DOTs had the PDP components based on the data analysis. Among PDP Components' sub-criteria, Environmental Studies/Documentation/Permits (4.8%) had the highest weight. Among the PDP Flowchart sub-criteria, the number of tasks in the flowchart (6.9%) had the highest weight since it indicated the level of detailed tasks in the PDP. Among the sub-criteria of Other Improvements, Value Engineering (4.9%) had the highest weight.

8.2.1.2.1. Descriptive Statistics of the PDP Comprehensiveness Criteria

Descriptive statistics concerning the criteria developed in Step 1 (Table 8.1) were also explored to determine the weights of the criteria shown in Table 8.2. The basic statistics, including the frequency percentage of the PDP comprehensiveness criteria, are shown in Table 8.3. The criteria' range was wide, and the Standard Deviation (SD) of the criteria was much larger than the mean of the criteria. The SD indicated that the comprehensiveness of each criterion varied highly from one state DOT to another. Data collected (Table 8.1) and descriptive statistics (Table 8.3) helped investigate the characteristic of current PDPs of state DOTs. Some criteria with high occurrence indicated that these criteria were documented widely across the state DOTs. In contrast, some criteria with low occurrence frequency indicated that these criteria were not documented widely across the country.

Criteria		Min	Mean	Max	SD	Frequency of Having the Criterion
Documentation Year of Publication and Update		1995	2015	2019	5	N/A
PDP Flowchart	Project-specific flowcharts	0	0.7	3	0.8	
	Flowchart Milestones	0	2.5	31	6	48%
	Flowchart Tasks	0	28	230	48	
PDP Components	Project Planning	0	8	47	11	90%
	Survey & Mapping	0	8	94	20	85%
	Preliminary Design	0	16	196	36	90%
	Right of Way	0	8	54	11	98%
	PS&E	0	7	84	16	88%
	Final Design	0	10	60	16	90%
	Contract administration	0	5	30	7	90%
	Environmental Studies/Documentation/Permits	0	12	94	17	100%
	Utility/Railroad Coordination	0	7	80	14	95%
	Construction	0	3	16	4	58%
Project management		0	3	30	6	33%
PDP Difference based on Project/Program Types	PDP paths	1	2	6	1	35%
Other Criteria	Value Engineering	0	2.6	31	6	50%
	Risk Assessment	0	3	90	15	18%
	Quality Management	0	1	25	5	8%

Table 8.3: PDP Comprehensiveness Criteria Descriptive Statistics

As shown in Table 8.33, the followings were concluded:

- Of 40 state DOTs, almost half of them had a PDP flowchart(s), and half of them did not have one.
- Regarding the PDP essential components, most of the state DOTs' PDP had components of project planning, survey and mapping, preliminary design, right of

way, PS&E, final design, contract administration, environmental studies/documentation/permits, and utility/railroad coordination.

- The majority of state DOTs had a construction component in the PDP.
- Approximately one-third of state DOTs' PDP documented project management.
- The majority of state DOTs used only one PDP for all projects.
- Approximately one-third of the state DOTs had multiple variations for their PDP.
- Half of the state DOTs did VE during the process of project development.
- State DOTs rarely documented risk assessment/management and quality management.

Although risk assessment/management and quality management were not documented widely, they were highly recommended as initiatives by other studies (1, 22) to potentially improve the PDP. The year of publication and update for the state DOTs PDP were also evaluated. Figure 8.4 displays the distribution of the publication and update years for the forty state DOTs. Two-thirds of the state DOTs' PDP were published/updated within the past five years, indicating that a majority of state DOTs update their PDP to maintain their relevance.

In addition, the similarity and differences between state DOTs' PDP regarding comprehensiveness were explored to determine the number of state DOTs with similar PDP comprehensiveness. A random forest model was implemented to distinguish different groups among all state DOTs using the "Random Forest" library in R software (35), which can appropriately classify the state DOTs' PDP. The variables used in the random forest model were criteria presented in Table 8.1. There were 40 observations

(i.e., state DOTs' PDP) used as inputs of the model. Each observation included a series of variables.

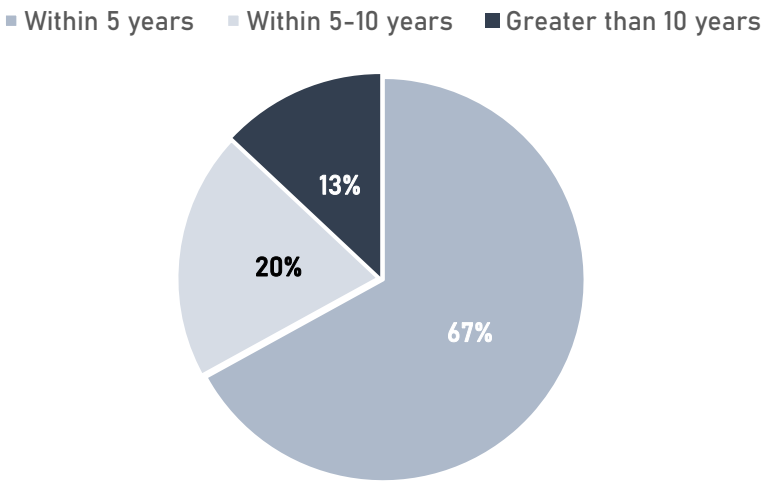


Figure 8.4: State DOTs' PDP Distribution of the Publication and Update Years

Table 8.4 shows representative data used for developing the random forest model. The random forest model algorithm generated a proximity matrix to identify the similarity between PDPs of state DOTs. Based on the random forest model, 40 states were divided into three groups. The state DOTs with similarity in the variables were clustered in the same group. Three distinct groups are shown in Figure 8.5 (the figure is two-dimensional). The comprehensiveness of the state DOTs' PDP was similar within a group, while the comprehensiveness of different state DOTs' PDP significantly varied among the three groups.

Figure 8.5 presented that half of the states had similar PDP comprehensiveness. The generated state DOTs groupings are listed in Table 8.4. The classification process is different from the AHP evaluation process. Within a group, the ranking score of each

state DOT could vary. Even though twenty state DOTs have similar comprehensiveness of PDP in the third Group, these states do not necessarily have the same ranking scores generated from the AHP.

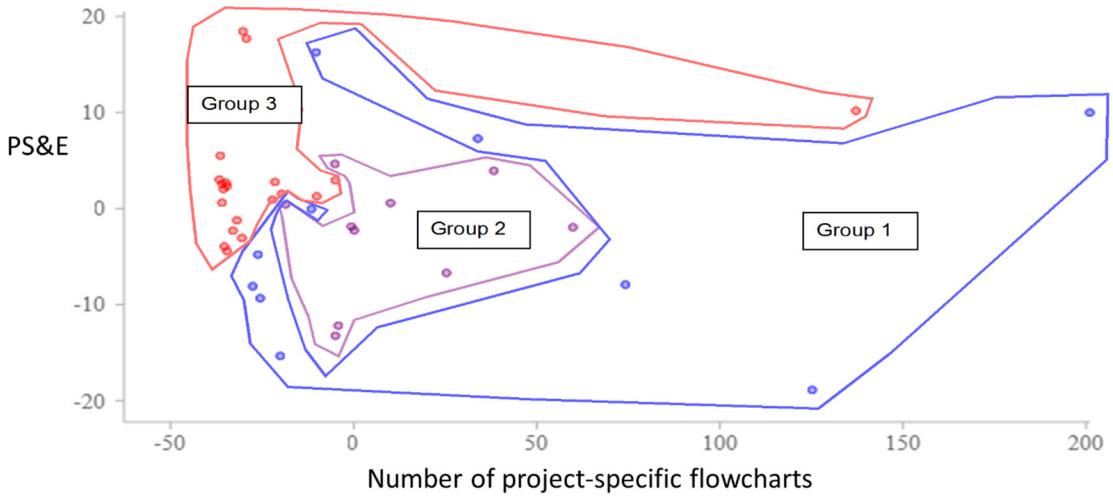


Figure 8.5: State DOTs Groups Generated by the Random Forest Model

Group	Names of States
Group 1 (10 states):	Wisconsin, Michigan, Florida, Idaho, Texas, Arizona, Missouri, Kentucky, Colorado, Indiana
Group 2 (10 states):	California, Georgia, Ohio, Louisiana, New York, Alaska, Iowa, Connecticut, Virginia, Massachusetts
Group 3 (20 states):	North Carolina, Illinois, Oregon, Delaware, Maryland, Oklahoma, Kansas, Nevada, Washington, Alabama, Arkansas, Mississippi, Maine, New Jersey, South Carolina, Vermont, Utah, Minnesota, Pennsylvania, Nebraska

Table 8.4: Distinct Groups of State DOTs PDP based on Random Forest Model

8.2.1.3. Step 3: State DOTs PDP Comprehensiveness Ranking

The last step in the evaluation method was to rank the state DOTs' PDP's comprehensiveness discussed in the previous steps. The primary task in Step 3 was to determine how much one state DOTs' PDP is more/less comprehensive than another. After defining the weights of each of the 19 PDP criteria (Table 8.2), the criterion was scored to calculate the criterion weighting. This weighted score created a ranked list of state DOTs based on PDP comprehensiveness using a 100-point scale score rating in the 'R Software.' The ranking results are presented in Table 8.5. Table 8.5 is a useful reference for state DOTs to identify the comprehensiveness of their PDP. In terms of the comprehensiveness of the PDP, the state of Wisconsin ranked the highest.

State DOT	Rank	State DOT	Rank	State DOT	Rank	State DOT	Rank
Wisconsin	1	Alaska	11	Delaware	21	Arkansas	31
California	2	Arizona	12	Virginia	22	Mississippi	32
Michigan	3	Missouri	13	Maryland	23	Maine	33
Florida	4	Kentucky	14	Indiana	24	New Jersey	34
Georgia	5	Iowa	15	Massachusetts	25	South Carolina	35
Ohio	6	North Carolina	16	Oklahoma	26	Vermont	36
Louisiana	7	Colorado	17	Kansas	27	Utah	37
Idaho	8	Illinois	18	Nevada	28	Minnesota	38
New York	9	Oregon	19	Washington	29	Pennsylvania	39
Texas	10	Connecticut	20	Alabama	30	Nebraska	40

Table 8.5: List of State DOTs' PDP Comprehensiveness Ranking

8.2.2. Task 6: Identification of Comparable State DOTs

In this task, state DOTs comparable to SCDOT were identified from the previous task list (Table 8.5). To identify the comparable state DOTs, a pool of state DOTs was generated, ranked higher than SCDOT at 35th (Table 8.5). The pool of higher-ranked state DOTs was chosen because it does not make any logical sense to gather input (via interviews) from the state DOTs with less comprehensive PDP than SCDOT. Then, comparable state DOTs to SCDOT were identified based on state DOTs' shared criteria, characteristics, and statistics with SCDOT to minimize the number of state DOTs from the pool generated in the first step (Table 8.6).

The state DOTs shared criteria and statistics are shown in Table 8.6 which are, organization type (centralized, decentralized, hybrid), state geography, state-owned/maintained highway miles, highway statistics (NHS/interstate mileage owned and maintained by the state, federal, and state highways length by the functional system to improve comparability with SCDOT), PDP comprehensiveness and components. This evaluation process resulted in selecting six state DOTs for further data gathering concerning PDP best practices that had: a) a well-defined, current project development process, and b) an organizational structure, approach, and transportation responsibilities comparable to SCDOT.

These selected state DOTs are (Table 8.6), Virginia (VDOT), Georgia (GDOT), Florida (FDOT), Kentucky Transportation Cabinet (KYTC), Louisiana (LaDOTD), and North Carolina (NCDOT). These state DOTs are selected to identify PDP best practices by further probing and gathering in-depth information on PDP concepts explored in previous phases of this research, which is discussed in the next section.

State DOT	Total (mile) (2)	Percentage of State-Owned (mile)	State-Owned/Maintained (mile) (3)			County/Town/Municipal Owned/Maintained (mile) (3)	PDP Components	Construction	Project Management Documentation	PDP Flowchart	PDP Documentation Year	Organization Type (1)
			Total	National Highway System (NHS) (4)	Interstate (5)							
VDOT	72,397	81%	58,940	4,589	1,119	13,457	Comprehensive	✓	✓	✓	2016	H
GDOT	125,429	14%	17,959	7,243	1,247	107,470	Comprehensive	✓	✓	✓	2019	C
FDOT	120,573	10%	12,107	8,782	1,495	108,466	Comprehensive	✓	✓	✓	2018	D
KYTC	78,523	35%	27,671	3,299	843	50,852	Comprehensive	✓	✓	✓	2016	H
LaDOTD	60,730	27%	16,677	3,231	937	44,053	Comprehensive	✓	✓	✓	2013	H
NCDOT	102,883	78%	79,923	5,659	1,272	22,290	Comprehensive	✓	✓	✓	2019	H
SCDOT	75,577	55%	41,311	3,602	850	34,266	Comprehensive	✓	N/A	✓	2011	H

(1) H-Hybrid of Centralized and Decentralized; C-Centralized; D-Decentralized
(2) Total mile is a summation of the mileage of the Highway System owned by State Highway Agency and mileage of Highway System owned by County/Town/Municipal
(3) Source: Highway Statistics 2017 (FHWA)
(4) The vast majority of NHS is maintained by the state
(5) Interstate is a subsystem of NHS

Table 8.6: Selected Comparable State DOTs

8.2.3. Task 7: Comparable State DOTs Interviews

This task presents the methodology of gathering input from comparable state DOTs identified in Task 5 and Task 6, alongside its findings and analysis. Structured interviews were conducted with the comparable state DOTs (Table 8.6) to develop and further identify and probe best practices concerning project development processes and performance concepts. Structured interviews were chosen to gather in-depth information on the topics related to addressing the research objectives. Phase 2 of the research, the national state DOTs computer-assisted self-administered questionnaire (Task 4), provided limited data from a broad sample. In contrast, the in-depth structured interviews with comparable state DOTs permitted a deeper understanding of the selected topics.

8.2.3.1. Topics of Inquiry and SMEs Selection

The initial step was a thorough review of the findings of previous phases of this research to help develop topics of inquiry for the interviews. After the development of the inquiry topics, the interview questionnaire was developed. These inquiry topics and the questionnaire were then used to guide interviews with the SMEs from comparable state DOTs. The inquiry topics explored seven PDP concepts and practices: state DOT organization, project scoping, professional services consultants, development process components and management, training, performance, and right-of-way/utility management. The full comparable state DOTs topics of inquiry and interview questionnaire can be found in Appendix B.

The next step was to identify appropriate SMEs for the interviews from the comparable state DOTs (Table 8.7). The SMEs that had already taken the national state

DOTs survey in Phase 2 of this research were selected as appropriate to increase the reliability and validity of the measure and data.

State DOT	Department and Functional Unit	Number of SME(s)
GDOT	Research Office Policy Engineering Procurement Office Program Delivery	4
NCDOT	Research and Development Technical Services Highway Department	3
KYTC	Research Office Professional Services Highway Design Division of Planning	4
LaDOTD	Research Office Project Development Division Road Design Project Management	4
VDOT	Research Office Location and Design Project Management	3
FDOT	Research Office Production Support Office State Project Management Environmental Development Procurement Office	5
	Total Interviewed	**23**

Table 8.7: Comparable State DOTs SMEs Interviewed

Additionally, the SME selection method helped investigate and probe deeper concerning some of the national DOTs survey's established findings. Due to the research's scope, the SMEs were advised that two or more SMEs from their state DOTs may be necessary to conduct the investigative interview. Over the course of approximately two months, structured interviews were conducted with twenty-three (23)

SMEs from six comparable state DOTs (Table 8.7). The SMEs represented a range of functional units and departments (mainly their head/director) shown in Table 8.7.

Each interview lasted approximately 1½ to 2 hours. With the interviewee's permission (s), each session was recorded to ensure comprehensive capture of their input and efficiently utilize the interviewee's time (s). Additional PDP documentation was identified and noted for collection after the interview process. Following each interview, a complete transcript was developed that was subsequently analyzed and summarized by theme/category using Content and Thematic forms of Analysis.

8.3. Findings and Analysis

Subsequent to the transcription of the data collected from the comparable state DOTs interviews, the data was analyzed using content analysis and thematic analysis. Through content analysis, the qualitative data is systematically transformed into a concise and organized summary. Besides, the data is coded, organized by category, and analyzed to identify central themes using MAXQDA software (Table 8.8). Via thematic analysis, by moving through the data back and forward, the association's patterns and descriptions are searched and explored across the interview transcripts.

Table 8.8 presents the interview analysis codes used during content and thematic analysis. The codes are categorized into seven major categories (themes): state DOT Organization, Project Scoping, Professional Services Consultants, Project Development Process, PDP Training, Performance Management, and Utilities. Each code category has its subcategories, which helped identify and organize the data by different themes and sub-themes. These codes also helped ease the comparative analysis of data across the comparable state DOTs by their themes.

Code	Theme	Code	Sub-Theme	Code	Sub-Theme
1	State DOT Organization	1.1	Preconstruction Organization	1.1.1	Organization Chart
		1.2	Project Management Manual		
		1.3	SEPA		
2	Project Scoping	2.1	Process	2.1.1	Scoping Software
		2.2	Level of Design Development		
		2.3	Project Scope Document		
3	Professional Services Consultants	3.1	Consultants Procurement Organization		
		3.2	Consultant Use		
		3.3	Consultant Procurement Process	3.3.1	Consultant Procurement Time
				3.3.2	Streamline Consultant Process
				3.3.3	On-call Method
				3.3.4	Contacting Method
		3.4	Consultants Deliverables		
		3.5	Consultant Managing Consultant		
		3.6	Consultants Performance Metrics		
4	PDP	4.1	Streamlining PDP		
		4.2	Scheduling	4.2.1	Scheduling Software
				4.2.2	Scheduling Template
				4.2.3	Milestones Tracking
				4.2.4	Schedule Responsibility
		4.3	Project Cost	4.3.1	Budget Development Process
				4.3.2	Budget Responsibility
				4.3.3	Cost Template
				4.3.4	Tracking Cost
5	PDP Training				
6	Performance Measurement	6.1	Performance Measurement Responsibility		
		6.2	Performance Metrics		
		6.3	Metrics Data Utilization		
7	Utilities/ROW				

Table 8.8: Comparable State DOTs Interview Analysis Code System (MAXQDA)

The qualitative analysis of the comparable state DOTs interviews using content and thematic forms of analysis (Table 8.8) provided a wealth of information concerning various PDP concepts and best practices. The data analysis helped clarify the PDP concepts and best practices explored from the previous phases of this research. The comparable state DOTs interview data were also compared to explore means and practices to streamline a state DOTs PDP and identify best practices. The identified PDP best practices from comparable state DOTs and the brief comparative summary of findings are presented in Table 8.9.

As shown in Table 8.9, all comparable state DOTs (VDOT, GDOT, FDOT, KYTC, LaDOTD, NCDOT) data are organized by the code system shown in Table 8.8 using MAXQDA software. Table 8.9 has also highlighted the effective and best practices concerning PDP explored from these comparable state DOTs during the interviews. The findings of the comparable state DOTs interviews have helped develop PDP best practices and recommendations to streamline a state DOT PDP discussed in the next chapter.

During the interviews, the SMEs also provided secondary documentation to support the interview data. The secondary documentation concerning PDP provided by the SMEs during the interviews was also used and analyzed to evaluate and establish support on how the identified PDP best practices are utilized in the comparable state DOTs. In addition, the secondary documentation clarified the PDP concepts and best practices explored from the interviews. The list and detailed description of the PDP best practices are discussed in Chapter 9.

Code	Theme/Sub-Themes	VDOT	GDOT	FDOT	KYTC	LaDOTD	NCDOT
1	State DOT Organization	Hybrid	Centralized	Decentralized	Decentralized	Centralized	Hybrid
1.1	Preconstruction Organization	Discipline	Discipline	Geography	Geography	Discipline, Project & Program Type	Geography
1.1.1	Organization Chart	✓	✓	✓	X	✓	✓
1.2	Project Management Manual	X	✓	✓	X, Highway Design Manual	✓	✓
1.3	SEPA	✓	✓	✓	✓	✓	✓
2	Project Scoping	✓	✓	✓	✓	✓	✓
2.1	Process	Smart Scale Prioritization Process	Planning and Program Delivery Office	Standard Scope of Services Template	SHIFT, Prioritization Process,	Six-Phase Individual Process	ATLAS, GIS Data, Prioritization Process
2.1.1	Scoping Software	Smart Scale, SGR	X	X	SHIFT	X	Project ATLAS
2.2	Level of Design Development	20-30%	10-30%	0-10%	0-10%	0-30%	0-10%
2.3	Project Scope Document	Smart Scale Application	Concept Report	PE Report	Planning Study, Data Needs Analysis	Individual Project Scoping Report	Project Scoping Report (Express Design)
3	PSCs Consultants	✓	✓	✓	✓	✓	✓
3.1	Procurement Organization	Central Office	Central Office	Districts	Central Office	Central Office	Central Office
3.2	Consultant Use	55%, LPA: 100%	83%	90%	80%	Less than 50%	75%
3.3	Consultant Procurement Process	Prequalification RFP – NTP	Prequalification RFP – NTP	Prequalification RFP – NTP	Prequalification RFP – NTP	RFP – NTP	Prequalification RFP – NTP
3.3.1	Consultant Procurement Time	6-9 months	9-12 months	4-6 months	100 days	6-12 months	6 months
3.3.2	Streamline Consultant Process	Lead Negotiator, Prequalification, Increased On-call Services,	Involvement of ACEC Community, Performance Track	Decentralization, Districts Use of PSCs	100 Days Goal, Timeframe Standards, Shared Online Portal	Lump-Sum Negotiations, Historical Data	Limited Services Contract, Prequalification
3.3.3	On-call Method	✓	✓	✓	✓	✓	✓

Table 8.9: Comparable State DOTs Interviews Summary of Findings, Analysis, and Coding

Code	Theme/Sub-Themes	VDOT	GDOT	FDOT	KYTC	LaDOTD	NCDOT
3.3.4	Contacting Method	Limited Lump-Sum	Limited Lump-Sum, Project Bundling	Lump-Sum, Standard Scope of Services	Lump-Sum	Lump-Sum List of Deliverables PSCs Specific	Limited Services Contract, Lump-Sum
3.4	Consultants Deliverables	✓ Same as In-House	✓ Same as In-House		✓ Same as In-House		✓ Same as In-House
3.5	Consultant Managing Consultant Consultants	✓ Mega Projects	✓	✓	X	X	✓
3.6	Performance Metrics	✓ (Figure 7.6)	✓ (Figure 7.6) Baseline Schedule Metrics	✓ (Figure 7.6) Standard Consultant Evaluation	✓ (Figure 7.6) Monthly Evaluation Report	✓ (Figure7.6) Standardized List of Deliverables	✓ (Figure7.6) Time, Cost & Utilization Metrics
4	PDP	✓	✓	✓	✓	✓	✓
4.1	Streamlining PDP	Smart Scale, SGR, PWA, Dashboard	Flowcharts, Tiered Bridge Development Program	Technology, Risk Analysis, Coordination	PSCs Timeline, PCEs, Bridge Reinstating Program Based on Legislature Highway Plan	CSS/CSD, USACE Funded Positions, Historical Database Enterprise System based on Historical Database	Consistency by Creating Individual PDP Process, IPD Standard Timeline Goals for PDP Milestones
4.2	Scheduling	Scheduling Templates, PWA	Scheduling Templates	District Scheduling Templates		Enterprise System, SAP	
4.2.1	Scheduling Software	Web-Based MS Project	Primavera P6	Primavera P6	MS Project		MS Project
4.2.2	Scheduling Template	54 Templates	P6 Template by Genre as Baseline	Templates by Districts	Four Templates as Baseline	X	X
4.2.3	Milestones Tracking	Dashboard	✓	✓	✓	Enterprise System Tracking	Monthly Tracking System
4.2.4	Schedule Responsibility	PM	Program Control	PM, Scheduler	PM, PSCs	PM, SMEs	PM
4.3	Project Cost Budget	✓	✓	✓	✓	✓	✓
4.3.1	Development Process	Tiered System	Historical Data	Statewide Cost Database	Based on Highway Plan and Manual	Standard Cost Data	Standardized Templates, Monthly PE Projections
4.3.2	Budget Responsibility	PM, SMEs	Program Control	PM	District, Project Managers	PM, SMEs	PM, SMEs
4.3.3	Cost Template	Within Scheduling Template	Within Scheduling Template	Tailored Cost Database	X	Historical Database	Standardized Estimating Templates
4.3.4	Tracking Cost	Dashboard	Minimal	✓	✓	Enterprise System	Monthly PE Projections

Table 8.9 Continued: Comparable State DOTs Interviews Summary of Findings, Analysis, and Coding

Code	Theme/Sub-Themes	VDOT	GDOT	FDOT	KYTC	LaDOTD	NCDOT
5	PDP Training	TPMI, Online and In-Person	PM Manual, Online and In-Person	Manuals, Online, and In-Person	PM Boot Camp	PM Manual	Limited
6	Performance Measurement	Dashboard, PWA	✓	Via Schedule and Production Meetings	✓	Enterprise System Milestones	✓
6.1	Performance Measurement Responsibility	Project/Program Management Office	PM	District Secretaries	District PM	PM	PM
6.2	Performance Metrics	Figure 7.6, Dashboard	Figure 7.6, P6 Templates	Figure 7.6, Schedule Activities	Figure 7.6	Figure 7.6	Figure 7.6, Major PDP Milestones
6.3	Metrics Data Utilization	On-time Delivery, Progress Evaluation	Performance Report, Progress Evaluation	Performance Report, Progress Evaluation	Performance Tracking, Progress Evaluation	Communication, Performance Report, Progress Evaluation	Tweak Processes, Progress Report, Evaluations
7	Utilities/ROW	✓	✓ Digitized	✓	✓	✓	✓
Explored PDP Best Practices from the Comparable State DOTs Interviews		Development and Establishment of Project Prioritization Process Development of a Formal Project Scoping Report Use of Professional Services Consultants Development of Standard Set of Deliverables for Professional Services Consultants Prequalification of Professional Services Consultants Evaluation of Professional Services Consultants Performance during Project Development Process Managing and Streamlining the Procurement Process of Professional Services Consultants Establishing Project, Department, and Agency Level Performance Measurement and Metrics Development of Process Flowcharts for Various PDP Development of a Project Development Process Manual Establishment and Monitoring Project-Level Critical Path Method Schedules During PDP Development of a Comprehensive Project Development Process Training for PMs and PSCs					
Comparable State DOTs Secondary Documentation							
Standard Scope of Services		✓	✓	✓	X	X	✓
Prequalification Manual		✓	✓	✓	✓	✓	✓
PSCs Procurement Manual		✓	✓	✓	✓	X	✓
PDP Manual		✓	✓	✓	✓	✓	✓
PDP Flowcharts		✓	✓	✓	✓	✓	✓

Table 8.9 Continued: Comparable State DOTs Interviews Summary of Findings, Analysis, and Coding

8.4. Conclusion

The literature related to PDP was reviewed, and PDP documents of different state DOTs were analyzed to identify 19 criteria and collected information for each criterion from 40 state DOTs. The analyzed data found that the comprehensiveness of each criterion varied from state to state. Three distinct groups of PDPs were identified, which indicated three different levels of comprehensiveness. Half of the states (20 states out of 40 states) had similar comprehensiveness of the PDP. Through AHP and inputs from the data analysis, PDP criteria were weighted and scored. PDP Components were the most important criterion, and its weight was 42.2%. Among the sub-criteria of PDP Components, Environmental Documentation had the highest weight.

Finally, the PDP's comprehensiveness was evaluated, and a list of the rankings of the state DOTs' PDP was generated through the AHP. Comparable state DOTs were identified based on state DOTs' shared criteria, characteristics, and statistics, and structured interviews were conducted. The structured interviews with comparable state DOTs' SMEs resulted in identifying all the objectives noted in this chapter.

To conclude, Phase 3 of this research helped identify PDP best practices by further probing and gathering in-depth information on PDP concepts explored in previous phases of this research. Besides, gathering in-depth input from comparable state DOTs helped establish support for PDP best practices and findings explored through the national state DOTs survey discussed in chapter 7. A detailed description of the identified PDP Best Practices is discussed in the next chapter.

CHAPTER NINE

PHASE 4: PROJECT DEVELOPMENT PROCESS BEST PRACTICES

This chapter discusses, describes, and presents the research methodology, Phase 4, States' Department of Transportation Project Development Process Best Practices identified from the data analysis and findings of the previous phases of this study discussed in the previous chapters. Phase 4 of the research methodology includes three tasks, review and summarization of findings and data analysis from previous research phases, development and detailed description of PDP best practices from the findings and analysis, and establishing recommendations concerning PDP for SCDOT (Figure 4.1).

9.1. Task 8: Summary of Findings and Analysis

As shown in Figure 4.1, the data analysis has occurred at several points in this study. First, analyzing the qualitative data collected from semi-structured SCDOT SMEs, and second, analyzing quantitative data collected from professional services consultants via a structured survey. Third, analyzing the quantitative data collected by computer-assisted self-administered questionnaires from national state DOTs and analyzing the qualitative data collected via structured interviews and secondary data from comparable state DOTs.

Task 8 aims to summarize these findings and analysis to identify and establish correlational support for the development of PDP best practices. The analyses from the quantitative results are connected to the qualitative phase, and subsequently, the qualitative results are used to understand the quantitative results. The qualitative results

have provided a deeper understanding of the relationships and statistical findings of the quantitative results.

For the quantitative analysis, a test of statistical significance is conducted to determine the significance of the explored concepts related to PDP best practices and project development performance from the data collected via surveys (Chapters 6 and 7). The survey instrumentation's measurement scale was mainly nominal and interval data; thus, both parametric and nonparametric tests are conducted. The statistical test results are presented by probability values (p-value).

Data collected from interviews (Chapters 5 and 8) are analyzed by content analysis and thematic analysis for the qualitative analysis. Through content analysis, the qualitative data is systematically transformed into a concise and organized summary. Besides, the data is coded, organized by category, and analyzed to identify central themes. Via thematic analysis, by moving through the data back and forward, the association's patterns and descriptions are searched and explored across the interview transcripts. The final analysis presented a clear understanding of the relationship between the study variables and provided support for the PDP best practices discussed in the next section.

9.2. Task 9: PDP Best Practices

This task presents the Project Development Process (PDP) Best Practices identified based on the findings and analysis from the previous phases of this research. This task outlines the twelve PDP Best Practices, their categories, and the key findings from the research study's data sources that support each Best Practice,

The PDP Best Practices were assembled based on the data, analysis, and findings supported by five different data sources as follows:

1. The national PDP survey of the 50 state DOTs throughout the U.S. was conducted during this research effort, with thirty-six (36) of the 50 state DOTs responding (72% response rate). The survey collected data on an agency's project development approach and organization, project planning and scoping, performance evaluation, project development timeframes, procurement of professional services consultants, and process improvement suggestions (Chapter 7).
2. The second data source was input received during structured interviews with six state DOTs (VDOT, GDOT, FDOT, KYTC, LaDOTD, and NCDOTD) that were systematically identified state DOTs comparable to SCDOT. Comparable states were identified based on their transportation program's similarity and the comprehensiveness of their project development process utilizing an Analytical Hierarchy Process (AHP) to weigh the criteria (Chapter 8).
3. The third data source was secondary documentation acquired during the interview process of comparable state DOTs and the state DOT's website.
4. The fourth data source was structured interviews of forty-four Subject Matter Experts (SMEs) with SCDOT. The interviews examined each component of the PDP and collected agency data on process, performance, and SME suggestions for improvement (Chapter 5).
5. The last data source was a survey of The American Council of Engineering Companies of South Carolina (ACEC-SC) that have, or currently are, providing professional

services to SCDOT. Forty-three (43) firms out of 82 member affiliates participated in the survey study (Chapter 6).

The analysis of all data sources was used to assemble PDP Best Practices, which are numbered and categorized into five categories, Project Prioritization and Scope Definition Process, Consultant Procurement and Management, Performance Measurement and Accountability, Project Development Process (PDP), and Project Development Process Training. What follows is a detailed description of the PDP Best Practices and associated source material for each.

9.2.1. Category A: Project Prioritization and Scope Definition Process

9.2.1.1. Best Practice #1

Development, establishment, and publication of an Enhanced and Transparent Project Prioritization Process to evaluate and select projects during the planning stage that best meet the agency's objectives.

9.2.1.1.1. Key Findings

- Top-performing state DOTs nationwide have developed an enhanced and transparent project prioritization system based on a data-driven, objective-specific, and collaborative approach.
- All of the comparable state DOTs (GDOT, NCDOT, FDOT, VDOT, KYTC, & LADOTD) have developed an enhanced and transparent project prioritization system that prioritizes transportation projects for development based on an objective and outcome-based process.

9.2.1.1.2. Summary of Findings

One of the well-defined processes explored from findings and analysis (state DOT interviews) is having an enhanced project prioritization system that starts with preliminary scoping for transportation projects managed by the Preconstruction Department of a state DOT. With project prioritization, state DOTs quantify their projects based on value, evaluate and rank the planned projects based on specific criteria, and find a balanced volume of projects based on available funding, human resources, expertise, and resources to continue with the development of transportation projects.

Of the state DOTs interviewed, all of them have an enhanced project prioritization process to quantify, evaluate, rank, and balance their project volume. State DOTs such as VDOT, NCDOT, KYTC have especially well-defined and comprehensive project prioritization systems and processes. Furthermore, state DOTs have different project prioritization systems and methods to evaluate and weigh the project criteria, score, and rank their projects. Still, the overall process and methodology are similar. The interviewed state DOTs' project prioritization processes are all well-defined and have the following common components:

- A system to gather project information for all projects throughout the state
- Project eligibility criteria for funding purposes
- A project screening process
- Project evaluation criteria along with their respective weights
- Project weighting, scoring, and evaluation process
- Development of prioritized project lists

- Use the prioritized projects and ranking system to help define detailed project scope
- Disclosure and publication of the project prioritization methodology and system to the public

9.2.1.2. Best Practice #2

Development of a formal project scoping report to define and document the anticipated project scope during the planning phase.

9.2.1.2.1. Key Findings

- All comparable state DOTs (GDOT, NCDOT, FDOT, VDOT, KDOT, & LADOTD) document their project scoping process to:
    - Establish the actions required to define the project scope
    - Develop the conceptual schedule and cost estimate for the project
    - Identify project goals, risks, alternatives, and departmental responsibilities
    - Serve as a guideline for the development of the project
- The majority of top-performing state DOT's nationwide develop a formal project scoping report/document prior to placement of the project in their STIP.
- State DOTs that develop a formal scoping document find that the process encourages them to clearly define the project scope prior to requesting PE funding in their STIP.
- Top Performing state DOTs in the national survey rarely have to revise the STIP funding due to changes to the project scope. Conversely, two-thirds (67%) of the

Poor Performing state DOTs had to revise their STIPs due to project scope changes during project development.

- Nationwide, the majority of state DOTs believe that developing a formal scoping document with a cross-functional project team during the planning stage reduces the need for project scope changes and STIP revisions.

9.2.1.2.2. Summary of Findings

The project scoping process is an important phase of PDP in which "*a series of project-focused activities that develop key design parameters and other project requirements to a sufficient level of definition such that scope discovery is complete and a budget and letting date can be firmly established before programming the project in the STIP to minimize the risk of change and project overruns during detailed design*." Documenting the project scoping process for transportation projects managed and developed by the preconstruction departments of state DOTs is a PDP best practice.

It is a process that outlines the actions required to initiate and establish a transportation project scope and the project's conceptual timeframe and cost. It also helps state DOTs to identify project goals, risks, alternatives, cost, schedule, and responsibilities of the SMEs involved early in the process to streamline the PDP. The development of the scoping report also serves as a guideline to support the scope development of a project planning phase of a project that can later be a reference to support scope decisions and limit changes during the development of the project.

Of state DOTs interviewed, all of them document their scoping process, which results in a report that documents the decisions made during the scoping process to define the project scope. Documenting the project scoping process for transportation

projects managed and developed by the preconstruction departments of state DOTs is one of PDP's best practices. It helps define project scope and outlines the actions required to initiate and complete a transportation project, and establishes the project's conceptual timeframe and cost. The interviewed state DOTs project scoping reports or documents share consistent components/elements, which are:

- Development of a standardized scoping report form/template to be used across different districts and regions of the state
- Involvement of SMEs (project team) from different functional units based on project/program type during the planning phase of the project
- Documentation of the SMEs responsibilities and roles in the scoping report
- Identification and documentation of scoping criteria such as project information & background, project need and purpose, project cost & schedule, project delivery method, project major & interim phases/milestones, project risks, and public involvement
- Creation of scoping report, which clearly defines the scope of a project for programming and development purposes

9.2.2. Category B: Consultant Procurement and Management

9.2.2.1. Best Practice #3

Utilization of Professional Services Consultants to meet the agency's workload.

9.2.2.1.1. Key Findings

- Nationally, the average percentage of state DOTs transportation projects developed by professional services consultants is 54%.

- Thirty-seven percent (37%) of the state DOTs nationwide indicated their use of consultants was increasing, and 63% noted their use of consultants was steady. None of the state DOTs indicated consultant use was decreasing.
- The use of consultants is widespread among state DOTs to the extent that some state DOTs are utilizing General Engineering Consultants Services (consultants managing consultants) as an effective practice to manage project consultants.

9.2.2.1.2. Summary of Findings

Professional Services Consultants play a significant role in project development and delivery and typically serve as part of the state DOT's project development team. Nationwide, the use of professional services consultants is well-established and a best practice utilized to meet and balance a state DOT's workload. Due to state DOTs increasing workload, the use of professional services consultants is increasing nationwide. According to national PDP survey findings, state DOTs contract an average of fifty-four percent (54%) of their agency's preconstruction project design and engineering activities to professional services consultants. Also, more than a third (37%) of the state DOTs participating in the survey indicated that their use of consultants was increasing.

In comparison, the remaining 63% noted that their use of consultants was steady. None of the states indicated that their contracting of professional services consultants was decreasing. Interestingly, several state agencies were even using professional services consultants as 'general' managers to manage other consultants delivering project-related services. The distribution of the use of professional services consultants is shown in Figure 7.5.

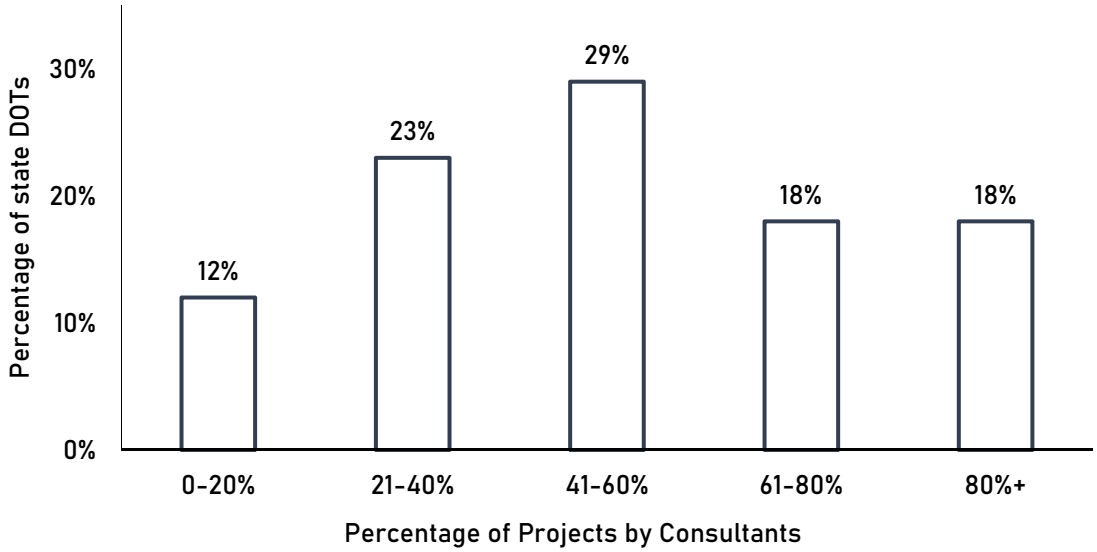


Figure 7.5: State DOTs Percentage of Projects by PSCs (Chapter 7)

State DOTs use professional services consultants for project development and engineering due to a number of factors, including insufficient in-house expertise, increased project demands, costly and time-sensitive large complex projects, and limited DOT resources and staff to develop these projects. The use of professional services consultants is necessary when state DOTs do not have the in-house expertise or the resource capacity needed for timely completion of the project. In addition, most state DOTs use professional services consultants for complex, large, unique, and special projects. Nationwide, as the complexity of the project increases in state DOTs, consultants' use correspondingly increases.

The use of professional services consultants is widespread and increasing among state DOTs to the extent that some state DOTs are utilizing General Engineering Consultants Services (Management Consultants or GEC) as an effective practice to

manage their project consultants. For example, GDOT, FDOT, VDOT, and NCDOT (comparable state DOTs to SCDOT) hire professional services consultants to manage and administer other consultants' work or projects.

To conclude, the use of professional services consultants is increasing among the state DOTs. State DOTs are using professional services consultants to meet and balance their workload as part of their project development team. Therefore, state DOTs need to systematically and regularly reevaluate their agency's workload balance, in-house expertise and capacity, industry trends, and the agency's use of consultants to determine their consultant use's effectiveness and efficiency.

9.2.2.2. Best Practice #4

Development of a Standard Set of Deliverables for professional services consultants so a state DOT can effectively and efficiently manage, evaluate, and track consultant performance.

9.2.2.2.1. Key Findings

- All of the comparable state DOTs have established a set of standard deliverables for their professional services consultants.
- Most state DOTs nationwide clearly define contractual milestones and establish consultant deliverables similar to those utilized for in-house design teams.
- The majority of state DOTs nationwide believe that the development of the same standard set of deliverables for both in-house and professional services consultants leads to consistency across the agency and provides a standard platform to track and evaluate consultant performance.

- SCDOT establishes deliverables for each project, but the agency's professional services consultants (ACEC-SC) view SCDOT deliverables as inconsistent from project to project.

9.2.2.2.2. Summary of Findings

State DOTs professional services consultants play a significant role in developing transportation projects, streamlining PDP, and enhancing project delivery as part of the Project Development Team (PDT). Depending on the complexity of the projects and the availability of resources, the use of professional services consultants varies from one state DOT to another. State DOTs such as GDOT, KYTC, and FDOT contract with consultants for development and engineering on more than 80% of their transportation projects.

One of the well-defined and best practices explored during the state DOTs interviews was establishing a standard set of deliverables for professional services consultants. State DOTs establish a standard set of deliverables to effectively and efficiently manage, evaluate, and track their professional services consultants' performance and schedule. This practice supports the streamlining of their PDP.

A standard set of deliverables can be described as quantifiable services that professional services consultants are bound to provide according to their contract and will be delivered during project execution and before completion. All six state DOTs interviewed have developed and established a set of standard 'global' deliverables for their professional services consultants. The global set of deliverables is adjusted for each transportation project based on the deliverables needed and required for the project.

The 'global' and project-specific set of deliverables are also different from one state DOT to another based on several factors, including project type, program type, type of services being consulted out (such as environmental, design, utilities, survey, SUE, etc.), project funding source, and project delivery method. But there are common criteria among these state DOTs in establishing the standard set of deliverables, which are listed below.

- Establishment of a 'global' set of deliverables based on the project schedule, PDP milestones, and major PDP phases
- Establishment of a standard set of deliverables for both in-house and professional services consultants (most state DOTs have the same set of deliverables for both in-house development team and consultants for consistency and performance measurement and comparison)
- Utilization of a set of project deliverables in the scope of services and contracts to bind the consultants to deliver their tasks and responsibilities
- Use of a standard set of project deliverables in determining, setting, and tracking the professional services consultants project schedule and performance

9.2.2.3. Best Practice #5

Prequalify Professional Services Consultants to ensure performance capability and accelerate the professional services consultant's procurement timeframe.

9.2.2.3.1. Key Findings

- All of the comparable state DOTs utilize a prequalification process for their professional services consultants.

- Three quarters (74%) of all state DOTs nationwide prequalify design consultants.
- Most all (92%) of the Top Performing state DOTs in the nation prequalify design consultants.
- Almost two-thirds of the state DOTs nationwide believe that professional services consultants' prequalification is an effective process to streamline and accelerate the consultant procurement timeframe.

9.2.2.3.2. Summary of Findings

FHWA defines Prequalification as '*a procedure to review and evaluate professional and technical firms' qualifications before their services are needed (before RFP) by a state transportation agency*.' Prequalification of professional services consultants is a necessary component of the procurement process. A state DOT evaluates the consultants' work experience, available resources, and capacity (workforce, equipment, financial, etc.), business practices, and performance. This process provides the framework for consultants' qualifications to perform a service on a future project and task.

The prequalification of professional services consultants is a well-defined and best practice of state DOTs nationwide and was explored with the comparable state DOTs during the interview process. All six of the comparable state DOTs have a prequalification process for their professional services and on-call consultants. The prequalification process's objective is to ensure that the consultant has the technical expertise and sufficient resources to accomplish its proposed service. The prequalification of professional services consultants streamlines the procurement and project

development process by mitigating project risks such as consultant incompetency, financial stability, and schedule performance.

State DOTs nationwide use prequalification of professional services consultants as a best practice to streamline and accelerate their procurement process. Prequalification of consultants in comparable state DOTs differs and depends mainly on the consultants' contracting methods and services. Some state DOTs such as LaDOTD do not prequalify their consultants for project-specific contracts, and other state DOTs such as NCDOT prequalify their consultants for both project-specific and on-call contracts. Some state DOTs such as VDOT have a prequalification process for specific services such as utilities or right-of-way. Still, other state DOTs such as KYTC prequalify their consultants no matter the type of service.

State DOTs have different consultant prequalification processes and guidelines due to their organizational goals and objectives. Their prequalification process differs based on project types, service and work types, delivery methods, projects/services schedule, projects/services complexity, and funding limitations. But the state DOTs prequalification processes share major similar and common criteria, which are listed below.

- A consultant's prequalification committee to evaluate and identify qualified firms and companies for the proposed professional services
- Consultant firms required to be state registered and licensed for the type of services they perform
- A prequalification application process that includes and lists the requirements for a professional service consultant

- Submission of the firm's past performance and expertise (completed similar work or projects)
- Define the type of work, service, and projects that the professional services consultant intends to provide (consultant niche)
- Professional services employees and team's expertise (resumes, certificates, etc.)
- Financial information (bonds, insurance, credit, statements)
- Available resources such as equipment, key personnel, software expertise, etc.
- Renewal and requalification process for previously qualified consulting firms

9.2.2.4. Best Practice #6

Evaluate professional services consultants' performance during project development to effectively track performance, ensure quality, communicate performance concerns, and provide constructive feedback.

9.2.2.4.1. Key Findings

- Comparable state DOTs believe that evaluating consultant performance is important to ensure a quality effort and achieve contractual milestones.
- Comparable state DOTs use consultant performance evaluations as part of the selection criteria.
- The majority of state DOTs measure and evaluate their professional services consultants' project development performance and use a similar process to evaluate their in-house production team.

- The majority of state DOTs have similar deliverables and performance metrics for both the in-house development team and consultants.
- A majority of SCDOT's consultants believe that performance expectations and measurements for consultant performance are not clearly defined.

9.2.2.4.2. Summary of Findings

One of the well-defined and best practices explored from the national survey and comparable state DOTs during the interview process was the evaluation of their professional services consultants' performance during the project development process. All of the comparable state DOTs evaluate their professional services consultants' performance to effectively manage their quality of service(s)work, communicate performance, create expectations, and provide constructive feedback on their performance.

Evaluation of professional services consultants' performance is considered important to ensure the quality of the consultant's service(s). In addition to providing feedback and evaluating the consultant's work's quality, the consultant performance is used by state DOTs as essential data for consideration of the consultant for future services. It was noted that effective evaluation of consultant performance was important for effective management of the services provided. Some state DOTs, including NCDOT and KYTC, also use consultant performance evaluation results to requalify and consider consultants for advertised or future service/work.

State DOTs interviewed by the research team have different ways and methods to evaluate their professional services consultants' performance, but all share common

criteria and components. These shared criteria and components provide information regarding:

- Why the consultant's performance is measured?
- When is performance measured?
- How often is performance measured?
- Who is involved in the evaluation?
- How is performance measured (scoring, rating, weighting)?
- What are the performance criteria measured?

Usually, in all state DOTs, the project manager is responsible for evaluating professional services' performance by scoring and weighing a set of performance metrics for consultant services. The consultant performance evaluation report includes the scored measures for each consultant's performance. The results are reported to the state DOT management or consultant procurement office. The consultant's performance evaluation report is used to provide feedback on the consultants' service(s), consider the consultant for future services, and effectively manage the current service(s) the consultant provides.

Most state DOTs evaluate and measure project development performance similarly for both projects developed in-house or by professional services consultants. State DOTs professional services consultants are part of the project development team and partner with state DOTs. Of the state DOTs interviewed, almost all of them, such as VDOT, GDOT, KYTC, NCDOT, have similar deliverables and performance metrics for both in-house and consultants.

Additionally, the state DOTs performance dashboard presents the metrics gathered for all projects developed in-house or by professional services consultants. Some state DOTs such as GDOT and FDOT use consultants on more than 80% of their projects; thus, the project development metrics and performance measures reported in their performance reports are mostly gathered from projects developed by their consultants.

9.2.2.5. Best Practice #7

Streamline and aggressively manage the process for procurement of professional services consultants to reduce the timeframe required for procurement.

9.2.2.5.1. Key Findings

- Nationwide, the use of consultants for design services is increasing for most state DOTs. None of the state DOTs expected the use of consultants to decline.
- Nationwide, state DOTs have an average procurement timeframe (RFP to NTP) of five (5) months for professional services consultants. The procurement time for Poor Performing state DOTs is six months or more.
- Based on the national survey findings, half of the state DOTs have a need and an opportunity to reduce their procurement timeframe.
- The efficient procurement of consultants is essential because of increasing use and agency pressure for timely and efficient project development.

9.2.2.5.2. Summary of Findings

The majority of state DOTs indicated that professional services consultants' timely procurement is key to streamlining the PDP phases and tasks. Below is the description

of key practices to streamline, accelerate and reduce the professional services procurement time derived from the findings of the national state DOT PDP survey, state DOTs PDP interviews, and ACEC-SC PDP survey.

National State DOT PDP Survey:

- To reduce procurement duration, almost all of the top-performing state DOTs have implemented a prequalification process for consultants. Ninety-two percent (92%) of Top Performers often or almost always prequalify design consultants. Top performer state DOTs view design consultants' prequalification as an effective action to reduce the procurement duration.
- Many state DOTs have increased their use of on-call/IDIQ/continuing consultants for project design to reduce procurement time.
- The most effective procurement action was the development of a well-defined project scope before the advertisement. Seventy-nine percent (79%) of the state DOTs indicated that this activity was very or extremely effective for reducing the procurement time.
- The activity that ranked second (based on the mean) was the use of standardized estimating/scoping templates, with 70% of the respondents submitting that it was very or extremely effective to reduce the consultant's procurement timeframe.
- Reduction of the number and time required for internal approvals and tracking procurement milestones was also viewed as very or extremely effective by most state DOTs, 61% and 51%, respectively.

Comparable State DOTs Interviews:

Virginia Department of Transportation (VDOT):

- To streamline the consultant procurement process, VDOT has a lead negotiator in each district that handles most of the consultant's procurement negotiations. The lead negotiator secures the contract, whether it is in a district or a program area.
- According to VDOT, increasing their use of on-call services has decreased the consultant's procurement time by 40% - 50%.

Georgia Department of Transportation (GDOT)

- The consultant procurement process is streamlined by coordinating and engaging with the ACEC community to refine the procurement process for negotiation, selection, and award.
- The use of on-call services (30%) has streamlined the consultants' procurement time.

Florida Department of Transportation (FDOT)

- FDOT consultant procurement is decentralized as the agency itself is decentralized. One of the pros of decentralizing the consultant procurement is that each district is responsible for its consultant procurement. Each district is familiar with area consultants, local governments, and local agencies, enhancing the procurement process.
- The use of extensive consultants (90%) and on-call services (40%) have helped reduce FDOT's consultant procurement time.

Kentucky Transportation Cabinet (KYTC)

- KYTC consultant procurement time goal is 100 days. KYTC has established a set of standards for consultant procurement timeframe, including the time from advertisement to receiving the proposals. Other timeframes established by KYTC to streamline their procurement time are for milestones such as consultant selection meetings, scoping meetings, design conferences, etc.
- KYTC has an online consultant portal where all the consultant work is handled and facilitated. All consultants have access, and they can start working on their units and production hours once they are selected. The portal allows the KYTC and the consultants to work simultaneously and remotely. The portal allows all related personnel to get notified through the milestones or completed tasks. Besides, the portal allows different individuals to get notifications for their approval and signatures to decrease the time of approval processes.
- The use of on-call services (50%) has helped KYTC to streamline its consultant procurement time.

Louisiana Department of Transportation and Development (LaDOTD)

- The historical database that LaDOTD has developed for its projects has helped them determine the scope, cost, schedule, and pre-establish the number of plan sheets, which reduces the time of the procurement process.

North Carolina Department of Transportation (NCDOT)

- NCDOT has developed the contracting method 'use of limited services contracts' to reduce their consultant procurement time. NCDOT selects anywhere between

10 to 20 firms per division on limited services contracts, and once these contracts are in place, NCDOT assigns specific projects to the firms. This contracting method was coordinated with FHWA, and with FHWA's help, the advertisement language was established to accommodate federal rules and laws.

ACEC-SC PDP Survey:

- One of the strongest assertions shared by consulting firms was that SCDOT's procurement timeframe was too long. Two-thirds (68%) of respondents noted that contract negotiations were seldom or almost never completed timely.
- A large portion of the firms indicated that project scope and objective were only 'sometimes' well-defined (42% and 36%, respectively).
- Approximately 42% noted that project deliverables were consistent, whereas almost half indicated that was the case only 'sometimes.'
- For consultant assessment of the agency's effectiveness and efficiency and comment on plan development, only one quarter (25%) of the firms felt the process was often or almost always effective and efficient. The remaining consultants (75%) submitted that it was only sometimes, seldom, or almost never effective and efficient.
- Professional services consultant firms strongly believe that bundling design RFPs would promote procurement efficiency. Almost three-quarters (74%) of the firms agree with this assertion.
- An even larger percentage of respondents (78%) agree or strongly agree that lump sum contracting would improve the delivery of services.

- Close to three-quarters (71%) of the responding firms submit (agree or strongly agree) that SCDOT's prequalification of Professional Services Consultants for procurement would be beneficial.

9.2.3. Category C: Performance Measurement and Accountability

9.2.3.1. Best Practice #8

Establish project, department, and agency performance measurements to track and evaluate performance at all levels of the agency for Project Development Process execution.

9.2.3.1.1. Key Findings

- Top-performing state DOTs nationwide track and evaluate performance metrics quarterly.
- Three-quarters of all state DOTs believe that tracking preconstruction project performance metrics improves and reduces the preconstruction project development timeline.
- Nationwide, a majority of State DOTs regularly collect performance metrics at the project, department, and agency level.
- Most all state DOTs nationwide compare actual with planned project performance of project development preconstruction activities.
- The majority of state DOTs nationwide believe that performance measurement helps their agency achieve established goals, objectives, and organizational values.

- To communicate performance results, the majority of comparable states have developed a performance dashboard for their agency. They find that the publication of performance metrics reinforces internal performance accountability.

9.2.3.1.2. Summary of Findings

One of the best practices that emerged from the interviews of state DOTs and the National State DOT PDP Survey was the concept of "Performance Measurement." The vast majority of state DOTs measure and evaluate their performance regularly to track their progress and gather detailed information to support data-driven and well-informed decisions at all levels of the agency during the execution of the PDP. Most agencies believe that performance measurement helps their state DOT reach the agency's established goals, objectives, and values. Measurement of the agency's performance also helps state DOTs identify the areas that need improvement from the insight provided by evaluating their performance metrics.

State DOTs are responsible for ensuring that their transportation systems meet the needs of their constituents. Usually, the constituents' needs are reflected in state DOTs' established goals and objectives, indicated in their STIP, LRTP, and other planning efforts. To track progress towards their goals and objectives and address the constituents' needs, state DOTs develop performance measures. These performance measures help state DOTs track performance and identify needed improvement.

Additionally, state DOTs are required by law, including The Moving Ahead for Progress in the 21st Century Act (MAP-21) and Fixing America's Surface Transportation (FAST) Act, to emphasize performance-based and data-driven transportation decisions

and approach. The purpose of these laws is to create streamlined and performance-based transportation programs, promote accelerated project delivery, and encourage innovations for transportation programs. The main goal areas of MAP-21 are Safety, Infrastructure Condition, System Reliability, Freight Movement and Economic Vitality, Environmental Sustainability, and Reduction of Project Development and Delivery Delays.

"What gets measured, gets done" is what the state DOTs SMEs mentioned repetitively during the interviews. According to the state DOTs SMEs, performance measurement drives operational improvement by identifying the areas that need improvement. When performance metrics are implemented within a well-defined framework, it enhances the development of their programs, demonstrates accountability for their staff, and provides transparency to their constituents.

Interviewed state DOTs had different approaches and methods to evaluate and measure the performance of their project development process (PDP), but all shared common criteria and components. These shared criteria and components address the following;

- What performance is measured? The purpose of measurement.
- How is individual, departmental, and agency performance measured?
- Precisely what performance metrics are to be collected?
- How frequently is each performance metric collected?
- Who has the responsibility for the collection of the performance metric(s)?
- Who has the responsibility for the evaluation of the performance metric(s)?
- How will performance information be shared with agency personnel and the public?

What performance is measured? What is the purpose of measurement? Precisely what performance metrics are to be collected?

The first set of questions as to 'what' performance should state DOTs measure is largely influenced by a) what state DOTs are required by law to report, b) what is necessary to support agency goals and needs identified for improvement, and c) the agency's primary driver which is to meet the needs of their constituents. State DOTs measure project development performance metrics (Figure 7.6) to track their progress towards their goals documented in their STIP and other planning efforts.

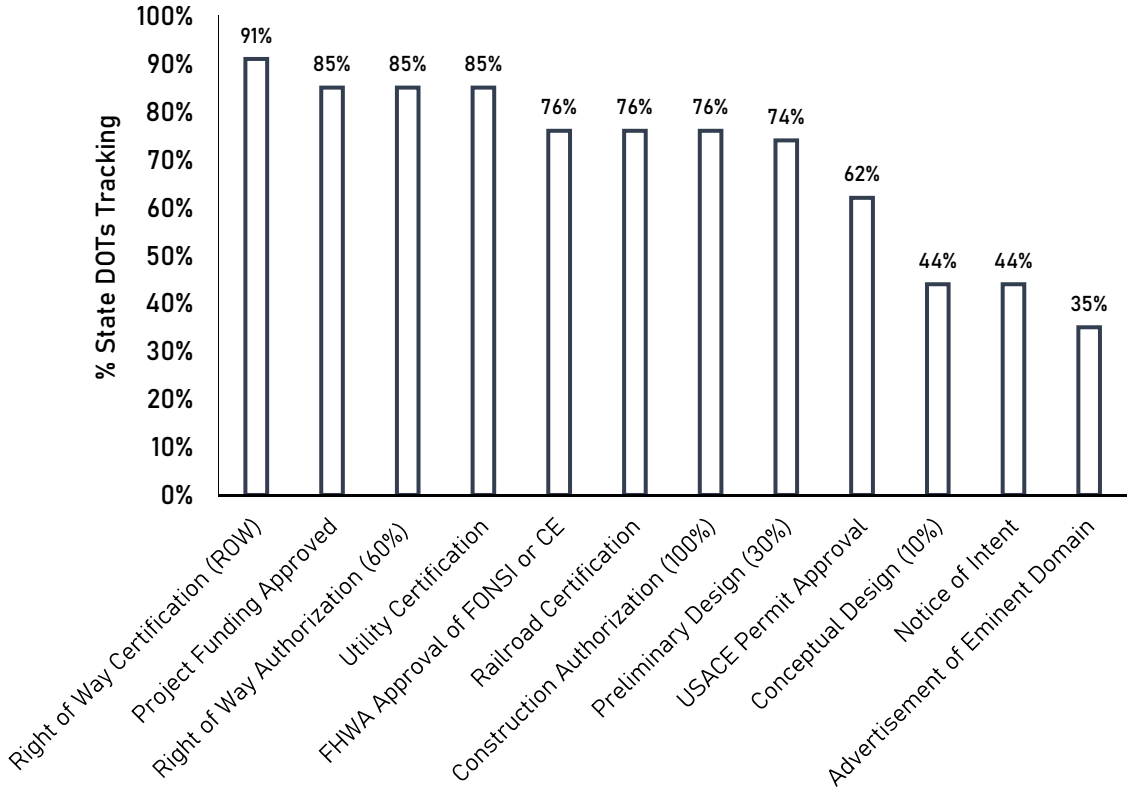


Figure 7.6: PDP Metrics/Milestones Tracked by State DOTs

According to the National PDP Survey of State DOTs, the PDP metrics/milestones that 75% or more state DOTs track are shown in Figure 7.6. These metrics/milestones include Approval of Project Funding, FHWA FONSI Approval, ROW Authorization, ROW Certification, Utility Certification, Railroad Certification, and Construction Authorization. The tracked milestones by less than 50% of state DOTs included Advertisement of Eminent Domain, Conceptual Design (10%), and Notice of Intent.

How frequently will each performance metric be collected?

Performance measurement frequency is an important factor in effectively and efficiently using performance data to help shape project development decisions/actions. State DOTs' frequency of performance measurement differs depending on agency goals and objectives. The performance measurement frequency depends on state DOT performance measurement at the organizational-level, departmental-level, or project-level. State and federal reporting requirements also influence the frequency of state DOTs measurement of certain performance metrics.

How will individual, departmental, and agency performance be measured? Who has the responsibility for the collection of the performance metric(s)?

Top-performing state DOTs such as VDOT, FDOT, and NCDOT have similar processes to measure their project development performance. These state DOTs measure project development performance at various levels, including project, departmental and organizational levels. At the project-level, each project's performance metrics (such as project development time or project development cost) are measured individually. Different functional or departmental units (such as design, right-of-way,

environmental, utility, permits) that are involved in the project also measure their performance metrics related to the project.

The project-level and departmental-level performance measures for all projects in a specific period (quarterly or yearly) are then combined, grouped, and rolled over to the organizational level to provide comprehensive measurement/feedback for overall organizational performance. The term organization depends on whether the state DOT is centralized or decentralized. If centralized, the state DOT is the 'organization.' If decentralized, the organizational-level performance metrics indicate state DOT districts' performance. The decentralized state DOTs agencies then combine/group their district's performance measurements to indicate overall organizational-level (agency) performance.

Different departments and functional units also measure PDP performance metrics, grouped and combined, so departmental leadership and upper management can track departmental performance. Combining project and department performance metrics to organizational-level measures highlights the relationship of project, department, and organizational performance metrics for PDP flowchart phases and milestones.

Typically, state DOT project development performance measures (project, departmental, and organizational level measures) include cost and schedule metrics. State DOTs project-level development measurements emanate from their PDP flowchart tasks and phases and project schedule targets. The PDP phases of interviewed state DOTs are shown in Table 9.1.

The measures are usually the phases and interim milestones of the agency's PDP, such as preliminary design completion time, final design completion time, the record of decision (ROD), initiation of the purchasing right-of-way, utility relocation, right-of-way procurement completion, right-of-way acquisition time, permit certification, the various permit requirements, solicitation of bids, start of construction, etc.

Performance measurements are also influenced by project type, funding source, and program type. Project phases, milestones, and interim milestones are compared to established performance expectations for project schedule and cost. 'Actual' performance versus 'planned' performance for each activity is compared to determine the schedule and budget status.

How, if at all, performance measurement data is shared with agency personnel and the public?

Department and organizational-level performance metrics are derived from project-level data. State DOTs report organizational level performance measurements to authorities, the legislature, and the public using an online dashboard. In addition to the broad distribution of agency performance, dashboards are a tool that also impacts performance by exposure and encourages a healthy level of 'shared' competition throughout the agency. The use of a dashboard, whether external or internal, helps management track and share departmental, regional, district, and state DOT's performance. A dashboard sharing performance metrics provide exposure for each project and functional unit within the state agency and promotes effective and efficient performance agency-wide. A dashboard also provides transparency to the public.

State DOTs	Project Development Process Phases based on State DOTs PDP Flowcharts											
VDOT	PE Authorized	Scoping	Final Scope (20%)	Preliminary Design	Public Hearing (40%)	Detailed Design	Field Inspection Meeting (75%)	Final Design and ROW Acquisition	Pre-advertisement Conference (100%)	Advertise Plans	Advertisement	Project Delivery
GDOT	Programming and Scheduling		Concept Stage		Environmental Document		Preliminary Design		ROW Plans		Final Design	Construction Authorization
FDOT	Project Initiation		Public Kick-off Meeting		Environmental and Engineering Analysis		Alternative Public Workshop		Draft Environmental and Engineering Documents		Public Hearing	Final Environmental and Engineering Documents	Location and Design Concept Acceptance
KYTC	Planning Study		Preliminary Design		Environmental Documentation		Right-of-Way		Utility Coordination		Final Design	PS&E and Letting
LaDOTD	Feasibility		Planning & Environmental		Funding/Project Prioritization		Final Design Process		Letting		Construction	Operation
NCDOT	LRTP	Project Initiation	STIP	Complete Project Scoping	NTP	Alignment Defined	Plan Review and Environmental Document Complete	Plan-in-Hand	Design Complete and All Permit Application Submitted	PS&E	PS&E Plan Review	Letting

Table 9.1: Interviewed State DOTs PDP Phases and Milestones

9.2.4. Category D: Project Development Process (PDP)

9.2.4.1. Best Practice #9

Development of process flowcharts for the state DOT's Project Development Process to identify the phases, tasks, and key milestones of the development process.

9.2.4.1.1. Key Findings

- The commitment of state agency leadership is essential for effective flowchart development and subsequent implementation.
- Self-evaluation of an agency's Project Development Process requires departmental and management leadership's active support and involvement.

9.2.4.1.2. Summary of Findings

Development and mapping of a state DOTs' PDP phases, tasks, milestones, and activities are among the best practices identified during the survey and state DOTs interview process conducted for this study. A state DOT's preconstruction project development process (PDP) shepherds a transportation improvement project through initial planning and scope definition, environmental review and analysis of project alternatives, design development and coordination with project constituents, permitting and approvals, and the advertising and bidding process leading to contract award and construction start.

A state DOT's PDP is executed daily at the project, departmental, and functional level. An effective and efficient PDP is essential for state DOT project development success. It requires departmental and functional units to plan, organize, coordinate, and

control resources to effectively meet state transportation needs and specific project goals.

State DOTs face several project development challenges, and their development processes are influenced by variables such as project type, environmental considerations, and funding source. Development and mapping of the state DOTs' preconstruction PDP identify key PDP tasks, sub-tasks, and activity sequences that help guide performance for various program/project types and funding source(s) that the agency faces. A well-defined PDP also provides a project development roadmap for the departmental and functional units involved in the process.

The foundation for an effective and efficient PDP relies on well-defined project development guidelines, standards, and processes for planning, developing, designing, constructing, and managing the highway systems to shape the roadway geometrics and design details (Peterson et al., 2017). The development of PDP phases and tasks is strategically crucial for highway projects because it encourages comprehensive planning of project phases, effective coordination of interagency and functional units, and aids in selecting the most appropriate projects (Le et al., 2009).

The PDP requires careful and active coordination between all phases of a project. State DOTs PDP share common phases, tasks, and activities but are also different based on project type, program type, environmental impact, and the individual project's funding source. Generally, the state DOTs transportation PDP consists of several common phases. These common phases include, but are not limited to, planning, scoping, programming, preliminary and final design, utility and railroad coordination,

environmental assessment, right-of-way acquisition, plans/specifications/estimates (PS&E), schedule development, construction, and maintenance (11,14).

State DOTs have developed different PDPs for their projects, depending on their project/program types (bridges, roadways), funding source (federal, state, local), and environmental impact (CE, EA, EIS). The different development processes define the departmental/functional unit's involvement and the level of tasks and activities involved depending on the specific type of program/project, project's environmental impact, or funding source.

Usually, the state DOTs' PDP phases, tasks, and activity sequences are shown in flowcharts. PDP flowcharts are roadmaps used by state DOTs to determine and portray the different phases, milestones, the level of involvement of functional/departmental units, and the sequence of tasks, sub-tasks, and activities. Table 9.1 shows the PDP phases and relationships for the PDP flowcharts of the state DOTs interviewed with a well-defined PDP flowchart. = The shared phases and activity sequences for the interviewed state DOTs are shown in Table 2. These state DOTs have a number of similar project development phases such as project programming, scoping, preliminary and final design, public engagement, an environmental assessment (NEPA), permit acquisition, utility coordination, and right-of-way acquisition, and letting. The sequence and level of activities in these phases vary based on project/program type, environmental impacts, and funding source.

In summary: the development and mapping of a state DOTs Project Development Process is a best practice. A well-developed PDP is vital to:

- Provide a road map for the project development process and phases

- Determine the sequence and level of tasks and activities involved in the process
- Establish project development team responsibilities
- Achieve effective and efficient interagency and departmental/functional coordination and communication
- Plan, organize, coordinate, and effectively manage the resources to meet the state transportation needs and specific goals
- Establish the process to support the comprehensive planning of transportation projects
- Guide coordination and tracking of each distinctive project phase
- Streamline and accelerate a state DOT's PDP

9.2.4.2. Best Practice #10

Development of a comprehensive Project Development Process (PDP) manual.

9.2.4.2.1. Key Findings

- Top-performing state DOTs nationwide create a comprehensive manual to document and communicate the agency's Project Development Process.

9.2.4.2.2. Summary of Findings

In addition to PDP flowchart development, Top Performing state DOTs develop a comprehensive manual to accompany their Project Development Process (PDP). The development of a state DOT PDP manual containing detailed documentation of the development process phases and tasks is a Best Practice to promote an effective and efficient PDP for the agency.

The PDP Manual development's main objectives are to provide a comprehensive understanding of the development process and promote consistent execution throughout the agency. The need to document the process and facilitate consistent execution across state DOTs intensifies as workload increases and new inexperienced personnel is hired to replace experienced personnel that has retired or left the agency. Faced with this situation, state DOTs are often forced to address their resource needs by involving new personnel with limited industry or organizational experience.

State DOTs typically have project development teams from different regions, groups, districts, and functional/departmental units with different organizational structures (centralized, decentralized, hybrid) involved in the transportation projects' development process. Documentation of a Project Development Process Manual for the agency's development process is essential for a state DOT to promote effective and consistent action across all regions, groups, and districts.

A PDP Manual promotes consistent and effective development and delivery of the agency's transportation projects by a broad spectrum of functional/departmental units and project development teams with varying experience levels. With PDP's complexity and the involvement of a wide range of project participants and constituents, a comprehensive PDP manual provides functional units and project development teams the insight to effectively and efficiently navigate the complex network of development phases and tasks of a transportation project.

Most of the state DOTs interviewed have documented their PDP and developed manuals. These states have developed a PDP manual for their agency's project managers, project development team, and consultants. KYTC has documented and

incorporated their PDP in the agency's highway design manual. Based on the findings from the state DOT interviews and review of the agency PDP documentation, the goal for the development of an agency's PDP manual is to:

- Establish a standardized reference tool to help guide the Project Development Team (PDT) through the Project Development Process
- Maintain consistency across the agency
- Provide a roadmap/framework for the consistent development of projects
- Maintain PDT's involvement with, and commitment to, the PDP phases and activities
- Accelerate the project development process
- Improve coordination and communication among the PDT and the various functional and departmental units involved in project development
- Achieve compliance with federal, state, and local laws, regulations, and requirements
- Provide quality control and quality assurance in project development
- Define the project development activities required by the various project and program types

9.2.4.3. Best Practice #11

Establish and actively manage/monitor a project-level Critical Path Method (CPM) development schedule throughout the project development process.

9.2.4.3.1. Key Findings

- Most state DOTs (80%+) nationwide develop preconstruction schedules that clearly define project milestones, and the schedules are regularly monitored and updated.
- State DOTs nationwide submit that regularly tracking preconstruction schedule metrics/milestones reduces the preconstruction project development timeframe.
- Only 30% of SCDOT's professional services consultants thought that the agency's scheduling process was effectively utilized to plan preconstruction activities.

9.2.4.3.2. Summary of Findings

Development of project schedules is a best practice supported during state DOTs interviews and national state DOTs survey. State DOTs develop project schedules to plan and track their PDP activities progress to meet their development goals on-time and within budget. Generally, state DOTs schedule activities are derived from their PDP phases, milestones, tasks, and subtasks presented in PDP flowcharts. The project schedules mainly depict project activities, activities sequence, timeline, and budget for various functional and departmental units involved in the project's development process.

State DOTs have different types of transportation projects and programs such as roadway, bridge, safety improvement, interstate improvement, etc. These project/program types usually vary depending on several factors such as the level of environmental impact (CE, EA, EIS) and how projects are funded (federal, state, local). Thus, these factors affect the number, type, and duration of activities involved in the transportation project schedule and how they are sequenced. An overview of the actual project development duration for the preconstruction activities from the start of PE to

Right of Way Authorization of the project/program types (bridge replacement, intersection improvement/roadway widening, interstate/interchange improvement) based on their environmental impact (CE, EA) are shown in Figure 7.7.

The average development duration of the preconstruction activities for different project/program types in Figure 7.7 was collected from the State DOTs National PDP Survey. As shown in Figure 7.7, the mean duration for all CE project types ranged from 15.5 to 20.0 months. The duration 'means' for EA/FONSI projects ranged from 27.9 to 33.7 months.

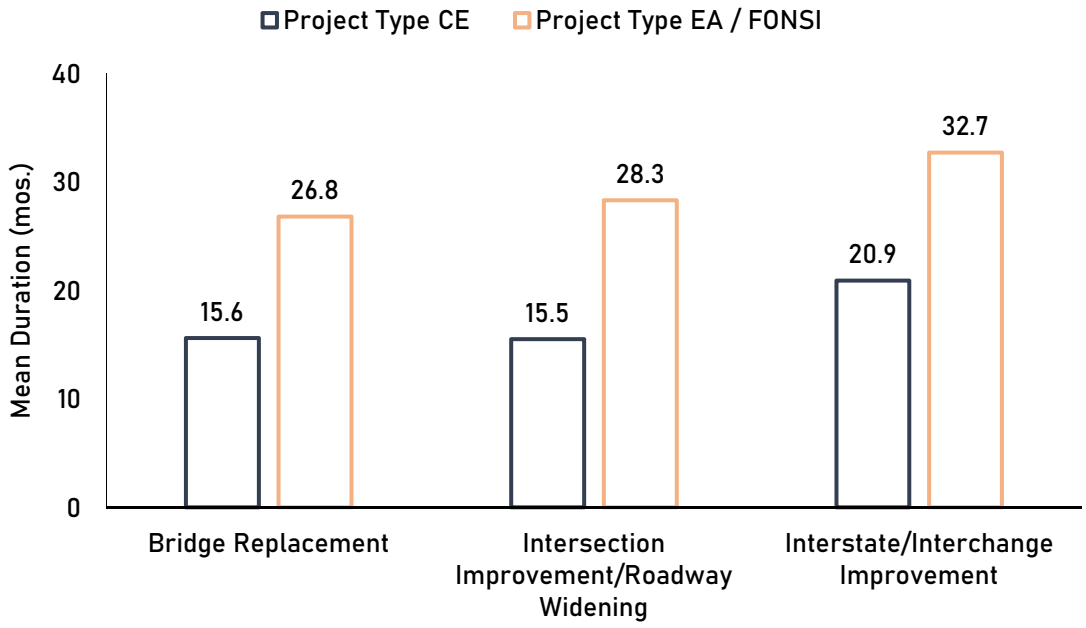


Figure 7.7: PDP Duration based on Project Type and Environmental Impact

The State DOTs National PDP Survey provided the average project development duration for each state DOT for both CE and EA projects, as shown in Figure 7.9. The project development durations for each state DOT are summarized to facilitate

comparative analysis. The average duration for CE and EA projects is calculated for each state DOT to assemble the listing. Besides, the average combined duration for CE + EA projects is determined. A data sort yielded the duration performance results for the top and bottom half of the state DOTs, as shown in Figure 7.9.

The Top Performers in Figure 7.9 represent the average duration of those state DOTs in the top half with an average project development duration that was substantially less than the Poor Performing state DOTs. For all three project categories, the average project development duration for the top performers was nearly half the project duration of the poor-performing state DOTs.

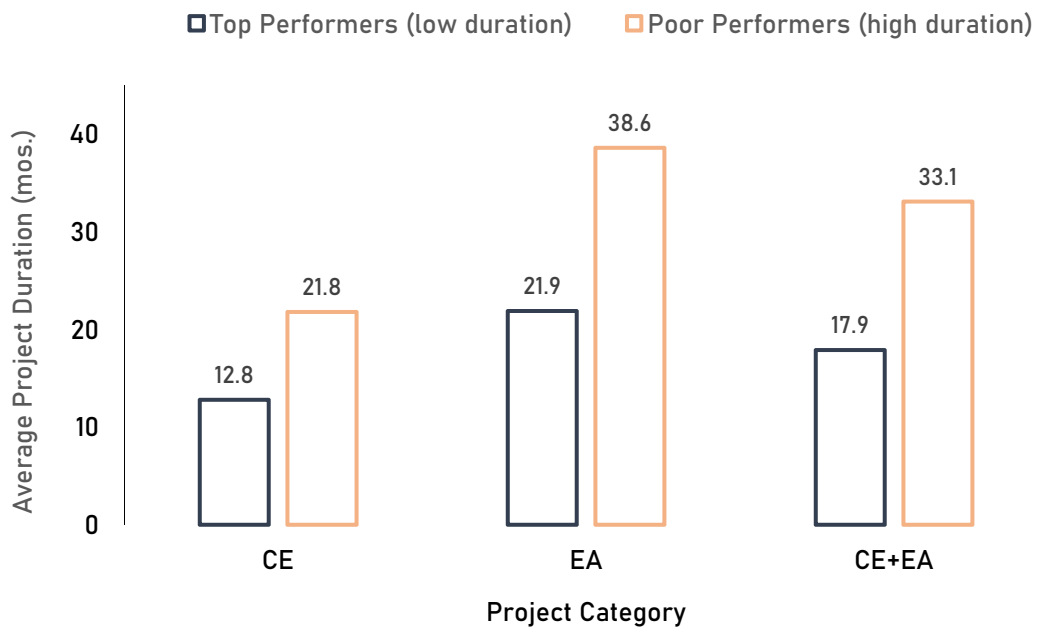


Figure 7.9: PDP Duration based on Project Category and Environmental Impact

As shown in Figure 7.5, the average project development duration for the best (top) performing state DOTs for CE and EA projects was 13mos and 22mos, respectively.

Conversely, the average development duration for the poorer performing state DOTs for CE and EA was 22mos and 39mos, respectively. The PDP for the poor-performing state DOTs was almost twice as long as top performers. While most state DOTs indicated that they have similar processes, top performers have a more effective execution of their project development activities. Based on the finding of this study, it is apparent that if the goal of a state DOT is to improve its PDP performance, the agency needs to expand its focus beyond 'what' the agency does to include 'how effectively' it performs each phase and activity of the development process.

In state DOTs, the development of a project schedule usually starts during the scoping phase. The project schedule is normally developed by the project manager and with the project development team's input. Important factors that affect the effective development of a project schedule in state DOTs are:

- Determination of the level of project activities based on several factors such as project/program type, funding source, environmental consideration, and the level of involvement of different departmental/functional units
- Adequate training for management personnel responsible for schedule development and updates.
- In lieu of individual project manager training/skillset, the establishment of a scheduling team or department for scheduling responsibility
- Selection of appropriate scheduling software that addresses the project need and the skillset of the manager and scheduling personnel responsible for development and updates.

- Development of a dynamic and logic-based project schedule to determine the timeline and responsibilities of functional units
- Creation of a plan to regularly monitor and update the project schedule activities based on the baseline

Of the state DOTs interviewed, VDOT, GDOT, and FDOT have also developed project schedule templates for their PDP. VDOT has produced more than 50 scheduling templates for different types of projects and programs. GDOT has developed project schedule templates, which are categorized by different transportation program types or genres. Since FDOT is a decentralized agency, it has set project schedule templates for each of its districts. These project schedule templates mainly act as a baseline for the development of individual project schedules.

The schedule templates are used by project development teams in different districts and regions to develop project schedules for every project by adjusting and altering activities based on their particular needs. In addition to creating project schedule templates, VDOT and GDOT have also established scheduling departments in their central office to work in conjunction with their project managers and project development teams to develop and manage their project schedules effectively.

To conclude, effective and efficient development of project schedules for the project development process in state DOTs:

- Identifies the responsibilities of different functional units involved in the development process of transportation projects
- Determines the timeframe for deliverables for each functional unit

- Identifies the PDP timeframe, sequence, and project risks in the early phase of project development, and it's normally initiated during the "scoping phase."
- Determines the number, timeframe, and sequence of activities that are required for the development of a transportation project
- Provides a comprehensive framework for the project phases, milestones, and activities.
- Provides a platform to track the progress of project development
- Provides a platform to track and measure the performance of each project, different functional units, and the overall organization

9.2.5. Category E: Project Development Process Training

9.2.5.1. Best Practice #12

Development of a comprehensive Project Development Process training program to communicate and promote consistent project development execution for the agency.

9.2.5.1.1. Key Findings

- The majority of state DOTs nationwide have developed comprehensive PDP training for both internal managers and consultants.
- PDP training is essential to ensure consistent development and delivery of projects by personnel with varying levels of expertise across various districts and regions of a state DOT.
- SCDOT's consultants consider the agency's existing training for professional services consultants to be inadequate.

9.2.5.1.2. Summary of Findings

From the interviewed state DOTs, one of the PDP best practices supported by this research effort is the development of comprehensive PDP training for the new and continuing project managers, functional/departmental unit leads, and professional services consultants. The primary purpose of creating a comprehensive PDP training program is to improve the development process's effectiveness, efficiency, and consistency.

With PDP training, the project managers, departmental unit leads, and professional services consultants gain a better understanding of the development process, its phases, activities, and numerous challenges associated with each phase of the project development. Understanding the PDP provides the insight necessary for project managers to meet a project's scope with quality requirements effectively. It supports the development of the project on-time and within a specified budget.

Another goal of developing a comprehensive PDP training program is to bring consistency in project development across a state DOT. State DOTs have different structures such as centralized, decentralized, and hybrid and often consist of several districts, regional groups, and departmental/functional units. The development of comprehensive PDP training for all new and continuing project managers is needed to promote consistent project development execution throughout a state DOT. This need is intensified as workload increases and experienced personnel retire or leave the agency. In either case, state DOTs are often faced with addressing their resource needs by utilizing personnel with limited industry or organizational experience. Thus, PDP training

is essential to ensure consistent development and delivery of projects by personnel with varying levels of expertise across the state DOT.

The common PDP training criteria identified during interviews with comparable state DOTs are listed in Table 9.2. These criteria include the training delivery method, training content, who develops the training material, and that personnel expected to receive the training. As shown in Table 9.2, state DOTs have both online and in-person PDP training for their new and continuing project managers, professional services consultants, and departmental/functional units lead. FDOT has one of the most comprehensive online PDP training among the state DOTs, and it is provided for both in-house and consultants. KYTC and VDOT have developed a project manager boot camp (Transportation Project Management Institute for VDOT) for both in-house and consultant project managers. The boot camp provides intensive two-week PDP and project management training. KYTC requires its in-house and consultant project managers to attend the project manager boot camp to be prequalified for the job.

The PDP and project management manual or handbook is also referenced as a training tool for project managers in state DOTs. The PDP and project management manual (or handbook) acts as a supplemental resource and reference for a PM to understand the development process and responsibilities. Most state DOTs have developed variations of the PDP and Project Management Manual. Generally, the training materials and resources are developed by experienced project managers and subject matter experts involved in the PDP. To improve the success rate and consistency in project development across a state DOT, it is essential that a state DOT develop comprehensive PDP training and regularly update its training program.

Training Criteria/State DOTs	VDOT	GDOT	FDOT	KYTC	LaDOTD	NCDOT
Method of Training Delivery and Resources	In-person	In-person	In-person	In-person	In-person	In-person
	Online	Online	Online	Online	Online	Online
	Presentations	Presentations	Presentations	Presentations	Presentations	Presentations
	Preliminary Engineering Project Manager Job Book	PDP Manual	Webinars	Project Manager Boot Camp	Project Delivery Manual	Integrated Project Delivery
	Transportation Project Management Institute (TPMI)	Project Management Handbook	Self-Guided Training	Highway Plan	Planning Manual	PDP Manual
			Plans Preparation, ETDM & PD&E Manual			Roles and Responsibilities in Project Delivery Manual
Content of Training	PDP	PDP	PDP	PDP	PDP	PDP
	Project Management	Project Management	Project Management	Project Management	Project Management	Project Management
	Scheduling	PM Experiences and Best Practices	Scheduling			
Training **Development**	Project Management Office	Project Managers and SMEs	FDOT Central Office	KYTC Leadership and the University of Kentucky	Project Managers and SMEs	Project Managers and SMEs
Training Recipient	In-house Project Managers	In-house Project Managers	In-house Project Managers	In-house Project Managers and Designers	In-house Project Managers	In-house Project Managers
	Consultants Project Managers	Consultants Project Managers	Consultants Project Managers	Consultants Project Managers		Consultants Project Managers

Table 9.2: Comparable State DOTs Comprehensive PDP Training Criteria

9.3. Deliverables

The twelve PDP best practices identified, developed, and listed in the previous section (Task 9) can be compared to SCDOT's current Project Development Process to generate a list of recommendations to enhance and streamline SCDOT's PDP. The PDP best practices are this research study's deliverables. These PDP best practices are focused on project and program-specific needs and aid the development and implementation of a streamlined and updated PDP permitting SCDOT and any other state DOT to more effectively and efficiently manage the transportation development process.

9.4. Conclusion

This chapter presented the research methodology, Phase 4, States' Department of Transportation Project Development Process Best Practices identified from the data analysis and findings of the previous phases of this study discussed in the previous chapters. It discussed three tasks, review and summarization of findings and data analysis from previous research phases, development and detailed description of PDP best practices from the findings and analysis, and establishing recommendations concerning PDP for SCDOT (Figure 4.1).

The identified Project Development Process (PDP) Best Practices were assembled based on the data, analysis, and findings supported by five different data sources, National PDP Survey, Comparable State DOTs Interview, Secondary State DOT Documentation, SCDOT SMEs Interview, and ACEC-SC Survey. The analysis of all data sources was used to assemble twelve (12) PDP Best Practices, which are numbered and categorized into five categories as follows:

1. Project Prioritization and Scope Definition Process

2. Consultant Procurement and Management
3. Performance Measurement and Accountability
4. Project Development Process (PDP), and
5. Project Development Process Training

CHAPTER TEN

CONCLUSION AND FUTURE RESEARCH

10.1. Conclusion

The purpose of this research study was to identify Project Development Process (PDP) Best Practices to enhance, streamline, and improve project delivery. This research provided SCDOT and other state DOTs the methodology and needed insight regarding best practices to help the agency streamline and update their PDP leading to an increase in efficiency of critical task initiation, execution, and coordination.

Most state DOTs face increasing transportation needs, scarcity of funding, growing pressure to reduce the time of project development, and an increasing need to enhance the effectiveness and efficiency of their PDP. Identification, development, and implementation of best practices will help state DOTs develop and deliver projects faster and improve project delivery effectiveness and efficiency. This study also provided a 'Model,' the methodology, for state DOTs to systematically assess their current practices and obtain input/suggestions for process improvement from the agency's own SMEs, other comparable state DOTs, and the external development and delivery partners providing professional services.

The methodology of this research study (Research Design) and how it is conducted is shown in Figure 4.1.

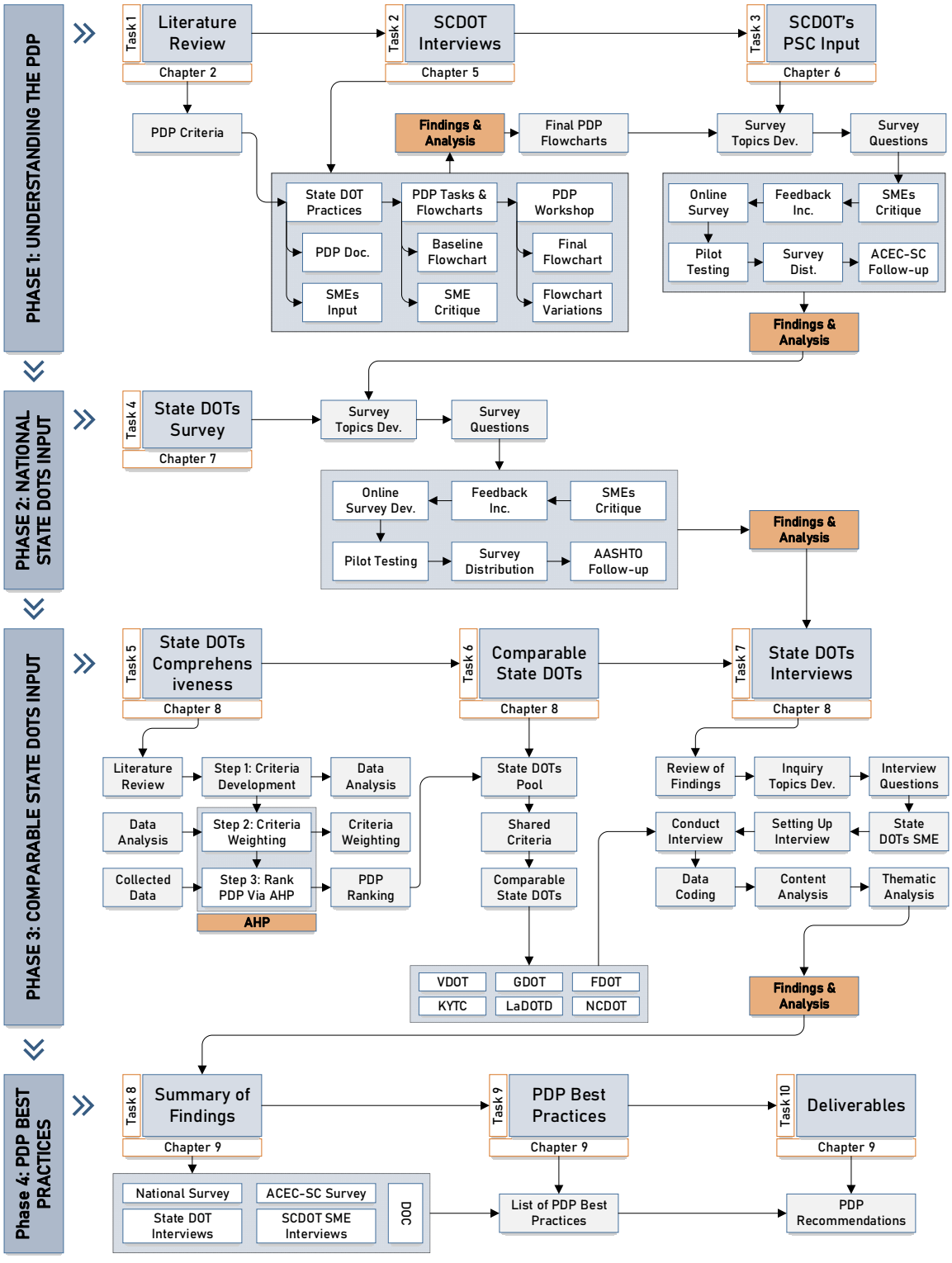


Figure 4.1: Research Design and Methodology Map

This research study utilized an Explanatory Sequential Design, as shown in Figure 4.1 (Mixed Method Research Design). It is categorized as explanatory because it seeks to identify and PDP best practices to streamline a State DOT's PDP to improve project development performance. This design was selected to facilitate a qualitative analysis to aid and enhance the quantitative findings. The proposed methodology for this research study is completed in four phases comprising ten tasks.

During Phase 1 of this research, documentation from state DOTs, past peer-reviewed studies, and scholarly publications from organizations involved with transportation (discussed in the literature review) is collected to evaluate the current state of practice in PDP and identify PDP criteria and best practices (Chapter 2). Furthermore, preliminary semi-structured exploratory interviews are conducted face-to-face with SCDOT's Subject Matter Experts (SME) of each department and functional unit involved in PDP to identify its current PDP as well as its issues (Chapter 5).

In addition, input from SCDOT's delivery partners (Professional Services Consultants) is solicited via a self-administered computer-assisted questionnaire to identify strengths and weaknesses in the current SCDOT PDP and obtain suggestions for improvement (Chapter 6). The preliminary interviews identified the primary issues and factors influencing project development performance in SCDOT, aligning with the literature review's summarized concepts.

During Phase 2 (Chapter 7), a computer-assisted self-administered questionnaire is administered to identify PDP best practices concerning project development performance in all state DOTs across the US. The primary objectives of this phase (survey) were to gain insight concerning: a) the preconstruction PDP of state DOTs,

b) state DOTs input on PDP to identify effective and efficient practices, c) the trend of PDP practices among state DOTs to improve their performance, and d) state DOTs professional services consultants procurement and utilization.

During Phase 3 (Chapter 8), structured interviews with comparable state DOTs to SCDOT are conducted to probe deeper in identifying and explaining PDP best practices and their relation to project development performance. Secondary documentation received from the comparable state DOTs is analyzed to support the development of PDP best practices. Phase 3 of this research helped identify PDP best practices by further probing and gathering in-depth information on PDP concepts explored in previous phases of this research. Besides, gathering in-depth input from comparable state DOTs helped establish support for PDP best practices and findings explored through the national state DOTs survey.

Data analysis has occurred at several points in this study. First, analyzing the qualitative data collected from semi-structured SCDOT SMEs, and second, analyzing quantitative data collected from professional services consultants via a structured survey. Third, analyzing the quantitative data collected by computer-assisted self-administered questionnaires from national state DOTs and analyzing the qualitative data collected via structured interviews and secondary data from comparable state DOTs.

Lastly, in Phase 4 (Chapter 9), the identified Project Development Process (PDP) Best Practices were assembled based on the data, analysis, and findings supported by five different data sources, National PDP Survey, Comparable State DOTs Interview, Secondary State DOT Documentation, SCDOT SMEs Interview, and ACEC-SC Survey. The analysis of all data sources was used to assemble twelve (12) PDP Best Practices, which

are numbered and categorized into five categories of Project Prioritization and Scope Definition Process, Consultant Procurement and Management, Performance Measurement and Accountability, Project Development Process (PDP), and Project Development Process Training.

10.2. Validity and Reliability

Preliminary exploratory semi-structured interviews were conducted face-to-face with SCDOT's SMEs of each department and functional unit involved in PDP to identify its current PDP and its related issues and causes related to project performance. These exploratory interviews served as a base for identifying primary factors influencing the variance between estimated and actual performance and the PDP dimensions.

Furthermore, the validation of the concept of PDP best practices was done within these interviews as part of understanding the concept, which bolstered the internal validity of the measures. The exploratory interviews also helped determine the control variables such as NEPA tiered documentation, funding sources, and project complexity to understand and include the variables' differences.

Construct validation was done by examining the theories underlying the concept (project development best practices, context-sensitive design, and solutions) and its relations by accumulating research evidence via the comprehensive literature review discussed previously. The qualitative validity is increased by sending the key findings to the study's key participants and determining whether they reflected their experience during the coding of interview transcripts.

The PDP best practices are universal. The external validity is addressed by controlling variables identified in the exploratory interviews, such as NEPA

documentation, funding sources, federal and state policies, organizational structure, project management, project/program type, and project complexity. For other state DOTs to utilize these best practices in their process, they need to employ the methodology and tailor the best practices based on the controlling variables mentioned above. Additionally, data from survey instrumentation is collected from a random sample of all state DOTs, which has bolstered the study's external validity.

10.3. Limitations

Variables such as organizational structure, state policies, funding source, delivery method(s), and project/program types unique to the state DOTs impact their transportation project development process. Thus, the application of each best practice identified by this study may not be warranted. Other state DOTs can use the methodology and guide used within this study to develop their own PDP best practices or tailor the finding and results of this study based on their agency objective, goal, organizational structure, policies, and other variables mentioned above.

Additionally, another limitation of this study concerns the identification of comparable state DOTs in Phase 3. As mentioned in Chapter 8, determining the relative weights of the PDP comprehensiveness criteria was difficult due to the number of variables involved; thus, AHP provided the most suitable framework to weigh the criteria. Since the human judgment was involved in the weighing process and the pairwise comparison for all the 19 criteria was difficult to do it manually or by hand, AHP provided the framework to consider both the underlying data and human judgment using statistical software such as “R.”

AHP allowed varying and incommensurable criteria to be compared to one another rationally and consistently. This advantage distinguished AHP from other decision-making techniques, which increased the validity of weights when human elements or judgments were involved in the evaluation process. The limitation of the methodology (AHP) used in identifying state DOTs' PDP comprehensiveness was the level of data used to determine the commensurable criteria weightings.

In AHP, the number of pages and the occurrence and frequency of the criteria from state DOT PDP manuals and websites were used. For the perfect criteria weighting, a qualitative analysis of all state DOTs' PDP documentation was necessary. Considering the number of state DOTs (50) and the number of documents each state DOT possesses for its PDP, it was difficult and time-consuming to analyze all the documents qualitatively. Thus, quantitative data such as the number of pages and the occurrence/frequency of the criteria were used, which is the only limitation for this evaluation.

Lastly, one of the limitations of this study primarily focused on the validity and reliability of the data collected. Since the development effort for the questions set was a rigorous process, this largely rests on the reliability and validity of the data provided by the respondents. Steps were taken to address this issue by targeting agency SMEs for participation. Still, in the final analysis, the data's validity and reliability largely depended on the individual SME respondent's assessment of their agency PDP.

10.4. Research Benefits and Contribution

Most state DOTs are faced with increasing transportation needs, scarcity of funding, growing pressure to reduce the time of project development, and an increasing need to enhance the effectiveness and efficiency of their Project Development Process.

This study has provided a 'Model,' the methodology, for state DOTs to systematically assess their current practices and obtain input/suggestions for process improvement from the agency's own SMEs and the external delivery partners providing professional services.

Similar to most industries, transportation needs and delivery expectations continually change. Best practices to address these changing needs and expectations also are in a continuous state of evolution. This study has provided SCDOT, and state DOTs, a listing of current PDP Best Practices relevant for comparable state transportation agencies across the U.S. It has provided insight regarding current Best Practices that each state DOT can utilize to improve their Project Development Process's effectiveness and efficiency. State DOTs can use the methodology utilized in this study to develop their own PDP best practices or tailor the finding and results of this study based on their agency objective, goal, organizational structure, policies, and other variables mentioned in this study.

Lastly, this research study's findings will help streamline the project development process and increase the efficiency of critical task initiation, execution, and coordination. This study's findings will also help SCDOT and other state DOTs deliver projects faster and improve projects' quality through improved PDP Best Practices execution. Updates and enhancements to the project development process will help streamline the tasks, improve coordination, and reduce redesign. Identification of the Project Development Process's best practices will allow program management staff of all experience levels to identify better and manage the various steps and procedures.

10.5. Future Research Suggestions

Future research should expand on the findings of this study. Each topic investigated during this study should be explored in greater detail to provide additional insight into the PDP. Poor performers' processes should be explored and compared to top performers to determine the most effective approach and identify top performance drivers. Besides, below is a list of some of the research suggestions based on this research study's findings.

- Extensive research on the identification of key drivers of top-performing state DOTs.
- Extensive research on the relationship between the use of professional services consultants and project development timeframe as this study found that the industry is moving towards more consultants.
- Extensive research on the relationship between performance evaluation and project development process efficiency and effectiveness.
- Extensive research on the use of enhanced prioritization systems in state DOTs and their impact on project scoping and project development timeframe.

APPENDICES

Appendix A

SCDOT SMEs Interview Topics of Inquiry and Questions

- Current SCDOT PDP Flowchart
    - Have you seen the 'current PDP'? Do you utilize it?
    - Does the flowchart properly and clearly reflect the Task Sequence?
- PDP Sub-tasks
    - What are the key subtasks (milestones) for each of the 20+/- Tasks?
    - What is the flow/relationship of these activities?
    - Project Milestone and Project Development Checklist
- PDP for Project/Program and Funding Types
- How is your Role/Responsibility impacted by?
    - Program: LPA, CTC, …
    - Project Type (bridge, HW, …)
    - Funding Source (local, state, fed)
    - Involvement with Planning
    - Process on those projects' w/o Feasibility Report
    - Involvement in establishing project expectations ($, time, scope)
    - How do you establish project priorities/sequence?
    - Program Manager Responsibilities
        - Number of projects they are managing
        - Do you assign based expertise (program and project type)?
- Process, Forms, Reporting, and Training
    - Standardization of process, procedure, milestones, forms, etc. w/i your 'Group'?
    - Standardization amongst the 4 'Groups' (Ex: 'Show Stoppers')
    - How often do you 'formally' require project updates (time, $)?
    - How often do all of the Group Leads meet? Agenda?
    - How often do group personnel meet (both w/i and between groups)? Agenda?
    - Group training? Topics and Frequency?
- What 'variations of' the PDP flowchart would you suggest?
- Use of Consultants? Should it be increased? Decreased?
    - Impact on the ability to manage. Time? Cost? Scope definition?
- Project Scheduling
    - How are projects currently scheduled?
    - Suggestions to improve the process.

- Other Suggested Improvements
    - What changes to the Process would you suggest?
    - What organizational changes would you suggest? (Ex: organize by type vs. area)
    - What suggestions do you have to improve accountability and timely completion of activities?

- Performance Metrics
    - What do you track now?
    - What should be tracked/measured?

Appendix B

State DOTs SMEs Interview Topics of Inquiry and Questions

DOT Organization:

- Overview of how the DOT is organized (centralized, decentralized, hybrid)
- How is Preconstruction organized?
    - By discipline, project type, geographical area, or other?
    - Multiple preconstruction groups?
- Project Management Manual
    - Level of development? Last update?
- Does the agency have a State Environmental Process (yes/no)?

Initial Project Scoping:

- Who's responsible, who's involved, when developed, how developed, and the extent of preliminary investigation (utilities, survey, environmental, …)?
- What is the level of design development for the initial project scoping effort? Does it vary based upon the project type, size, funding source, etc.?
- Scoping report/documentation
    - Is a formal detailed scoping report generated?
    - Is a scoping report produced for all projects or a select group?
- What is the accuracy of the initial scoping process (cost and timing)? How often does the agency need to revise STIPs?

Professional Services Consultants:

- The agency's use of consultants:
    - What percentage of engineering/design is contracted to consultants?
    - Design consultants: entire project vs. specific discipline?
    - CEI: entire project vs. inspectors only?
- Consultant Procurement Process
    - Overview of the procurement process (prequalification, responsibility)
    - How long does it normally take to procure a consultant? What actions has the agency taken to streamline the process?
    - Does the agency typically utilize a 'project' advertisement or on-call? If both, what is the percentage of 'On-call' vs. separate advertisement?
    - Does the agency procure multiple projects in one advertisement (or one at a time)?
    - What is the agency's normal contracting method (Lump Sum, Cost Plus, combination)?
    - Does the DOT track consultant procurement metrics (duration for procurement steps)?
- Consultants deliverables

    - What are the normal requirements?
    - Are the deliverables standard or typically unique to the project?
- Does the DOT utilize Pure Management Consultants (Consultants to manage consultants)? If yes, how often?
- Consultant Performance
    - Are consultant cost and time performance tracked? By project type, size, etc.?
    - Does the DOT evaluate in-house versus consultant performance (cost and time)?

Project Development Process (PDP):

- Overview of the level of detail and documentation of the agency's PDP.
- Is the PDP defined for different programs/project types?
- What is the level of consistency of processes throughout the agency?
- Streamlining of the PDP
    - What actions has the agency taken to streamline the PDP?
    - What has been particularly effective at improving project planning and preconstruction efforts?
    - What actions are being contemplated (or need to be taken)?
- Project Scheduling:
    - What is the process for the development of the project schedule?
    - Who has responsibility for schedule development and updating?
    - What is the level of detail?
    - Does the agency regularly track planned vs. actual?
    - What software does the DOT use?
- Project Cost:
    - What is the process for the development of the project budget?
    - Does the agency have a historical database to drawn from?
    - Who is responsible for development?
    - Does the agency regularly track planned vs. actual?

PDP Training:

- What is the agency's level of PDP formal training (hours, frequency, documentation)?
- What are the different training topics?
- Within the state DOT, who receives formal training? Is training mandatory or optional? Is personnel training tracked? Does the agency issue training certifications?
- Does the agency provide training to consultants and other vendors? If yes, what topics?
- Is the training face-to-face or online (if both, % of each)?
- Who is responsible for the development of the training program?
- What training has been particularly effective?
- Does the DOT utilize (or require) third-party training and certifications?

Performance:

- Who (or what department or group) has primary responsibility for project performance (time, cost, quality)?
- What PDP performance metrics does the DOT capture/track?
    - Project-level data (time, cost, quality, procurement, consultant, etc.)
    - Department (or group) combined
    - Agency/DOT consolidated data
    - Other
- Performance data:
    - How often are performance data collected?
    - What is the distribution of the performance data?
    - Why is the agency collecting the data – the purpose?
- How is the performance data utilized? For example: is used to help evaluate personnel and department (group) performance?
- What impact has measurement/monitoring had on the improvement of state DOT performance?
    - If time permits, we would suggest that we also explore:

ROW and Utility:

- How does the DOT normally establish R/W limits? Normal design vs. NEPA footprint box?
- Who (what department/group) is responsible for the initial budgeting of ROW and utility relocation costs?
- Does the agency track planned vs. actual (time/cost) for ROW acquisitions and Utility relocation?
- What actions, if any, has the DOT taken to reduce time/cost for ROW and Utility relocation?

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