SCDOT PROJECT DEVELOPMENT PROCESS: UPDATE AND BEST PRACTICES

FINAL REPORT

Prepared by:

Dennis C. Bausman
NfCSM Department of Construction Science and Management
Clemson University

Tanin A. Haidary
NfCSM Department of Construction Science and Management
Clemson University

Mashrur Chowdhury
Glenn Department of Civil Engineering
Clemson University

Matt Lifsey
Neel-Schaffer

FHWA-SC-21-03

June 2021

Sponsoring Agencies:

South Carolina Department of Transportation
Office of Materials and Research
1406 Shop Road
Columbia, SC 29201

Federal Highway Administration
South Carolina Division
Strom Thurmond Federal Building
1835 Assembly Street, Suite 1270
Columbia, SC 29201

Technical Report Documentation Page

1. Report No FHWA-SC-21-03	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle SCDOT Project Development Process: Update and Best Practices		5. Report Date June 2021 6. Performing Organization Code	
7. Author/s Dennis Bausman, Tanin Haidary, Mashrur Chowdhury, Matt Lifsey		8. Performing Organization Report No.	
9. Performing Organization Name and Address Clemson University 300 Bracket Hall, Box 345702 Clemson, SC 29634		10. Work Unit No. (TRAIS) 11. Contract or Grant No. SPR No. 744	
12. Sponsoring Organization Name and Address South Carolina Department of Transportation Office of Materials and Research 1406 Shop Road Columbia, SC 29201		13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code	
15. Supplementary Notes			

16. Abstract

In the United States, federal, state, and local governments are responsible for addressing their residents' transportation infrastructure needs. Similar to most State 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. 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). 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 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. The analysis of all data sources is used to assemble twelve (12) PDP Best Practices, that are organized into five categories.

17. Key Words	18. Distribution Statement		
Project Development Process, State DOT, PDP, Transportation, STA, Consultants, NEPA	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161.		
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. Of Pages	22. Price

Form DOT F 1700.7 (8-72)

DISCLAIMER

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the South Carolina Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

The State of South Carolina and the United States Government do not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

ACKNOWLEDGMENTS

The research team would like to acknowledge the South Carolina Department of Transportation and the Federal Highway Administration as the sponsors of this study. Their continuing support has been instrumental for the project's success. We would also like to express our sincere appreciation for the guidance, commitment, insight, and involvement of SCDOT's Steering Committee: Rob Bedenbaugh, Chair and Committee Members: Kati Holland (Co-chair), Joy Riley, Adam Humphries, Michael Pitts, Casey Lucas, Mark Anthony, Leah Quattlebaum, Jason Stillwell, Carolyn Fisher (FHWA), Terry Swygert, and Meredith Heaps. The foundation for the success of this research project was the Steering Committee's genuine enthusiasm and continuing support. Additionally, we would like to acknowledge the extensive support, insight, and knowledge provided by over forty SCDOT agency managers from each of the disciplines involved in the agency's Project Development Process.

EXECUTIVE SUMMARY

The South Carolina Department of Transportation's (SCDOT) Project Development Process (PDP) serves as the agency's guideline for delivering the spectrum of transportation projects and programs assigned to the Preconstruction Division. SCDOT delivers projects based upon numerous programmatic guidelines. The agency's current PDP was last updated in 2011 and contains guidelines that are outdated, changed, and/or incomplete. In addition, the current guidelines were developed for one 'standard' PDP process that applies to all programs and projects. This all-inclusive process does not identify the steps that must be added, or eliminated, to accommodate the varying program and project types.

The SCDOT has commissioned Clemson University to accomplish two primary research Goals:

Goal I: Update and streamline the agency's current Preconstruction Project Development Process.

Goal II: Identify state DOT Project Development Process Best Practices

To support these Research Goals the following research objectives were established:

a) Engage with SCDOT staff to document the agency's current PDP, understand the critical tasks, and identify responsibilities for the PDP execution.
b) Strategically engage other state DOTs to identify PDP best practices applicable for updating or enhancing SCDOT's PDP.
c) Develop a streamlined and updated all-inclusive PDP and corresponding flowchart(s) of the process that incorporates SCDOT's current organizational structure. The updated PDP is constructed to permit the agency to easily refine the processes based upon program and/or project type.
d) Develop an interactive program and PDP user interface for the automated creation of flowcharts based upon program and/or project type.
e) Develop a web-based training program to provide Program Management staff with an overview of the PDP user interface.
f) Develop an executive-level summary of recommendations for enhancement of SCDOT's PDP.

The research methodology utilized to achieve the research goals and supporting objectives was developed, and executed, in four (4) phases comprising ten (10) tasks. These four phases are: a) Investigate studies, publications, and SCDOT's current PDP, b) Collect state DOT's process data and practices, c) Identify and develop PDP Best Practices and Recommendations, and d) Prepare/finalize deliverables.

The research phase(s) and methodology to support the findings for each research goal are as following:

Goal I: Update and streamline the agency's current Preconstruction Project Development Process

Phase 1: During this phase secondary data from state DOTs, past studies, and scholarly publications was collected to evaluate the current state of practice in PDP. Interviews were conducted with SCDOT's Subject Matter Experts (SME) from each department and functional unit involved in PDP and input from SCDOT's Professional Services Consultants was solicited. In addition, a two-day workshop was held with SCDOT PDP leadership and Steering Committee members to develop updated PDP flowcharts that reflected current agency practice for different project and program types. A web-based training program to provide Program Management staff with an overview of the PDP user interface was subsequently developed with the research deliverables in Phase 4.

Goal II: Identify state DOT Project Development Process Best Practices

Phase 2: This Phase involved collecting data from state DOT concerning their project development process and professional services procurement. A national online survey was conducted in which 36 state DOTs participated.

Phase 3: Each state DOT was investigated to identify states with a comprehensive and current PDP. Based upon those findings six states that are comparable with SCDOT, regarding transportation responsibilities and organizational structure, were selected and interviewed to investigate their practices.

Phase 4: During this Phase the research team summarized the data and findings of the preceding Phases to support development of the PDP Best Practices, The PDP Best Practices were assembled based on the data, analysis, and findings supported by the five different data sources: a) national PDP survey of the state DOTs, b) input received during structured interviews with six state DOTs (VDOT, GDOT, FDOT, KYTC, LaDOTD, and NCDOTD), c) secondary documentation acquired during the interview process of comparable state DOTs and/or the state DOT's website, d) structured interviews of forty-three SMEs within SCDOT, and e) a survey of The American Council of Engineering Companies of South Carolina (ACEC-SC) that have, or currently are, providing professional services to SCDOT.

The Best Practices were shared with the research Steering Committee and SCDOT leadership and can be found in the Appendix H. In addition, the following SCDOT's Steering Committee were involved for a part or entirety of the research project: Rob Bedenbaugh, Chair and Committee Members: Kati Holland (Co-chair), Joy Riley, Adam Humphries, Michael Pitts, Casey Lucas, Mark Anthony, Leah Quattlebaum, Jason Stillwell, Carolyn Fisher (FHWA), Terry Swygert, and Meredith Heaps.

TABLE OF CONTENTS

Technical Report Documentation Page ii
Disclaimer iii
Acknowledgements iv
Executive Summary v

Chapter 1: Introduction 1

Section 1.1. Research Scope 1
Section 1.2. Problem Statement 2
Section 1.3. Research Objectives 4
Section 1.4. Primary Research Goals 4

Chapter 2: Literature Review 5

Section 2.1. Project Development Process (PDP) 7
Section 2.2. Conclusion 11

Chapter 3: Research Design and Methodology 12

Section 3.1. General Research Strategy 12
Section 3.2. Specific Research Questions 12
Section 3.3. Specific Research Design 14
Section 3.4. Conclusion 22

Chapter 4: Research Findings and Analysis 23

Section 4.1. Phase 1: Investigate SCDOT PDP and PSC Input 23
Section 4.2. Phase 2: National State DOTs Input 40
Section 4.3. Phase 3: Comparable State DOTs Input 51
Section 4.4. Phase 4: PDP Best Practices 56

Chapter 5: PDP Best Practices and Recommendations 60

Section 5.1. Category A: Project Prioritization and Scope Definition Process 61
Section 5.2. Category B: Consultant Procurement and Management 62
Section 5.3. Category C: Performance Measurement and Accountability 65
Section 5.4. Category D: Project Development Process (PDP) 66
Section 5.5. Category E: Project Development Process Training 67

Chapter 6: Conclusions and Discussion 68

Section 6.1. Investigate SCDOT PDP and PSC Input 68
Section 6.2. National State DOTs Input 70
Section 6.3. Comparable State DOTs Input 72
Section 6.4. PDP Best Practices 72

References 74

Appendices 81

Appendix A: SCDOT SMEs Interview Topics of Inquiry and Questions ..... A
Appendix B: SCDOT PDP Flowcharts Tasks and Subtasks C
Appendix C: Mapping SCDOT PDP Paper ..... DD
Appendix D: Professional Services Consultants' Survey Paper ..... QQ
Appendix E: National State DOTs Survey Paper ..... DDD
Appendix F: Evaluation of PDP Comprehensiveness Paper XXX
Appendix G: State DOTs SMEs Interview Topics of Inquiry and Questions ..... QQQQ
Appendix H: PDP Best Practices and Recommendations – Detailed ..... TTTT

LIST OF FIGURES

Figure 2.1: Literature Review Map and Bodies of Knowledge 6
Figure 2.2 - FHWA and AASHTO PDP Strategies Map Area 10
Figure 3.1: Research Design and Methodology Map 13
Figure 3.2: Research Methodology Phase 1 15
Figure 3.3: Research Methodology Phase 2 17
Figure 3.4: Research Methodology Phase 3 18
Figure 3.5: Evaluation of State DOTs PDP Comprehensiveness 19
Figure 3.6: Research Methodology Phase 4 21
Figure 4.1: SCDOT PDP Mapping Process Methodology 24
Figure 4.2: SCDOT 'EA FONSI' Baseline PDP Flowchart 29
Figure 4.3: SCDOT 'CE' PDP Flowchart 30
Figure 4.4: SCDOT 'USACE Permit' PDP Flowchart 31
Figure 4.5: SCDOT 'Non-USACE Permit' PDP Flowchart 32
Figure 4.6: Phase 1-Professional Services Consultants Input 34
Figure 4.7: PSCs Area of Operation (%) 36
Figure 4.8: Phase 2 – National State DOTs Input 40
Figure 4.9: State DOTs Participating in the Survey 44
Figure 4.10: State DOTs Preconstruction Department Organization 45
Figure 4.11: State DOTs Percentage of Projects by PSCs 45
Figure 4.12: PDP Duration based on Project Type 47
Figure 4.13: PDP Duration based on Project Category. 50
Figure 4.14: Phase 3 – Comparable State DOTs Input 52
Figure 4.15: PDP Comprehensiveness Criteria Categories for AHP 54

LIST OF TABLES

Table 2.1: PDP Focus Areas and Best Practices Categories 9
Table 4.1: SCDOT Interviewed Subject Matter Experts 26
Table 4.2: PDP Areas for Improvement 28
Table 4.3: PSCs Survey Coding for Analysis 35
Table 4.4: t-Test, PSCs National and Regional/Local Means 39
Table 4.5: State DOTs Survey Coding for Analysis 42
Table 4.6: Comparable State DOTs Interviews Findings & Analysis 57

LIST OF ACRONYMS AND ABBREVIATIONS

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 1: 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).

State Transportation Agencies (STA), 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 (i.e., 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) 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 SCDOT's 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 Goals

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 goals.

1. Goal I: Update and streamline the agency's current Preconstruction Project Development Process
2. Goal II: Identify state DOT Project Development Process Best Practices

The abovementioned primary research goals are a refined form of management question or problem statement. The primary questions have led development of the detailed research objectives, which will be discussed in later chapters. The primary research goals along 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 2: LITERATURE REVIEW

This research study's first task was 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 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 aimed 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.

Figure 2.1 shows the map of 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.

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 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).

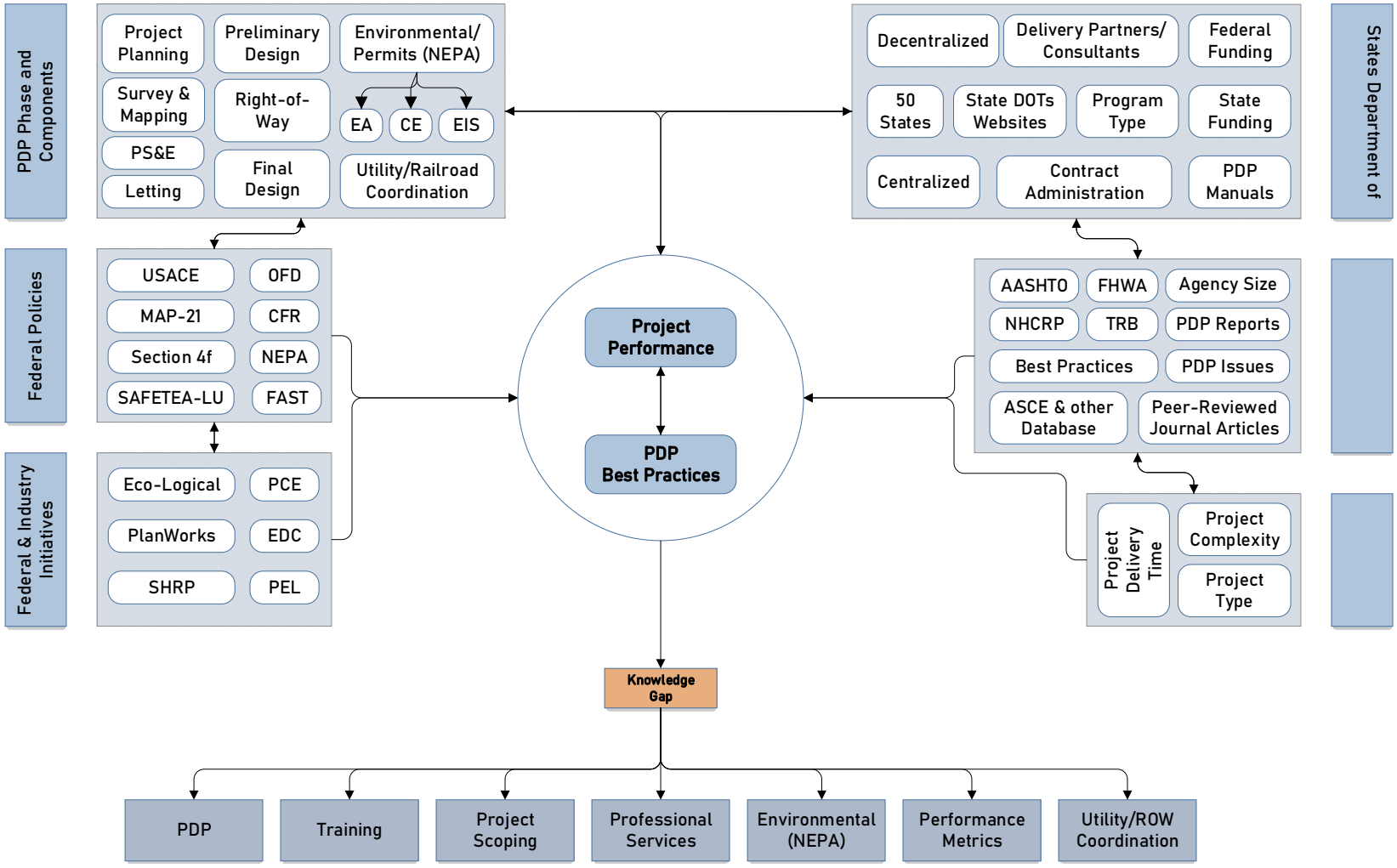


Figure 2.1: Literature Review Map and Bodies of Knowledge

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.”

2.1. Project Development Process (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 2.1) 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).

Table 2.1: PDP Focus Areas and Best Practices Categories (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

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 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. 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. 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 (Figure 2.2).

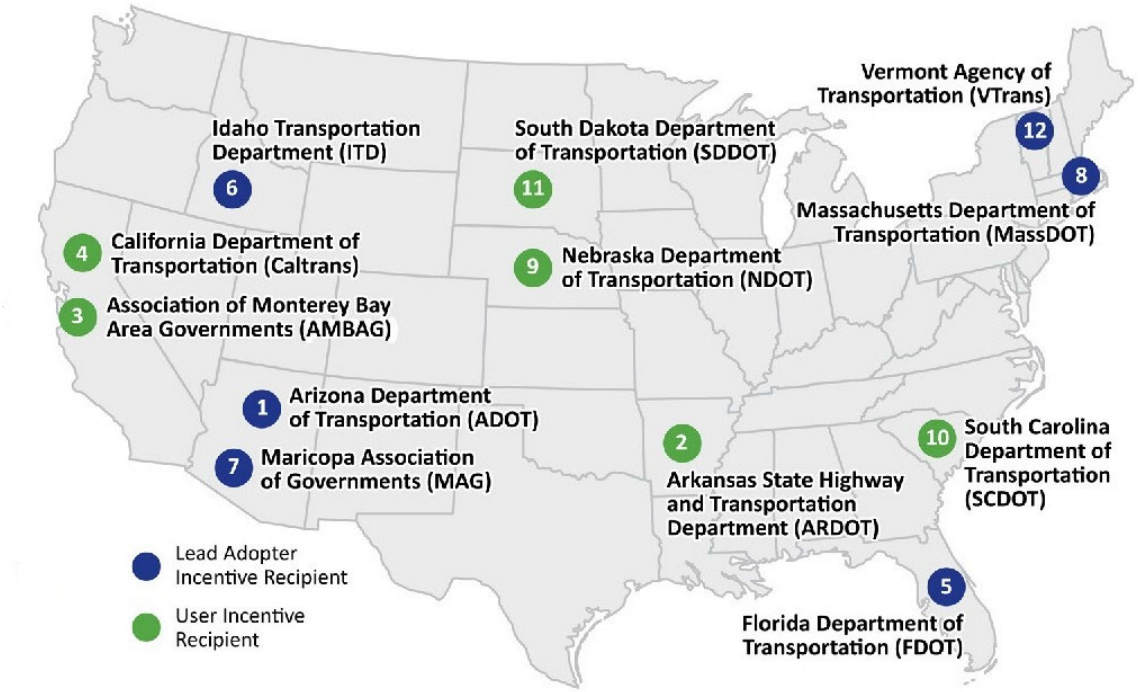


Figure 2.2 - FHWA and AASHTO PDP Strategies Map Area (Andrle & Heilman 2012)

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.

2.2. 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: National Environmental Policy Act (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 3. 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 3: RESEARCH DESIGN AND METHODOLOGY

3.1. General Research Strategy

The purpose of this research study is to: 1) streamline and update the SCDOT's PDP to enhance and improve project development and delivery, and 2) identify 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 SCDOT's PDP to improve project development performance. Figure 3.1 shows the Research Design and Methodology Map for this research study, discussed in detail in the following sections. The proposed methodology (Figure 3.1) for this research study is completed in four phases comprising ten tasks.

3.2. 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.

3.2.1. Primary Research Questions

- What is SCDOT's current Project Development Process(es) for the agency's primary project and program types?
- What are the Project Development Process best practices utilized by State Departments of Transportation that could improve and streamline the South Carolina Department of Transportation's PDP?

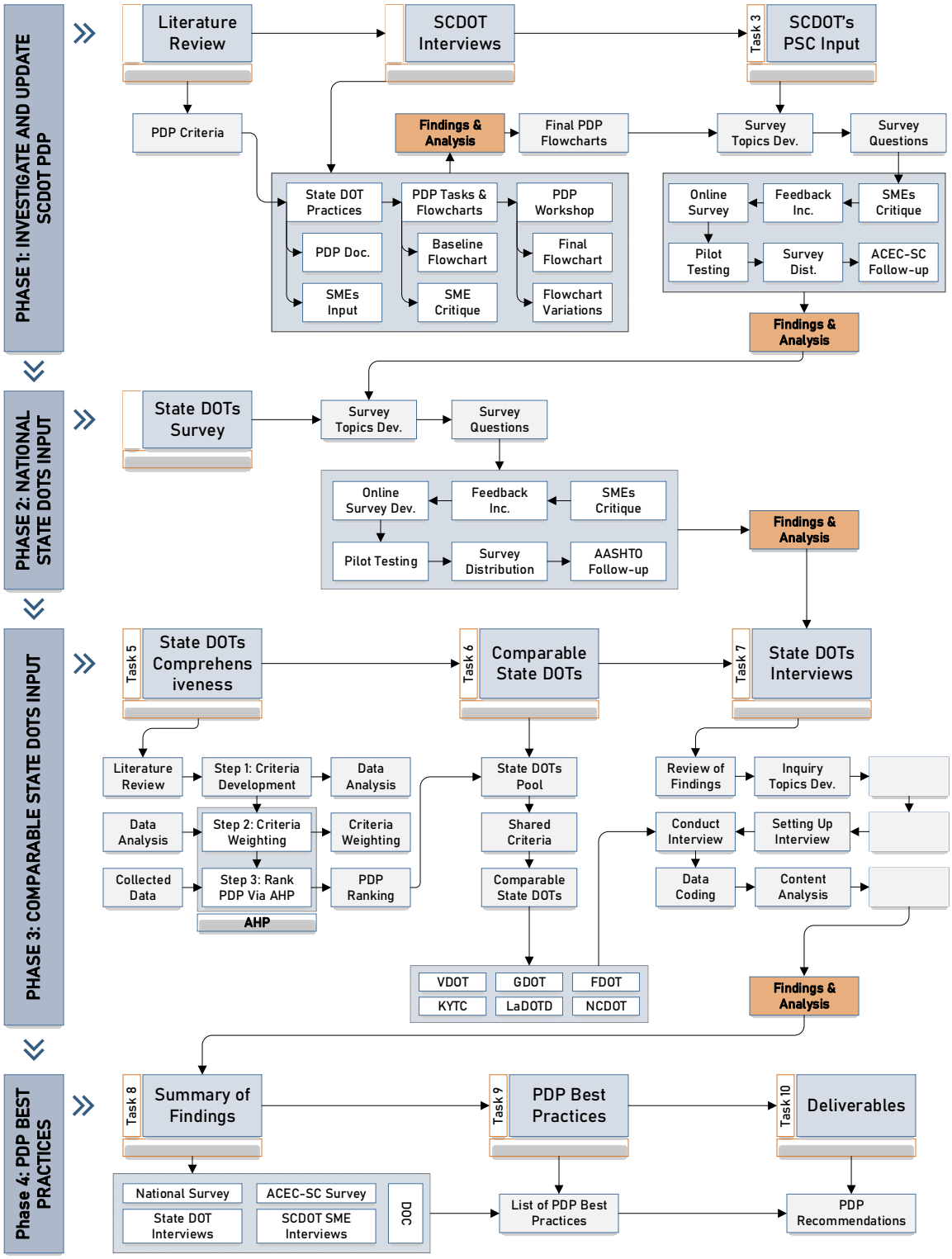


Figure 3.1: Research Design and Methodology Map

- What PDP best practices distinguish the top-performing state DOTs from Poor-performing state DOTs?
- How do these PDP best practices affect the PDP timeline among the top-performing and poor-performing state DOTs?
- What steps should SCDOT consider taking to improve their PDP?

3.2.2. 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 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?

3.3. Specific Research Design

This research study utilized an Explanatory Sequential Design, as shown in Figure 3.1 (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 3.1). 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 3.1), 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 this phase, a two-day workshop was held with SCDOT PDP leadership and Steering Committee members to develop an updated PDP flowchart that reflected current agency practice for different project and program types.

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 3.1).

3.3.1. Phase 1: Investigate and Update SCDOT Current Practices

Figure 3.2 shows the research methodology, Phase 1, the SCDOT Project Development Process Current Best Practices investigation and update. 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.

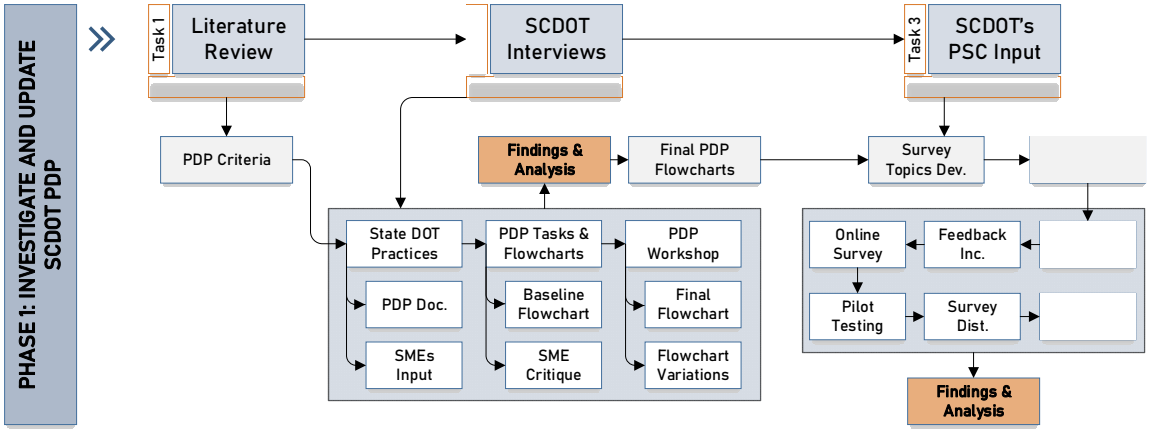


Figure 3.2: Research Methodology Phase 1: Investigate SCDOT PDP Current Best Practices

3.3.1.1. 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.

3.3.1.2. 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 department functional units were interviewed. These departments and functional units were, 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 were to:

- Identify and document the agency's current PDP.
- Map the agency's PDP.
- Obtain documentation regarding current PDP tasks and subtasks.
- Identify each departments 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. A two-day workshop was held with SCDOT PDP leadership and Steering Committee members and updated PDP flowcharts were developed that reflected current agency practice for different project and program types. Detailed findings and analysis alongside the PDP flowcharts are discussed in Chapter 4.

3.3.1.3. 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 4.

3.3.2. Phase 2: National State DOTs Input

Figure 3.3 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 via a self-administered computer-assisted questionnaire.

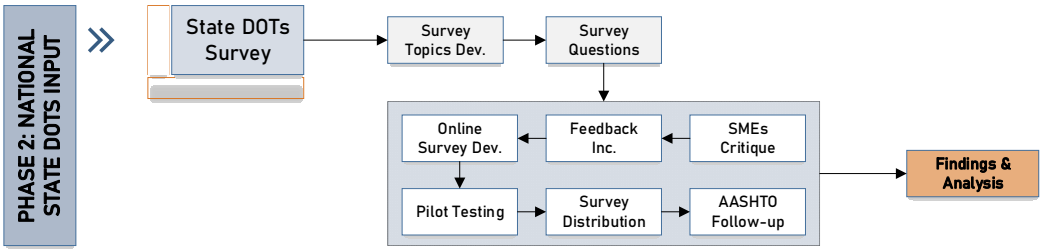


Figure 3.3: Research Methodology Phase 2: National State DOTs Input

3.3.2.1. Task 4: State DOTs Survey

Task 4 involved developing, distributing, and collecting data from all state DOTs utilizing a computer-assisted self-administered questionnaire. The targeted population was the States Department of Transportation. The population number was 50 states of the US. The sampling frame was a list of all 50 state DOTs. The targeted respondent(s) for each state DOT was 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 4.

3.3.3. Phase 3: Comparable State DOTs Input

Figure 3.4 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.

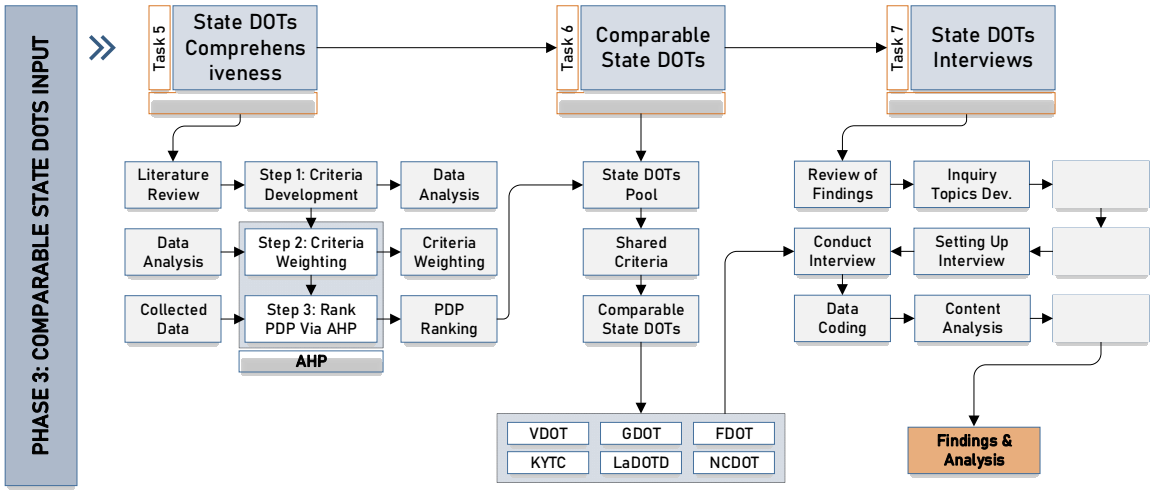


Figure 3.4: Research Methodology Phase 3: Comparable State DOTs Input

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 3.4) 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 4.

3.3.3.1. 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 3.5. A brief explanation of this process (Figure 3.5) is described in the steps outlined below.

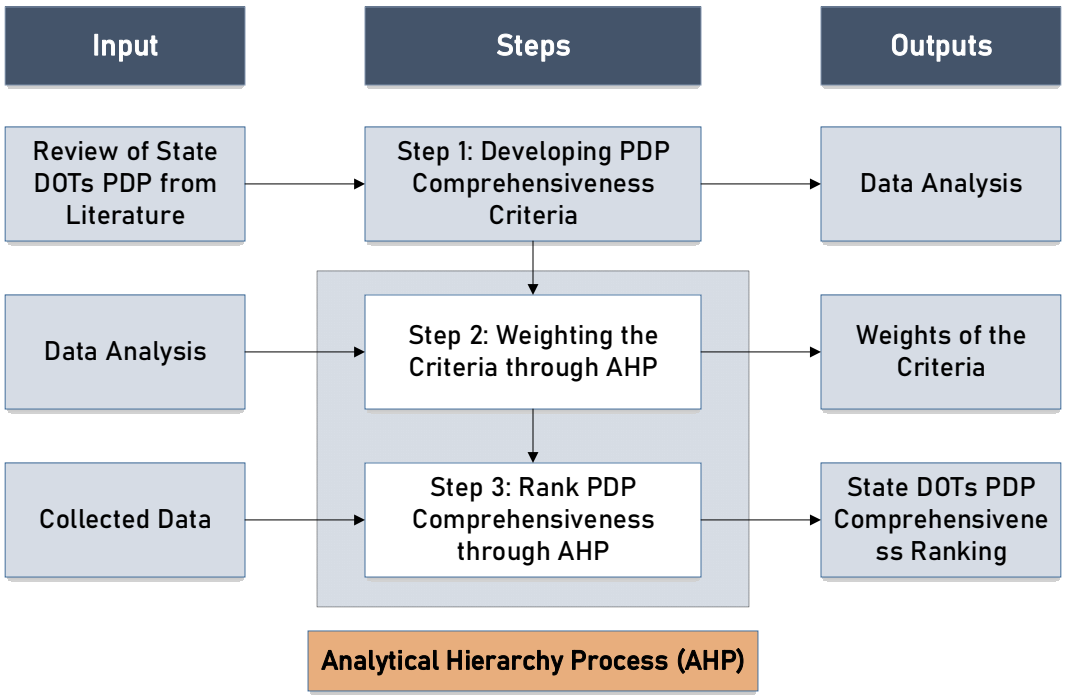


Figure 3.5: Evaluation of State DOTs PDP Comprehensiveness Methodology

Step 1: Developing PDP Comprehensiveness Criteria

As shown in Figure 3.5, 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.

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 3.5). 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 properly represent the state PDP's current comprehensiveness.

Empirically, it is difficult to determine 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.

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 3.5). 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.'

3.3.3.2. 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 3.4. 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.

3.3.3.3. 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.

3.3.4. Phase 4: PDP Best Practices

Figure 3.6 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 5.

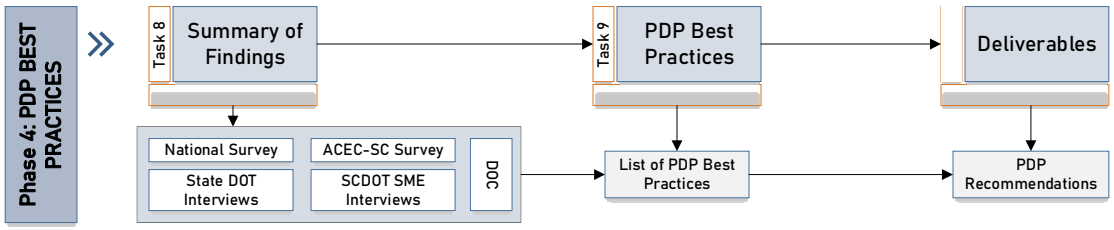


Figure 3.6: Research Methodology Phase 4: PDP Best Practices

3.3.4.1. Task 8: Summary of Findings and Analysis

As shown in Figure 3.1, the data analysis 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 supported the development of PDP best practices (see Figure 3.6). 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.

3.3.4.2. 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.

3.3.4.3. 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 5.

3.4. 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 3.1 shows the Research Design and Methodology Map for this research study, discussed in detail in this chapter. The proposed methodology (Figure 3.1) for this research study is completed in four phases comprising ten tasks.

CHAPTER 4: RESEARCH FINDINGS AND ANALYSIS

This chapter discusses, describes, and presents the findings and analysis of four research phases described in Chapter 3. These phases are: a) Phase 1, Investigate and Update the South Carolina Department of Transportation's Project Development Process (SCDOT PDP) Current Best Practices, including SCDOT preliminary exploratory interviews and obtaining input from SCDOT's professional services delivery partners concerning the agency's current PDP, b) Phase 2, the States' Department of Transportation input concerning Project Development Process (PDP), c) Phase 3, the Comparable States' Department of Transportation input concerning Project Development Process (PDP), and d) Phase 4, States' Department of Transportation Project Development Process Best Practices. What follows is a description of these phases' findings and analysis.

4.1. Findings and Analysis: Phase 1 – Investigate SCDOT PDP and Consultants' Input

Preliminary Exploratory Interviews with SCDOT SMEs were conducted to: 1) investigate, understand, and map SCDOT's preconstruction PDP activities and development sequence to document current PDP practices, and 2) during SME mapping of current practices, identify areas for improvement. This exercise 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. Develop updated flowcharts of SCDOT's PDP based on various factors including project/program type, funding source, and environmental impact.
c. Identify PDP areas for improvement to pave the way for improving and streamlining SCDOT's 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 4.1. 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.

The first step for this Phase 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.

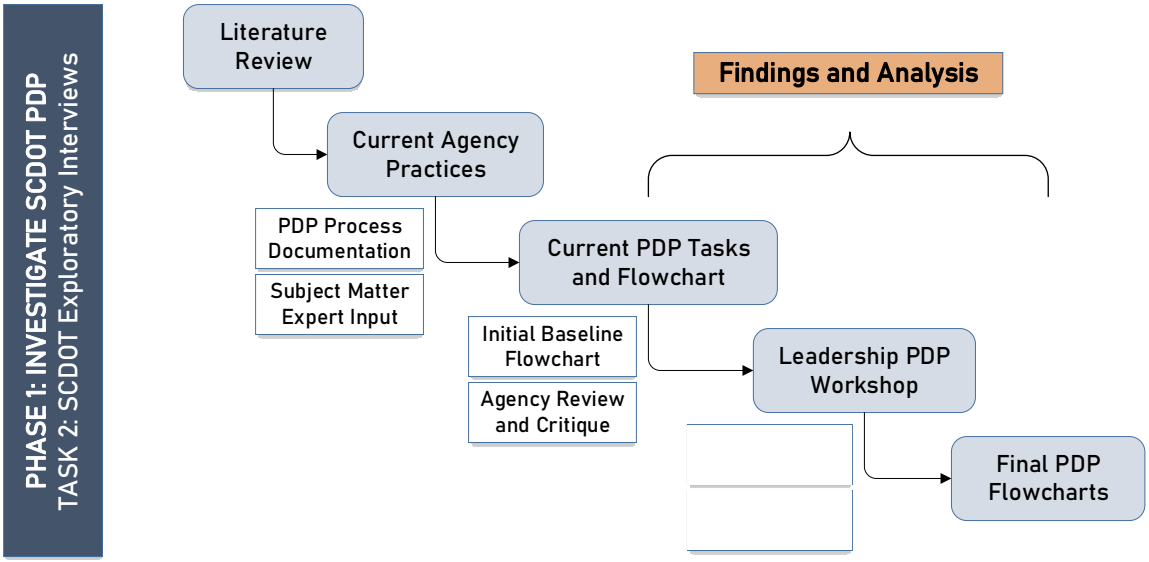


Figure 4.1: SCDOT PDP Mapping Process Methodology

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:

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

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 4.1). 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.

4.1.1. 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. The research team also identified suggested milestones for the development process. This 'baseline' flowchart contained fifty-nine tasks and eight gates (milestones), shown in Figure 4.2. Once the flowchart development was completed, the research team 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.

Table 4.1: SCDOT Interviewed Subject Matter Experts

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**	

4.1.2. Finalize Baseline Flowchart

A two-day workshop was held to finalize PDP flowchart development and establish the 'subtasks' for each flowchart task. The research team and the attendees included the preconstruction support leadership, Steering Committee members, 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 Environmental Assessment Finding of No Significant Impact (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.

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.

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 4.2. The flowcharts based on varying environmental and permit requirements are shown in Figure 4.3, Figure 4.4, and Figure 4.5. In addition, the key sub-tasks for each task on the flowcharts were linked to their corresponding task (see Appendix B). 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.

4.1.3. 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 4.2. 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.

Table 4.2: PDP Areas for Improvement

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

For the detailed description, findings, and analysis of the SCDOT PDP Mapping Process, see Appendix C which provides a journal paper that was submitted and presented at Transportation Research Board (TRB) 2021 Annual Meeting.

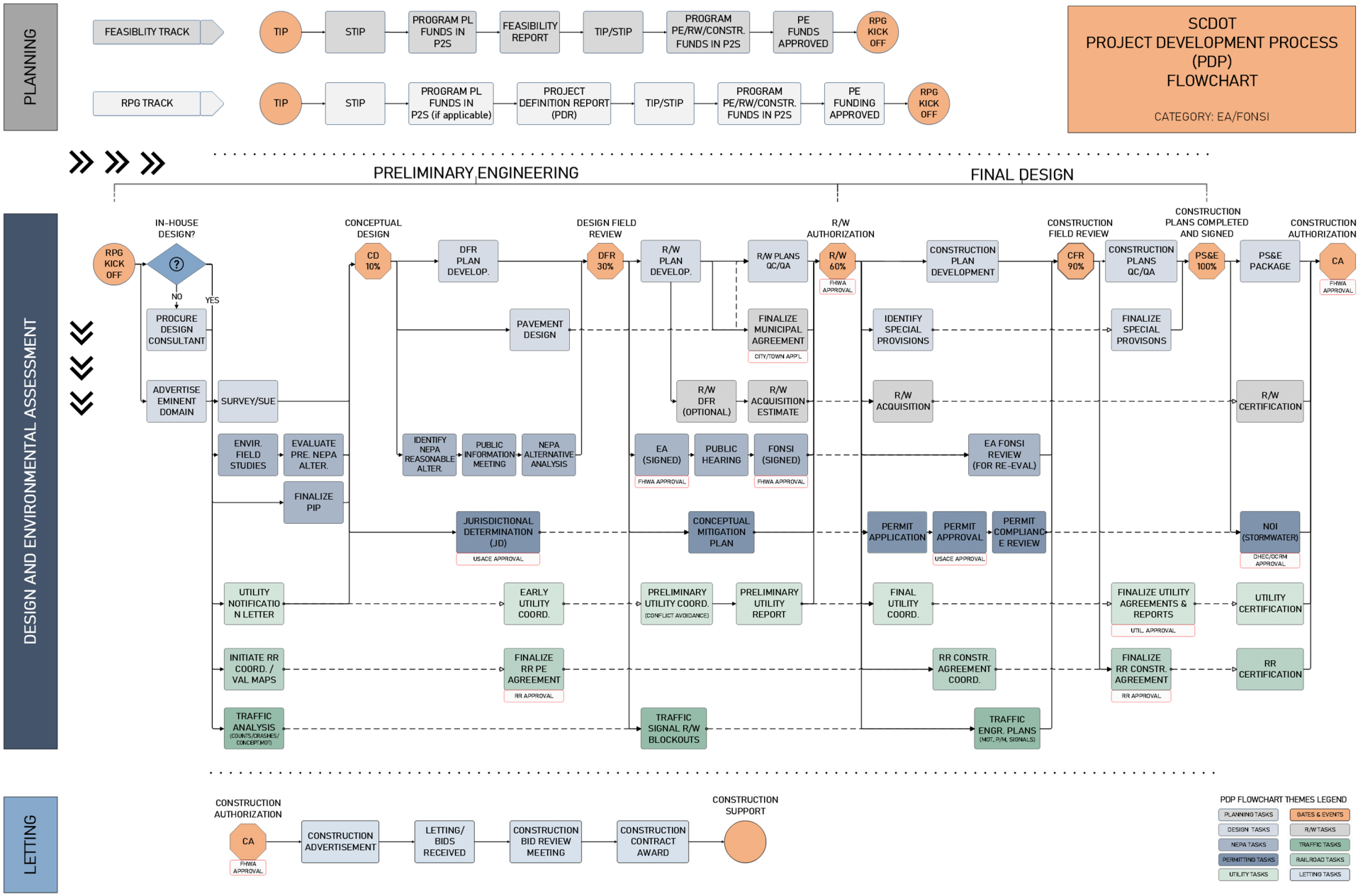


Figure 4.2: SCDOT 'EA FONSI' Baseline PDP Flowchart

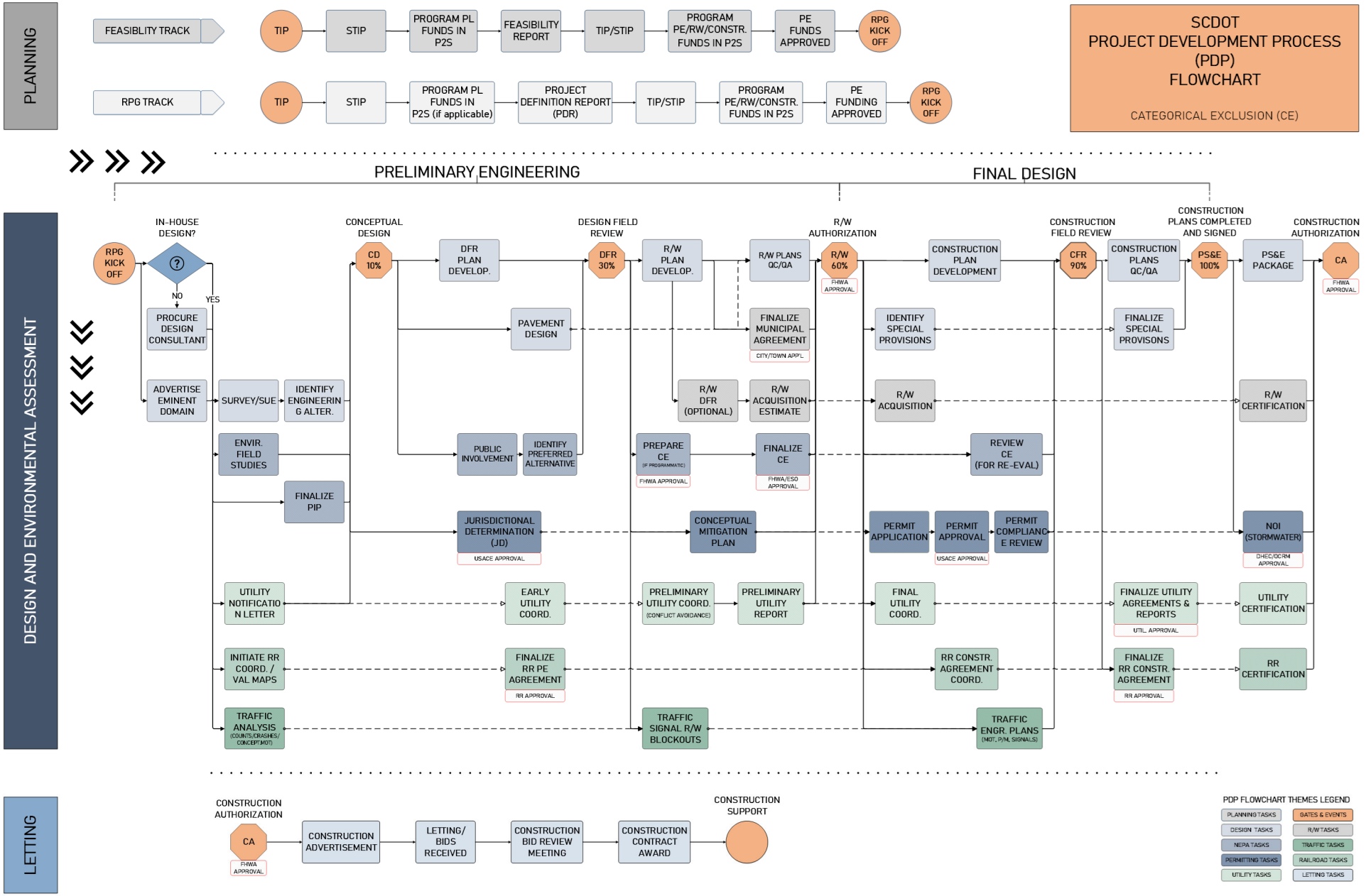


Figure 4.3: SCDOT ‘CE Programmatic and Non-Programmatic’ PDP Flowchart

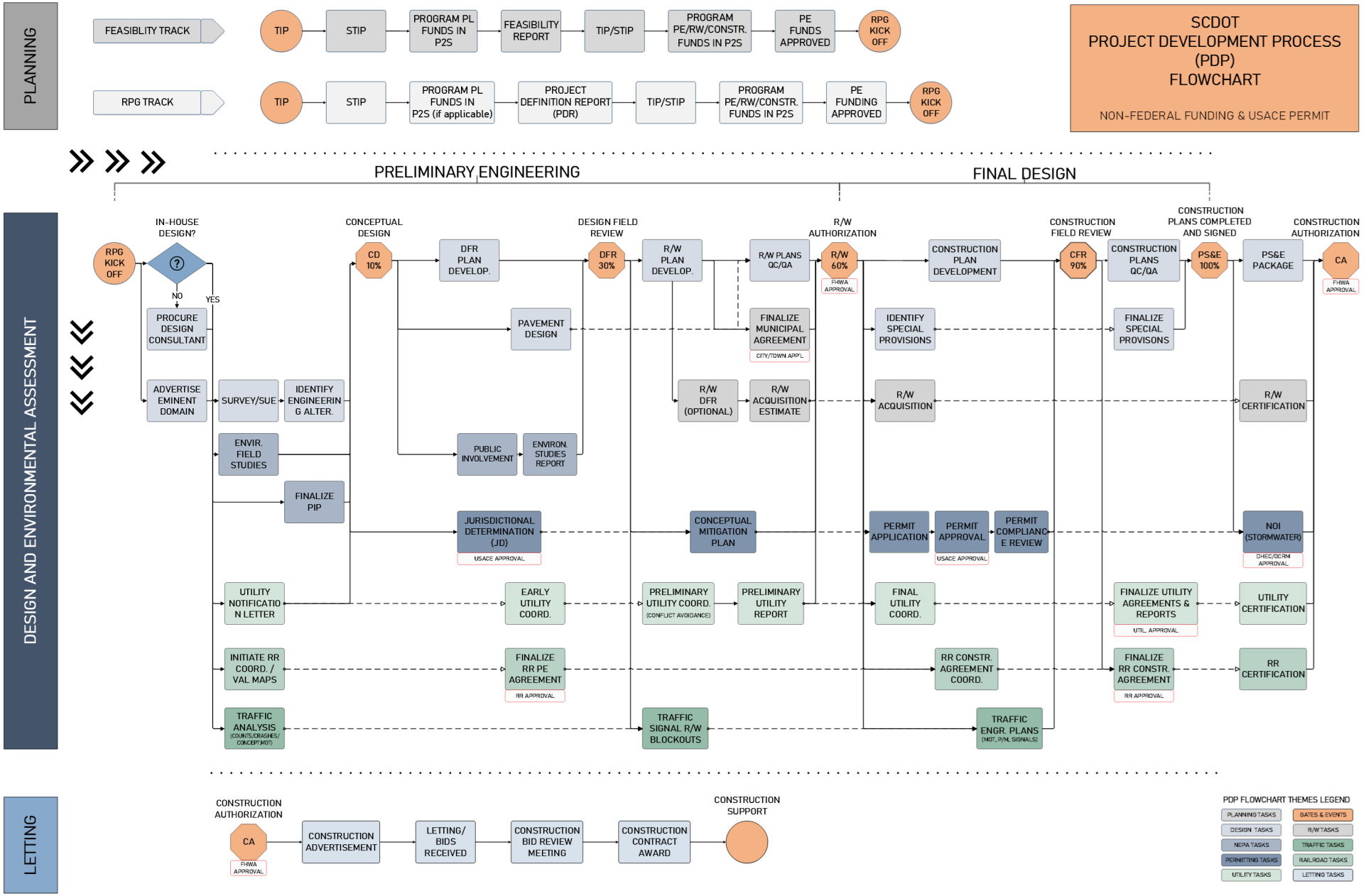


Figure 4.4: SCDOT 'Non-Federal Funding and USACE Permit' PDP Flowchart

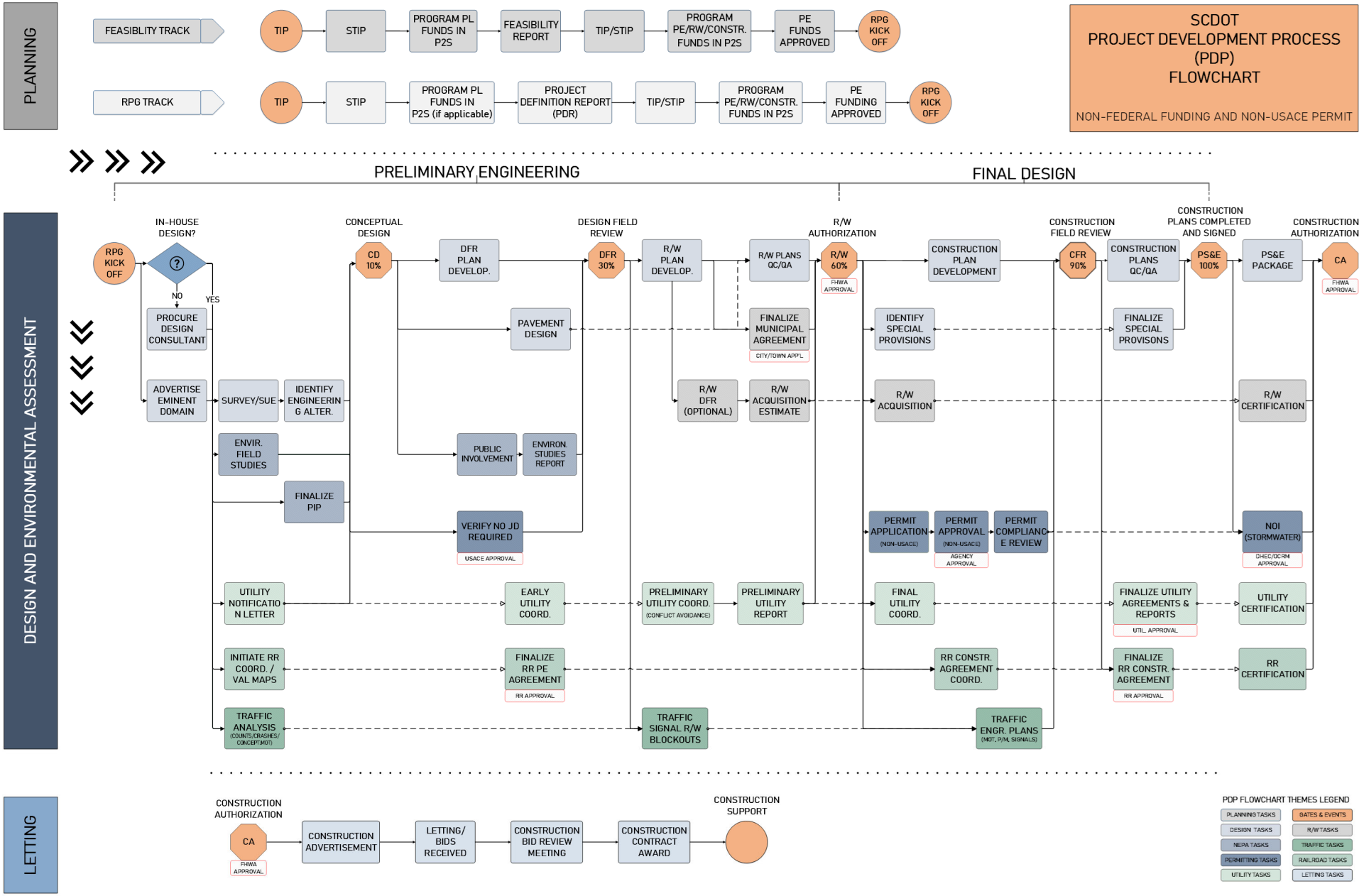


Figure 4.5: SCDOT 'Non-Federal Funding and Non-USACE Permit' PDP Flowchart

4.1.4. 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 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.

Gathering input was an essential step (see Figure 4.6) 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.

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. 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.

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 4.3. The development of the individual questions was an eight-step process. Similar to the national state DOT survey, 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 4.6).

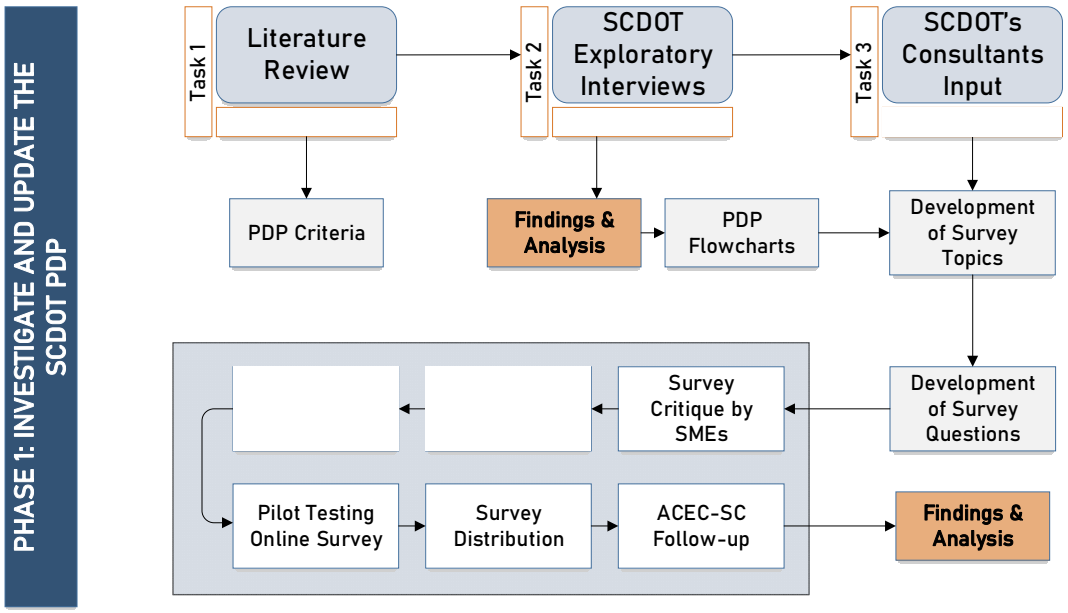


Figure 4.6: Research Methodology Phase 1-Professional Services Consultants Input

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.

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, subsequent distribution, and follow-up by ACEC to their membership was in March, April and early May 2020.

Table 4.3: PSCs Survey Questions and Responses Coding for 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

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 4.3 shows the survey questions and responses coding that is used for the analysis. 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.

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 4.7). 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. 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.

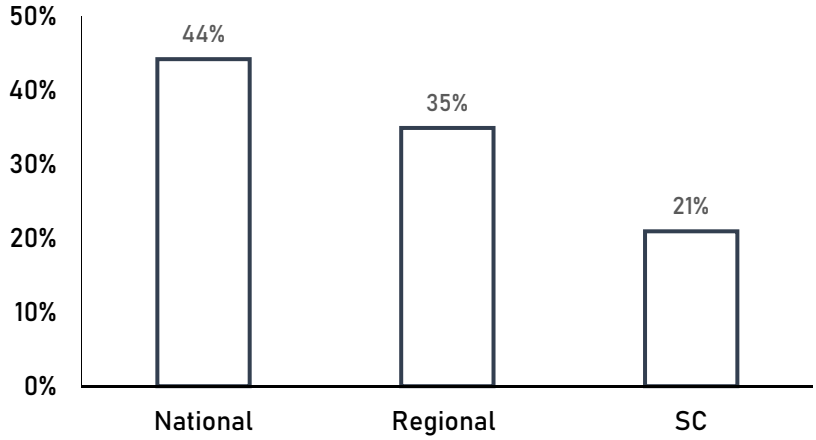


Figure 4.7: PSCs Area of Operation (%)

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%. 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:

4.1.4.1. 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. 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.

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.

The second grouping of questions presented in Table 4.3 provides response options addressing the level of agreement or disagreement with the question/statement. 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.

4.1.4.2. 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. 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.

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. Another question 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.

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. 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.

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.

4.1.4.3. 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 4.4 presents the variables that the t-test resulted in determining a significant difference between the two groups' means.

Table 4.4: t-Test, PSCs National and Regional/Local Means

Variable	Level	Means and Standard Deviations					
		Count (N)	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
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

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.

For the detailed description, findings, and analysis of the Professional Services Consultants' Input, see Appendix D which presents a white paper that was submitted and presented to SCDOT.

4.2. Findings and Analysis: Phase 2 – National State DOTs Input

This research phase's primary objectives were to gain insight concerning the state DOT's preconstruction PDP and the use of Professional Services Consultants (PSC). This phase presents the findings, and analysis of a national state DOT survey to gain insight concerning a) the preconstruction PDP of state DOTs, b) state DOT's 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.

Figure 4.8 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.

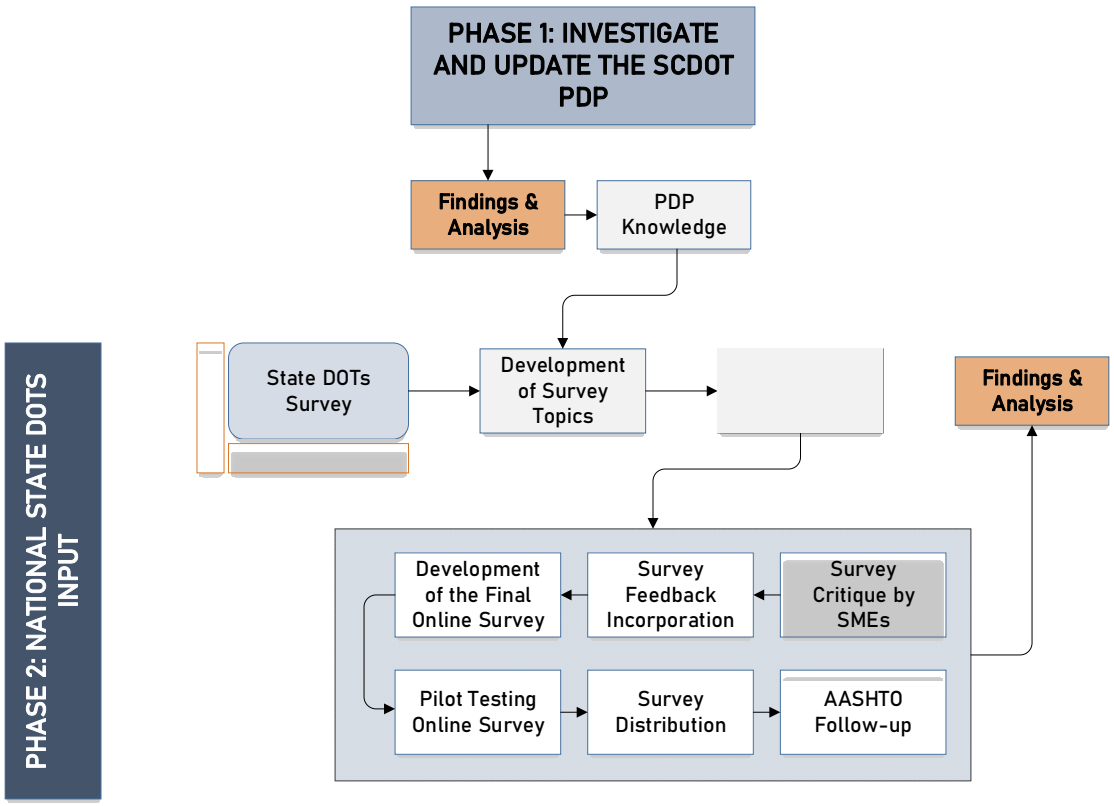


Figure 4.8: Research Methodology Phase 2 – National State DOTs Input

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 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. 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 4.5.

The development of the individual questions was a multi-step process (Figure 4.8). 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.

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. 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 respondents' groupings. Table 4.5 presents the survey questions and responses coding used for analysis.

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 4.9). 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. For the detailed description, findings, and analysis of the National State DOT's Input, see Appendix E which presents a journal paper that was submitted and presented in Transportation Research Board (TRB) Annual Meeting.

Table 4.5: State DOTs Survey Questions and Responses Coding for 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 4.5 (Continued): 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		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)				

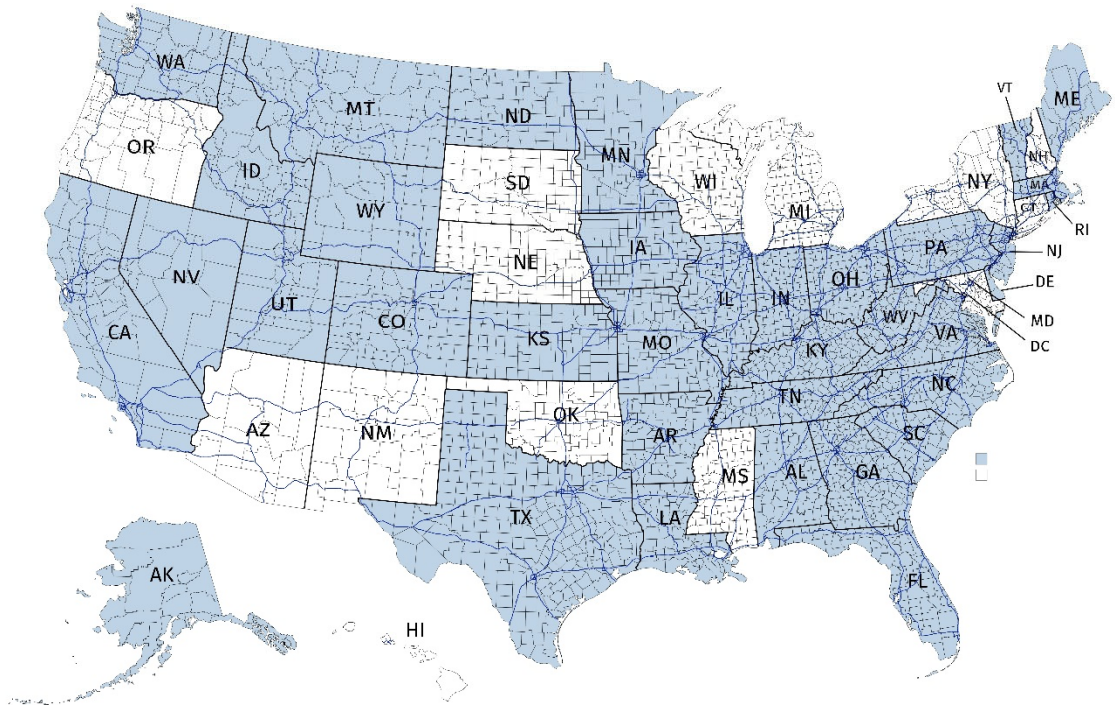


Figure 4.9: State DOTs Participating in the Survey

4.2.1. General State DOTs Information

Survey participants were asked if centralized, decentralized, or hybrid best described their general state DOT preconstruction organizational structure (Figure 4.10). 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.

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.

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 4.11. 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.

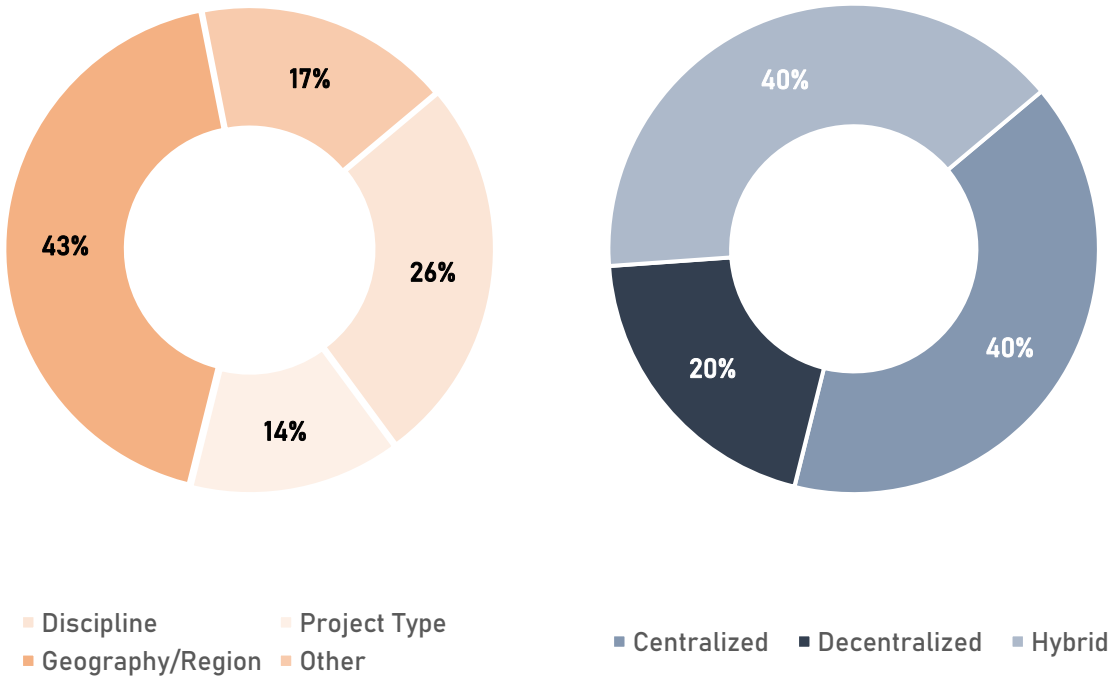


Figure 4.10: State DOTs Preconstruction Department and Management Organization

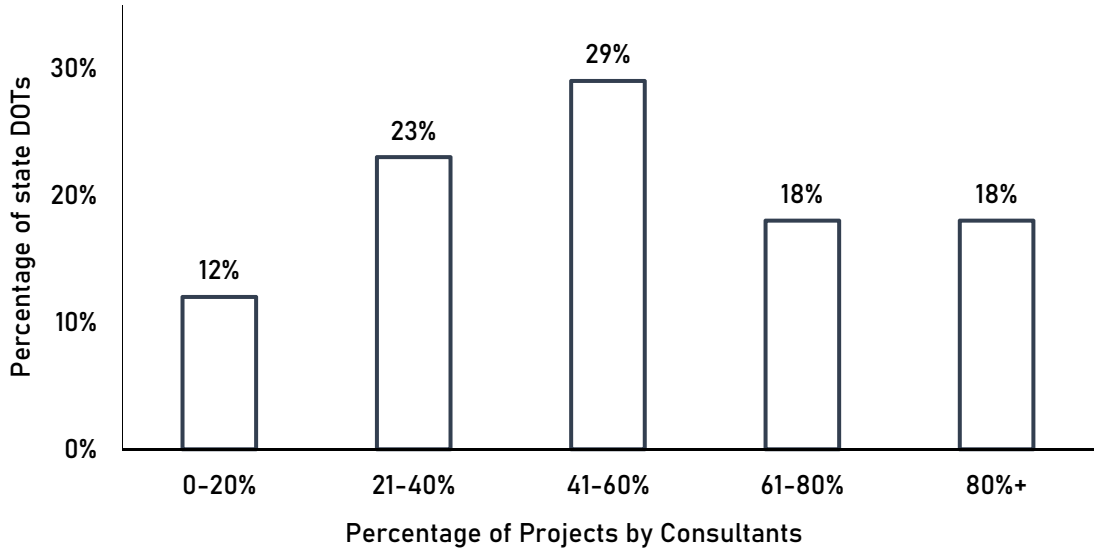


Figure 4.11: State DOTs Percentage of Projects by PSCs

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.

4.2.2. 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.

4.2.3. Project Scoping Process

Survey participants were presented with a series of questions concerning their project scoping practices. The 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.'

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.

4.2.4. 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/milestone. The metrics/milestones that 75% or more state DOTs tracked included Approval of Project Funding, FHWA FONSI Approval, Right of Way (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. 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%, 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'.

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 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 Figure 4.12.

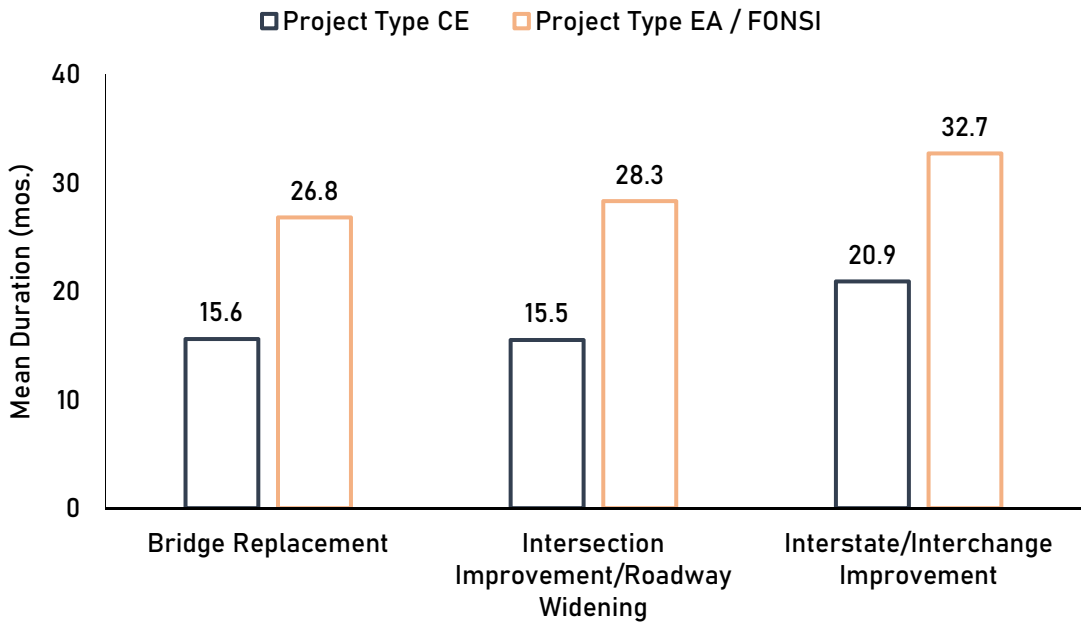


Figure 4.12: PDP Duration based on Project Type and Environmental Impact

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. The two activities identified as frequently the controlling factors in the PDP were ROW acquisition and Utility Relocation. 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.

4.2.5. 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. 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 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. 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. 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.

The next series of questions 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.

4.2.6. 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. 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 were determined. A sort of data yielded the duration performance results for the top and bottom half of the state DOTs, as shown in Figure 4.13. The Top Performers in Figure 4.13 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.

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.

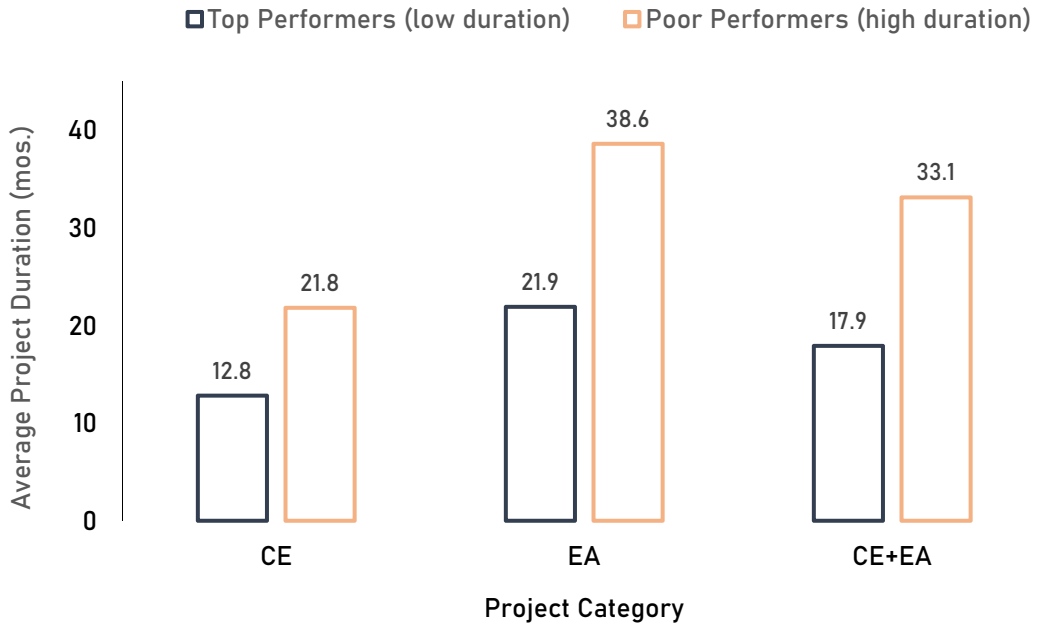


Figure 4.13: PDP Duration based on Project Category and Environmental Impact

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 4.13 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.

4.3. Findings and Analysis: Phase 3 – Comparable State DOTs Input

Subsequent to the national state DOTs survey, Phase 3 of this research study aimed to obtain input from the comparable or peer state DOTs to SCDOT 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. Phase 3 of the research study includes three main interrelated tasks (Figure 4.14): 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.

4.3.1. Evaluation of State DOTs PDP Comprehensiveness

A three-step method was used to develop the evaluation procedure of PDP, as shown in Figure 4.14. The goal 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. For the detailed description, findings, and analysis of the State DOTs PDP Comprehensiveness, see Appendix F.

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.

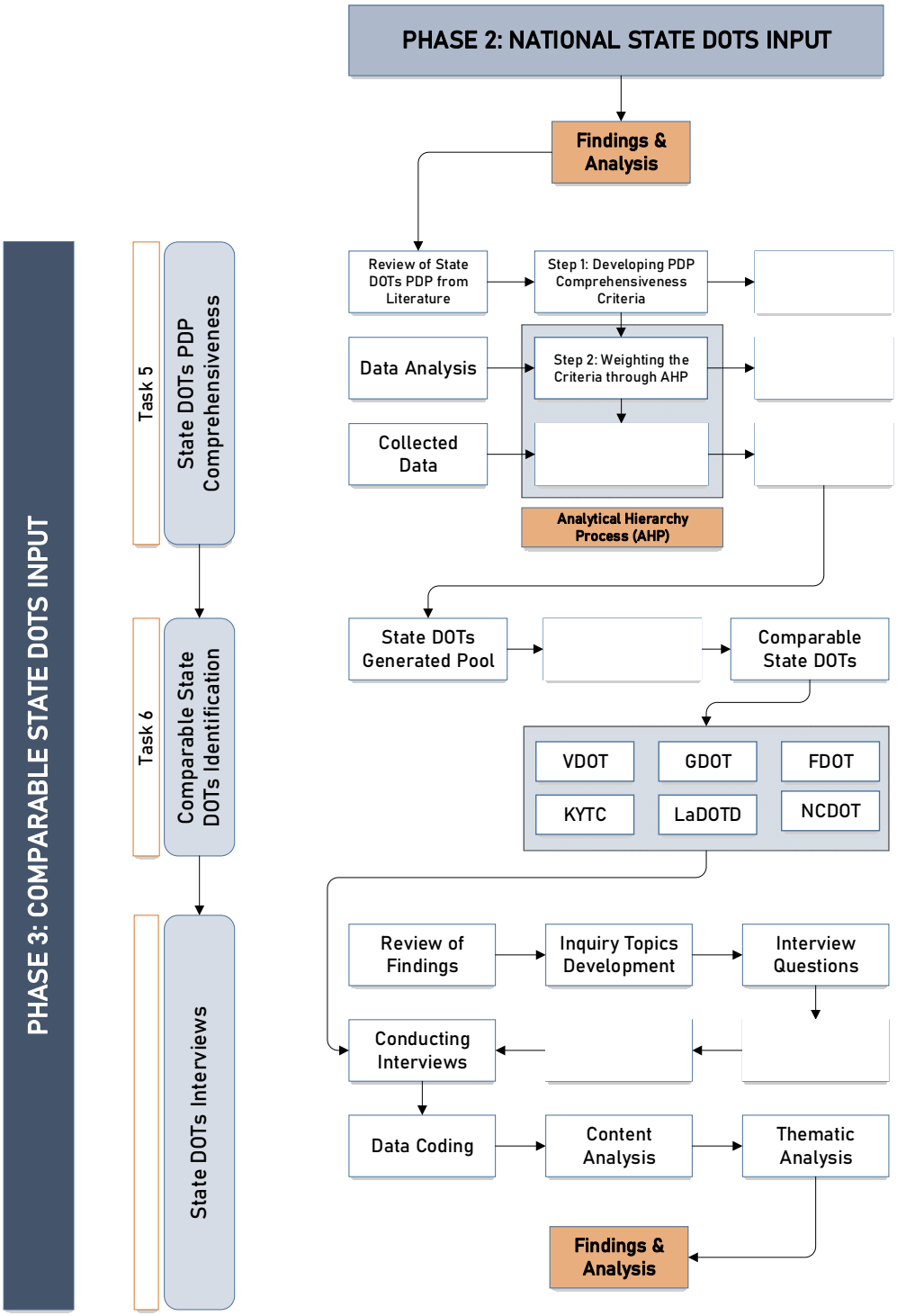


Figure 4.14: Research Methodology Phase 3 – Comparable State DOTs Input

The literature review identified 19 criteria (Figure 4.15) 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. 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 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.

Once the PDP comprehensiveness criteria were developed, the next 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. 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. The researcher followed the AHP's typical steps and developed a process for weighting the criteria. 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 (Figure 4.15).

Data collected, 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. 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. 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.

The last step in the evaluation method was to rank the state DOTs' PDP's comprehensiveness. The primary objective 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, 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.'

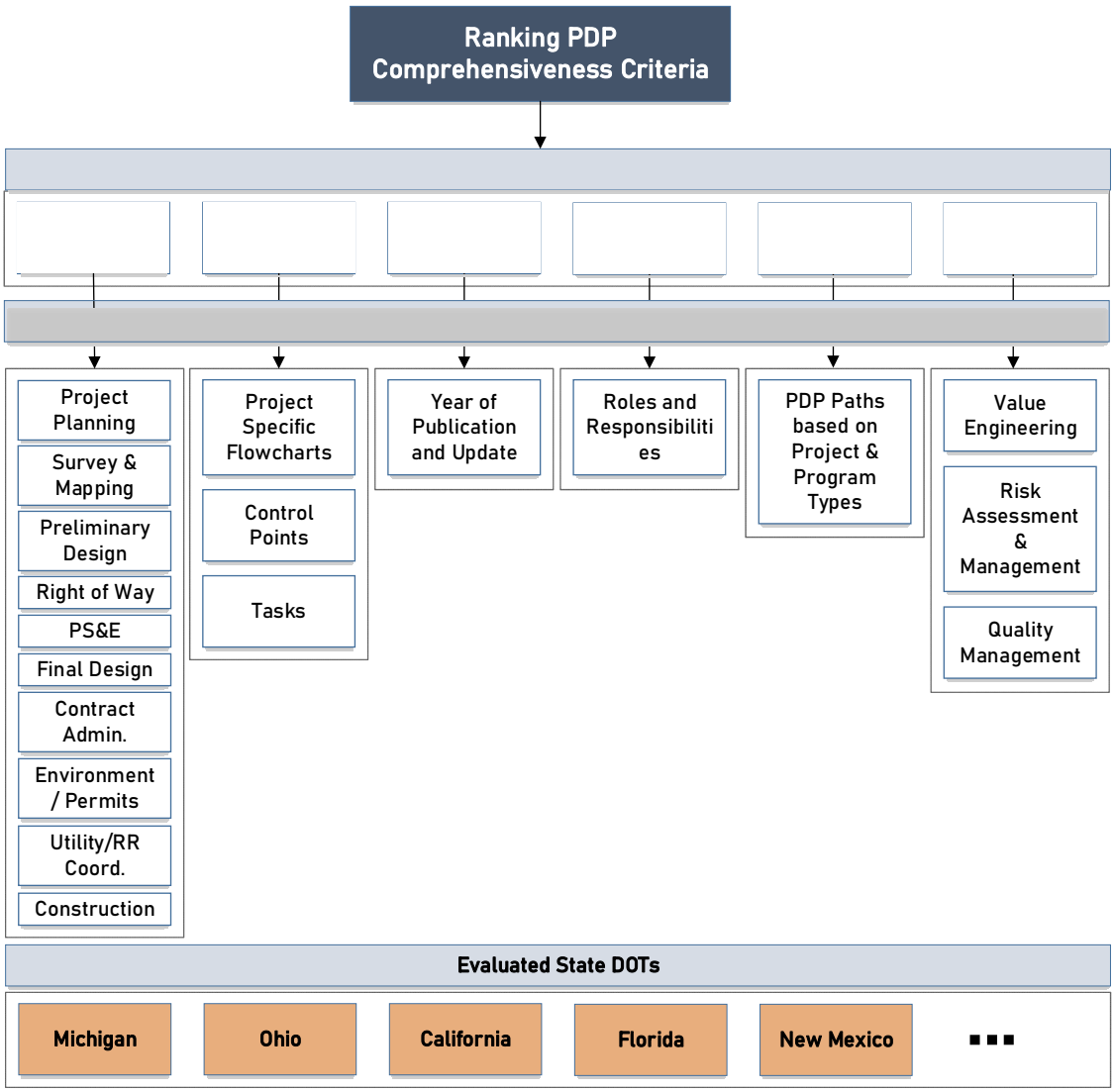


Figure 4.15: PDP Comprehensiveness Criteria Categories for AHP

4.3.2. Identification of Comparable State DOTs

In this task, state DOTs comparable to SCDOT were identified subsequent to the evaluation of the state DOTs PDP comprehensiveness. To identify the comparable state DOTs, a pool of state DOTs was generated, ranked higher 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 generated pool. The state DOTs shared criteria and statistics 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. The selected state DOTs are, Virginia (VDOT), Georgia (GDOT), Florida (FDOT), Kentucky (KYTC), Louisiana (LaDOTD), and North Carolina (NCDOT).

4.3.3. Task 7: Comparable State DOTs Interviews

Structured interviews were conducted with the comparable state DOTs 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, 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.

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 (see Appendix G). 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 next step was to identify appropriate SMEs for the interviews from the comparable state DOTs. 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.

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 the comparable state DOTs. The SMEs represented a range of functional units and departments (mainly their head/director). 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. 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.

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 4.6). 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 4.6 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.

The qualitative analysis of the comparable state DOTs interviews using content and thematic forms of analysis (Table 4.6) 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 4.6.

As shown in Table 4.6, six comparable state DOTs (VDOT, GDOT, FDOT, KYTC, LaDOTD, NCDOT) shared meaningful data that is organized by the code system using MAXQDA software. Table 4.6 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 5.

4.4. Findings and Analysis: Phase 4 – PDP Best Practices

Phase 4 of this research study is 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 sections. The research methodology for Phase 4 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. Best Practices are identified based on these findings and analysis from the previous phases of this research which will be presented in Chapter 5 and discussed in detail in Appendix H.

Table 4.6: Comparable State DOTs Interviews Summary of Findings, Analysis, and Coding

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 4.6 (Continued): 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	✓ Mega Projects	✓	✓	X	X	✓
3.6	Consultants Performance Metrics	✓	✓ Baseline Schedule Metrics	✓ Standard Consultant Evaluation	✓ Monthly Evaluation Report	✓ Standardized List of Deliverables	✓ 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			
4.2.1	Scheduling Software	Web-Based MS Project	Primavera P6	Primavera P6	MS Project	Enterprise System, SAP	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	✓	✓	✓	✓	✓	✓
4.3.1	Budget 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 4.6 (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	Dashboard	P6 Templates	Schedule Activities	✓	✓	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		✓	✓	✓	✓	✓	✓

CHAPTER 5: PDP BEST PRACTICES AND RECOMMENDATIONS

This chapter discusses, describes, and presents the research methodology utilized for Phase 4. It presents the States' Department of Transportation Project Development Process Best Practices identified from the data analysis and findings of the previous phases of this study. 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 3.1).

As shown in Figure 3.1, data analysis occurred at several points in this study: 1) analyzing the qualitative data collected from semi-structured SCDOT SMEs, 2) analyzing quantitative data collected from professional services consultants via a structured survey, 3) analyzing the quantitative data collected by computer-assisted self-administered questionnaires from national state DOTs, and 4) analyzing the qualitative data collected via structured interviews and secondary data from comparable state DOTs. To summarize, these findings and analysis are used to identify and establish correlational support for the development of PDP best practices.

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. 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 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.

The Project Development Process (PDP) Best Practices are identified based on the findings and analysis from the previous phases of this research. This chapter 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.
2. 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.
3. Secondary documentation acquired during the interview process of comparable state DOTs and the state DOT's website. The link to access these documents are provided in ProjectWise.
4. 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.
5. 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.

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, recommendations, and associated source material for each. Appendix H presents the detailed description of the PDP best practices, recommendations and support from the findings and analysis of all research phases.

5.1. Category A - Project Prioritization and Scope Definition Process

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.

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.

Recommendations for SCDOT:

- SCDOT has developed a well-defined project prioritization process; however, the research team recommends that the transparency for the project prioritization process be enhanced.
- Establish a dashboard, or other effective venues, to publish the project prioritization process and results.

Best Practice #2: Development of a formal project scoping report during the planning phase to define and document the anticipated project scope.

Key Findings:

- All comparable state DOTs (GA, NC, FL, VA, KY, & LA) 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 the top performing state DOTs 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.

Recommendations for SCDOT:

- SCDOT should continue to develop feasibility reports for larger and complex projects.
- For smaller projects, the agency should clearly define the project scope during the planning stage in a Project Definition Document for departmental use/reference during project development.

5.2. Category B – Consultant Procurement and Management

Best Practice #3: Utilization of Professional Services Consultants to meet the agency's workload.

Key Findings:

- Nationally, the average percentage of state DOT 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 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.

Recommendations for SCDOT:

- SCDOT should proactively and systematically evaluate the agency's workload balance, use of consultants, in-house staffing, and national trends to assess the agency's effectiveness and efficiency of its staffing and consultant use.

Best Practice #4: Development of a Standard Set of Deliverables for professional services consultants so SCDOT can effectively and efficiently manage, evaluate, and track consultant performance.

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 that are 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 consultants services 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 view SCDOT deliverables as inconsistent from project to project.

Recommendations for SCDOT:

- The agency should investigate the current practice and consider development of a 'global' set (master list) of consultant deliverables to promote consistency.

Best Practice #5: Prequalify Professional Services Consultants to ensure performance capability and accelerate the professional services consultant's procurement timeframe.

Key Findings:

- All of the comparable state DOTs (GA, NC, FL, VA, KY, & LA) utilize a prequalification process for their professional services consultants. Comparable state DOTs have developed a prequalification process that complies with the Brooks Act.
- 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 the prequalification of professional services consultants is an effective process to streamline and accelerate the consultant procurement timeframe.

Recommendations for SCDOT:

- SCDOT should reconsider prequalifying professional services consultants in order to streamline the professional services procurement timeframe.

Best Practice #6: Evaluate professional services consultants' performance during project development to effectively track performance, ensure quality, communicate performance concerns, and provide constructive feedback.

Key Findings:

- Comparable state DOTs believe that evaluation of 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 in-house and consultants.
- A majority of SCDOT's consultants believe that performance expectations and measurements for consultant performance are not clearly defined.

Recommendations for SCDOT:

- SCDOT provides consultant performance evaluations semi-annually on all consultant contracts, but agency consultants indicated that a lack of clarity on the performance expectations. The agency should consider soliciting input from agency consultants to more clearly define consultant performance expectations/scoring.

Best Practice #7: Streamline and aggressively manage the process for procurement of professional services consultants to reduce the timeframe required for procurement.

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 findings from the national survey, half of the state DOTs have a need and/or 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.

Recommendations for SCDOT:

- SCDOT's procurement timeframe is well above the industry average, and there are likely a number of drivers that yield the agency's current performance. The recommendation is that SCDOT thoroughly researches their current process to identify areas for improvement and actions that could be taken to streamline the process.

5.3. Category C – Performance Measurement and Accountability

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.

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/or 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.

Recommendations for SCDOT:

- Based on the review of the SCDOT documentation and feedback from Subject Matter Expert (SME) interviews, performance metrics at the project and departmental levels are absent and/or inconsistent. SMEs advised that they need to be expanded and consistently monitored.
- SCDOT should enhance the monitoring of performance metrics at the project and departmental levels consistent with the new PDP flowcharts.
- The agency should consider development of a performance dashboard to reinforce performance accountability.

5.4. Category D – Project Development Process (PDP)

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.

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.

Recommendations for SCDOT:

- None. SCDOT is currently taking steps to implement this Best Practice.

Best Practice #10: Development of a comprehensive Project Development Process (PDP) manual.

Key Findings:

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

Recommendations for SCDOT:

- SCDOT should develop a Project Development Process Manual for use/reference by internal managers and professional services consultants.

Best Practice #11: Establish and actively manage/monitor a project-level Critical Path Method (CPM) development schedule throughout the project development process.

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 software was effectively utilized to plan preconstruction activities.
- Only 30% of SCDOT's consultants thought that the agency's scheduling process/software was effectively utilized.

Recommendations for SCDOT:

- A consistent theme that surfaced during SCDOT SME interviews was that the current scheduling process and software is ineffective. The agency should reevaluate how CPM schedule is developed, who is responsible for the CPM schedule, and, more importantly, how the schedule is managed/monitored during the project development process.

5.5. Category E – Project Development Process Training

Best Practice #12: Development of a comprehensive Project Development Process training program to communicate and promote consistent project development execution for the agency.

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.

Recommendations for SCDOT:

- The agency should develop and implement formal Project Development Process Training for both internal project managers and external consultants. The development of a PDP Manual would support and enhance this effort.

CHAPTER 6: CONCLUSIONS AND DISCUSSION

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.

This research study utilized an Explanatory Sequential Design, as shown in Figure 3.1 (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. What follows is a brief description of conclusions supported by each phase of this research.

6.1. Conclusions: Phase 1 – Investigate SCDOT PDP and Consultants' Input

The knowledge gained and the lessons learned by the Steering Committee and the research team 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 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.

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:

6.1.1. 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.

6.1.2. 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.

6.2. Conclusions: Phase 2 – National State DOTs Input

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.

6.3. Conclusions: Phase 3 – Comparable State DOTs Input

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 4. A detailed description of the identified PDP Best Practices is discussed in Chapter 5.

6.4. Conclusions: Phase 4 – PDP Best Practices

This research phase 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 3.1).

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:

- Project Prioritization and Scope Definition Process
- Consultant Procurement and Management

- Performance Measurement and Accountability
- Project Development Process (PDP), and
- Project Development Process Training

The twelve PDP best practices identified, developed, and listed in this phase is 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.

REFERENCES

1. AASHTO. (2013). Practical guide to cost estimating. Washington, DC; 2013.
2. Alaska Department of Transportation and Public Facilities. (2020). Alaska Highway Preconstruction Manual.
3. Amekudzi, A., & Meyer, M. D. (2006). Considering the environment in transportation planning: Review of emerging paradigms and practice in the United States. *Journal of Urban Planning and Development*, *132*(1), 42-52.
4. Andrle, S., & Heilman, J. (2012). *Expedited Planning and Environmental Review of Highway Projects*. Transportation Research Board.
5. Ang-Olson, J., Crossett, J., Batista, A., & Choe, J. (2016). Environmental Performance Measures for State Departments of Transportation. *Transportation Research Record*, *2596*(1), 10-18.
6. Antoine, A. L., & Molenaar, K. R. (2016). Empirical Study of the State of the Practice in Alternative Technical Concepts in Highway Construction Projects. *Transportation Research Record*, *2573*(1), 143-148.
7. Baird, M. E., & Stammer Jr, R. E. (2000). Measuring the performance of state transportation agencies: three perspectives. *Transportation research record*, *1729*(1), 26-34.
8. Barberio, G., Barolsky, R., Culp, M., & Ritter, R. (2008). Using the planning and environment linkages umbrella approach to streamline transportation decision making. *Transportation Research Record*, *2058*(1), 1-6.
9. Barrella, E., Amekudzi, A. A., Meyer, M. D., Ross, C. L., & Turchetta, D. (2010). Best practices and common approaches for considering sustainability at US state transportation agencies. *Transportation research record*, *2174*(1), 10-18.
10. Bausman, D., Chowdhury, M., & Tupper, L. (2014). Best practices for procurement and management of professional services contracts. *Journal of Professional Issues in Engineering Education and Practice, 140*(3), 04013019.
11. Beaty, C., Ellis, D., Glover, B., & Stockton, B. (2016). *Assessing the costs attributed to project delay during project pre-construction stages* (No. Report 0-6806-FY15 WR# 3). Texas. Dept. of Transportation.
12. Bejleri, I., Roaza, R., Thomas, A., Turton, T., & Zwick, P. (2003). Florida's efficient transportation decision-making process: Laying the Technology Foundation. *Transportation research record*, *1859*(1), 19-28.
13. Berger, L. and I. Associates. (2005), NCHRP 25-25 Task 12: Design-build environmental compliance process and level of detail: Eight case studies, *American Association of State Highway and Transportation Officials (AASHTO)*, Standing Committee on the Environment.
14. Bingham, E., & Gibson Jr, G. E. (2017). Infrastructure project scope definition using project definition rating index. *Journal of management in engineering, 33*(2), 04016037.
15. Blanchard, B. A., Bohuslav, T. R., Schneider, C., Anderson, S., Schexnayder, C. J., DeWitt, S. D., ... & Sheffield, R. (2009). *Best practices in accelerated construction techniques* (No. NCHRP Project 20-68A).
16. Boadi, R. S., & Amekudzi, A. A. (2013). Risk-based corridor asset management: Applying multiattribute utility theory to manage multiple assets. *Transportation research record*, *2354*(1), 99-106.
17. Bochner, B., Perkinson, D., Zietsman, J., & Higgins, L. (2003). Expediting the Transportation Planning and Project Development Process to Meet Fast Paced Customer Requirements. *American Association of State Highway and Transportation Officials (AASHTO),* Standing Committee on Planning.

18. Breiman L, Cutler A, Liaw A, Wiener M. (2018). Package 'randomForest'. *University of California, Berkeley: Berkeley, CA, USA*. Retrieved July 6, 2019, from https://cran.r-project.org/web/packages/randomForest/randomForest.pdf

19. Bremmer, D., Cotton, K. C., & Hamilton, B. (2005). Emerging performance measurement responses to changing political pressures at state departments of transportation: practitioners' perspective. *Transportation research record*, *1924*(1), 175-183.

20. Brown, B. Z., & Marston, J. J. (1999). Tennessee Department of Transportation's Vision 2000: Reengineering the Project-Development Process. *Transportation research record*, *1659*(1), 129-140.

21. Caldas, C. H., Gibson, G. E., & Le, T. (2007). *TxDOT best practices model and implementation guide for advance planning risk analysis for transportation projects* (No. 0-5478-P2). Center for Transportation Research, University of Texas at Austin.

22. Caltrans (2018). Project Development Procedures Manual.

23. Cambridge Systematics, & Parsons Brinckerhoff. (2006). *Performance measures and targets for transportation asset management* (Vol. 551). Transportation Research Board.

24. Cochran, J. A., Crocker, J., Kingsley, G., & Wolfe, P. (2004). Best practices in consultant management at state departments of transportation. *Transportation research record*, *1885*(1), 42-47.

25. Compin, N. S. (2008). State DOT performance programs: From program development to strategic planning. *Intl Journal of Public Administration*, *31*(6), 616-638.

26. Cook, T. D., Campbell, D. T., & Day, A. (1979). *Quasi-experimentation: Design & analysis issues for field settings* (Vol. 351). Boston: Houghton Mifflin.

27. Cooper, D. R., & Schindler, P. S. (2008). *Business Research Methods*.© The McGraw− Hill Companies.

28. Covey Stephen, R., & Center, C. L. (1993). *The Seven Habits of Highly Effective People: Restoring the Character Ethic*. Business Library.

29. Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. Sage publications.

30. Crossett, J., & Oldham, S. (2005). Framework for measuring state transportation agency performance in context-sensitive solutions. *Transportation research record, 1904*(1), 84-92.

31. Daniel, R. (2018). *The Analytic Hierarchy Process: Advances in Research and Applications*. Nova Science Publishers, Inc.

32. De Corla-Souza, P., & Skaer, F. (2003). Mainstreaming pricing alternatives in the project development process. *Transportation research record*, *1859*(1), 1-8.

33. Delaware Department of Transportation (2015). Project Development Manual.

34. Devore, J. L., Farnum, N. R., & Doi, J. (2013). *Applied statistics for engineers and scientists*. Nelson Education.

35. Fay, B. (1996). *Contemporary philosophy of social science : a multicultural approach*. United Kingdom: Wiley.

36. Feigenbaum, B., Fields, M. G., & Purnell, S. (2019). 24th Annual Highway Report. *Reason Foundation, August*.

37. FHWA, F. L. H. (2007). Western Federal Lands Highway Division Project Development Process Flow Chart. Retrieved January 6, 2021, from https://flh.fhwa.dot.gov/resources/design/tools/wfl/process/

38. Fields, M. G., & Purnell, S. (2018). 23rd Annual Highway Report on the Performance of State Highway Systems. *Reason Foundation Policy Study*, (457).

39. Fischer, M., Ashcraft, H. W., Reed, D., & Khanzode, A. (2017). *Integrating project delivery*. John Wiley & Sons.

40. Florida Department of Transportation (2019). Project Management Webinar Series. Retrieved July 18, 2019, from https://www.fdot.gov/designsupport/pm/webinarseries.shtm

41. Flyvbjerg, B., Holm, M. S., & Buhl, S. (2002). Underestimating costs in public works projects: Error or lie?. *Journal of the American planning association*, *68*(3), 279-295.

42. Forman, E. H., & Gass, S. I. (2001). The analytic hierarchy process—an exposition. *Operations research*, *49*(4), 469-486.

43. Georgia Department of Transportation (2019). Project Development Process.

44. Gihring, C. K., & Greene, W. (2000). Washington state ferries: Performance measures and information support. *Transportation research record, 1704*(1), 93-99.

45. Gransberg, D. D., & Buitrago, M. E. V. (2002). Construction project performance metrics. *AACE International Transactions*, CS21.

46. Gransberg, D. D., Scheepbouwer, E., & Lopez del Puerto, C. (2017). Framework for objectively determining best practices for alternative contracting methods. *Transportation Research Record, 2630*(1), 51-58.

47. Hecht, H., & Niemeier, D. (2002). Evaluation of past audits of project development on California state highway system. *Transportation research record, 1817*(1), 1-10.

48. Henkel, T. A., Miller, H., Stevens, J., Orsbon, B., Larkin-Thomason, T., Lee, W. D., & Clash, T. W. (2010). *Best Practices In Managing STIPS, TIPS, And Metropolitan Transportation Plans In Response To Fiscal Constraints* (No. NCHRP Project 20-68A).

49. Highway, F. L. (2005). Project development and design manual (PDDM).

50. Hillis, D., Jones, J., & Ekern, D. (2016). *Executive Strategies to Deliver Practical Design* (No. NCHRP Project 20-24, Task 102).

51. Idaho Department of Transportation (2014). Roadway Design Manual.

52. Illinois Department of Transportation (2017). Illinois Bureau of Design and Environment Manual.

53. Iowa Department of Transportation (2013). Project Development Process Manual.

54. Jin, W., Haidary, T. A., Bausman, D. C., & Chowdhury, M. (2020). Evaluation of Project Development Process at State Transportation Agencies. *Transportation Research Record*, 0361198120971260.

55. Keck, D. (2010). *Accelerating Transportation Project and Program Delivery: Conception to Completion* (Vol. 662). Transportation Research Board.

56. Kenney, M., Farzaneh, M., & Prozzi, J. (2015). *Maintaining Project Consistency Throughout the Project Development Process* (No. 15-4732).

57. Kermanshachi, S., Anderson, S. D., Goodrum, P., & Taylor, T. R. (2017). Project scoping process model development to achieve on-time and on-budget delivery of highway projects. *Transportation Research Record, 2630*(1), 147-155.

58. Kermanshachi, S., Safapour, E., Anderson, S., Goodrum, P., Taylor, T., & Sadatsafavi, H. (2019). Development of multi-level scoping process framework for transportation infrastructure projects using IDEF modeling technique. In *Proceedings of Transportation Research Board 98th Annual Conference*.

59. Kraus, E., Quiroga, C., & Le, J. (2008). Development of a Tool for Utility Conflict Data Management in the Project Development Process. *Transportation Research Record, 2060*(1), 153-161.

60. Le, T., Caldas, C. H., Gibson Jr, G. E., & Thole, M. (2009). Assessing scope and managing risk in the highway project development process. *Journal of Construction Engineering and Management, 135*(9), 900-910.

61. Levy, S. M. (2018). *Project management in construction*. McGraw-Hill Education.

62. Louisiana Department of Transportation and Development (2013). Project Delivery Manual.

63. Mallett, W. J., & Luther, L. (2011, August). Accelerating Highway and Transit Project Delivery: Issues and Options for Congress. In *CRS Report for Congress* (No. R41947).

64. Malley, W. G., & Dusenbury, A. M. (2002). Tiered environmental studies in the national Environmental Policy Act process for highway projects. *Transportation research record*, *1792*(1), 101-108.

65. Mansfield, T. J., & Hartell, A. M. (2012). Institutionalizing sustainability at the level of state departments of transportation: Quantitative assessment of transportation sustainability plan quality. *Transportation research record*, *2271*(1), 9-18.

66. Maurer, L. K., Mansfield, T. J., Lane, L. B., & Hunkins, J. (2013). Blueprint for Sustainability: One Department of Transportation's Pursuit of Performance-Based Accountability. *Transportation research record*, *2357*(1), 13-23.

67. Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (Vol. 41). Sage publications.

68. McMinimee, J. C., Schaftlein, S., Warne, T. R., Detmer, S. S., Lester, M. C., Mroczka, G. F., ... & Yew, C. (2009). *Best practices in project delivery management* (No. NCHRP Project 20-68A).

69. Michaelson, D., & Stacks, D. W. (2011). Standardization in public relations measurement and evaluation. *Public Relations Journal*, *5*(2), 1-22.

70. Michigan Department of Transportation (2018). Preconstruction Process Documentation Manual.

71. Miller, J. S., & Evans, L. D. (2006). Centralized and decentralized multimodal statewide transportation planning: Survey of states. *Transportation research record*, *1981*(1), 60-67.

72. Minchin Jr, R. E., Li, X., Issa, R. R., & Vargas, G. G. (2013). Comparison of cost and time performance of design-build and design-bid-build delivery systems in Florida. *Journal of Construction Engineering and Management*, *139*(10), 04013007.

73. Molenaar, K. R. (2010). *Guidebook on risk analysis tools and management practices to control transportation project costs* (Vol. 658). Transportation Research Board.

74. Molenaar, K. R. (2010). *Guidebook on risk analysis tools and management practices to control transportation project costs* (Vol. 658). Transportation Research Board.

75. NEPA: Environmental Review Toolkit. (n.d.). Retrieved January 6, 2021, from https://www.environment.fhwa.dot.gov/nepa/nepa_projDev.aspx.

76. Neuman, T. R., Schwartz, M., Clark, L., Bednar, J., Forbes, D., Vomacka, D., ... & Abere, D. (2002). *A Guide to Best Practices for Achieving Context Sensitive Solutions (CD-ROM)* (No. CRP-CD-23).

77. New York Department of Transportation (2017). Project Development Manual.

78. Nlenanya, I., & Smadi, O. (2018). Risk Management and Data Needs: A State of the Practice Survey of State Highway Agencies. *Transportation Research Record*, *2672*(44), 55-61.

79. Odreman, G. J., & Hessami, A. R. (2018). *Project Scoping Process for Metropolitan Planning Organizations* (No. 18-03706).

80. Oehlert, G. W. (2010). *A first course in design and analysis of experiments*.

81. Ohio Department of Transportation (2018). The Project Development Process Manual.

82. Oregon Department of Transportation (2017). Project Delivery Guide.

83. Ozbek, M. E., Clevenger, C. M., & Fillion, A. C. (2012). Quantitative Decision-Making Framework to Evaluate Environmental Commitment Tracking Systems: Colorado Department of Transportation Case Study. *Transportation research record*, *2270*(1), 188-194.

84. Pagano, A. M., McNeil, S., & Ogard, E. (2005). Linking asset management to strategic planning processes: Best practices from state departments of transportation. *Transportation research record*, *1924*(1), 184-191.

85. Paiewonsky, L., DiPaolo, T. A., Bonsignore, R., Larkin, B., & Conklin, C. (2007). Mainstreaming context-sensitive design in Massachusetts: deployment of the new project development and design guide. *Transportation research record*, *2025*(1), 98-107.

86. Pandit, D. M., Kaushik, K., & Cirillo, C. (2019). Coupling National Performance Management Research Data Set and the Highway Performance Monitoring System Datasets on a Geospatial Level. *Transportation Research Record*, *2673*(4), 583-592.

87. Pei, Y. L., Amekudzi, A. A., Meyer, M. D., Barrella, E. M., & Ross, C. L. (2010). Performance measurement frameworks and development of effective sustainable transport strategies and indicators. *Transportation research record*, *2163*(1), 73-80.

88. Peterson, S., Braun, S., Salazar, J., & Balmaseda, M. S. (2017). *Accelerating Pre-construction Project Delivery* (No. 17-05044).

89. Pishdad-Bozorgi, P., & de la Garza, J. M. (2018). *Flash Tracking for Accelerated Project Delivery (APD)* (No. FHWA-GA-19-1621). Georgia. Dept. of Transportation. Office of Performance-Based Management and Research.

90. Popic, Z., & Moselhi, O. (2014). Project delivery systems selection for capital projects using the analytical hierarchy process and the analytical network process. In *Construction Research Congress 2014: Construction in a Global Network* (pp. 1339-1348).

91. Postma, S. S., Carlile, F., & Roberts, J. E. (1999). Use of best value selection process: Utah Department of transportation I-15 design-build Project. *Transportation research record*, *1654*(1), 171-180.

92. Ramsey, D. W., & El Asmar, M. (2015). Cost and Schedule Performance Benchmarks of US Transportation Public-Private Partnership Projects: Preliminary Results. *Transportation Research Record*, *2504*(1), 58-65.

93. Redd, L., & McDowell, T. (2013). Minimizing the Impacts of Cost and Revenue Uncertainties on Transportation Project Delivery. *Transportation research record*, *2346*(1), 56-62.

94. Ross, C. L., Hylton, P. J., & Lee, D. J. H. (2014). Megaregion planning: State of practice in metropolitan planning organizations and state departments of transportation. *Transportation Research Record*, *2453*(1), 171-177.

95. Rothblatt, D. N., & Colman, S. B. (2001). *Best practices in developing regional transportation plans* (No. FHWA/CA/OR-2001-27). Norman Y. Mineta International Institute for Surface Transportation Policy Studies.

96. Saaty, T. L. (1999). Fundamentals of the analytic network process. In *Proceedings of the 5th international symposium on the analytic hierarchy process* (pp. 12-14).

97. Saaty, T. L., & Vargas, L. G. (2013). Sensitivity analysis in the analytic hierarchy process. *Decision making with the analytic network process* (pp. 345-360). Springer, Boston, MA.

98. Saaty, T. L., & Vargas, L. G. (2013). The analytic network process. *Decision making with the analytic network process* (pp. 1-40). Springer, Boston, MA.

99. Samsami, R., Minchin, R. E., Tran, D., Tian, Y., Scott, S., D'Angelo, D., ... & Russell, J. (2019). *A Report on the NCHRP 10-99 Project Framework for Implementing Constructability Across the Entire Project Development Process: NEPA to Final Design* (No. 19-04686).

100. Santorella, G. (2017). Lean culture for the construction industry: Building responsible and committed project teams. Taylor & Francis.

101. Sayer, R. A. (1992). *Method in social science: A realist approach*. Psychology Press.

102. Schaufelberger, J. E. (2011). *Construction business management*. Pearson Higher Ed.

103. Selman, K., Khwaja, N., Machemehl, R. B., Motamed, M., & LaVaye, C. (2016). Evaluation of a Development Program for Transportation Engineers. *Transportation Research Record*, *2552*(1), 32-42.

104. Shalkowski, J. S. (1998). Mon/Fayette route 51 to Pittsburgh Transportation project: A success story in integrating congestion management system analysis, major investment study, and National Environmental Policy Act processes. *Transportation research record*, *1617*(1), 130-138.

105. Silver, C., & Lewins, A. (2014). *Using Software in Qualitative Research, a step-by-step guide, 2nd Ed.* Thousand Oaks, CA: SAGE Publications, Ltd.

106. Silverman, D. (2014). *Interpreting Qualitative Research (5th ed.)*. Thousand Oaks, CA: Sage Publications Ltd.

107. Singleton, Jr., R. A., & Straits, B. C. (2018). *Approaches to Social Research, 6th Edition.* New York, NY: Oxford University Press.

108. Skinner, N. T., & Delaney, D. J. (2008). Tennessee Environmental Procedures Manual: New Resource for Environmental Analysis and Documentation. *Transportation Research Record, 2058*(1), 7-14.

109. Smith, T. J., & Butler, M. (2005). Streamlining success of southeast Arkansas interstate 69 connector project: Integrating geographic information system and stakeholder involvement. *Transportation research record*, *1941*(1), 145-148.

110. Sonnenberg, A. H., Southworth, F., Meyer, M. D., & Comer, C. L. (2013). Statewide Multimodal Planning: Current Practice at State Departments of Transportation. *Transportation research record, 2397*(1), 1-10.

111. Sperling, E., & Ross, C. (2018). Strategically Aligning Capital Improvement Prioritization to Performance Goals. *Transportation Research Record, 2672*(51), 68-78.

112. The Louis Berger Group, Inc. (Ed.). (2005). Design-Build Environmental Compliance Process and Level of Detail: Eight Case Studies. Retrieved, January 6, 2021, from https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1548.

113. Tran, D. Q., Harper, C. M., Molenaar, K. R., Haddad, N. F., & Scholfield, M. M. (2013). Project delivery selection matrix for highway design and construction. *Transportation research record*, *2347*(1), 3-10.

114. Tran, D., Molenaar, K. R., & Gransberg, D. D. (2016). Implementing best-value procurement for design–bid–build highway projects. *Transportation Research Record*, *2573*(1), 26-33.

115. TransTech Management, Inc. (2004). *Performance Measures for Context Sensitive Solutions: A Guidebook for State DOTs*. Transportation Research Board.

116. U.S. Department of Transportation, Federal Highway Administration. (n.d.). NEPA | Environmental Review Toolkit | FHWA. Retrieved January 6, 2021, from https://www.environment.fhwa.dot.gov/nepa/nepa_projDev.aspx

117. U.S. Dept. of Transportation, Federal Highway Administration, Western Federal Lands Highway Division. (2018). Project development and design manual. Washington, DC. doi: https://flh.fhwa.dot.gov/resources/design/pddm/

118. Van Dyke, C., Gibson, B., Jasper, J., & Kreis, D. (2017). Review of Project Development Practices and Project Management Resources at State Transportation Agencies.

119. Venner, M. (2003). Measuring environmental performance at state transportation agencies. *Transportation research record*, *1859*(1), 9-18.

120. Venner, M., DeWit, M., Gibson, W., Concienne, R., Sanghavi, S., & Hunkins, J. (2007). Current Department of Transportation Environmental Management System Development Efforts: Examples from Construction, Maintenance, Project Development, and Planning. *Transportation research record*, *2011*(1), 1-10.

121. Vyas, M., Harris, J., Knowlton, T., LaBonty, G. J., Milam, R. T., Seager, S., ... & Zundel, L. (2018). Applying Innovative Performance Metrics for Corridor Evaluation. *Transportation Research Record*, *2672*(44), 93-102.

122. Wagner, J. (2013). Measuring performance of public engagement in transportation planning: three best principles. *Transportation research record*, *2397*(1), 38-44.

123. Wisconsin Department of Transportation (2019). Facilities Development Manual.

124. Wood, H. P., Kassoff, H., McGrath, T., Malley, W. G., Rose, D. C., & Skinner, N. (2011). *Guidance for managing NEPA-related and other risks in project delivery, Volume 1: Guide for managing NEPA-related and other risks in project delivery* (No. NCHRP Project 20-24).

125. Wood, H. P., Kassoff, H., McGrath, T., Malley, W. G., Rose, D. C., & Skinner, N. (2014). *Guidance for Managing NEPA-Related and Other Risks in Project Delivery, Volume 2: Expediting NEPA Decisions and Other Practitioner Strategies for Addressing High Risk Issues in Project Delivery* (No. NCHRP Project 20-24, Task 71).

126. Yin, R. K. (2017). *Case study research and applications: Design and methods*. Sage publications.

127. Zavadskas, E. K., & Turskis, Z. (2011). Multiple criteria decision making (MCDM) methods in economics: an overview. *Technological and economic development of economy*, *17*(2), 397-427.

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

SCDOT PDP Flowcharts Tasks and Subtasks

South Carolina Department of Transportation
Preconstruction Project Development Process

Tasks, Sub-Tasks & Resources
Based on SCDOT Workshop
09/09/19 & 09/10/19

Report Organization:

The PDP Tasks identified in this report summary pertain to the PDP for an EA/FONSI project. The Tasks are grouped by the following ten disciplines/themes: Planning, Design, Municipal Agreement, ROW, Environmental, Permitting, Utilities, Railroad, Traffic, and Letting.

Within each of the ten disciplines/themes:

- The Tasks and their respective Sub-tasks are identified along with the relevant reference resources.

Prepared by Clemson Research Team 9/16/19

Planning (Tasks & Sub-Tasks)

The Department has developed two processes to develop the scope and fees for upcoming projects: Feasibility Reports and Project Definition Reports (PDR). Both processes will begin by establishing a PL phase of work to allow the project team to develop a scope of work and cost estimate for the project. Feasibility Reports will be managed by Planning, and PDRs will be managed by the Regional Production Group (RPG) that will ultimately manage the project. The RPG's, Planning, and the MPO/COG will collectively determine the process that will be utilized to develop the scope of work and cost estimate prior to the project being added to the Transportation Improvement Plan (TIP).

Planning Process to Initiate a Project

TIP

- MPO/COG identifies project from LRTP to begin the project development process for guideshare projects only.
- SCDOT will identify projects to begin the project development process for all state and federally funded non guideshare projects.
- Planning submits cost and schedule for a PL phase of work to MPO/COG to be added to the TIP

The MPO/COG adds the Project to the TIP and sends notification (transmittal) to the SCDOT Regional Planner to add the project to the STIP.

Resources:

STIP

Sub-Tasks:

- After receiving the transmittal, planning to ensure dates and funding in the TIP align with the proposed schedule and cost estimate for the PL phase of work.
- Commission Approves the Project
- SCDOT Regional Planner inputs the Project into the STIP

Resources:

- Planning PPT
- Planning intranet site has an extensive amount of resources:
    - STIP/TIP Transmittal Document

Program PL Funds (P2S)

- After the project is added to the STIP, PM programs the PL phase of work into P2S
- FHWA Authorization and Charge Code created

Feasibility Report

Sub-Tasks:

- FRM to initiate feasibility report process
- PM and Design to provide assistance as outlined in the roles and responsibilities chart.

Resources

- Draft Feasibility Report Process
- Roles and Responsibilities Chart
- Risks for FR Meetings (Planning's Intranet Site)

TIP/STIP

Sub-Tasks:

- Based on the results of the Feasibility Report, Planning submits cost and schedule of the project to the MPO/COG to be added to the TIP.
- The MPO/COG adds the funding for the remaining phases of work to the TIP and sends notification (transmittal) to the SCDOT Regional Planner to add the remaining phases of work to the STIP.
- Planning to coordinate with PM to ensure dates and funding align with schedule and cost estimate
- Commission approves the additional phases of work for the project.
- Planning adds new phases of work to the STIP

Program PE/ROW/Constr. Funds (P2S)

Sub-Tasks:

- Once funding is in the STIP the PM to program funding for remaining phases of work in P2S
- PM to ensure obligations coincide with STIP
- PM to identify needed agreements (IGA, FPA, etc.), if applicable

Resources:

- P2S guidelines

PE Funding Approval

Sub-Tasks:

- PM to verify that funding is authorized and notify PDT to begin design efforts.

RPG Kickoff

- RPG Kickoff marks the transition of a project from the planning phase to the preliminary engineering phase of the project.

RPG Project Definition Report Process

TIP

- MPO/COG identifies project from LRTP to begin the project development process for guideshare projects only.
- SCDOT will identify projects to begin the project development process for all state and federally funded non guideshare projects.
- RPG (and PM) to determine if Planning phase is needed. If PL funding is necessary, PM provides MPO/COG cost and schedule for PL phase to be added to the TIP. If a Planning phase is not necessary, PM will submit cost and schedule to MPO/COG for all phases of work to be added to the TIP
- The MPO/COG adds the Project to the TIP and sends notification (transmittal) to the SCDOT Regional Planner to add the project to the STIP

STIP

Sub-Tasks:

- After receiving the transmittal, Planning coordinates with PM to ensure dates and funding in the TIP align with the proposed schedule and cost estimate for the PL phase of work.
- Commission Approves the Project
- Planner inputs the Project into STIP

Resources:

- Copy of Transmittal

Program PL Funds (P2S)

- PM programs PL phase of the project into P2S
- FHWA Authorization and Charge Code created

Project Definition Report (PDR)

Sub-Tasks:

- PM leads/coordinates the PDT for development of a Project Definition Report (PDR)
- The PM/RPG will establish a Project Development Team (PDT) and notify the participants of project ID and charge code
- PM to obtain traffic data and accident history
- ESO to perform GIS screening of area
- PM to schedule the scoping meeting and ensure critical staff are in attendance
- PM to hold scoping meeting and completed PDR form
- PM to prepare and distribute PDR to PDT for review and comment.
- Once the PDR has been finalized, PM to provide the MPO/COG the cost and schedule for the remaining phases of work to be added to the TIP

Resources:

- Traffic data request form
- Accident request form
- Project Development Report
- 811 ticket, utilities located prior to scoping
- Project Screening Tool (PST)

TIP/STIP

Sub-Tasks:

- MPO/COG submits transmittal to Planning
- Planning coordinated with PM to ensure submittal aligns with schedule and cost estimate
- Planner inputs the Project into STIP

Resources:

- Planning PPT
- Copy of Transmittal
- Planning intranet site has an extensive amount of resources:
    - STIP/TIP Transmittal Document

Program PE/ROW/Constr. Funds (P2S)

Sub-Tasks:

- Once funding is in the STIP the PM to program funding for remaining phases of work in P2S
- PM to ensure obligations coincide with STIP
- PM to identify needed agreements (IGA, FPA, etc.), if applicable

Resources:

- P2S guidelines

PE Funding Approval

Sub-Tasks:

- PM to verify that funding is authorized and notify PDT to begin design efforts.

RPG Kickoff

- RPG Kickoff marks the transition from the planning phase to the preliminary engineering phase of the project.

Design (Tasks & Sub-Tasks)

Advertise Eminent Domain

Sub-Tasks:

- PM prepares project specific portion of Eminent Domain (ED) ad and submits with charge code information to RPG administration for advertisement in a local newspaper with general distribution in the project area.

Resources:

- Copy of ED ad

Procure Design Consultant (if needed)

Sub-Tasks:

- PM to request professional services office to add project to tentative ad list
- PM to develop preliminary scope and fee for the requested contract.
- PM to complete Package A for Turnkey Advertisement or Form 1 for On Call and Small Purchase Contracts and submit along with scope and fee to the professional services office
- If other departments need consultant contracts (ESO, SUE, Utility Coordination, ROW, etc.) they should begin that process as needed
- In direct coordination with the professional services office, advertise, select, negotiate & execute contract with consultant

Resources:

- Package A, Fee Template
- Contract Modification/task order request form (Form 1, Form 2)
- Contract Manager On-line Training
- SCDOT Procurement Manual

Surveys/SUE

Sub-Tasks:

- The PM initiates the Designer to prepare the survey and Subsurface Utility Engineering (SUE) request and submit both to the Surveys Office
    - Review utilities and preliminary alignment alternatives with Utilities to determine SUE recommendations

    - Coordinate with ESO for wetland boundaries
    - Request RR and VAL Maps simultaneously with survey requests via survey request form
- Once the survey(s) is completed, the Surveys Office submits the survey information to RPG and Environmental Services Office (ESO)

Resources:

- Survey Request Form

Conceptual Design

- Prepare conceptual roadway plans to include horizontal and vertical alignment and typical sections to generate the project's construction limits

DFR Plan Development

Sub-Tasks:

- PM/Design distributes preliminary DFR plans for review to the project team and stakeholders.
- PM and Design to discuss potential design exceptions and variances and initiate preliminary discussions with SCDOT Support if needed.
- If necessary, PM/Design to distribute to SCDOT support for Quality Assurance (QA) design criteria, etc.
- PM/Design to prepare revised cost estimate
- PM and Design need to consider VE study if required (See ED-34)

Resources:

- ED-34

Pavement Design

Sub-Tasks:

- Design prepares and submits request for pavement design to SCDOT Pavement Design Engineer

Resources:

- Pavement Design PPT
- Pavement Design Request Form

Design Field Review

Sub-Tasks:

- PM should consider if the project Draft Interstate Access Request (IAR) is required
- PM should coordinate date for DFR to ensure all critical SCDOT staff attends.
- PM schedules DFR meeting and provides pdf plans (provided by Design) to attendees prior to meeting
- PM should consider inviting any critical Utility Companies to the DFR so that any impacts can be considered during the review.
- PM should prepare a list of discussion items before the meeting to ensure all critical items are covered.
- PM to coordinate with ROW to see if all ROW will be acquired in Fee Simple or if there are other options.
- PM and Design to coordinate with ROW if there are plan revisions (ex: retaining walls, alignment revisions, etc.) that need to be evaluated due to ROW impacts.
- Identify design variances and/or design exceptions and initiate documentation
- PM should take notes during the meeting and provide meeting minutes to attendees
- PM should provide attendee sign-in sheet to get contact information for distribution of the meeting minutes
- PM should follow up with any critical groups that did not attend the meeting.
- VE Study (if applicable) should be initiated

Resources:

- SCDOT to develop the list people that should be invited to the DFR

ROW Plan Development

Sub-Tasks:

- PM, Design and other SCDOT staff as needed analyze written comments from DFR plans and comments received at DFR to determine what revisions will be made.
- PM and Design to review and revise cost estimate and schedule based on preferred alternatives. Ensure P2S and STIP align with any revisions.
- RR coordination is continued through this process if needed.
- PM ensures that Design provides plans, cross sections, pavement design, typical sections, etc. to Traffic to begin preparation of MOT, P/M and Signals plans.
- PM ensures that Design prepares a preliminary geotechnical investigation and report (PGER)
- PM ensures that Design prepares a preliminary Hydraulic Design Report
- PM ensures that Design provides completed right of way plans to the Utilities Office and District Office to initiate final utility coordination and final railroad coordination, as necessary

- PM ensures that Design provides guidance on construction access needs and ensure all construction activities can occur in permitted areas

ROW Plan QC/QA

Sub-Tasks:

- PM to ensure proper QC has been done by Design Team prior to QA review
- PM and Design reviews plans 4 months prior to ROW obligation and plans are revised accordingly
- PM or Design submits revised plans and applicable reports for review and comment to Support, RCE, HQ ROW, District ROW, ESO, Utilities, and DCE for review 3 months prior to ROW obligation
- PM to ensure all comments are addressed/resolved
- PM to review and revise, as necessary, the project schedule
- Ensure documentation is completed for design variances and design exceptions.

Resources:

- PCDM-4
- QC Checklist

Identify Special Provisions

Sub-Tasks:

- PM coordinates with Design, Utilities, ESO, and ROW to ensure special provisions are identified
- Ensure that the district construction engineer, RCE, and headquarters construction review any special provisions to confirm that the specifications will be clear to a contractor and enforceable by the construction engineer.

Resources:

Construction Plan Development

Sub-Tasks:

- Design staff finalizes plan development and calculates quantities
- PM/Design staff to obtain inclusions from RCE
- PM to obtain moving items and removal/disposal items from District ROW

Construction Field Review

Sub-Tasks:

- PM, Design and RCE to determine if a construction field review meeting on the project site is required.
- PM to coordinate with the Environmental Office to confirm that all environmental commitments are addressed in the plans and specifications.
- PM to coordinate with HQ Traffic Engineering and District to ensure traffic requirements are addressed in the documents.
- Construction (Headquarters & District) to examine the construction plans for completeness with emphasis on the estimated quantities.

Construction Plans QC/QA

Sub-Tasks:

- PM to ensure proper QC has been done by Design Team one month prior to QA review
- PM and Design to initial the documents and submit to Support for QA review
- PM to refer to PCDM-15 for submittal dates for Support to perform QA review

Resources:

- PCDM-15 (Obligations Chart)
- QC checklist

Finalize Special Provisions

Sub-Tasks:

- PM to ensure Project-Specific Special Provisions are gathered for submittal to the letting prep.
- PM to coordinate with Operations staff for historical sample special provisions if necessary.

Resources:

- Plan submittal checklist

Construction Plans Completed

Sub-Tasks:

- PM to ensure the QC/QA comments are addressed and plans are initialed by Support
- PM to ensure distribution of final construction plans to project team as needed
- PM to ensure that quantities are entered in P2S (including landscaping and moving items)

PS&E Package

Sub-Tasks:

- Submit PS&E package to Operations in accordance to the PCDM-15 and PCDM-18
- PM to verify that funding is available based on the Engineer's estimate (see PCDM-15 for distribution date)
- PM to attend Pre-Let meeting or communicate with Contract Administration office to confirm project status.
- PM & RCE to review proposal

Resources:

- PCDM-15 (Obligations Chart), PCDM-18
- STIP

Construction Authorization

Sub-Tasks:

- PM to attend let review meeting and report on funding status.
- If bid is approved, then, will adjust funding authorization in P2S

Resources:

Municipal Agreement

Municipal Agreement

Sub-Tasks:

- PM to identify municipality or stakeholder maintenance items that need agreements
- PM provides letter, copy of preliminary plans, and Municipal Agreement to Municipality for authorization
- PM delivers original executed Municipal Agreement to ROW Office

Resources:

- Municipal Agreement Template (ROW form)

R/W

ROW Acquisition Estimate

Sub-Tasks:

- PM submits final signed ROW plans to Operations two months prior to ROW obligation date.
- Headquarters ROW will provide ROW estimate to PM for concurrence.
- PM ensures there is adequate funding to cover the estimate prior to providing concurrence.

ROW Authorization

Sub-Tasks:

- PM to ensure NEPA document is approved on all federally funded project prior to ROW authorization.
- PM to check overall project budget and revised construction estimates as necessary
- Ensure final ROW plans are provided to Utility and RR coordinators for coordination and Update Stakeholders and Sponsors.

ROW Acquisition

Sub-Tasks:

- PM provides assistance to the ROW agents as needed during acquisition to explain project plans, consider ROW revisions to the plans, or other options.
- PM serves as agency witness in the event of any depositions or condemnations.
- PM Coordinates with Design on all ROW revisions and submitted revised sheets to Operation according to PCDM 18

Resources:

- ROW Acquisition Manual
- PCDM 18

ROW Certification

Sub-Tasks:

- PM to ensure plans are submitted to R/W for certification on all federally funded projects that do not require any R/W
- The Right of Way Office is responsible for providing the Right of Way Certification to FHWA, Program Manager, Obligation Management and Director of Construction Office two months prior to letting

Resources:

- Certification Example

Environmental

Environmental Field Studies

Sub-Tasks:

- PM coordinates with ESO to provide necessary documentation to initiate NEPA studies

Public Involvement Plan

Sub-Tasks:

- PM coordinates with ESO to prepare Public Involvement Plan

Resources:

- Public Involvement Policy

Identify and Screen Preliminary NEPA Alternatives

Sub-Tasks:

- PM, Design, ESO and other SCDOT departments/staff as necessary to discuss alternative alignments and impacts.
- PM to coordinate review and comment of the screening for alternative alignments with members of the project team and provide comments to ESO and Design
- Project team to determine alternative(s) cost and schedule

Identify and Analyze NEPA Reasonable Alternatives

Sub-Tasks:

- Project team to evaluate NEPA Alternatives via impact matrix
- Project team identifies Preferred NEPA alternative

Resources:

Public Information Meeting

Sub-Tasks:

- PM to coordinate with ESO to set up Public Information Meeting (PIM).

- PM to provide Public Involvement Coordinator the necessary information to create a project website.
- PM to coordinate with ESO and the Designer to prepare displays.
- ESO will provide posting requirements for PIM notifications/communications which may include ads, mailers, signage, website, etc.
- PM is responsible to acquire a meeting location and arrange for law enforcement personnel to be present at the PIM for security.
- PM to ensure that the necessary personnel are present for the PIM
- PM to submit first bridge letter for bridge replacement projects requiring detours according to EDM 36
- The PM is responsible to ensure responses are provided to public information comments and to determine the feasibility of revising plans to address public comments.

Resources:

- Public Involvement Policy (Need a Copy of latest Draft)
- EDM 36

NEPA Alternative Analysis

Sub-Tasks:

- The ESO is responsible to coordinate with regulatory agencies and the PM support ESO's efforts as needed.
- PM to initiate a meeting(s) with Design and ESO to evaluate the design alternatives and assess their human and environmental impact. The Team will:
    - Identify design alternatives
    - Evaluate the NEPA alternatives via the impact matrix.
    - Select the potential preferred alternative on which to advance design
- Once preferred alternative is selected ESO will prepare the environmental document

Resources:

- NEPA process
- Environmental Services Tool Shed https://www.scdot.org/business/environmental-toolshed.aspx

EA (Signed)

Sub-Tasks

- ESO is responsible to distribute environmental document to the PM and FHWA for review and comment

- ESO is responsible for revising the environmental document, as necessary, and submitting the document for FHWA's approval (with notification to PM of submission)
- ESO is responsible for distributing a copy of the approved environmental document to the Program Manager
- If an IAR (IJR or IMR) is required, approval of EA and IAR will coincide

Public Hearing

Sub-Tasks:

- PM to coordinate with ESO to set up Public Hearing.
- PM to work with ESO and the Designer to prepare displays.
- ESO will provide posting requirements for Public Hearing notifications/communications which may include ads, mailers, signage, website, etc.
- PM is responsible for acquiring a location and arranging for law enforcement personnel to be present at the Public Hearing for security.
- PM to ensure that a court reporter (stenographer) is present to record the Public Hearing
- PM to ensure that the necessary personnel are present for the Hearing.
- PM is responsible for provided presentation at the Public Hearing.
- The PM is responsible for ensuring responses are provided to public hearing comments and determining the feasibility of revising plans to address public comments.

Resources:

- Public Involvement Policy (Need a Copy of latest Draft)

FONSI (signed)

Sub-Tasks:

- ESO is to review with the PM any project changes that may have occurred since document approval, prepare the FONSI request, prepare public hearing certification package and submit documentation to FHWA.
- If the project requires FHWA approval of an Interstate Access Request (IAR) the approval must be obtained prior to submission of the FONSI.
- ESO is to provide a copy of the approved NEPA Document (Environmental Commitments Form included in NEPA document) & FONSI to Program Manager
- If necessary, the PM is responsible to coordinate with ESO and prepare project-specific portion of advertisement that the FONSI is approved
- ESO is responsible to complete the preparation of the advertisement and submit appropriately
- The PM is responsible to receive approved IAR [Interchange Modification Report (IMR) or Interchange Justification Report (IJR) from FHWA].

EA FONSI Review (for Re-Eval)

Sub-Tasks:

- The PM initiates ESO and Designer document review to ensure that nothing significant has changed during project development and that no action is necessary.
- The PM to ensure environmental commitments are addressed.

Permitting

Jurisdictional Determination

Sub-Tasks:

- ESO Permit Coordinator to initiate the JD, if required.
- ESO to advise the PM of any changes to JD.
- PM is to verify information in the CORPs letter is incorporated into the project.
- PM needs to confirm that the wetlands lines are acceptable.
- ESO to provide approved JD and any modifications to PM

Conceptual Mitigation Plan

Sub-Tasks:

- PM to coordinate with ESO to ensure that permit strategy and cost are accounted for in a project budget and schedule

Permit Application

Sub-Tasks:

- PM to coordinate with Design, ESO, Utilities and Traffic to determine that all needs are identified prior to environmental permit application submission
- The Environmental Office is responsible to prepare, submit, and coordinate necessary water quality permit, USACOE permit(s), navigable waters permit, and OCRM permit
- Design is responsible to prepare, submit, and coordinate NOI/SWPP package.

Permit Approval

Sub-Tasks:

- ESO to follow for Permit Approval (and provides a copy PM)

Permit Compliance Review

Sub-Tasks:

- PM provides final plans and special provisions to ESO to initiate Compliance review.
- PM ensures ESO comments are incorporated in Final Plans.

NOI (Stormwater)

Sub-Tasks:

- PM ensures signed NOI and sealed plans are provided to headquarters construction office

Resources:

- Copy of NOI

Utilities

Utility Notification Letter

Sub-Tasks:

- PM to ensure that the Utility Coordinator issues letter to utilities.
- PM must notify the Utility office to send the letter and indicate who will be performing utility coordination (Consultant or District).

Resources:

- Example Utility Notification Letter

Early Utility Coordination

Sub-Tasks:

- Utility Coordinator to meet with utility companies, discussing preliminary costs, schedule, large or small wet utilities, trying to determine each utility design criteria, help assist in SUE decisions, and coordinate the information received with PM and Design.

Resources:

- Utility Accommodations Manual
- Utility Conflict Matrix

Preliminary Utility Coordination/Conflict Avoidance

Sub-Tasks:

- PM to ensure that the Utility Coordinator meets and reviews preliminary ROW plans with utility companies to ensure all utility needs are accounted for. Need determination from utilities if they will be included in SCDOT permit, ROW needs, etc.
- PM to ensure that the Utility Coordinator discusses potential conflicts and options for resolution or conflict avoidance. Need to discuss timelines moving forward and get preliminary determinations of costs and utility company timelines. Need to determine whether any utilities require early relocation work (such as transmission with long lead times).

Resources:

- SCDOT Utility Accommodations Manual

- Utility Conflict Matrix

Preliminary Utility Report

Sub-Tasks:

- PM to ensures Utility Coordinator prepares and distributes Preliminary Utility Report to project team.
- Utilities to identify in-contract relocations details for R/W and Permitting (company, alignment, construction means and methods)

Resources:

- Utility Accommodations Policy

Final Utility Coordination

Sub-Tasks:

- The PM to ensure the Utility Coordinator initiates final utility coordination, as necessary. Informs utility companies of permitting responsibilities and obtain relocation plans from utility companies that intend to be included in SCDOT's letting package for environmental permit review
- The PM to ensure the Utility Coordinator has determined whether a utility window is needed in the construction contract
- The PM provides utility coordinator all project information regarding any aspects of the project that penetrate the ground level that could cause utility conflict.
- Utility to confirm all utilities in the Utility Coordination Matrix as no conflict, no cost, or UA in order to plan final budgets and schedules

Resources:

- Utility Accommodations Manual
- Utility Coordination Training Manual

Final Utility Agreements & Report

Sub-Tasks:

- PM to receive and distribute Final Utility Report to project team.
- PM ensures Final Utilities Agreements and Reports are submitted to the District Utility Coordinator and the Utilities Office for review and approval six months prior to construction letting

- Ensure that all in-contract utility relocations packages and/or special provisions are included in the project proposal.
- The PM to ensure that the District Office uploads all Utility Agreements to ProjectWise for Financial Analyst access.

Utility Certification

Sub-Tasks:

- PM ensures that utility coordination has been completed.
- PM completes the railroad portion of the utility and railroad certification and submits for state utilities engineer's signature.

Resources:

- Instructions for Completing and Filing a Certification of Utility and Railroad Coordination for Federally Funded Projects
- Railroad and utility certification form

Railroad

Initiate RR Coordination & Val Maps

Sub-Tasks:

- PM to request VAL Maps simultaneously with survey requests via survey request form
- The PM to initiate project coordination with RR Office

Resources:

- Railroad Project Process

Finalize RR PE Agreement

Sub-Tasks:

- The RR/Utility office coordinates, negotiates and executes the PE agreement
- RR Office to submit application, fees, and insurance requirements to RR for approval 60 days prior to conducting surveys or borings on RR ROW

Resources:

- Utility Accommodation Policy

RR Construction Agreement Coordination

Sub-Tasks:

- The PM submits the preliminary construction plans to RR Office

Resources:

- Utility Accommodation Policy

Sub-Tasks:

- The PM ensures the RR comments are addressed in plans/specs
- The RR/Utility office coordinates, negotiates and executes the construction agreement
- The PM programs/adjusts RR construction phase in P2S in accordance with construction agreement

RR Certification

Sub-Tasks:

- PM ensures that RR coordination has been completed.
- PM completes a portion of the RR certification and submits the form to the utility's office for execution.
- The PM submits final plans to utility office for distribution to railroad.

Resources:

- Railroad and utility certification form

Traffic

Traffic Analysis (counts/crashes/concept/MOT)

Sub-Tasks:

- PM and Designer need to request traffic counts, crashes, concept MOT (ex: temporary bridge or retaining walls, detours, etc.), pavement loading or any additional analysis needed from Traffic.
- Request traffic study from Traffic Engineering (TE), if necessary
- PM and Traffic to determine if the project requires Traffic to develop an Interstate Access Request (IAR). If required, it must be submitted prior to FHWA approval of the EA

Resources:

Traffic Signal ROW Blockouts

Sub-Tasks:

- Traffic to provide conceptual signing and traffic signal/ITS info as related to ROW – PM and Design to coordinate with Traffic

Traffic Engineering Plans (MOT, P/M, Signals)

Sub-Tasks:

- Traffic to Provide completed pavement marking, signing, traffic signal and ITS plans, TMP, special provisions and updated staging plans (work zone) as necessary to Design Manager
- Traffic or District to provide detour and signing plans

Letting

Construction Advertisement

Sub-Tasks:

- Once construction funds are authorized by FHWA, the construction advertisement is posted by the Construction Administrator's office.
- PM is to provide attendee list to Contract Administrator if there is a mandatory pre-bid conference

Resources:

- PCDM – 15 (Obligation Chart)

Letting/Bids Received

Sub-Tasks:

- PMs can attend the Letting in the Contract Administrator's office or view the "Apparent Low Bid" Information on the SCDOT Construction Extranet.
- PM to ensure adequate funding is available to cover the low bid, contingencies, and E&I and be prepared to report the status at the construction bid review meeting

Resources:

- SCDOT Construction Extranet
- AASHTOWare Project (formerly Transport)
- PCDM – 15 (Obligation Chart)
- FHWA guidelines on evaluation of bids

Construction Bid Review Meeting

Sub-Tasks:

- PM to attend and provide input regarding award recommendations (including funding status)
- PM to coordinate with Utility Engineer to ensure that all in-contract utility work has concurrence for award from the Utility Company.

Resources:

Construction Contract Award

Sub-Tasks:

- Bid information is evaluated by the Bid review committee to compare bids to the Engineer's Estimate and other competitive bids.
- Award Letters are issued by the Director of Construction's office, if the bid meets the criteria for award.
- PM to notify project sponsor(s) of award

Resources:

- Bid Reviews and Recommendations Leading to Contract Award and Execution

Construction Support

Sub-Tasks:

- PM to monitor project progress and budget throughout construction
- PM or Designer to submit Construction Revisions to Operations.

Resources:

- PCDM - 18

APPENDIX C

MAPPING THE PRECONSTRUCTION PROJECT DEVELOPMENT PROCESS FOR TRANSPORTATION PROJECTS

Tanin A. Haidary
Ph.D. Candidate
Clemson University
Department of Construction Science and Management
Clemson, SC 29634 Tel: (864)-624-6216
Email: thaidar@g.clemson.edu

Dennis C. Bausman, Ph.D., FAIC, CPC
Constructor Certification Commission
Professor and CSM Endowed Faculty Chair
Clemson University
2-133 Lee Hall, Clemson, SC 29634
Tel: (864)-656-3919
Email: dennisb@clemson.edu

Ajay S. Jadhav
Ph.D. Candidate
Clemson University
Department of Construction Science and Management
Clemson, SC 29634 Tel: (864)-482-8836
Email: asjadha@g.clemson.edu

Mashrur Chowdhury, Ph.D., P.E., F.ASCE
Eugene Douglas Mays Endowed Professor of Transportation and
Professor of Automotive Engineering
Clemson University
Glenn Department of Civil Engineering
216 Lowry Hall, Clemson, SC 29634
Tel: (864) 656-3313 Fax: (864) 656-2670
Email: mac@clemson.edu

Word count: 4,279 words text + 1 table x 250 words = 4,529 words

ABSTRACT

Project Development Process (PDP) is crucial for any state DOT to effectively meet its state transportation needs. Infrastructure projects are often complex and can pose significant challenges, including an incomplete and changing project scope, environmental and permitting requirements, and incomplete or inconsistent development processes. This challenge often results in project delay and an increase in cost. This paper focuses on the methodology to investigate and map an agency's preconstruction PDP activities and development sequence to document current practices. It provides guidance to determine key PDP tasks, sub-tasks, and activity sequence for the agency's various program/project type and funding source(s). The research team developed a five-step methodology to guide the mapping process of PDP. The initial step for the case study 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 topics of inquiry were then used to guide interviews with the Subject Matter Experts (SME) from departments and/or functional units of the state DOT serving as the focus of this case 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 DOT leadership team. After incorporating the input from the workshop, the research team mapped PDP flowcharts for the case study DOT based on program/project type, funding source, and environmental requirements.

Keywords: Project Development Process, Process Mapping, PDP Flowcharts, Infrastructure Development Process

INTRODUCTION

In the United States, federal, state, and local governments are responsible for addressing the infrastructure needs of their citizens. State and local governments often receive federal aid to assist states and local agencies with the funding of transportation infrastructure, including highways, bridges, and roadways. Federal funding accounts for 60% of all capital expenditures on infrastructure and 90% of the operational cost to maintain roadways *(1)*. State Transportation Agencies (STA) 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 *(2)*.

Moss et al. *(3)* define transportation project development as "the process to take a transportation improvement from concept through construction." The Project Development Process (PDP) includes planning, organizing, coordinating, and controlling resources to meet specific goals. It has six phases; initiation, definition, design, development, implementation, and follow-up. Virginia DOT (VDOT) similarly 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 development process, from initial planning to final commissioning *(4)*.

Historically, transportation planning and engineering have been a cost-conscious, flexible, forward-thinking, and innovative discipline that has led STAs to the construction of robust transportation systems *(5)*. 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, construction, and operation of transportation infrastructure *(6)*. 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 *(5).*

The 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 that is to be implemented *(7)*. Federal guidance or directives have a substantial influence on DOT activities, especially in the PDP *(8)*. According to Hecht & Niemeier *(9)*, state and federal acts, policies, and regulations significantly influence the PDP timeline.

Of primary concern for the Federal Highway Administration (FHWA), and the nation is the protection of the environment. The National Environment Policy Act (NEPA) *(10)* and a continuing amendment to this Act establish the national environmental policy. Essentially, 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.

In project development, three basic classes of action and documentation are required to address federal environmental requirements. The federal NEPA classifications are Environmental Impact Statement (EIS), Environmental Assessment (EA), and Categorical Exclusion (CE).

Environmental Impact Statement (EIS) is for projects that significantly impact the environment. An EIS requires the development of a full disclosure document that: a) describes the PDP, b) develops and presents the range of reasonable alternatives for the transportation project, and c) provides a detailed analysis of the potential impacts of each alternative for the project. Projects requiring an EIS are typically large, complex projects with a substantial impact on the environment, and typically the timeframe for development of the period is significantly longer.

Projects viewed as likely to have no significant impact on the environment may qualify for conducting only an EA. With an EA, the state DOT must provide sufficient evidence and analysis for the preparation of an environmental assessment that supports the finding. If the assessment determines the project to have significant impact(s), an EIS must be prepared. However, if the assessment determines there are no significant impact(s) associated with the project, a Finding of No Significant Impact (FONSI) is prepared for approval by the FHWA. If the EA FONSI is approved, the PDP can proceed in a fashion similar to one designated as a CE.

Categorical Exclusion (CE) is defined as "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, people, nature, cultural, historical, and/or recreational resources. In addition, CE actions do not cause a significant impact on air, noise, or water quality. As a result, projects classified as Categorical Exclusion are not required to complete the comprehensive environmental assessment of an EA FONSI or address the extensive environmental regulations and mitigation requirements of an EIS.

The FHWA's PDP flowchart *(11) (Appendix A)* outlines the development process and the state or local development team's interaction with federal authorities during the PDP for all three environmental classifications. Since many infrastructure projects are fully or partially funded by the federal government, the FHWA flowchart typically serves as the foundation for the project development flowchart of individual state DOT and local transportation projects.

STAs are under growing pressure to deliver projects in a timely manner, cost-effectively, and to improve the performance of their programs and projects to meet the needs of constituents *(12,13)*. The pressure is due to high demand, environmental policies, limited funding and revenue sources, stakeholder concerns, federal and state policies, and intense public interest and involvement *(13)*. The planning, design, environmental stewardship, and construction of highway projects are complicated, complex, and contingent on uncertainties that result in the difficulty of accurately predicting project performance *(14)*.

Due to rising demand and pressure to reduce the time of project delivery, STAs are seeking initiatives to deliver projects as efficiently and expeditiously as possible *(13)*. Many initiatives have been designed to streamline the practices and processes used in delivering the projects efficiently and timely. Hillis et al. *(5)* list these initiatives in their study, which include expanding the modal solutions, increasing public involvement, streamlining the 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, STAs are challenged to find a balance among the uncertainties of community, project development, environmental compatibility, project scoping, unidentified risks, and fiscal constraints *(5,14)*.

STAs have initiated different programs to tackle increasing pressure and achieve a balance among project uncertainties *(5)*. 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. Many State DOTs have failed to improve their PDP due to other management priorities such as funding, labor issues, maintenance, and public relations *(4)*. The PDP is strategically crucial for highway projects because it encourages comprehensive planning of project phases and aids in the selection of the most appropriate projects *(14)*. 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 *(11,14)*.

Considering the rising need for all STAs to have an effective and efficient PDP, this paper presents the research methodology and findings of a case study for a STA that investigated and documented current practice. This effort serves as a prelude to updating and streamlining a STA's PDP. The actual case study that provides the foundation for this paper is focused on one State DOT. However, the methodology utilized, the findings, and lessons learned are most likely applicable for other State DOT's that desire to investigate and document their current Project Development Process.

METHODOLOGY

The objective of this paper is to review the methodology that was utilized to comprehensively determine a State DOT's current PDP. In essence, its goal is to provide insight regarding the approach taken by agency leadership and the research team to investigate and document an agency's current preconstruction processes and practices of their PDP for infrastructure projects.

Ultimately, the agency's objective was to improve their PDP. To achieve that goal, the agency recognized that the establishment (documentation) of an agency's current process and practices was an essential first step for a state DOT that desires to improve their PDP. The methodology utilized for this research to accomplish the research objective incorporated five steps and associated sub-steps, as shown in Figure 1.

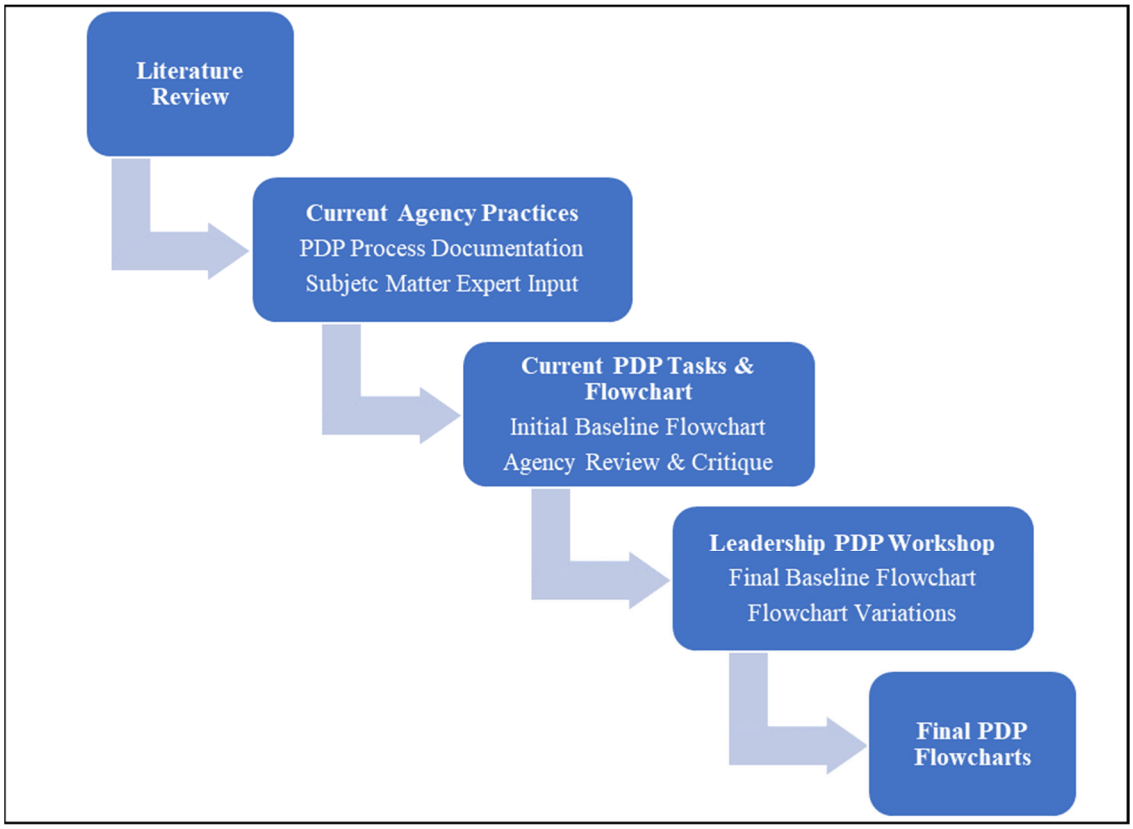


Figure 1 Case Study Methodology Steps

It is anticipated that the methodology utilized for this case study will be applicable for use by other STAs as a guide to identify project development current practices, document their PDP, and utilize the insight they gained through the process to improve the agency's future performance in the delivery of the state's infrastructure projects.

A detailed summary of each step taken by the research team and agency personnel involved is provided as follows:

CASE STUDY SEQUENCE AND APPROACH

LITERATURE REVIEW

To gain a comprehensive understanding of the PDP, the first task for the research project was to complete a thorough review of publications, research papers, and studies concerning the PDP for transportation projects. Special emphasis was placed on studies and publications from state DOTs and related industry and professional organizations, including FHWA, the American Association of State Highway and Transportation Officials (AASHTO), TRB, and the National Cooperative Highway Research Program (NCHRP). The research team also examined state DOT websites to obtain relevant information on the practice, process, organization, training, and execution of the agency's PDP. 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. In addition, the team explored the extent of the state's system, the agency's organizational structure, gained insight regarding the impact that the funding source had on the state's process, and sought to identify any pending modifications to the state agency's PDP.

CURRENT AGENCY PDP PRACTICES

The identification of current PDP practices utilized by the state agency for this study entailed two sequential activities: a) review of the agency'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/or departments. An overview of the investigative process for each activity is as follows:

PDP Documentation

Subsequent to the literature search, the next step in the research process was to investigate the development process of the state agency that serves as the 'case study' – hereafter referred to as the 'Study DOT' (StDOT). The research team collected and examined StDOT's PDP documentation regarding practices, policies, reports, studies, and other relevant material for each program and/or project type of project development. The team examined information and documentation regarding the StDOT organization structure, personnel responsibilities, critical tasks, control activities, communication/coordination, and reporting. The agency's approach and scheduling software utilized for the planning and management of the PDP was identified and investigated. The research team then examined StDOT's organizational structure and identified its functional departments in preparation for the next step of the investigative process.

State DOT Subject Matter Experts (SMEs)

This activity involved development of a detailed listing of topics for inquiry to understand the activities and process flow of the agency. The topics were developed after studying PDP components, tasks, and activities of StDOT and other state DOTs, and identifying important components that are 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/or funding source had on the PDP activities.

The research team then met with StDOT'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 improvement of 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 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/or 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 permission of the interviewee(s), each session was recorded to ensure comprehensive capture of their input and to efficiently utilize the time spent with the interviewee(s). Additional PDP documentation that was identified was noted for collection subsequent to the interview process.

Following each interview, a complete transcript was developed that was subsequently summarized by theme/category. The SME input was then organized by flowchart task to supplement and/or clarify the PDP information that was previously assembled during an examination of the agency's PDP documentation.

Table 1 Agency SMEs Interviewed

Department/Functional Unit	**Numbers**	**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 Assess.	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 Adm.
Construction	1	Director
Total Interviewed	**44**	

CURRENT PDP TASKS AND FLOWCHART

Develop Initial Baseline Flowchart.

Once the DOT process documentation and SME input were summarized, organized, and evaluated, the research team developed a 'baseline' PDP flowchart. This flowchart reflected the agency's current tasks and sequence (flow) for the PDP for projects classified as an EA FONSI. The team also identified suggested milestones for the development process. This draft 'baseline' flowchart contained fifty-nine tasks and eight milestones (included in Appendix B).

Agency Review & Comment

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

LEADERSHIP PDP WORKSHOP

Finalize Baseline Flowchart

To finalize PDP flowchart development and establish the 'sub-tasks' for each flowchart task, a two-day workshop was held. Along with the research team, attendees included the preconstruction support leadership, senior regional leadership responsible for project development, senior design management, project management, FHWA representatives, and members of the research team. 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 first day of the workshop 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 agency's intended practice. The participants appropriately thought it best to first document and stabilize current practices prior to initiating improvement.

Flowchart Variations for Program/Project Type

The second day focused on three key elements: a) determining how the EA FONSI flowchart varied based on project type, environmental classification, and/or funding source, b) review and finalize the sub-tasks 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 sequence needed to be added, changed, or eliminated. The key decisions reached during this review were:

- StDOT leadership decided to limit the development of PDP flowcharts 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.

- StDOT'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. In addition, 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 for the planning and execution of 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 were examined, and 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 where determined, the workshop participants identified the modifications to the baseline flowchart sequence, tasks, and sub-tasks that were required for each.

Final PDP Flowcharts & Sub-Tasks

Subsequent to the workshop, the EA FONSI baseline flowchart and the three additional flowcharts based on varying environmental and/or permit requirements were finalized. In addition, 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 prior to 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.

CONCLUSIONS

The knowledge gained and the lessons learned by agency leadership and the research team during the execution of this research project was extensive. This review of the case study methodology (steps) and the lessons learned should be of value to any agency planning to evaluate its own approach to project development. The lessons learned include the following:

- The commitment and involvement of DOT leadership is essential: Self-evaluation of agency process can be a fearful and intimidating experience, especially for those personnel currently engaged in performing the activities. To encourage broad support for agency self-evaluation of the development process, it is vital to have DOT leadership involved with the project steering committee and committed to the effort. In addition, it is essential for DOT leadership to signal their continuing support of the self-evaluation effort by staying actively engaged in the process.

- Agency self-evaluation of their PDP requires the active support of departmental and functional leadership. A state DOT's PDP is executed at the departmental/functional level.

To gain valid insight regarding current practice and substantive input to improve the process, it is vital to have functional leadership supportive and actively engaged in the effort. Essential steps to gain support include an initial briefing concerning project objectives, the team's approach to gather 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 research team will need to interact with multiple SMEs with a number of demands on their time. It is important for the research team to have prior agency experience and functional knowledge. For this research effort, DOT leadership and the steering committee selected lead researchers that had successfully completed prior research efforts spanning multiple agency functions. In addition, committee leadership had the foresight to encourage the principal investigator to include a practicing transportation engineer with prior DOT experience and 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/or functional units operate in a vacuum. On multiple levels of the organization, information & process knowledge 'gaps' are often filled in at the direction or guidance of an individual's supervisor. In the process of gaining input on process and agency interaction from SMEs, it was enlightening to see the variations in execution. This reinforced the need for departmental/functional involvement and input to the project.

- Performance metrics are important: During the interview process with agency SMEs, the research team 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 application of the metrics. 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/or experienced personnel retire or leave the agency. In either case, organizations are often faced with addressing their resource needs by utilizing personnel that have limited industry or or organizational experience. Documentation of agency PDP practice and process is essential to ensure consistent delivery of projects by personnel with varying levels of experience.

LIMITATIONS OF THE CASE STUDY

The state DOT that was the focus of this case study had a hybrid organization with some departments/functions centralized while others were decentralized. In addition, the agency currently had limited development and documentation of their PDP flowchart(s), tasks, and subtasks. A research team evaluating a state DOT with an advanced state of PDP development and documentation may not result in the same 'lessons learned.' However, the investigation framework (steps) will still most likely be applicable.

FUTURE RESEARCH

The logical next step with StDOT, and most any state DOT, subsequent to investigating and documenting current PDP practice is to improve the process. The team's next research activities are to identify PDP best practices. To support that objective the research team plans to: a) solicit operational feedback, along with suggestions for improvement, from the state's private sector delivery partners (consultant industry), b) conduct a national survey of state DOTs to gain insight regarding their PDP, and c) identify comparable state DOTs to explore their PDP processes and practices with their SMEs. Once the data from all three sources is collected and analyzed, the research team will develop best practices and provide StDOT suggestions for the improvement of their PDP.

ACKNOWLEDGEMENT

The authors acknowledge the South Carolina Department of Transportation (SCDOT), which provided funding for this research. The authors also acknowledge Matt Lifsey, an industry professional, for his expertise and contribution in mapping the PDP.

DISCLAIMER

The contents of this paper reflect the views of the authors who are responsible for the facts and the accuracy of the presented data. The contents do not reflect the official views of any state or federal agency. This study is based on the insight, experiences, and data collected from the case study state DOT.

AUTHOR CONTRIBUTION STATEMENT

The authors confirm contribution to the paper as follows: study conception and design: Tanin A. Haidary, Dennis C. Bausman, and Mashrur Chowdhury; data collection: T. Haidary; analysis and interpretation of results: D. Bausman, T. Haidary, and M. Chowdhury; draft manuscript preparation: Ajay S. Jadhav, D. Bausman, and M. Chowdhury. All authors reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Bausman, D., M. Chowdhury, and L. Tupper, Best practices for procurement and management of professional services contracts. Journal of Professional Issues in Engineering Education and Practice, Vol. 140, No. 3, 2014, p. 04013019.
2. Sperling, E. and C. Ross, Strategically Aligning Capital Improvement Prioritization to Performance Goals. Transportation Research Record, Vol. 2672, No. 51, 2018, pp. 68–78.
3. Moss, V., H. Dinçer, and Ü. Hacıog˘lu, State financed social housing model in South Africa requires capacity building injection. In Handbook of Research on Behavioral Finance and Investment Strategies: Decision Making in the Financial Industry, IGI Global, 2015, pp.338–349.
4. Wood, H. P., H. Kassoff, T. McGrath, W. G. Malley, D. C. Rose, and N. Skinner, Guidance for managing NEPA-related and other risks in project delivery, Volume 1: Guide for managing NEPA-related and other risks in project delivery, 2011.
5. Hillis, D., J. Jones, and D. Ekern, Executive Strategies to Deliver Practical Design, 2016.
6. Crossett, J. and S. Oldham, Framework for measuring state transportation agency performance in context-sensitive solutions. Transportation research record, Vol. 1904, No. 1, 2005, pp. 84–92.
7. Barberio, G., R. Barolsky, M. Culp, and R. Ritter, Using the planning and environment linkages umbrella approach to streamline transportation decision making. Transportation Research Record, Vol. 2058, No. 1, 2008, pp. 1–6.
8. Barrella, E., A. A. Amekudzi, M. D. Meyer, C. L. Ross, and D. Turchetta, Best practices and common approaches for considering sustainability at US state transportation agencies. Transportation research record, Vol. 2174, No. 1, 2010, pp. 10–18.
9. Hecht, H. and D. Niemeier, Evaluation of past audits of project development on California state highway system. Transportation research record, Vol. 1817, No. 1, 2002, pp. 1–10.
10. Agency, U. S. E. P., National Environmental Policy Act. https://www.environment.fhwa.dot.gov/nepa/nepa_projDev.aspx, 1969.
11. FHWA, Project Development Process Flowchart. https://flh.fhwa.dot.gov/resources/design/tools/wfl/process/PD-Process.pdf, 2007.
12. Berger, L. and I. Associates, Design-Build Environmental Compliance Process and Level of Detail: Eight Case Studies, 2005.
13. McMinimee, J. C., S. Schaftlein, T. R. Warne, S. S. Detmer, M. C. Lester, G. F. Mroczka, D. B. Nichols, J. N. Taylor, A. T. Teikari, and C. Yew, Best practices in project delivery management, 2009.
14. Wood, K. H. M. T. M. W. G. R. D. C. S. N., Howard P, Guidance for Mapping NEPA-Related and Other Risks in Project Delivery, Volume 2: Expediting NEPA Decisions and Other Practitioner Strategies for Addressing High Risk Issues in Project Delivery. http://www.trb.org/Publications/Blurbs/170764.aspx, 2014.

APPENDIX D

A COMPONENT OF THE SCDOT PROJECT DEVELOPMENT PROCESS (PDP) RESEARCH PROJECT

by Dennis Bausman, Tanin Haidary and Ronnie Chowdhury with Matt Lifsey Consultant
Sept. 2020

PROFESSIONAL SERVICES CONSULTANTS

Assessment of the Agency's Procurement Process and Management of the PDP

INTRODUCTION

State Department of Transportation development and delivery of transportation projects is a complicated and complex process that can take an agency years for project development. State DOTs are faced with the development of a variety of different project types that demand a wide range of agency expertise for project delivery. During project development state agencies 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/or limit the impact the project may have 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 a 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 transportation agencies are seeking ways to more efficiently, effectively, and expeditiously deliver projects. To reach that objective state agencies are taking steps to streamline their project development and delivery processes and approach (Capers 2009).

Agency initiatives include expanding contracting options to include delivery methods such as Design-Build and Construction Management. In addition, a number of state agencies have focused on the implementation of Best Practices for the development of 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 Department of Transportation's project development to enhance the agency's project delivery process (Bausman et.al. 2014, Cochran et.al. 2004).

The focus on the role of professional services consultants is especially relevant considering the findings of a recent national study (Haidary & Bausman 2020). Thirty-six state transportation agencies, representing 72% of all state DOTs, participated in the study. The objective of the study

was to investigate the preconstruction project development process of state DOTs, and the agency's procurement and utilization of professional service consultants.

A finding of the national DOT study was 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 while 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, a number of state agencies were even using professional services consultants as 'general' managers to manage other consultants that were delivering project related services. To support the efficient procurement of consultants, State DOTs were also focused on reducing the procurement timeline for professional services consultants. Interestingly, the primary driver for agency 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/or the absence of agency expertise (Haidary & Bausman 2020).

The increased involvement of professional services consultants for project delivery does not eliminate the need for agencies to streamline the process and enhance the effectiveness and efficiency of project delivery. To 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 the delivery of 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 *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 agency improvement. Feedback from an agency's 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 for the enhancement of 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 research team worked closely with leadership and the Steering Committee for development of the survey and identification of the consultants to be solicited for participation. The study objective, research methodology, findings, and conclusions are presented in the following sections.

STUDY OBJECTIVE AND METHODOLOGY

Objective

SCDOT commissioned a Clemson University research team to assist the agency with updating and streamlining their Project Development Process (PDP). An essential step in that effort was to gain feedback on the agency's process from professional services consultants providing engineering and consultant services to the agency during project development. The objective for this phase of the research effort was to seek the input of SCDOT's delivery partners, the professional services consultants, to help the agency improve and streamline their PDP.

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

METHODOLOGY

Population and Sampling Frame

The unit of analysis for this consultant study 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.

Survey Development & Distribution

Data collection for this study was obtained from a self-administered online survey. A detailed questionnaire containing thirty-three (33) questions was 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's procurement of professional services consultants, and b) the issues faced subsequent to award including execution, expectations, performance, and management of the project development process.

The development of the individual questions was an eight-step process. Similar to a companion study (Haidary and Bausman 2020), subsequent to a comprehensive literature review the research team interviewed forty-four (44) SMEs from twenty-two (22) different functional units within the state DOT.

Once the preceding data was collected, organized, and analyzed the survey topics and individual questions were developed. This first draft of the questionnaire developed by the research team 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 prior to each succeeding review. The final draft of the questionnaire was then posted to an online survey site and pilot tested. A group of academic professionals, SMEs from industry, and DOT department/functional leaders pilot tested the online survey and their feedback was addressed prior to finalizing the online survey.

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.

Data 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.

FINDING AND ANALYSIS

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 substanitially 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.

Responding Firm Characteristics

Forty-four percent (44%) of the responding firms indicated that they operated nationally, 35% were Southest regional firms, and 21% limited their area of operation to the state (Figure 1). Forty-

four percent (44%) of the responding firms indicated that they operated nationally, 35% were Southest regional firms, and 21% limited their area of operation to the state (Figure 1).

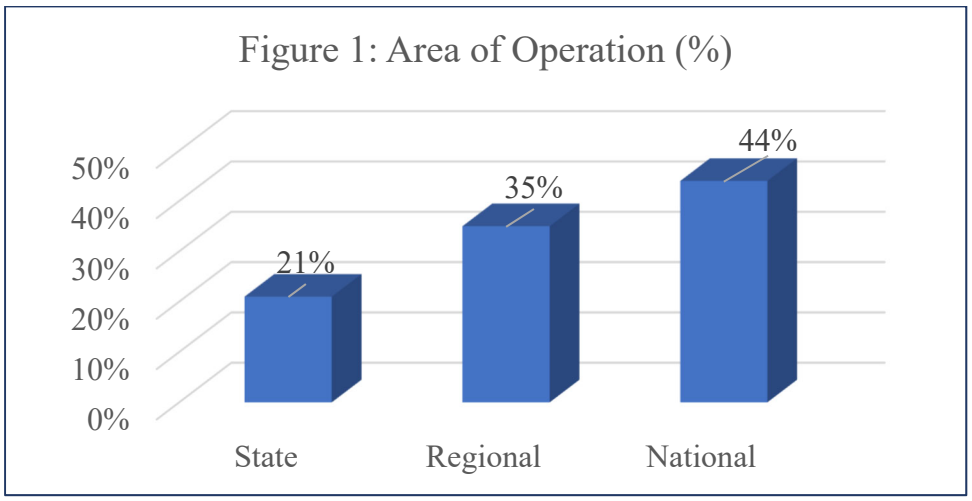


Figure 1: Area of Operation

Eighty-nine percent (89%) of the firms indicating their area of operation was national or state offered engineering design services. Whereas, eighty percent (80%) of the regional firms provided engineering design services. Combined, 86% of the respondents performed engineering design services. 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 profressional employees.

Respondents were asked to provide the approximate percentage of the the firm's annual volume that was 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%

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

Professional Services Consultants – Procurement (Pre-Award)

The questionnaire asked a series of questions (9) that focused on the procurement of professional services consultants. The topics of investigation ranged from the advertisement of the Request for

Proposal (RFP) to contract negotiation and contracting. The first grouping of questions presented in Table 1 provided 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 and the remaining third (32%) felt that the required level of effort for response was seldom or almost never reasonable.

Approximately half of the responding firms thought that project scope and objectives were clearly defined prior to award. However, a large portion of the firms indicated that project scope and objective were only 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 'sometime'.

The last 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.

The second grouping of questions presented in Table 1 provided response options addressing the level of agreement or disagreement with the question/statement.

As summarized in Table 1, 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.

Project Development Process – Post Award

The next series of questions on the survey focused on the delivery of professional services and the DOTs management of the project development process. Table 2 summarizes questions, mean response, and the associated consistency (frequency) of agency response and/or 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 effectiveness and efficiency of the agency's review 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. In addition, most of the consultant firms (70%) felt that the agency was only sometimes, seldom, or almost never receptive to deviations in design standards that reduced the cost or the impact of the project.

Table 1: Procurement of Professional Services Consultants

Question	Mean	Frequency (respondent %)				
		Almost Never	Seldom	Some-times	Often	Almost Always
RFPs are well advertised.	3.41	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%
Project deliverables are consistent from project to project.	3.32	3.2%	6.5%	48.4 %	38.7 %	3.2%
Contract negotiations are completed timely.	2.29	19.4%	48.4%	19.4 %	9.7%	3.2%
Question	Mean	Level of Agreement/Disagreement				
		Strongly Disagree	Disagree	Neither A or DA	Agree	Strongly Agree
Bundling design advertisements promotes 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 PSC's for procurement would be beneficial.	4.13	3.2%	0	25.8 %	22.6 %	48.4%

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 both transparency/consistency of the process and clear/consistent direction during design, the remaining (56%) consultants indicated that was 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.

Table 2: Project Development Process – Post Award

Question	Mean	Frequency (respondent %)				
		Almost Never	Seldom	Some-times	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%
Clear and consistent direction is provided during design.	3.44	0%	9.4%	46.9 %	34.4 %	9.4%
Preconstruction development process is transparent & clearly communicated.	3.31	6.3%	9.4%	40.6 %	34.4 %	9.4%
Payment for services is timely.	3.52	6.1%	9.1%	30.3 %	36.4 %	18.2 %
Performance expectations (metrics) are clearly defined.	3.25	6.3%	6.3%	53.1 %	25.0 %	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%

For both the clarity of performance expectations and the regularity of feedback regarding their performance consulting firms had a similar distribution of response. 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 2 addressed the consistency of Project Manager (PM) administration (management) of the project development process. 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 and the remaining one-third (34%) noted that the consistency of PDP management PM to PM was seldom or almost never their experience.

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 3). 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.

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.

Table 3: Project Development Process – Post Award (cont.)

Question	Mean	Level of Agreement/Disagreement				
		Strongly Disagree	Disagree	Neither A 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%
DOT's schedule software is effectively utilized to plan preconstruction activities	3.00	3.0%	24.3%	42.3%	27.3%	3.0%
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 has sufficient project staff to permit timely response to consultants	3.21	9.1%	18.2%	33.3%	36.4%	12.1%

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.

Respondent Suggestions

Design Standards and Support/Comment

Plan Review

- Better communication is needed between Pre-construction Support and Pre-construction. Decisions made by PMs and design staff in the RPGs that affect design and deliverables are often not communicated to Pre-construction Support resulting in many unnecessary review comments.
- 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 Program/Project Manager (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.

Design Standards

- 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 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.

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 applies 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 low volume determination is made by the PM.
- The extent of budget detail required leads to excessive micro-management of the project budget during execution.

Project Management of the PDP

- Inconsistency between RPGs & 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 or APM 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/or training yields inconsistencies between RPGs.

PSC Performance Evaluation

- Need to improve the consistency between RPGs and project managers for consultant performance evaluation.

CONCLUSIONS

Conclusions supported by the survey data received from Professional Services Consulting firms for both procurement of professional services consultants and management of the project development process include the following:

Procurement of Professional Services Consultants (PSC)

Professional Services Consulting firms thought that the agency's Requests for Proposal (RFP) were not consistently well-advertised. In addition, 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 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. In addition, most consulting firms suggest that prequalification of PSC's 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.

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 that the review process was often effective and efficient. However, consultants felt that agency staffing was sufficient for 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 application of the agency's software was ineffective for management of the preconstruction activities. In addition, PSCs considered PDP training for consultants to be inadequate.

Lastly, a consistent and recurring theme from professional services consulting firms was that management of the Project Development Process was inconsistent from project manager to project manager.

REFERENCES

Berger, L. and I. Associates, Design-Build Environmental Compliance Process and Level of Detail: Eight Case Studies, 2005

Harry Capers P.E , Arora and Associates, Best Practices in Project Delivery Management, National Cooperative Highway Research Program, Scan Team Report NCHRP Project 20-68A, Scan 07-01, October 2009

Covey, Stephen R. The 7 Habits Of Highly Effective People: Restoring The Character Ethic. New York : Free Press, 2004. Print.

Martin Fischer, Howard Ashcraft, Dean Reed and Atul Khanzode, Integrating Project Delivery, John Wiley & Sons, Hoboken, New Jersey, 2017

Tanin A. Haidary & Dennis C. Bausman, Mashrur Chowdhury, and Ajay S Jadhav, An Investigation of the Preconstruction Project Development Process of State Transportation Agencies, submitted to the Transportation Research Board for publication, 8/31/20

Sidney M. Levy, Project Management in Construction 7th Ed (2018), McGraw Hill, New York NY, Library of Congress # 2017947675

McMinimee, J. C., Schaftlein, S., Warne, T. R., Detmer, S. S., Lester, M. C., Mroczka, G. F., ... & Yew, C. (2009). Best practices in project delivery management (No. NCHRP Project 20-68A)

Gary Santorella, Lean Culture for the Construction Industry, CRC Press, Taylor & Francis, New York NY, 2011, ISBN 978-1-4398-3508

John Schaufelberger, Construction Business Management, Prentice Hall, Columbus OH, 2009

APPENDIX E

AN INVESTIGATION OF THE PRECONSTRUCTION PROJECT DEVELOPMENT PROCESS FOR STATE TRANSPORTATION AGENCIES

Tanin A. Haidary
Ph.D. Candidate
Clemson University
Department of Construction Science and Management
Clemson, SC 29634 Tel: (864)-624-6216
Email: thaidar@g.clemson.edu

Dennis C. Bausman, Ph.D., FAIC, CPC
Constructor Certification Commission
Professor and CSM Endowed Faculty Chair
Clemson University
2-133 Lee Hall, Clemson, SC 29634
Tel: (864)-656-3919
Email: dennisb@clemson.edu

Mashrur Chowdhury, Ph.D., P.E., F. ASCE
Eugene Douglas Mays Endowed Professor of Transportation and
Professor of Automotive Engineering
Clemson University
Glenn Department of Civil Engineering
216 Lowry Hall, Clemson, SC 29634
Tel: (864) 656-3313 Fax: (864) 656-2670
Email: mac@clemson.edu

Word count: 5,825 words text + 4 table x 250 words = 6,825 words

Paper Submitted for Presentation and Publication at the 2021 TRB Annual Meeting

DDD

ABSTRACT

State Transportation Agencies (STA) are under increasing pressure to deliver projects timely, cost-effectively, and improve the performance of their programs and projects to meet the needs of their constituents. The primary objectives for this study were to gain insight concerning the state DOT preconstruction Project Development Process (PDP) and the use of professional services consultants. Input was solicited from the fifty state DOTs in the U.S. using the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee (RAC) membership listing. An online survey containing forty-eight questions investigated the topics of scheduling, project planning and scope development, performance evaluation, development activities and timeframes, and the utilization and management of professional service consultants. Responses were received from 36 state Departments of Transportation (DOT) (72% response rate). The findings include that the duration of the (PDP) varies significantly amongst states. The use of consultants is widespread and increasing. Prequalification and use of on-call/IDIQ/continuing consultants for project design reduces procurement duration. Project scoping with cross-functional teams is widespread, state DOTs that develop a formal scoping document have fewer scope revisions, and agency preconstruction department organization and structure have an impact on the duration of the PDP.

Keywords: Project Development Process, Department of Transportation, State Transportation Agencies, Professional Services Consultants, Performance Measurement, PDP, DOT

INTRODUCTION

In the United States, federal, state, and local governments are responsible for addressing the infrastructure needs of their citizens. State and local governments often receive federal aid that obliges them to invest funding in transportation infrastructure such as highways, bridges, roadways, etc. State Transportation Agencies (STA) 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 *(1)*.

Historically, transportation planning and engineering have been a cost-conscious, flexible, forward-thinking, and innovative discipline that has led STAs to the construction of robust transportation systems *(2)*. Due to these criteria and the involvement of a broad spectrum of stakeholders, STAs have embraced a cooperative and knowledge-based philosophy for planning, managing, design, construction, and operation of transportation infrastructure *(3)*. 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 *(2)*.

STAs are responsible for the transportation system of their states while their transportation system needs continue to expand *(4)*. The continued expansion of state transportation needs, and programs also places increasing pressure on personnel responsible for the efficient and effective delivery of transportation projects, which is also a challenge for most every DOT.

STAs are under growing pressure to deliver projects timely, cost-effectively, and improve the performance of their programs and projects to meet the needs of constituents *(5,6)*. The pressure is due to high demand, environmental policies, limited funding and revenue sources, stakeholder concerns, federal and state policies, and intense public interest and involvement *(6)*. 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 *(7)*. 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 *(3,7)*.

The National Environment Policy Act (NEPA), which was passed in 1969, establishes a system for environmental planning and project development decision-making, and the Federal Highway Administration (FHWA) initiatives such as linkage of planning and environmental encourage state DOTs to integrate Project Development Process (PDP) and environmental process and documentation. NEPA requires federal agencies to document the process to promote public participation and coordination among STAs. Coordination of state DOTs and documentation of their processes and practices are an essential part of NEPA Project Development. STAs struggle with the variation, the lack of details, and insufficient documentation corresponding to PDP, which often leads to delays, an increase in cost, and establishes inter-agency and intra-agency communication gap *(8,9)*. According to Wood et al. *(10)*, NEPA integration with the PDP did not simplify the process but reduce the risks of delay and cost overruns in the last decade. PDP

documents provide written processes and practices that guide project managers, traffic engineers, and stakeholders during the project delivery process. A defined process also provides information regarding the essential components of the PDP, which state DOTs can share with their peers and counterparts and utilize in their agencies. Surprisingly, there are not many studies that have addressed the variation and insufficient documentation of PDP and their relationships to delays and cost increase.

Due to rising demand and pressure to reduce the time of project delivery and deliver projects cost-effectively, STAs are seeking initiatives to deliver projects as efficiently and expeditiously as possible *(6)*. Many initiatives have been designed to streamline the practices and processes used in delivering the projects efficiently and timely. Hillis et al. *(2)* list these initiatives in their study, which include expanding the modal solutions, increasing public involvement, streamlining the (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, STAs are challenged to find a balance among the uncertainties of community, project development, environmental compatibility, project scoping, unidentified risks, and fiscal constraints *(2,7)*.

STAs, including DOTs, MPOs, and COGs, have initiated different programs to tackle increasing pressure and achieve a balance between project uncertainties *(2)*. Among these initiatives, is streamlining their PDP to improve the performance of their programs. Moss et al. *(11)* define transportation project development as *"the process to take a transportation improvement from concept through construction."* According to Moss et al. *(11)*, PDP includes planning, organizing, coordinating, and controlling resources to meet specific goals and has six phases; initiation, definition, design, development, implementation, and follow-up phases. The 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 development process, from initial planning to final commissioning *(10)*.

Considering all above and the rising need for STAs to have an effective and efficient PDP, this paper presents the methodology and findings of a National 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 d) state DOTs professional services consultants procurement and utilization.

STUDY OBJECTIVE AND METHODOLOGY

OBJECTIVE

The primary topics of interest for this study were to gain insight concerning a) the preconstruction PDP of state DOTs, and b) agency procurement and utilization of professional service consultants.

METHODOLOGY

Population and Sampling Frame

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

The sampling frame utilized as the portal for initial agency contact and distribution was the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee (RAC) state agency contact list.

Survey Development & Distribution

Data collection for this study 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 agency, such as location, organizational structure, overall use of professional service consultants, and agency responsibility for preconstruction development activities.

Additional sections addressed the topics of scheduling/planning, project scope, performance evaluation, development activities and timeframes, and the utilization and management of professional service consultants.

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

Once the research team's knowledge base was established, the questionnaire topics and individual questions were developed. This initial questionnaire was reviewed and critiqued by academic 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 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.

Survey Distribution

A request to complete the survey was then sent by the research engineer from the DOT sponsoring the study to each of the 50 state DOT 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.

Data 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.

FINDING AND ANALYSIS

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 1). 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 agency senior managers classified as chief engineer, district engineer, director of program delivery, manager of project delivery, and project management director.

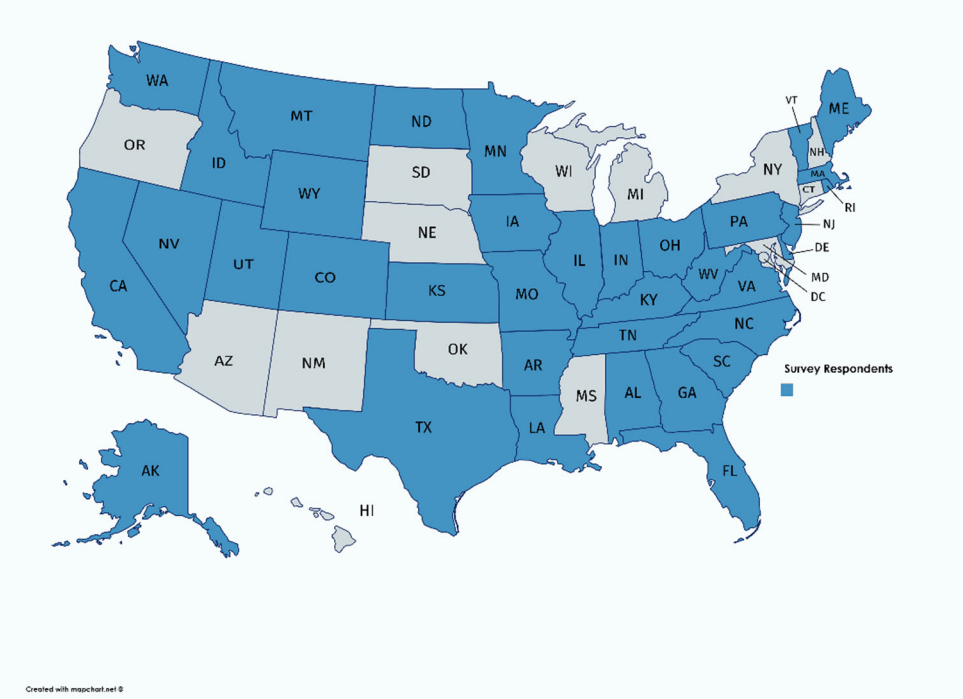


FIGURE 1 State DOTs Participating in the Study

GENERAL DOT INFORMATION

Organizational Structure

Survey participants were asked if centralized, decentralized, or hybrid best described their general DOT preconstruction organizational structure. Forty percent (40%) selected centralized, 20% decentralized, and 40% selected hybrid. Probing deeper, respondents were then asked to identify

how the DOT was organized to manage individual projects. The most frequent response was by geography/region at 43%. About a quarter (26%) of the DOTs selected by discipline and 14% noted by project type. None of the respondents selected funding source. The remaining 17% of the DOTs provided a variety of options, with most noting a combination of factors including project type and/or complexity.

Timely Completion

One half (50%) of the 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 head of preconstruction, but only one DOT selected design management. The remaining DOTs (28%) provided responses including regional engineer(s), district engineer(s), director of program delivery, district director, and technical services division.

Use of Design Consultants

DOTs were asked the percentage of their transportation projects that had design development performed by 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 2. In addition, 37% of the DOTs indicated their use of consultants was increasing, and 63% noted their use of consultants was steady. None of the DOTs indicated their consultant use was decreasing.

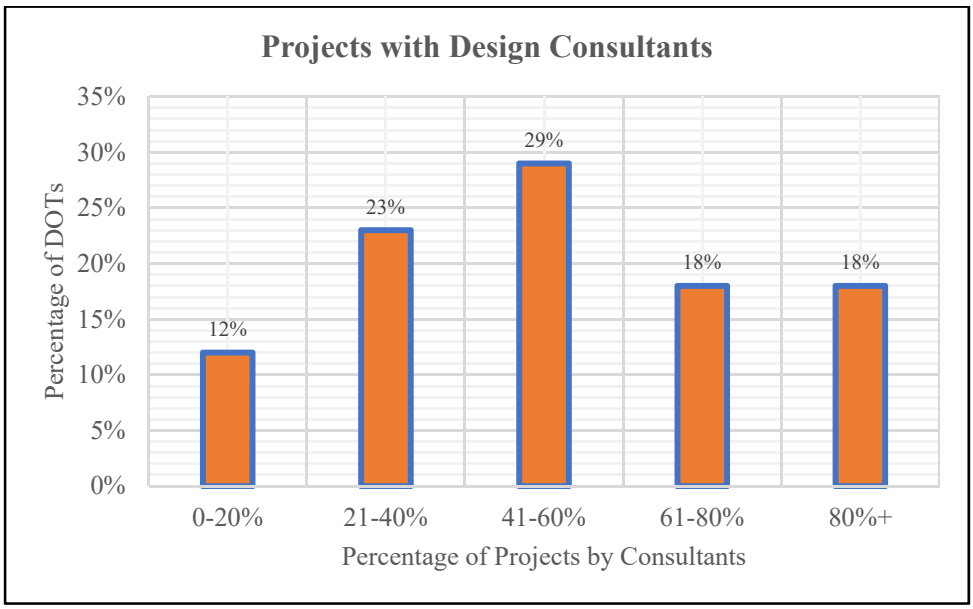


FIGURE 2 Percentage of Projects by Consultants

Respondents were also asked if their use of design consultants varied based upon the project type, and fifty-three percent (53%) answered affirmative. When asked why, most noted that complex, large, unique, and/or 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.

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 milestones that were clearly defined. 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.

PROJECT SCOPING PROCESS

Survey participants were presented a series of questions concerning their project scoping practices. Table 1 identifies the theme of each question, the mean response, and the frequency of each response. As noted in Table 1, response options ranged from 'almost never' to 'almost always.'

TABLE 1 Project Scoping and Scheduling

Topics of Inquiry	Mean	Frequency (respondents %)				
		Almost Never	Seldom	Sometimes	Often	Almost Always
Project Scoping						
Project scope developed by a cross-functional team	4.00	0%	6%	28%	28%	39%
Project scope clearly defined prior to placing in STIP	3.83	6%	0%	28%	39%	28%
Frequency of scoping document development	3.31	8%	28%	17%	19%	28%
Frequency scope change requires STIP revision	2.64	11%	36%	31%	22%	0%
Frequency design deviations encouraged.	3.33	0%	25%	22%	47%	6%
Schedule Controlling Factor						
Completion of project design	2.92	6%	28%	42%	19%	6%
Right of Way acquisition	3.97	0%	8%	22%	33%	36%
Utility Relocation	3.52	6%	11%	19%	47%	17%
Permitting	3.00	6%	14%	56%	25%	0%

Two-thirds (67%) of 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 DOTs developed a formal project scoping document prior to placement of funding requirements for PE

in the STIP. Twenty-two percent (22%) of the DOTs had to revise the STIP 'often' because of project scope change(s), and 31% needed to revise their STIP 'sometimes.' A comparative analysis of the responses yields additional insight.

- Eighty percent (80%) of the 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 DOTs that seldom or almost never develop a formal scoping document also believe that their 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 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 DOTs that seldom or almost never developed a formal scoping document often had to revise their STIP.

PERFORMANCE EVALUATION

The next section of the questionnaire investigated PDP performance evaluation. The initial question asked if their DOT regularly tracked the preconstruction project performance metrics/milestones noted in Figure 3. The metrics/milestones that 75% or more DOTs tracked included Approval of Project Funding, FHWA FONSI Approval, ROW Authorization, ROW Certification, Utility Certification, Railroad Certification, and Construction Authorization. The milestones that were tracked by less than 50% of DOTs included Advertisement of Eminent Domain, Conceptual Design (10%), and Notice of Intent.

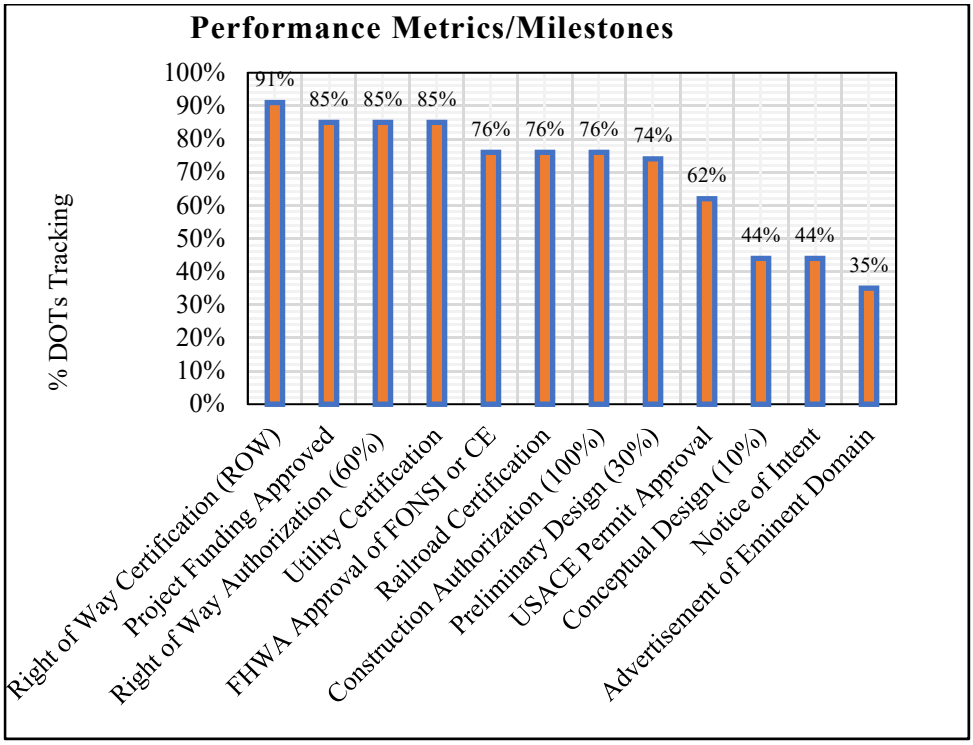


FIGURE 3 Performance Metrics /Milestones

When asked how frequently their 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%, respectively. This level of tracking frequency is likely supported by the finding that three-quarters of the DOTs either agree (44%) or strongly agree (31%) with the statement 'tracking preconstruction project performance metrics improves and/or reduces the pre-construction project development timeline.'

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 Figure 4.

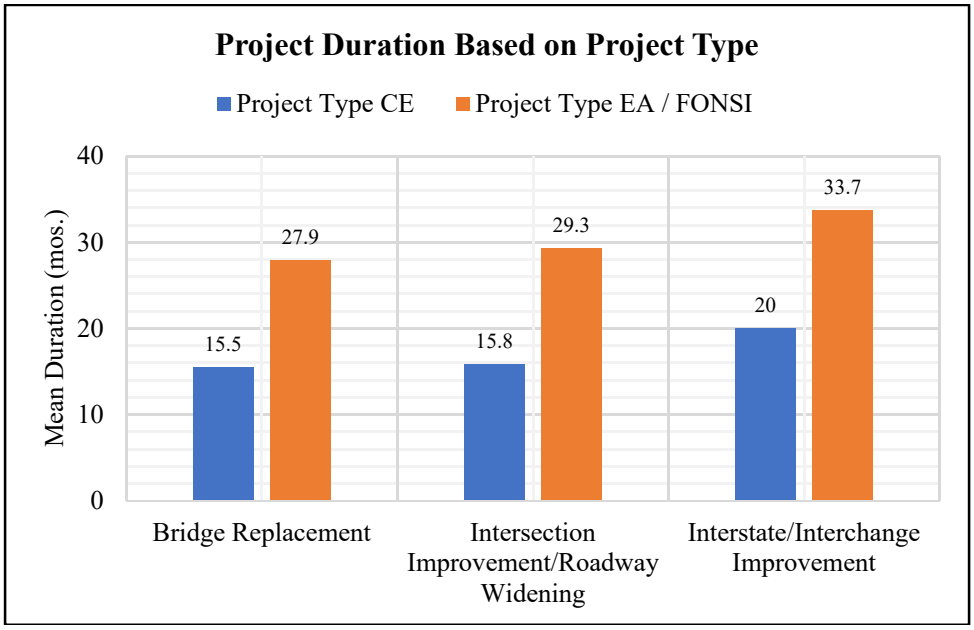


FIGURE 4 Duration based on Project Type

The mean duration for all CE project types ranged from 15.5 to 20.0 months. The duration mean for EA/FONSI projects ranged from 27.9 to 33.7 months. In addition, respondents also advised that the approximate timeframe from 100% construction plans to receipt of construction bids for DOTs ranged from 1-6 months with an average of 3.3 months.

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

The two activities identified as frequently the controlling factors in the PDP were ROW acquisition and Utility Relocation (Table 1). ROW was the controlling factor often or almost always greater than two-thirds (69%) of the time, while 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.

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:

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

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

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

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

Performance 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

PROFESSIONAL SERVICES CONSULTANTS

For 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. It should be noted that most of the DOTs were at opposite ends of the spectrum. The procurement time for forty-one percent (41%) of the DOTs was 3 months or less while it took a similarly sized group of 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 mean and DOT level of agreement or disagreement with each statement are summarized in Table 2.

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 DOTs agree or strongly agree with this statement. In addition, a majority (53%) of the DOTs participating believe they provide adequate training for their consultants.

TABLE 2 Professional Services Consultants – Training and Value

Topics of Inquiry	Mean	Level of Agreement/Disagreement				
		Strongly Disagree	Disagree	Neither A or DA	Agree	Strongly Agree
Design standards organized/accessible	4.06	0%	3%	17%	51%	29%
Adequate consultant training	3.28	0%	21%	27%	50%	3%
Consultant use reduces time frame	3.03	0%	20%	57%	9%	14%
Consultant use cost effective	2.34	14%	43%	40%	0%	3%

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 DOT's frequency of using certain activities concerning consultant procurement and the impact their use had on project design development time and cost. A summary of the findings is presented in Table 3. The frequency response options ranged from almost never to almost always, as noted in Table 3.

TABLE 3 Professional Services Consultant – Procurement and Performance

Topics of Inquiry	Mean	Frequency (respondents %)				
		Almost Never	Seldom	Sometimes	Often	Almost Always
Consultant Procurement						
Pre-qualification of design consultants	3.94	11%	6%	11%	15%	57%
On-call/IDIQ/Continuing consultants for project design	3.82	6%	0%	24%	47%	24%
Bundling consultant promotes procurement efficiency	2.64	20%	17%	40%	11%	11%
Lump sum contracting for design services	2.26	40%	20%	20%	14%	6%
In-house and consultant deliverables are similar	4.40	0%	3%	6%	40%	51%
Consultant milestones are clearly defined	4.32	0%	3%	9%	41%	47%
Procurement of consultants is timely	3.86	0%	6%	28%	40%	26%
Consultant Performance						
Evaluate consultant vs. in-house schedule performance	2.17	31%	34%	26%	3%	6%
Evaluate consultant vs. in-house cost performance	2.49	26%	26%	31%	0%	9%

The first seven questions noted in the table addressed consultant procurement activities. The findings were that almost three quarters (74%) of the DOTs often or almost always prequalify design consultants. Only 17% of the DOTs seldom or never prequalify. In addition, close to three quarters (73%) of the DOTs use on-call/IDIQ/continuing consultants for project design often or almost always. Conversely, lump-sum contracting for consultants is seldom or never used by a majority (60%) of the state agencies. 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 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 DOTs believe that their procurement of professional services consultants is accomplished in a timely fashion. This is interesting when compared with the finding from an earlier question, that found close to half (44%) of the DOTs averaged six months or more for consultant procurement.

The last two questions shown in Table 3 focused on tracking and evaluation of consultant performance. DOTs were asked how frequently they compared and evaluated consultant vs. in-house schedule and cost performance on projects of similar scope. The majority of DOTs seldom or almost never compared and evaluated either schedule (65%) or cost (52%) performance. Only 9% of the DOTs often or always compared and evaluated each of the performance metrics.

Survey participants were also asked if their DOT utilized Management Consultants to manage design consultants. Only a third (33%) of the 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 DOTs (31%) utilized Management Consultants sometimes. In summary, Management Consultants are utilized often or almost always by only 19% of the DOTs that use consultant managers, and those 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 DOTs participating in this study.

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 are tabulated in Table 4.

TABLE 4 Procurement Effectiveness of Professional Services Consultants

Topics of Inquiry	**Mean**	**Effectiveness**				
		Not Effective	Slightly Effective	Mod. Effective	Very Effective	Extremely Effective
Well-defined scope prior to advertisement	4.06	0%	3%	18%	49%	30%
Standardized estimating/scoping templates	3.91	0%	0%	30%	49%	21%
Pre-qualification of consultants	3.69	9%	14%	16%	25%	38%
Reducing the # and time for approvals	3.64	3%	9%	27%	43%	18%
Tracking procurement milestones	3.61	3%	6%	40%	30%	21%
Lumpsum contracts for consultants	2.48	19%	32%	29%	20%	0%

The most effective procurement action was the development of a well-defined project scope prior to advertisement. Seventy-nine percent (79%) of the DOTs indicated that this activity was very or extremely effective for reducing the procurement time period. 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. 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 somewhat less effective, with 63% of 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.

ADDITIONAL ANALYSIS & FINDINGS

The project development durations for each DOT were summarized to facilitate comparative analysis. To assemble the listing, the average durations for CE and Environmental Assessment (EA) projects were calculated for each 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 DOTs as shown in Figure 5.

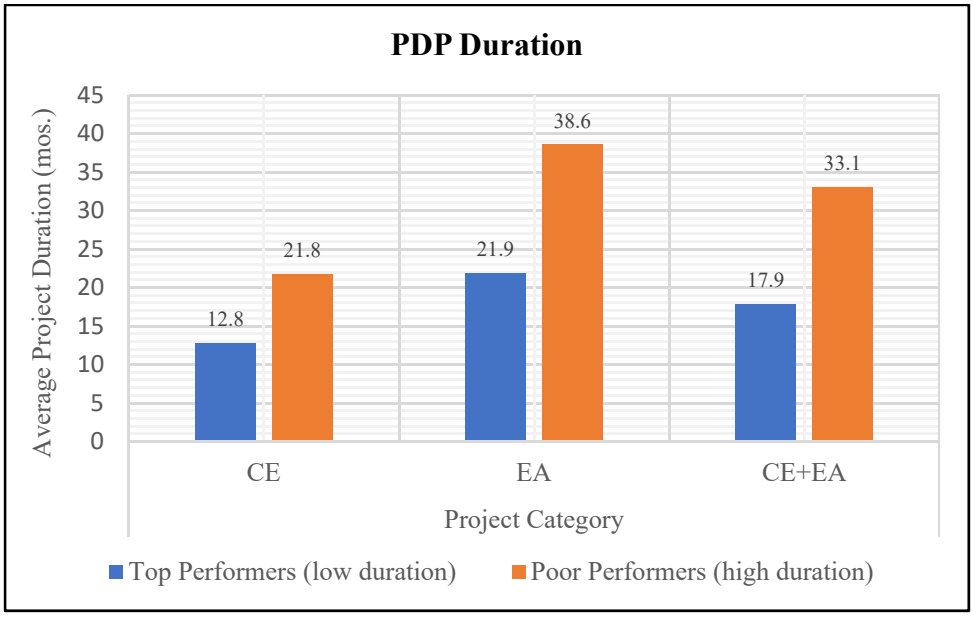


FIGURE 5 Project Duration

The Top Performers in Figure 5 represent the average duration of those DOTs in the top half with an average project development duration that was substantially less than the Poor Performing DOTs. For all three project categories, the average project development duration for the top performers was nearly half the project duration of the poorer performing DOTs. Statistical testing found the duration differential for all three categories (CE, EA, CE+EA) to be statistically significant.

Comparative analysis utilizing project duration indicators (CE, EA & CE+EA) was used to analyze various response groupings of the survey data. 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 sections.

Preconstruction Department Structure: The survey question addressing the organizational structure of the DOT's preconstruction department offered three response options – centralized, decentralized, and hybrid. Three-quarters of the top performers represented in Figure 5 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, DOTs with a centralized preconstruction department had a statistically significant longer project development duration than DOTs with a decentralized or hybrid preconstruction department.
- The average combined project development duration for CE & EA projects for DOTs with a centralized preconstruction department was a statistically significant longer project development duration than the duration for 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 DOTs with a centralized preconstruction department.

Preconstruction Department Organization for Projects: 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 $\alpha = .05$. But, with t-tests using an $\alpha = .10$, there was a statistically significant finding that provided support for 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 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 initial scope of the project. Conversely, two-thirds (67%) of the Poor Performing 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 for the reduction of 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.

CONCLUSIONS

The transportation infrastructure needs of states across the U.S. continue to expand, and funding remains limited. In this environment, STAs are under increasing pressure to design and develop projects within a shorter timeframe and to 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 wide-spread participation in this study. Conclusions supported by the findings of this study 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 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***:** Development of 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 DOTs participating in this study place a high value on performance tracking and evaluation. In addition, there were limited differences between the participating 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 DOTs for CE and EA was 22mos and 39mos, respectively. The PDP for the poorer performing DOTs was almost twice as long for project development. While most DOTs indicated that they have similar processes, top performers apparently 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. In addition, 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 DOTs have a need and/or an opportunity to reduce their procurement timeframe. To reduce the duration of procurement, almost all of the top-performing 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 the time for procurement.

Performance evaluation of Professional Services Consultants is needed: The majority of 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 effectively evaluate the use of in-house versus consultant design services.

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

LIMITATIONS OF THE STUDY

The limitation of this study primarily focuses 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, but in the final analysis, the validity and reliability of the data largely depend on the individual SME respondent's assessment of their agency PDP.

FUTURE RESEARCH

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. The processes of poor performers should be compared to those of top performers to determine the most effective approach and identify the drivers for top performance.

ACKNOWLEDGEMENT

The authors acknowledge the South Carolina Department of Transportation (SCDOT), which provided funding for this research. The authors also acknowledge Matt Lifsey, an industry professional, for his expertise and contribution to this research effort.

DISCLAIMER

The contents of this paper reflect the views of the authors who are responsible for the facts and the accuracy of the presented data. The contents do not reflect the official views of any state or federal agency. This study is based on the insight, experiences, and data collected from the state DOTs.

AUTHOR CONTRIBUTION STATEMENT

In terms of author contributions, Tanin A. Haidary and Dennis C. Bausman were involved in study conception, methodology, survey development, data collection and analysis; Dennis Bausman, Tanin Haidary, and M. Chowdhury in manuscript preparation. All authors reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Sperling, E., & Ross, C. (2018). Strategically aligning capital improvement prioritization to performance goals. Transportation Research Record, 2672(51), 68-78. doi:10.1177/0361198118787639

2. Hillis, D., Jones, J., & Ekern, D. (2016). Executive Strategies to Deliver Practical Design (No. NCHRP Project 20-24, Task 102).

3. Crossett, J., & Oldham, S. (2005). Framework for measuring state transportation agency performance in context-sensitive solutions. Transportation Research Record: Journal of the Transportation Research Board, 1904(1), 84-92. doi:10.1177/0361198105190400109

4. Fields MG, Purnell S. 23rd Annual Highway Report on the Performance of State Highway Systems. Reason Foundation Policy Study. 2018 Feb(457).

5. Berger, L. and I. Associates, Design-Build Environmental Compliance Process and Level of Detail: Eight Case Studies, 2005.

6. McMinimee, J. C., Schaftlein, S., Warne, T. R., Detmer, S. S., Lester, M. C., Mroczka, G. F., ... & Yew, C. (2009). Best practices in project delivery management (No. NCHRP Project 20-68A).

7. Wood, H. P., Kassoff, H., McGrath, T., Malley, W. G., Rose, D. C., & Skinner, N. (2014). Guidance for Managing NEPA-Related and Other Risks in Project Delivery, Volume 2: Expediting NEPA Decisions and Other Practitioner Strategies for Addressing High Risk Issues in Project Delivery (No. NCHRP Project 20-24, Task 71).

8. Beaty, C., Ellis, D., Glover, B., & Stockton, B. (2016). Assessing the costs attributed to project delay during project pre-construction stages (No. Report 0-6806-FY15 WR# 3). Texas. Dept. of Transportation

9. Kermanshachi, S., Anderson, S. D., Goodrum, P., & Taylor, T. R. B. (2017). Project scoping process model development to achieve on-time and on-budget delivery of highway projects. Transportation Research Record, 2630(1), 147-155. doi:10.3141/2630

10. Wood, H. P., Kassoff, H., McGrath, T., Malley, W. G., Rose, D. C., & Skinner, N. (2011). Guidance for Managing NEPA-Related and Other Risks in Project Delivery,

Volume 1: Guide for Managing NEPA-Related and Other Risks in Project Delivery (No. NCHRP Project 20-24).

11. Moss, V., H. Dinçer, and Ü. Hacıog˘lu, State financed social housing model in South Africa requires capacity building injection. In Handbook of Research on Behavioral Finance and Investment Strategies: Decision Making in the Financial Industry, IGI Global, 2015, pp.338–349.

APPENDIX F

EVALUATION OF PROJECT DEVELOPMENT PROCESS AT STATE TRANSPORTATION AGENCIES

Weimin Jin
Ph.D. Student
Clemson University
Glenn Department of Civil Engineering
Clemson, SC 29634
Tel: (864)-952-7678
Email: weiminj@clemson.edu

Tanin A. Haidary
Ph.D. Candidate
Clemson University
Nieri Family Department of Construction Science and Management
Clemson, SC 29634
Tel: (864)-624-6216
Email: thaidar@g.clemson.edu

Dennis C. Bausman, Ph.D., FAIC, CPC
Constructor Certification Commission
Professor and CSM Endowed Faculty Chair
Clemson University
2-133 Lee Hall, Clemson, SC 29634
Tel: (864)-656-3919
Email: dennisb@clemson.edu

Mashrur Chowdhury, Ph.D., P.E., F.ASCE
Eugene Douglas Mays Endowed Professor of Transportation
Clemson University
Glenn Department of Civil Engineering
216 Lowry Hall, Clemson, SC 29634
Tel: (864) 656-3313 Fax: (864) 656-2670
Email: mac@clemson.edu

Word count: 5,322 words text + 7 table x 250 words (each) = 7,072 words

Submitted 8/6/2020

ABSTRACT

In the United States, transportation agencies across the country are increasingly challenged to deliver projects with greater speed and efficiency. This study evaluated the comprehensiveness of the PDPs adopted by different states. The authors excluded ten (10) states from their study due to the lack of available online data. The authors developed a three-step method to assess the comprehensiveness of the PDP, which was informed by a review of each state's PDP and related literature. The authors then developed a series of criteria for assessing the comprehensiveness of the PDPs of 40 State Departments of Transportation (DOTs), which was used to amass and analyze that multi-state information to explore individual PDP variations and comprehensiveness. Data analysis indicated a wide variance from state-to-state in the comprehensiveness of each criterion with a similar comprehensiveness characterizing the PDPs in twenty (20) states. Additionally, the authors conducted an Analytic Hierarchy Process (AHP) to weight the criteria and rank PDP comprehensiveness. Through the AHP, PDP components relating to the process were determined as the most important criterion in the hierarchy. Environmental studies/documentation/permits, the number of tasks in PDP flowcharts, and value engineering had the highest weight among the sub-criteria of the PDP components, PDP flowchart, and other improvements, respectively. To demonstrate how the evaluation method works, a case study that produced a list of rankings of the comprehensiveness of the state's PDP was presented. The first five states identified through our ranking process were as follows: Wisconsin, California, Michigan, Florida, and Georgia.

Keywords: Project development process, Evaluation, Random forest classification, Analytic hierarchy process

INTRODUCTION

A well-defined and current Project Development Process (PDP) is crucial for any state Department of Transportation (DOT) to effectively meet the transportation needs of the state. A PDP helps to ensure that the appropriate project is selected, properly planned, and delivered in accordance with governing regulations. Careful and comprehensive coordination between all components that are parts of a project is required, including the following- planning and programming, schedule, design, environmental evaluation, right-of-way acquisition, permits, utility and railroad coordination, plans, specifications and estimates (PS&E), construction, and maintenance (*1*).

The Texas Transportation Institute (*2*) identified two issues that can result in project delay, most particularly an absence of documentation and poor project definition. State transportation agencies struggle with the variation, the lack of details, and insufficient documentation corresponding to PDP, which often leads to delays and cost increases (*2*, *3*). A previous study found that an insufficient defined project scoping process has a high risk of producing increases in cost and time (*3*). Cost increases and time delays on one project can result in the funding reduction and elimination for other projects because the funding related to transportation projects were limited (*4*). These outcomes can harm the relationships between state transportation agencies and the public and legislative institutions (*3*). The Florida Department of Transportation (FDOT) identified opportunities that could accelerate pre-construction project delivery. Specifically, FDOT conducted a Value Engineering (VE) review on project development, environmental studies, and final design to identify key issues that affect the project delivery. It turns out that enhancing and updating the existing practices on project delivery resulted in considerable cost and time reductions (*5*). An effective and comprehensive PDP will guide state transportation agencies to make the right decisions to meet desirable outcomes for the projects or/and programs, thus accelerate and streamline the project delivery. PDP documents provide written processes that guide project managers, traffic engineers, and stakeholders during the project delivery process. PDP documents are valuable materials that help state transportation agencies to efficiently meet their state's needs. The objective of this study was to evaluate the comprehensiveness of the PDP adopted by different states in the United States.

LITERATURE REVIEW

Past studies often focus on specific activities of a PDP such as the Project Scoping Process (PSP) and were targeted to reduce the delays and costs of project development. Various evaluation methods were adopted in the scoping process. For example, in their assessment of project scoping processes, Kermanshachi et al. observed a considerable variation in terms of the definition of those processes (*3*). They also noted a great variance of the characteristics of the PSP across states, particularly in terms of the end and the beginning of project scoping during the PDP (*3*). Based on these findings (*3*), Kermanshachi's research team redefined PSP and developed a PSP framework to accelerate the delivery of highway projects.

In their evaluation of the current practices of PSP in the highway industry, Kermanshachi et al. (*6*) developed a multi-level project scoping model for transportation projects. Specifically, they used resources from the literature to assess current industry practices for the development of alternative scoping processes. They then used the integrated definition modeling technique to develop these scoping processes. Their proposed scoping model consisted of four levels, composed of 20

activities and 84 sub-activities. The development of such a comprehensive and detailed project scoping process model led to the adoption of appropriate best practices and strategies, which reduced costly scope changes and prevented unnecessary project delays (*6*).

Odreman and Hessami found that the absence of a defined PDP hindered the efforts of Metropolitan Planning Organizations (MPOs) to implement metropolitan transportation programs and transportation improvement plans (*7*). They, in turn, presented a robust project-scoping framework tailored explicitly for these MPOs (*7*).

Le et al. (*1*) identified a comprehensive list of elements in the scope activity and evaluated the level of definition of the elements quantitatively. After assessing the level of clarity of each element of scope and the entire project, they identified the potential project risk and developed a scheme to manage likely high-risk elements (*1*).

A study (*5*) reported several tasks performed by FDOT to enhance pre-construction project delivery practices. FDOT evaluated the existing practices in the pre-construction project delivery at both the statewide and district levels by conducting a VE study on project development, environment studies, and final design. Based on the evaluation results found in the VE study, several recommendations were generated and later were approved for implementation by District IV of FDOT.

Samsami et al. (*8*) presented their research progress of a National Cooperative Highway Research Program (NCHRP) project that they were involved with. This NCHRP project focused on implementing constructability reviews in the PDP. They found that constructability practices varied from state to state. Constructability reviews should include some aspects of VE and quality management. Some state DOTs have implemented the constructability in the review of their projects.

Kenney et al. (*9*) identified project inconsistency with transportation plans and improvement programs in the PDP. They found that the primary reason contributing to this inconsistency was insufficient communication between the local, state, and federal agencies, when any changes to projects' scope, cost, and letting date occurred.

Garza and Pishdad-Bozorgi (*10*) evaluated the readiness of the project team who undertook the flash track projects for two projects by employing the Delphi process and Analytic Hierarchy Process (AHP). During the evaluation process, they ranked six practice categories, including 19 critical practices. They found that the importance of six practice categories for managing flash track projects is safety, execution, planning/evaluation/environmental practices, right-of-way and utility issues, contractual considerations, and operations and public engagement.

Popic and Moselhi (*11*) implemented the AHP to determine the weights of variables and identified the best project delivery system for capital projects. They determined that integrated project delivery was ranked the first, construction management at risk was ranked the second, and the fast track was ranked the third.

At the present time, few if any detailed investigations have been undertaken to assess the comprehensiveness of the PDP adopted by different states. The intent of this study was to address this research gap, particularly through the creation of a three-step method to evaluate the comprehensiveness of the PDP, as described in the following sections.

RESEARCH METHOD

A three-step method was used to develop the evaluation procedure of PDP, as shown in Figure 1.

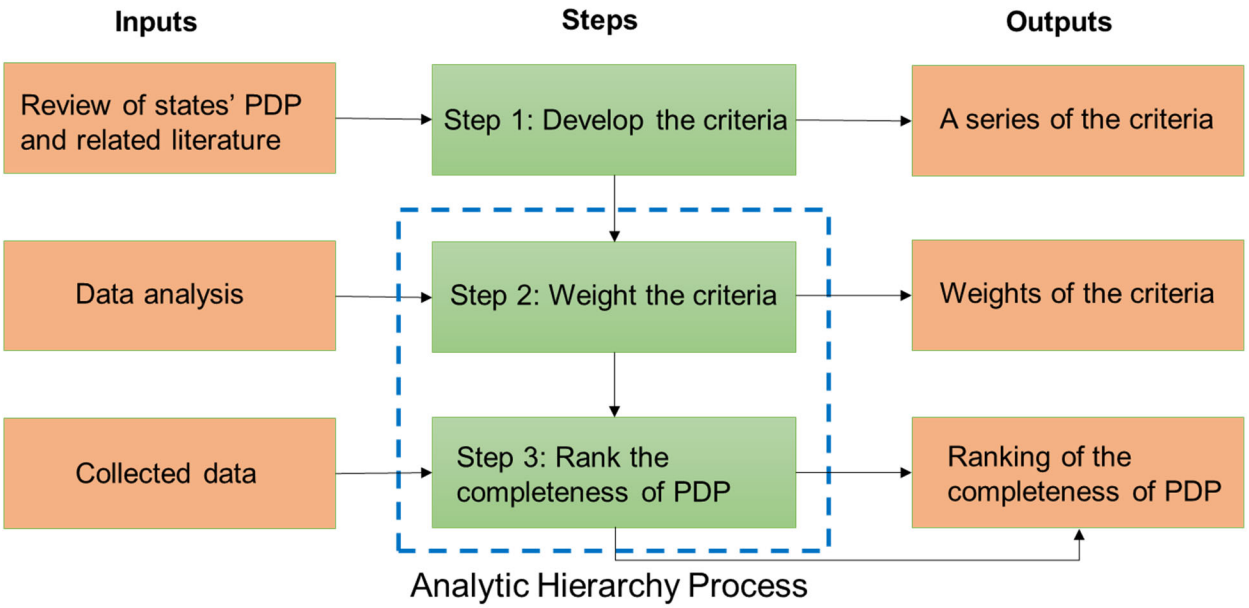


Figure 1 Research Method Steps

Step 1: Develop a series of criteria for the evaluation.

The first step in developing the evaluation method was to identify the components that should be incorporated into a comprehensive PDP. The authors identified a comprehensive list of criteria through a review of published State DOT's PDP (*12–20*), Federal Highway Administration (FHWA)'s guidelines (*21*), and literature (*1*, *3*, *22–25*) related to the PDP. A list of documented and undocumented criteria obtained from representative PDP related studies and publications from State DOTs and organizations including FHWA, AASHTO, TRB, ASCE, and NCHRP, as shown in Table 1.

Table 1 A list of documented and undocumented criteria

Criterion	Source									
	Caltrans (*12*)	Louisiana DOT (*13*)	Ohio DOT (*14*)	Wisconsin DOT (*15*)	New York DOT (*17*)	FHWA (*21*)	NCHRP (*26*)	TRB (*3*)	ASCE (*1*)	AASHTO (*27*)
PDP Flowchart	×	×	×	×	×	×				
Project Planning	×	×	×	×	×	×	×	×	×	
Survey and Mapping	×	×	×	×		×				
Preliminary Design	×	×	×	×	×	×	×	×	×	
Right of Way	×	×	×	×		×	×	×		
PS&E	×		×	×	×	×	×	×		
Final Design	×	×	×	×	×	×	×	×	×	
Contract Administration	×	×	×	×	×	×		×		
Environmental Studies/Documentation/Permits	×	×	×	×	×	×	×	×		
Utility/Railroad Coordination	×	×	×	×	×	×	×	×		
Construction	×	×	×			×	×	×	×	
Project Management	×	×		×						×
PDP Difference based on Project/Program Types	×	×	×	×	×					
Value Engineering	×	×	×	×	×					×
Risk Assessment/Management	×	×			×		×		×	×
Quality Management	×				×					

×: documented criterion

Ten essential PDP criteria were initially identified during the review process (*21*, *22*):

- Project Planning
- Survey and Mapping
- Preliminary Design
- Right of Way
- Utility/Railroad coordination
- PS&E
- Final Design
- Contract Administration
- Construction

- Environmental Studies/Documentation/Permits

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

PDP Document Year of Publication and Update

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

Project Management

Several states (*12–14*) discussed project management as a means to improve the project delivery process. Indeed, one such NCHRP report (*25*) indicated that project management is one of the best practices that characterize successful project delivery. Good project management is essential to facilitate the successful delivery of a project with a properly defined scope that meets the quality, time, and cost constraints of the project. Conversely, poorly documented project management procedures result in inconsistency and inefficiency in the development of projects. Thus, documentation of project management's roles and responsibilities was added to the evaluation criterion concerning the comprehensiveness of a state's PDP.

PDP Difference based on Project/Program Types

Different project types, programs and/or funding sources, population densities, environmental impacts, and geographic location can have a significant impact on the PDP. As a result, these variables must be considered in the PDP to address the economic, social, environmental, and geographic differences as well as the changing federal and state legal requirements (*12*). In some states (*12*, *15–17*, *20*, *28*), 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 project development process are essential to ensure the proper adjustment of individual state processes to meet these varying requirements.

PDP Flowchart

A flowchart is an effective method that a number of states (*12–14*, *16–19*, *28–30*) have incorporated in their PDP documentation to graphically convey the development process. Three criteria were identified in the PDP flowchart to assess the degree of flowchart development: a) the number of project-specific flowcharts, b) the number of control points (milestones) in the flowcharts, and c) the level of detail (number of tasks) in the flowchart (s).

Other Improvements

Past studies proposed other possible strategies to improve the efficiency of PDP. Based on the literature search (*1*, *13–15*, *30–32*), other possible improvement strategies included Value Engineering (VE), risk assessment/management, and quality management. The primary objective of a VE study 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 (*17*). Half of the states do VE in their projects based on data gathering. In June 2013, Florida DOT initiated a VE study of the project development and environment process to streamline the processes of the majority of their projects. Some DOTs (*30*, *33*) have incorporated risk management into project delivery. In one NCHRP report (*25*), risk management is accounted for as one of the best practices during project delivery. Risk management can improve the achievement of the desired project results within scope, cost, schedule, and quality (*17*). 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 (*17*). Although the 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.

Step 2: Weighting the Criteria through AHP

Once the criteria were developed in Step 1, the second step in developing an evaluation method was to weight the criteria. Although all criteria were critical to the evaluation of the comprehensiveness of the PDP, they may have different relative weights. Criterion with a higher weight would have a significant impact on the evaluation results. If the weight of each criterion was 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. In this study, it's hard to determine directly how much the documentation year of publication and update is more or less important than project management. In tackling this issue, the authors determined that AHP would be the most suitable way to weight the criteria (*10*, *11*, *34*). The advantage of the AHP is that not only the underlying data information but also human judgments can be used during the evaluation procedure. AHP allows varying and incommensurable criteria to be compared to one another rationally and consistently. This advantage distinguished AHP from other decision-making techniques (*34*).

The authors followed the AHP typical steps and developed a process for weighting the criteria. The authors first defined the problem, which was to rank the comprehensiveness of PDP. Then, the authors decomposed their problem into a hierarchy of more easily comprehended sub-problems, as shown in Figure 2. The problem was firstly decomposed by the following six main criteria: PDP components, PDP flowchart, project management, documentation year of publication and update, PDP difference concerning different types of projects, and other improvements. Then, the PDP components were decomposed by ten sub-criteria, which were project planning, survey and mapping, preliminary design, right of way, utility/railroad coordination, PS&E, final design, contract administration, construction, and environmental studies/documentation/permits. Three sub-criteria were decomposed in the PDP flowchart: the number of project-specific flowcharts, the

number of control points (milestones) in the flowchart, and the number of tasks in the flowchart. The other improvements were decomposed by VE, risk assessment/management, and quality management.

Once the hierarchy was developed, the authors systematically evaluated its 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, the weight of project planning could be determined through being compared with survey and mapping, preliminary design, right of way, utility/railroad coordination, PS&E, final design, contract administration, construction, and environmental studies/documentation/permits. In the pairwise comparison procedure, the subject matter experts were construction management researchers involved in this study. The team of the subject matter experts consisted of a principal investigator, a co-principal investigator, and two graduate research assistants. The team was led by the principal investigator with over 22-year experience in construction management projects. The co-principal investigator has more than ten years of experience in construction management and is involved with various types of transportation projects. One graduate research assistant has five-year experience in construction management projects, and another graduate research assistant has five-year experience in transportation projects. In determining the weights of incommensurable criteria, the subject matter experts used their subject matter expertise in determining a criterion's weight. In determining the weights of commensurable criteria, the subject matter experts used collected data such as the number of pages in the document relating to each criterion to determine a criterion's weight. For example, the higher the number of pages in the document relating to the criterion, the more weights should be put on the criterion. Through the pairwise comparison procedure, the authors obtained all comparison results from the subject matter experts to develop the set of pairwise comparison matrices. Multiple comparison results were synthesized by using their geometric mean.

Step 3: Rank the comprehensiveness of the PDP through AHP

The last step in developing the evaluation method was to rank the comprehensiveness of the PDP through the AHP. As shown in Figure 1, this step needed inputs of weights of each criterion from Step 2 and the collected information on the criteria. The primary task in Step 3 was to determine how much one state's PDP is more/less comprehensive than another. In the pairwise comparison, the rating procedure of each state's PDP employs mathematical functions that convert the quantities of the criteria to the corresponding rating score. Here, the 100 point scale score rating was used. Since the information of all criteria for each state's PDP was collected, human judgments were not involved with the rating procedure of each PDP. Once the rating process of all criteria for each state's PDP was completed, the ranking of the comprehensiveness of the PDP for all states was generated.

Based on the identified criteria, the authors collected data for 19 criteria. The authors searched all states' PDP manuals by using different research databases, search engines, and the State DOTs' websites. Forty states' PDP documents were found online in their State DOT website. Of 40 state PDPs, four (4) states, which are Florida, North Carolina, Washington, and Nevada, focus on project management guidance.

The remaining ten (10) states do not have PDP manuals published in their DOT websites based on the authors' search. The authors excluded these states from their study due to the lack of available

online data. These states are Tennesse, Hawaii, Montana, New Hampshire, New Mexico, North Dakota, Rhode Island, South Dakota, West Virginia, and Wyoming.

The basic statistics of the criteria were shown in Table 2. The range of the criteria was wide, and the Standard Deviation (SD) of the criteria was much larger than the mean of the criteria. This indicated that the comprehensiveness of each criterion varied highly from one state to another state.

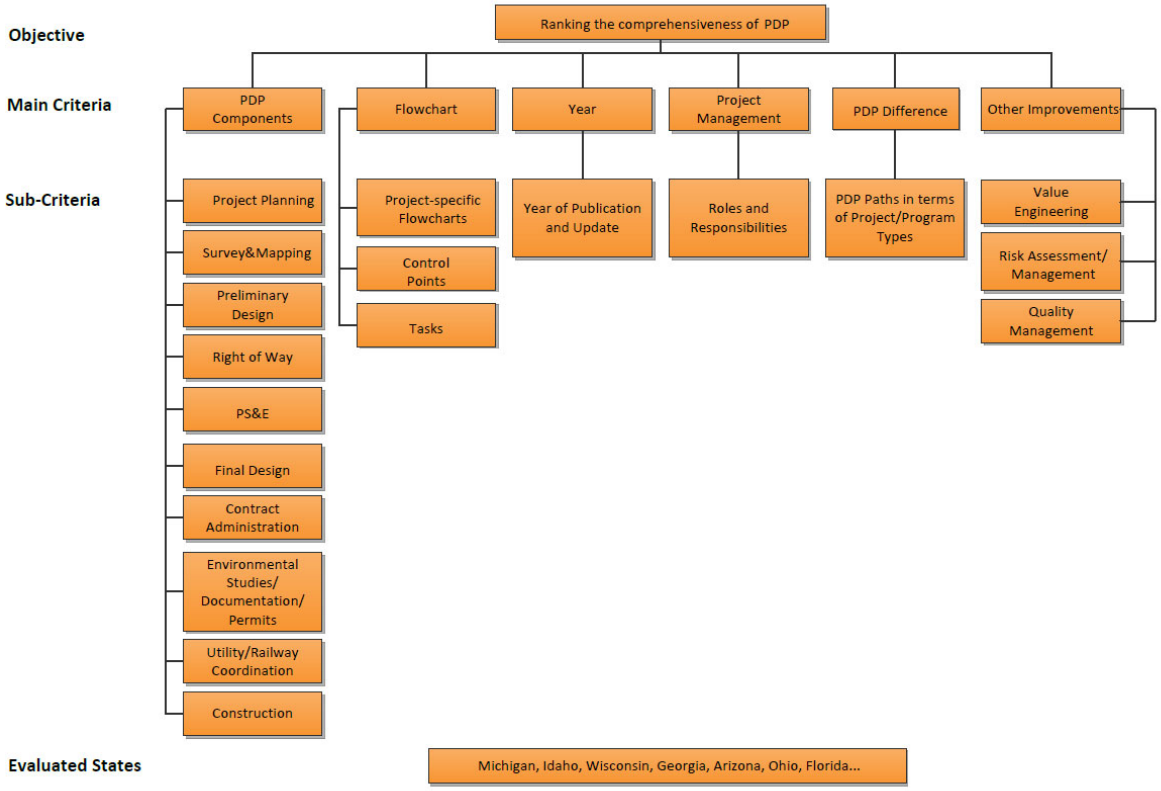


Figure 2 Hierarchical Tree for Ranking PDP

DATA COLLECTION

Table 2. Basic Statistics of Criteria

Criteria		Min	Mean	Max	SD*
Documentation Year of Publication and Update		1995	2015	2019	5
PDP Flowchart	The number of project-specific flowcharts	0	0.7	3	0.8
	The number of control points (milestone) in the flowcharts	0	2.5	31	6
	The number of tasks in the flowcharts	0	28	230	48

Criteria		Min	Mean	Max	SD*
PDP Components	The number of document pages of project planning	0	8	47	11
	The number of document pages of survey & mapping	0	8	94	20
	The number of document pages of preliminary design	0	16	196	36
	The number of document pages of right of way	0	8	54	11
	The number of document pages of PS&E	0	7	84	16
	The number of document pages of the final design	0	10	60	16
	The number of document pages of contract administration	0	5	30	7
	The number of document pages of environmental studies/documentation/permits	0	12	94	17
	The number of document pages of utility/railroad coordination	0	7	80	14
	The number of document pages of construction	0	3	16	4
The number of document pages of project management		0	3	30	6
PDP Difference based on Project/Program Types	The number of PDP paths	1	2	6	1
Other Improvements	The number of document pages of value engineering	0	2.6	31	6
	The number of document pages of risk assessment/management	0	3	90	15
	The number of document pages of quality management	0	1	25	5

*Standard Deviation

DATA ANALYSIS

Based on the collected data, the authors conducted the following data analysis to help the authors to investigate the characteristic of current PDPs of states. Some criteria with high occurrence indicate that these criteria were documented widely across the country. In contrast, some criteria with low occurrence frequency indicate that these criteria were not documented widely across the country.

As shown in Table 3, the authors found the following:

- Of 40 states, 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 states had 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 states had a construction component in the PDP.
- Approximately one-third of PDPs documented project management.
- The majority of states used only one PDP for all projects.
- Approximately one-third of the states had multiple variations for their PDP.
- Half of the states do VE during the process of project development.
- State DOTs rarely documented risk assessment/management and quality management.

Although the 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.

Table 3. Occurrence Frequency of Criterion in the PDP Across States

Criterion	Having the Criterion		Not Having the Criterion	
	Frequency	Percentage	Frequency	Percentage
PDP Flowchart	19	48%	21	52%
Project Planning	36	90%	4	10%
Survey and Mapping	34	85%	6	15%
Preliminary Design	36	90%	4	10%
Right of Way	39	98%	1	2%
PS&E	35	88%	5	12%
Final Design	36	90%	4	10%
Contract Administration	36	90%	4	10%
Environmental Studies/Documentation/Permits	40	100%	0	0%
Utility/Railroad Coordination	38	95%	2	5%
Construction	23	58%	17	42%
Project Management	13	33%	27	67%
PDP Difference based on Project/Program Types	14	35%	26	65%
Value Engineering	20	50%	20	50%
Risk Assessment/Management	7	18%	33	82%
Quality Management	3	8%	37	92%

The authors evaluated the year of publication and update for the State PDPs. Figure 3 displays the distribution of the publication and update years for the forty states. Two-thirds of the PDPs were published/updated within the past five years, indicating that a majority of states update their PDP to maintain their relevancy.

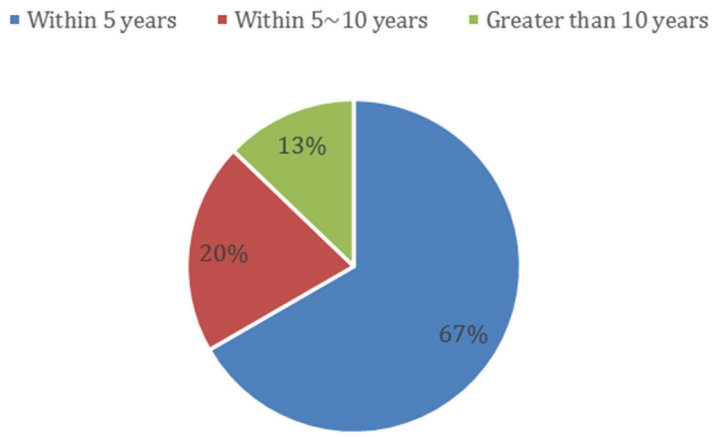


Figure 3 Documentation Year of Publication and Update

The similarity and the differences between PDPs, regarding comprehensiveness, were explored to determine the number of states with similar PDP comprehensiveness. The authors implemented a random forest model to distinguish different groups among all states. Using the "RandomForest" library in R software (*35*) can appropriately classify the PDPs. The variables used in the random forest model were criteria presented in Table 2. There were 40 observations (i.e., PDPs of states) that were used as inputs of the model. Each observation includes a series of variables. Table 4 shows representative data used for developing the random forest model. The algorithm of the random forest model generated a proximity matrix to identify the similarity between PDPs of states. Based on the random forest model, 40 states were divided into three groups.

The states with similarity in the variables were clustered in the same group. Three distinct groups are shown in Figure 4 (the figure is two-dimensional). The comprehensiveness of the states' PDPs was similar within a group, while the comprehensiveness of different states' PDPs significantly varied among three different groups. It presented that half of the states had similar comprehensiveness of the PDP. The names of states in each group were noted in Table 5, and twenty (20) states were in the third Group. The classification process is different from the AHP evaluation process. Within a group, the ranking score of each state could vary. Even though twenty states have similar comprehensiveness of PDP in the third Group, these states do not necessarily have the same ranking scores (generated from the AHP).

Table 4 Representative data used for developing the random forest model

Variables	**Observation 1**	**Observation 2**	**Observation 3**	**Observation 4**	**…**
	Michigan	Wisconsin	Kentucky	Pennsylvania	…
Documentation Year of Publication and Update	2018	2019	2016	2002	…
The number of project-specific flowcharts	1	1	0	0	…
The number of control points (milestone) in the flowcharts	31	8	0	0	…
The number of tasks in the flowcharts	104	36	0	0	…
The number of document pages of project planning	33	5	1	2	…
The number of document pages of survey & mapping	94	80	52	2	…
The number of document pages of preliminary design	196	60	14	7	…
The number of document pages of right of way	27	15	20	2	…
The number of document pages of PS&E	2	40	2	0	…
The number of document pages of the final design	44	60	18	5	…
…	…				…
Grouping results based on the random forest model	**Group 1**	**Group 1**	**Group 2**	**Group 3**	…

Table 5. Distinct Groups of States

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

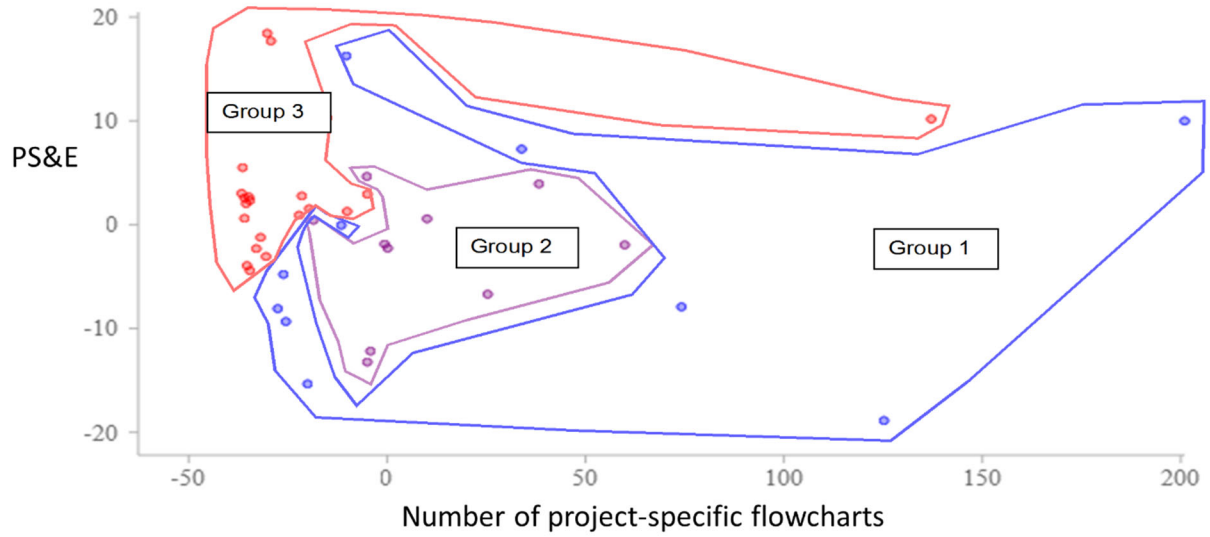


Figure 4 Groups Generated by the Random Forest Model

EVALUATION RESULTS

This section represented the weights of the criteria and the ranking of the comprehensiveness of the PDP.

Weights of the Criteria

The weight of each criterion was identified through the AHP. The weights of both criteria and sub-criteria are shown in Table 6. 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 PDP, and most of the state DOTs had the PDP components based on the data analysis. Among the sub-criteria of PDP Components, Environmental Studies/Documentation/Permits (4.8%) had the highest weight. Among the sub-criteria of PDP Flowchart, 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.

Ranking of the Comprehensiveness of PDP

To demonstrate how the evaluation method works, a case study that produced a list of rankings of the comprehensiveness of the state's PDP was presented. Through the AHP and inputs of collected data of the criteria of each state's PDP, the PDP ranking was determined. The ranking results were presented in Table 7. These rankings are a useful reference for states to identify the comprehensiveness of their PDP. In terms of the comprehensiveness of the PDP, the State of Wisconsin ranked the highest.

Table 6. Weight of Each Criterion

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 based on Project/Program Types	14.7%	The number of PDP paths	14.7%
Other Improvements	9.8%	Value Engineering	4.9%
		Risk Assessment/Management	2.5%
		Quality Management	2.5%
Sum	100%	Sum	100%

Table 7. Example of PDP Rankings

State	Ranking	State	Ranking	State	Ranking	State	Ranking
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

CONCLUSIONS

The authors reviewed literature related to the improvements of PDP and PDP documents of different state DOTs. This paper identified 19 criteria and collected information for each criterion from 40 states (PDP documents of the other 10 states are not published online according to on-line search by the authors). The authors analyzed data and 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, the authors determined the weights of each criterion. The authors found that PDP Components was the most important criterion, and its weight was 42.2%. Among the sub-criteria of PDP Components, Environmental Studies/Documentation/Permit had the highest weight. Among the sub-criteria of the PDP flowchart, the number of tasks in a flowchart had the highest weight. Among the sub-criteria of other improvements, Value Engineering had the highest weight.

Finally, the comprehensiveness of the PDP was evaluated, and a list of the rankings of the PDP was generated through the AHP. By following the PDP evaluation process depicted in this paper, a state can identify the comprehensiveness of its PDP and develop better project development initiatives by correcting the discrepancies identified in the comprehensiveness evaluation.

FUTURE RESEARCH

The criteria and their importance identified in this study were indicators of critical components in the PDP, which will help DOTs to focus on future PDP practice development and process improvement that could enhance the project delivery process. Based on the evaluation of the comprehensiveness of the PDPs, the research team will screen a few candidate states that have a high ranking in the comprehensiveness of the PDP for further face-to-face or phone interviews in a follow-up research.

ACKNOWLEDGMENT

The authors acknowledge the South Carolina Department of Transportation (SCDOT), which provided funding for this research.

DISCLAIMER

The contents of this paper reflect the views of the authors who are responsible for the facts and the accuracy of the presented data. The contents do not reflect the official views of SCDOT or FHWA. Weights and ranking provided to each state's PDP process in this study are entirely based on the availability of the information to the authors during on-line access to the corresponding department of transportation's website at the time of the research.

AUTHOR CONTRIBUTION STATEMENT

In terms of author contributions, Weimin Jin, Tanin A. Haidary, Dennis C. Bausman, and Mashrur Chowdhury were involved in study conception and design; W. Jin and T. Haidary were responsible

for data collection; W. Jin, and M. Chowdhury for interpretation of results; and W. Jin, T. Haidary, D. Bausman, and M. Chowdhury in manuscript preparation. All authors reviewed the results and approved the final version of the manuscript.

REFERENCE

1. Le T, Caldas CH, Gibson GE, Thole M. Assessing Scope and Managing Risk in the Highway Project Development Process. J Constr Eng Manag. 2009;135(9):900–10.
2. Beaty C, Ellis D, Glover B, Stockton B. Assessing the Costs Attributed to Project Delay During Pre-Construction Stages. 2016.
3. Kermanshachi S, Anderson SD, Goodrum P, Taylor TRB. Project Scoping Process Model Development to Achieve On-Time and On-Budget Delivery of Highway Projects. Transp Res Rec J Transp Res Board. 2017;2630(1):147–55.
4. AASHTO. Practical guide to cost estimating. AASHTO Washington, DC; 2013.
5. Peterson S, Braun S, Salazar J, Balmaseda MS. Accelerating Pre-construction Project Delivery. In: TRB 2017 Annual Meeting. 2017.
6. Kermanshachi S, Safapour E, Anderson S, Goodrum P, Taylor T, Sadatsafavi H. Development of Multi-Level Scoping Process Framework for Transportation Infrastructure Projects Using IDEF Modeling Technique. In: TRB 2019 Annual Meeting. 2019.
7. Odreman GJ. Project Scoping Process for Metropolitan Planning Organizations. 2018;
8. Samsami R, Minchin RE, Tran D, Tian Y, Scott S, D'Angelo D, et al. A Report on the NCHRP 10-99 Project Framework for Implementing Constructability Across the Entire Project Development Process: NEPA to Final Design. In: TRB 2019 Annual Meeting. 2019.
9. Kenney M. Maintaining Project Consistency throughout the Project Development Process. In: TRB 2015 Annual Meeting. 2015.
10. Garza JM de la, Pishdad-Bozorgi P. Virginia Department of Transportation Flash Tracking Best Practices for Accelerated Project Delivery. In: TRB 2018 Annual Meeting. 2018.
11. Popic Z, Moselhi O. Project Delivery Systems Selection for Capital Projects Using the Analytical Hierarchy Process and the Analytical Network Process. In: Construction Research Congress 2014. 2014. p. 1339–48.
12. Caltrans. Project Development Procedures Manual. 2018.
13. Louisiana Department of Transportation and Development. Project Delivery Manual. 2013;
14. Ohio Department of Transportation. The Project Development Process Manual. 2018.
15. Wisconsin Department of Transportation. Facilities Development Manual. 2019.
16. Illinois Department of Transportation. Illinois Bureau of Design and Environment Manual. 2017.
17. New York Department of Transportation. Project Development Manual. 2017;
18. Idaho Department of Transportation. Roadway Design Manual. 2014.
19. Iowa Department of Transportation. Project Development Process Manual. 2013.
20. Oregon Department of Transportation. Project Delivery Guide. 2017.
21. USDOT FHWA. Project Development Process Flow Chart. 2007.
22. The University of Colorado Texas A&M University. Research Report for Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs.

OOOO

2009;(September).
23. Mallett WJ, Luther L. Accelerating Highway and Transit Project Delivery : Issues and Options for Congress. 2011.
24. Bochner B, Perkinson D, Zietsman J, Higgins L. Expediting The Transportation Planning and Project Development Process to Meet Fast Paced Customer Requirements FINAL REPORT Requested by : American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Planning Prepar. 2003;(August):51.
25. Keck D, Patel H, Scolaro AJ, Bloch A, Ryan C. Accelerating Transportation Project and Program Delivery: Conception to Completion. Transportation Research Board; 2010.
26. Molenaar KR. Guidebook on risk analysis tools and management practices to control transportation project costs. Vol. 658. Transportation Research Board; 2010.
27. AASHTO. AASHTO Technical Committee on Project Management [Internet]. 2017 [cited 2020 Jul 4]. Available from: https://design.transportation.org/wp-content/uploads/sites/21/2018/03/Project-Management-Resource-Guide.pdf
28. Michigan Department of Transportation. Preconstruction Process Documentation Manual. 2018.
29. Alaska Department ofTransportation. Alaska Highway Preconstruction Manual. 2018.
30. Georgia Department of Transportation. Plan Development Process. 2019.
31. Delaware Department of Transportation. Project Development Manual. 2015.
32. Bausman D, Chowdhury M, Tupper L. Best Practices for Procurement and Management of Professional Services Contracts. 2014;140 (3):1–10.
33. Florida Department of Transportation. Project Management Webinar Series [Internet]. 2019 [cited 2019 Jul 18]. Available from: https://www.fdot.gov/designsupport/pm/webinarseries.shtm
34. Wikipedia. Analytic Hierarchy Process [Internet]. 2019 [cited 2019 Jul 18]. Available from: https://en.wikipedia.org/wiki/Analytic_hierarchy_process
35. Breiman L, Cutler A, Liaw A, Wiener M. Breiman and Cutler's Random Forests for Classification andRegression [Internet]. 2018 [cited 2019 Jul 18]. Available from: https://cran.r-project.org/web/packages/randomForest/randomForest.pdf

APPENDIX G

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?

APPENDIX H

PROJECT DEVELOPMENT PROCESS (PDP)
BEST PRACTICES AND RECOMMENDATIONS

CATEGORY A – PROJECT PRIORITIZATION AND SCOPE DEFINITION PROCESS

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.

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.

Summary of Findings:

One of the well-defined processes explored from 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 by the research team, all of them have an enhanced project prioritization process to quantify, evaluate, rank, and balance their project volume. The state DOTs interviewed were VDOT, GDOT, FDOT, KYTC, LaDOTD, and NCDOT. State DOTs such as VDOT, NCDOT, KYTC have especially well-defined and comprehensive project prioritization systems and processes.

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

For each of the DOTs interviewed, the research team evaluated the system and processes of the state DOTs project prioritization processes, criteria, and scoring systems, as summarized below.

Virginia Department of Transportation (VDOT)

VDOT project prioritization process aims to pick the right transportation projects for funding using a system called "SMART SCALE," which is a method of scoring planned projects. Using SMART SCALE, VDOT scores, and prioritize transportation projects based on an objective and outcome-based process to select the right project for funding and development. The VDOT SMART SCALE prioritization system has a simple process that includes five steps. These steps are project eligibility and funding, project application, project screening, project evaluation and scoring (Figure 1), and project prioritization and programming, which are described below.

- First, through the project funding and eligibility step, the regional entities such as MPOs and COGs, localities, and Public Transit Agencies apply for funds across the state of Virginia.
- Second, the VDOT determines if these projects meet certain criteria (such as project type, number of applications per region, or entity) to be eligible for their requested funding.
- Third, the projects are screened based on the identified and categorized need determined by VDOT in their long-term transportation plan. These project categories are Corridors of Statewide Significance, Safety, Regional Networks, Urban Development Areas, and Industrial and Economic Development Areas.
- Once the projects meet the determined need mentioned above, the projects are evaluated and scored by the VDOT scoring evaluation team shown in Figure 1. The VDOT scoring evaluation team collects data on each project and evaluate each project based on six criteria or factor. These factors are Safety, Congestion Mitigation, Accessibility, Environmental Quality, Economic Development, and Land Use.
- Once the data has been collected for each project sufficient to evaluate each factor, measure values are calculated and weighted, which leads to scoring and ranking of each project and funding consideration.

The factor measures and their respective weights are established by VDOT and are the same for all projects. The project's weight and scores are presented in a scorecard developed by the SMART SCALE. It includes a project overview, project information, project map, score summary, and a detailed measure scoring and weighing table (Figure 1). Finally, VDOT using SMART SCALE scoring and results, prioritizes the projects based on four different categories and releases the SMART SCALE result to the public for comments, which leads to the establishment of STIP or Six-Year Improvement Program (SYIP).

SMART SCALE — Funding the Right Transportation Projects in Virginia

VDOT · DRPT · Office of INTERMODAL Planning and Investment

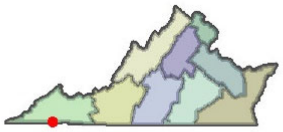
PROJECT SCORECARD

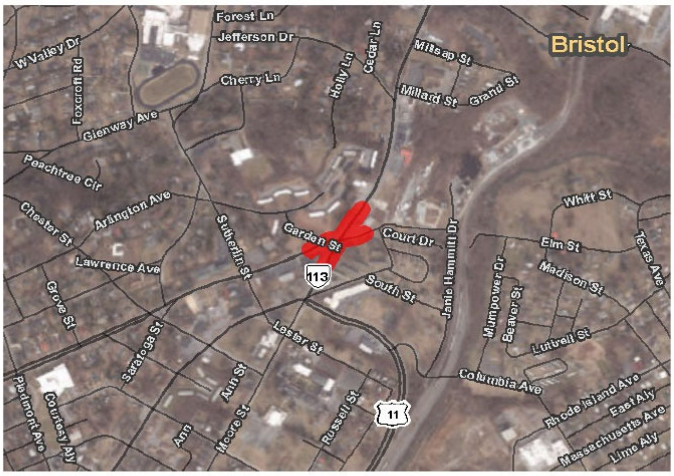
For more information on how to read a scorecard, click here.

Lee Highway and Euclid Avenue Roundabout — Project Id: 3836

This project will convert an existing intersection into a roundabout.

Submitting Entity: Bristol City
Preliminary Engineering: Underway
Right of Way: Not Started
Construction: Not Started
Eligible Fund Program: Both
VTRANS Need: CoSS
(click here for details)





7.4 SMART SCALE SCORE			
	#58	OF 433 STATEWIDE	
	#4	OF 44 DISTRICTWIDE	

SMART SCALE Requested Funds.....	**$2,825,000**
Total Project Cost.....	**$2,825,000**
Project Benefit.....	**2.1**
Project Benefit / Total Cost.....	**7.4**

SMART SCALE Area Type D														
Factor	Congestion Mitigation		Safety		Accessibility			Economic Development			Environment		Land Use	
Measure	Increase in Peak Period Person Throughput	Reduction in Peak Period Delay	Reduction in Fatal and Injury Crashes	Reduction in Fatal and Injury Crash Rate	Increase in Access to Jobs	Increase in Access to Jobs for Disadvantaged Populations	Increase in Access to Multimodal Travel Choices	Square Feet of Commercial/Industrial Development Supported	Tons of Goods Impacted	Improvement to Travel Time Reliability	Potential to Improve Air Quality	Other Factor Values Scaled by Potential Acreage Impacted	Transportation Efficient Land Use	Increase in Transportation Efficient Land Use
Measure Value	13.3 persons	6.5 person hrs.	16.8 EPDO	3,553.5 EPDO / 100M VMT	0.0 jobs per resident	0.0 jobs per resident	19.9 adjusted users	0.0 thousand adj sq. ft.	0.0 thousand adj daily tons	368,766.8 adj. buffer time index	26.6 adjusted points	1.7 scaled points	access * pop/emp density.h	access * pop/emp density change.
Normalized Measure Value (0-100)	0.0	0.1	4.8	7.3	0.0	0.0	0.1	0.0	0.0	0.0	0.2	5.2		
Measure Weight (% of Factor)	50%	50%	50%	50%	60%	20%	20%	60%	20%	20%	50%	50%	N/A	N/A
Factor Value	0.1		6.1		0.0			0.0			2.7			
Factor Weight (% of Project Score)	10%		30%		15%			35%			10%		N/A	
Weighted Factor Value	0.0		1.8		0.0			0.0			0.3			
Project Benefit	2.1													
SMART SCALE Cost	$2,825,000													
SMART SCALE Score (Project Benefit per $10M SMART SCALE Cost)	**7.4**													

FIGURE 1: VDOT SMART SCALE Project ScoreCard

VVVV

Kentucky Transportation Cabinet (KYTC)

Similar to VDOT, KYTC preliminary project scoping starts from a database in which transportation projects are prioritized through an authorization program called Strategic Highway Investment Formula for Tomorrow (SHIFT). SHIFT aims to create a transportation project prioritization model by developing a data-driven, objective specific, and collaborative approach to balance the KYTC's over-programmed highway program-

and prioritize the state's transportation funding priorities. The SHIFT is created by a 22-member multidisciplinary workgroup by creating quantitative and qualitative criteria to evaluate the transportation projects across Kentucky. The criteria used in SHIFT are categorized into five different factors, which are Safety, Asset Management, Economic Growth, Congestion, and Benefit/Cost.

Data is gathered for each of the mentioned five factors for each statewide and regional project. Thus, projects are scored based on these factors by using project scoring formulas published on the KYTC website. These formulas and their respective scoring and weights are different based on the following:

- Prioritization categories or factors which are Safety, Asset Management, Economic Growth, Congestion, and Benefit/Cost.
- Regional and statewide Projects
- Urban and Rural Projects

The project prioritization and scoring by SHIFT are done for both statewide and regional projects. In both statewide and regional project prioritization and scoring, the data on each factor/criterion is gathered. The scores are determined by weights assigned to these factors, which leads to a ranked projects list. Figure 2 shows the statewide and regional processes of project prioritization and scoring of KYTC by SHIFT. Figure 3 shows the KYTC's statewide and regional project prioritization weights. KYTC SHIFT offers a balanced approach and dependability to project prioritization and selection. The KYTC project prioritization system provides a transparent process that encourages collaboration between different planning partners by using data-driven quantitative measures to assess planned projects' benefits and compare them to one another.

Georgia Department of Transportation (GDOT)

According to the Transportation Funding Act of Georgia, which is a funding measure that provides predictable and sustainable revenue for the repair and maintenance of statewide roads and bridges, the GDOT funding priority is given to the expansion and improvement of highway infrastructure and maintenance projects in the area most impacted by traffic congestion and which attract economic development. GDOT's project prioritization processes are unique for each category of projects, such as new highway projects, maintenance of existing infrastructure, bridge repairs and replacements, safety enhancements, and administrative expenses. GDOT's project prioritization aims to determine a uniform statewide project scoring criteria and values to make holistic data-driven based decisions by evaluating quantitative criteria and measures.

As mentioned, GDOT's project prioritization processes are unique for each category of projects. The key criteria used for project scoring of new highways are freight network, Government Road Improvement Program (GRIP) prioritization review, state route prioritization, logistic plan, safety, local government support, etc. For example, the state route prioritization criteria have been categorized into critical, high, medium, and low priorities, which are included in the prioritization process. The criteria used for scoring maintenance projects are computerized pavement condition evaluation system, truck percentage, population, and state route prioritization. Similarly, the criteria used for scoring bridge projects are the bridge's age, sufficiency ratings such as structural, functional, condition, and importance. The key criteria used for scoring safety enhancement projects are the number of crashes, type of crash, crash reduction factors, crash modification factors, road safety audit data, and programmed systematic improvements. GDOT's unique way of prioritizing the different type of programs and projects are data-driven in which scoring results are implemented in STIP through an approval process.

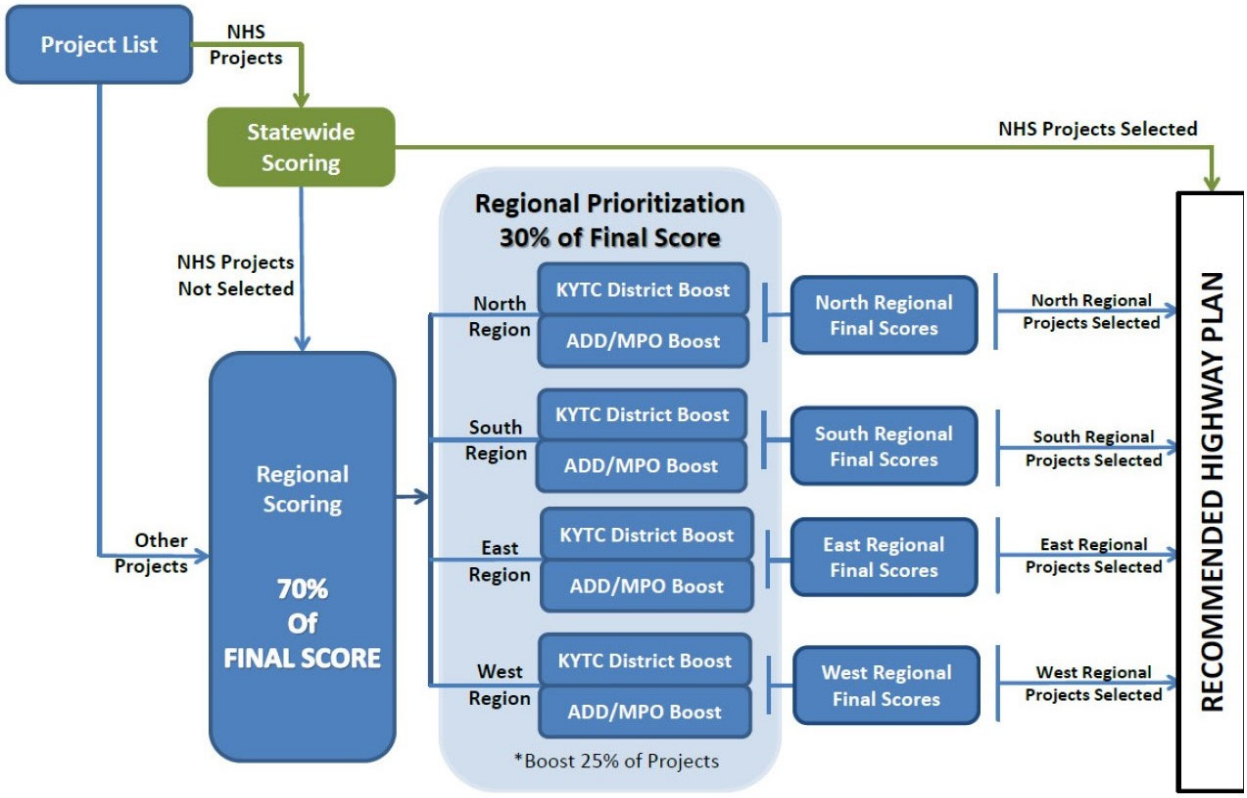


FIGURE 2: KYTC SHIFT Project Prioritization and Scoring Process

Florida Department of Transportation (FDOT)

FDOT prioritizes its transportation projects as part of its Efficient Transportation Decision Making (ETDM) Process, as shown in Figure 4. The ETDM process's objective is to identify project scope potential issues, timely decision-making, early involvement of the Environmental Technical Advisory Team (ETAT) to incorporate environmental consideration in transportation planning, and linking planning and project development. The ETDM process also facilitates the early involvement of project sponsors (federal, state, local). It provides stakeholders an opportunity to

deliver input on qualifying transportation projects to support planning decisions and the development of Project Development and Environment (PD&E) project scope. As shown in Figure 4, the ETDM process is composed of the Planning Screen and the Programming Screen. FDOT transportation projects undergo either planning or programming screening or both to advance to the PD&E phase, which is discussed in later paragraphs.

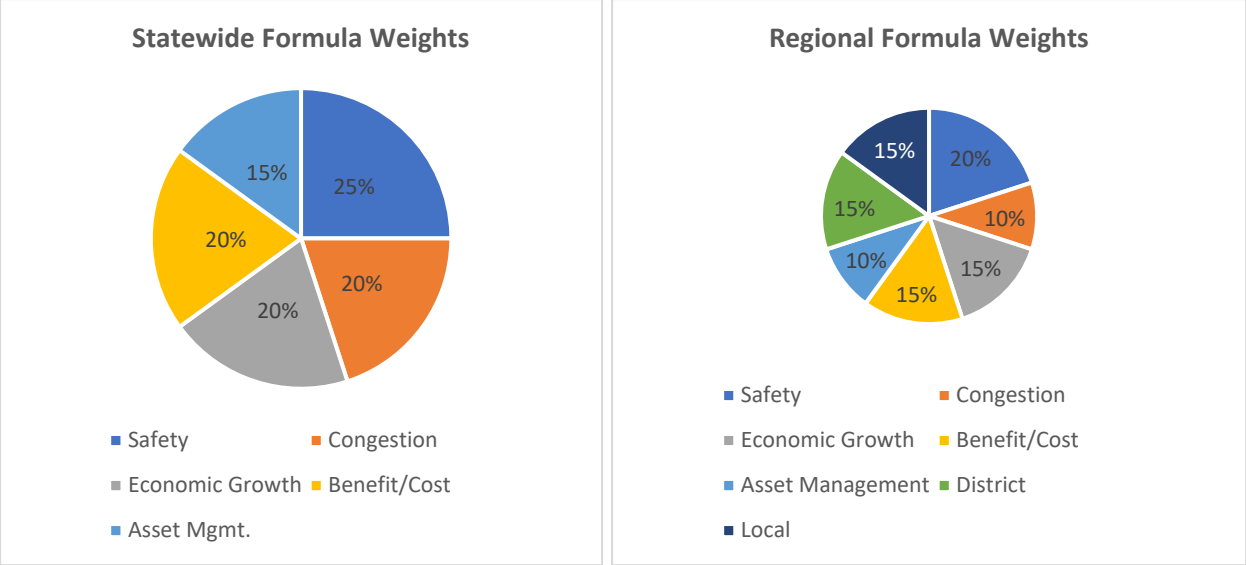


FIGURE 3: KYTC's Statewide and Regional Prioritization Formula Weights

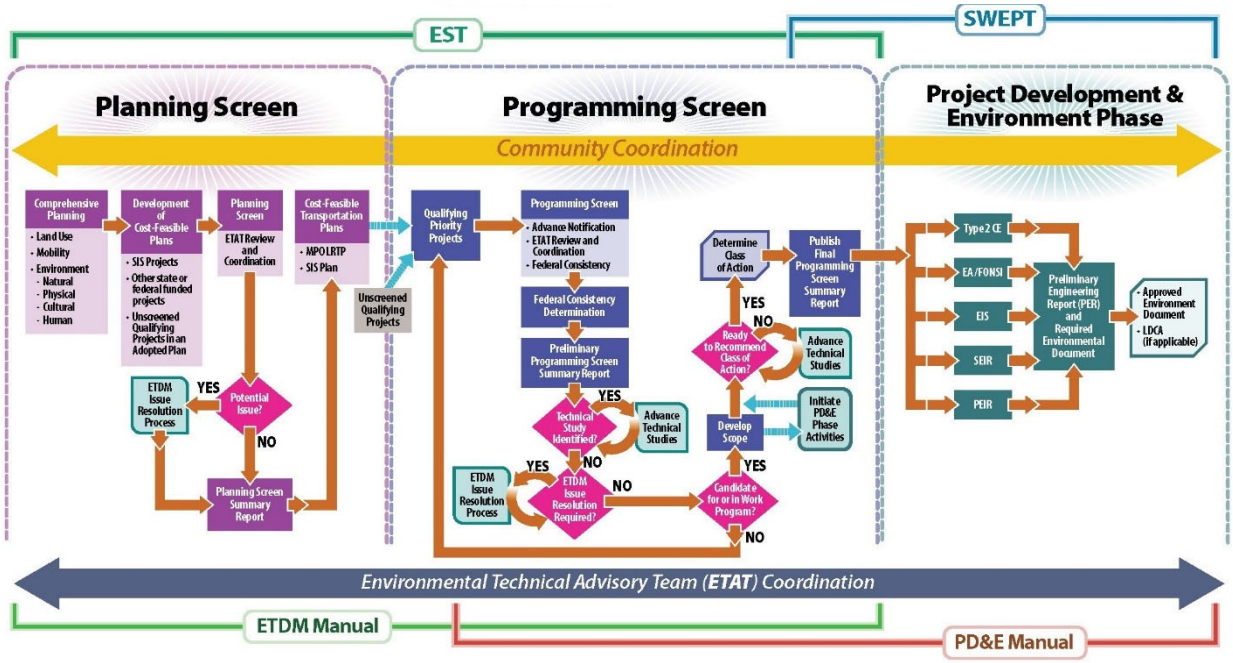


Figure 4: FDOT's ETDM Screening Process

FDOT's planning activities such as monitoring existing transportation asset conditions, forecasting future population and growth, identifying transportation problems and needs, and developing long-

range and short-range plans and programs result in the identification of project priorities to address future transportation needs. These project priorities are identified in FDOT's Strategic Intermodal System (SIS) Plan, MPO/TPO LRTP, or other long-range planning documents listed below.

- SIS Cost Feasible Plan
- Statewide Bridge Replacement Program
- Transportation Needs Plans
- Master Plans
- Action Plans
- Corridor Plans
- TIPs
- LRTP
- Local Government Comprehensive Plans
- Capital Improvement Programs
- Priority Lists
- Statewide Acceleration and Transformation (SWAT) Planning Meetings

As the funding sources for these projects are identified, FDOT's priority projects advance into implementation phases through STIP, TIP, and FDOT's Five-Year Work Program. The project sponsors, whether FDOT, MPO/TPO, or local government, in coordination with planning agencies, project managers, planning managers, district liaisons, and environmental specialists, select the qualifying projects for development. For these qualified projects to advance to the PD&E phase, they must undergo the ETDM process screening. Not all qualified projects go through ETDM process screening. The ETDM process applies to certain types of state and federal transportation projects that meet certain conditions. To determine whether a project must undergo the ETDM process, the project sponsor first considers the project type. Qualifying project types include:

- Roadway Projects
    - Additional through lanes which add capacity to an existing road
    - A new roadway, freeway, or expressway
    - A highway that provides new access to an area
    - A new or reconstructed arterial highway (e.g., realignment)
    - A new circumferential or belt highway that bypasses a community
    - Addition of interchanges or major interchange modifications to a completed freeway or expressway (based on coordination with OEM)
    - A new bridge which provides new access to an area, and bridge replacements
- Public Transportation (Planning Screen only)

Once the qualifying project type is determined, the project sponsor uses the ETDM Screening Matrix shown in Figure 5 to check if the project must undergo the ETDM Screening Process. Figure 5 categorizes the qualified projects based on their transportation system, funding source(s), and responsible agency. Using the ETDM Screening Matrix, a pass/fail system, a project sponsor determines whether the qualified project must undergo the ETDM Screening Process. Once it is

determined that the qualified project must undergo the ETDM Screening Process based on Figure 5, the project advances to either the planning screen or programming screen.

Qualified projects that are considered for inclusion in cost feasible (fiscally constrained) element of LRTP undergo ETDM Planning Screen. Not all FDOT's projects require a Planning Screen and may enter the process before the Programming Screen. For example, local government priority projects in non-MPO/TPO areas and qualifying bridge projects do not complete a Planning Screen. In terms of responsibility, FDOT is responsible for screening all qualifying SHS, SIS, and non-MPO/TPO qualifying priority projects. The MPO/TPO is responsible for screening qualifying MPO/TPO projects in their jurisdiction; however, this may be completed by FDOT and in coordination with the MPO/TPO.

Qualifying projects that are and will be included in the FDOT's Five-Year Work Program undergo a Programming Screening. The FDOT's Five-Year Work Program includes transportation projects and services with their schedule that FDOT will provide in five years. The central office develops the FDOT's Five-Year Work Program from work programs of different FDOT's programs such as districts, turnpike, MPOs, and LPAs. The programming screen is performed before developing project scope services and the PD&E phase, which assists in identifying the activities to be completed during the PD&E study.

For both Planning and Programming Screen, the project sponsor enters project information such as purpose and need, description, preliminary environmental discussion, and logical termini into the Environmental Screening Tool (EST), which is an online transportation project planning tool managed by early participation of different agency team members. ETAT members use the EST to review project information, identify potential project effects, and submit comments to FDOT. This web-based GIS database and mapping tool provide access to project information and data about natural, physical, cultural, and community resources in the project area.

Both planning and programming screening event centers on project reviews. It includes project preparation activities and follow-up tasks occurring before and after the review, shown in detail in Figure 4. The ETDM Coordinator for the project sponsor (i.e., FDOT District, Turnpike, or MPO/TPO) uses the EST to notify the ETAT when a project is ready for review. At the same time, the information is published on the ETDM Public Access Site. During the review period, ETAT members and the public have the opportunity to provide input about potential project effects. The ETDM Coordinator is responsible for checking the data for completeness and accuracy, and the Office of Environmental Management (OEM) Project Delivery Coordinator and SMEs review and provide comments as well. These reviews help to:

- Determine the feasibility of a proposed project.
- Identify the project's potential involvement with the natural, physical, and human environment.
- Identify potential avoidance, minimization, and mitigation opportunities.
- Focus on the issues to be addressed during the PD&E phase.
- Create documentation and support information that may be carried forward into the PD&E phase.
- Establish evaluation methodologies for the review of potential project alternatives.

AAAAA

- Assure clear communication and understanding of the proposed project's description as well as its purpose and need.

ETDM Screening Matrix for Qualifying Projects

	Federal Dollars (any FHWA, FTA or FRA funds or federal authorization)		State Dollars (TRIP, Transit/ Intermodal System Grants, etc) No Federal Dollars Involved		Local Dollars Only	
	Responsible Agency	ETDM Screening	Responsible Agency	ETDM Screening	Responsible Agency	ETDM Screening
System						
Highways on the State Highway System (SHS) and on the Strategic Intermodal System (SIS)	FDOT	YES FDOT Lead	FDOT	YES	FDOT	YES
	Local		Local and FDOT	Local Option	Local and FDOT	Local Option
Highways on the SHS but not on the SIS	FDOT	YES FDOT Lead	FDOT	YES	FDOT	YES
	Local		Local and FDOT	Local Option	Local and FDOT	Local Option
Highways not on SHS but on the SIS	FDOT	YES FDOT Lead	FDOT	YES	FDOT	YES
	Local		Local and FDOT	Local Option	Local and FDOT	Local Option
Highways not on SHS nor on the SIS	FDOT	YES FDOT Lead	FDOT	YES	Local	N/A
	Local		Local	Local Option		
Major Transit Projects (new fixed guideway, New Starts) or Major Freight Projects	FDOT	YES	FDOT	YES	Local	N/A
	Local	Local Option	Local	Local Option		

FIGURE 5: FDOT ETDM Screening Matrix

At the end of the review period, the project sponsor (FDOT District, Turnpike, or the MPO/TPO) summarizes the reviews' comments. FDOT subsequently uses this information to focus on the issues that need to be addressed during the PD&E phase and develop the scope of services for the PD&E Study. The results of the screening events link the transportation Planning phase and the PD&E phase.

Eventually, the ETDM Planning Screen results in:

BBBBB

- Refining the initial project concept
- Refining the project's purpose and need
- Identifying potential avoidance, minimization, or mitigation opportunities
- Improving project cost estimates
- Considering resource management plans and community values
- Advancing technical studies, if appropriate
- Development of Planning Screen Summary Report (Includes the reviews and consideration of project advancement)

And the programming screen results in:

- Evaluation of input received from ETAT, OEM Project Delivery Coordinator, and SMEs
- Development of scope of services for the PD&E study
- Determination of appropriate environmental class of action
- Preliminary Programming Screening Summary Report
- Final Programming Screen Summary Report
- Support development of the project's scope of work

Louisiana Department of Transportation and Development (LaDOTD)

LaDOTD identifies its projects by gathering and analyzing technical data on state highway conditions, performance, safety, and congestion with established criteria. Also, LaDOTD seeks input from public, regional, local, and industry planning officials to identify projects across the state. All the projects that come to LaDOTD go to the feasibility stage, which results in selecting the projects to proceed with for the next phases, which are shown in Figure 6.

These phases are:

1. Stage 0: Feasibility
2. Stage 1: Planning/Environmental
3. Stage 2: Funding and Project Prioritization
4. Stage 3: Final Design Process
5. Stage 4: Letting
6. Stage 5: Construction
7. Stage 6: Operation

Each phase has to be greenlighted to move on to the next phase, depending on the resources and funding availability. The design is usually started once LaDOTD is determined and sure that they have construction funding available. The prioritization of projects for funding is accomplished at Stage 0: Feasibility by deciding the project's feasibility to determine its funding eligibility and transition to Stage 1: Planning and Environmental Process. Once the project is identified from LRTP, MPO Plans, Districts, Federal and State Agencies, and various LaDOTD programs, it undergoes a feasibility analysis to assist a "go" or "no go" decision. The feasibility analysis results in selecting potential projects and providing the information needed to make rational decisions

regarding selecting and allocating funds among competing projects. The feasibility stage includes the following steps:

- Identification of purpose and need and development of problem statement outlining the reason for proposing the project
- Identification and description of the range of project alternatives that address the purpose and need
- A preliminary review of the potential environmental impacts of the project alternatives
- Development of preliminary scope and cost estimate for project alternatives
- Identification of anticipated funding sources for the project

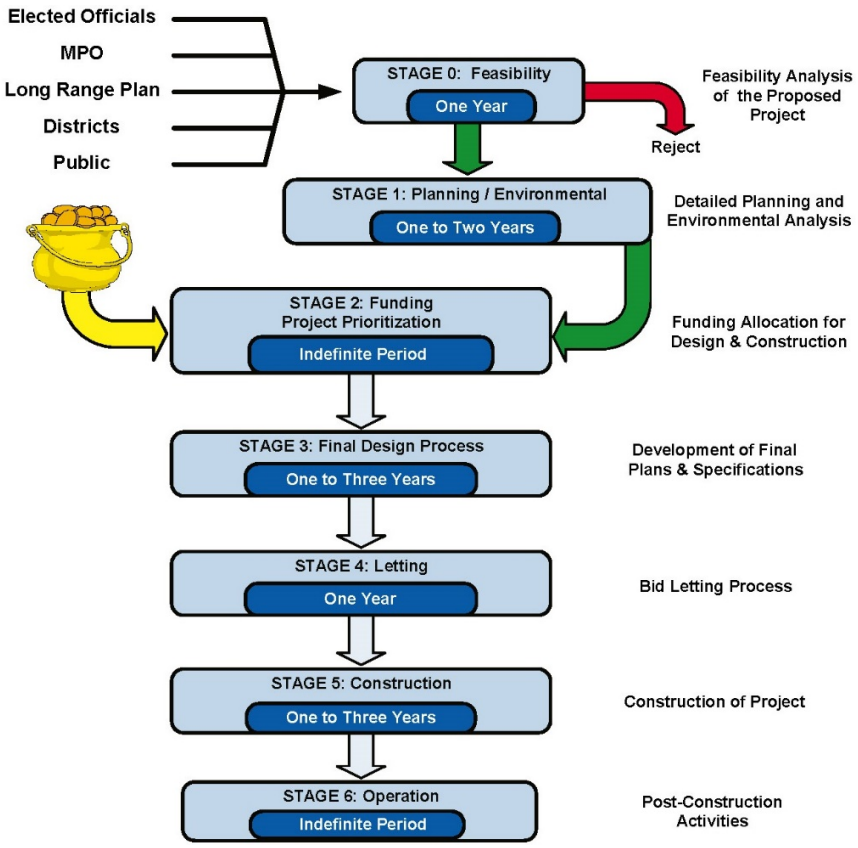


Figure 6: LaDOTD Project Development and Deliver Phases

Figure 7 shows a detailed flowchart of how LaDOTD selects and prioritizes its projects at Stage 0: Feasibility. For most types of projects, the prioritization systems are established in each state's region through the district offices in consultation with state and local officials. Once district offices prioritize the projects, teams of experts such as LaDOTD PMs, Project Selection Teams, and SMEs select projects by deciding the project's feasibility in terms of funding eligibility within a pre-established budget, and then the selected projects are assembled in the proposed Highway Program and approved by the legislature for funding. The aim of project prioritization in LaDOTD is mainly for funding purposes of design and construction.

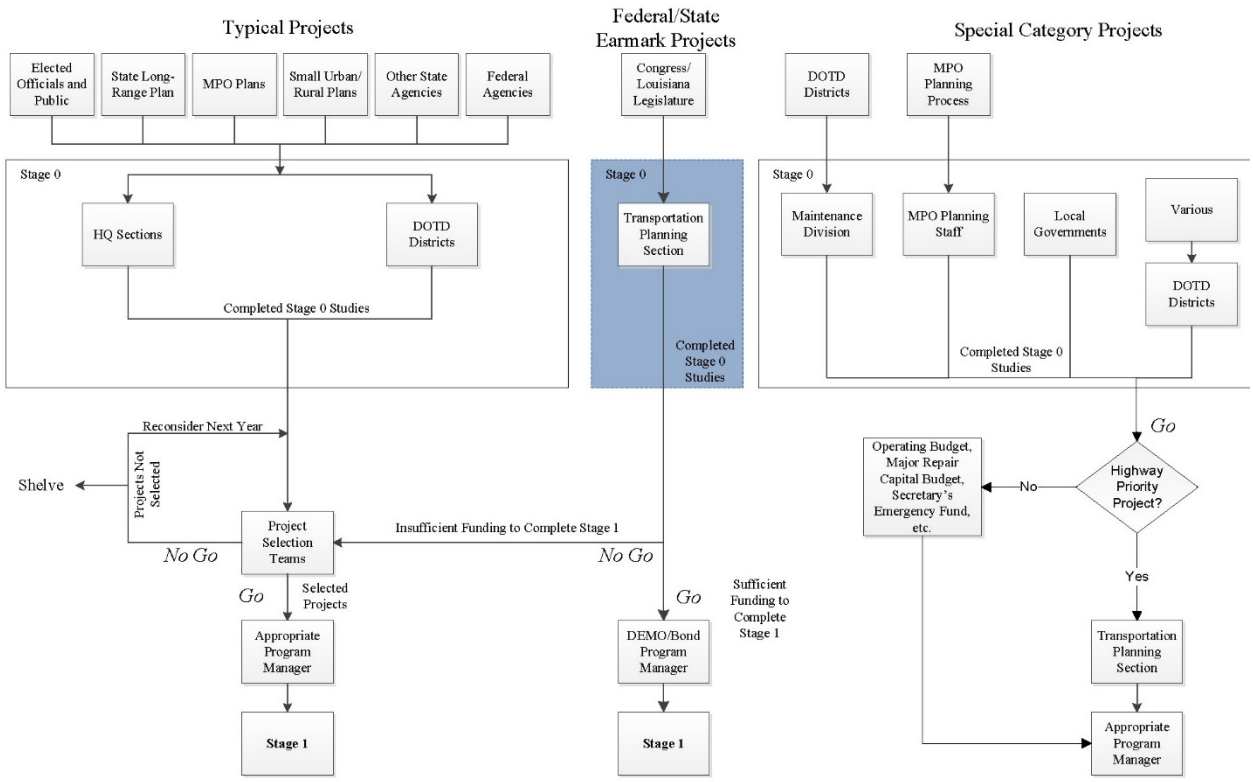


FIGURE 7: LaDOTD Project Prioritization Process

North Carolina Department of Transportation (NCDOT)

The NCDOT project scoping process starts with using GIS data layers and sources called project ATLAS. Through ATLAS, the data is accessed by all NCDOT teams and firms in one platform and is used to make more specific decisions before doing fieldwork and analysis. Teams, division offices, or field offices who need to have input on a specific project are identified, and this team develops the need for the project. The SMEs then refine the need for the project, and a clear scope is given to the house designer to develop conceptual designs (also called express design). The conceptual designs are based on GIS data and context that have cost associated with it. The express design numbers are fed to the NCDOT prioritization process, which is part of the STIP development. In the prioritization process, the project is scored, and based on the scores, it is determined whether to proceed with the project or not.

The project prioritization process in NCDOT is called Prioritization 6.0, in which a project is scored based on established criteria. Prioritization 6.0 uses data-driven methods to score and rank projects to help transportation investment and development decisions. In Prioritization 6.0, projects are broken into three funding categories: Statewide Mobility, Regional Impact, and Divisions Need. The projects in these categories compete for rank and funding against the projects within their own category. Within each category, projects are evaluated (scoring criteria) based on the following criteria.

- Congestion,
- Benefit-Cost,

- Freight,
- Economic Competitiveness,
- Safety,
- Accessibility,
- Pavement Condition,
- Lane Width,
- and Pavement Shoulder Width

The mentioned evaluation criteria in each category have their own weights. Projects within each category are scored based on the weighted criteria for that specific category, which leads to projects scores based on the established criteria. Based on these project scores, NCDOT STIP, which includes a 10-year schedule for projects, is updated every two-year using the Prioritization 6.0.

BEST PRACTICE #2

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

Key Findings:

- All comparable state DOTs (GA, NC, FL, VA, KY, & LA) 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.

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 that are managed and developed by the preconstruction departments of state DOTs is a best practice of the PDP. 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 process for 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 by the research team, 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 that are 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

Below is a summary of what is included in the comparable state DOTs scoping report document, personnel and departments that are involved in the process, and DOT funding sources that are used to support the process and develop the report.

Virginia Department of Transportation (VDOT)

VDOT develops a project scoping report for each individual project through the preconstruction department for use during the development. The form PM-100 is a scoping report template that VDOT uses to establish the project scoping report for each transportation project. PM-100 outlines the actions required to initiate scoping a project and conducting the scoping kickoff team meeting. The project scoping criteria that are documented in PM-100 are:

- Project information such as district area, length, purpose & need, GIS data, etc.
- Project team identification
- Relevant cost and schedule risks (environmental, R/W acquisition, permits, utilities, etc.)
- Project delivery methods such as DBB or DB

- Project risks including a risk management plan
- Project estimate and funding such as PE, R/W, and Construction funding
- Public Involvement
- Project schedule and major PDP milestones such as PE, R/W, and Letting
- Proposed project phases such as environmental, design, right-of-way, etc.
- Scope approval by the legislature and state authorities

In developing the project scope, the project team involved in VDOT is interdisciplinary and depends on a specific project's requirements. The team representatives include all the disciplines and functional areas involved in providing design or support services for project development and the project sponsor, key residence staff, FHWA, municipalities, and stakeholders. The VDOT project manager usually leads the team. The project scoping report includes the inter-disciplinary team's responsibility and commitment to the proposed project from their discipline's perspective. Once the project scoping process for a transportation project is completed and documented in form PM-100, the form is submitted to the legislature for approval. It constitutes formal approval of the project concept. The PM-100 form also acts as a baseline scoping report for a project and helps if the project's scope is changed or revised in the future.

Georgia Department of Transportation (GDOT)

GDOT's project scoping report for transportation projects is called the Concept Report, which outlines the scoping decisions made and developed by an interdisciplinary team. Like VDOT, the GDOT's concept report documents the action required to initiate scoping a transportation project. The project criteria included in the concept report are project map, project planning and background data (including traffic studies), major PDP milestones and activities (design, environmental analysis, permits, public involvement, utilities, right of way, etc.), cost, and estimates, schedule, concept team responsibilities, coordination, typical sections, VE, and project risk analysis. GDOT prepares a concept report for different project types such as bridges, operational improvements, median work, highways, roundabouts, etc. The projects' initial scoping is accomplished by an interdisciplinary team of SMEs that need to be involved in the scoping process.

Florida Department of Transportation (FDOT)

The project scoping process in FDOT is accomplished in the districts using the standard scope of services templates developed in the central office. FDOT's central office prepares scoping templates and provides them to the districts to tweak these templates based on the specific transportation project. The FDOT scoping report contains; general project information and description, purpose and need, public involvement, existing condition and traffic analysis, engineering and alternative analysis, schedule, cost estimates, SME teams, and their roles and responsibilities, and major PDP milestones (Design, R/W, Utilities, Environmental & Permits) and activities. SMEs from different disciplines statewide are involved in the scoping process and are identified based on project needs and types. Also, the project scoping report shows the involvement of consultants in developing the project scope and team.

Kentucky Transportation Cabinet (KYTC)

KYTC is one of the state DOTs that develop two different scoping reports for their transportation projects. For larger projects such as corridor improvements, KYTC develops a planning study, which is also called a Planning Study Report. For smaller transportation projects, KYTC develops a data need analysis study. The Planning Study Report or study is much detailed and developed by SMEs from different disciplines. The data needs analysis study is a brief, limited, and small-scale study for projects that do not have a planning study. The planning study includes criteria such as general project information, project purpose and need, project existing condition, environmental and utility overview, public involvement, traffic study, project schedule, PDP major milestones and activities, project estimates, and project development team. The data need analysis study includes preliminary project information, common geometry, project purpose and need, preliminary environmental review, project estimate, affected utilities, and project schedule.

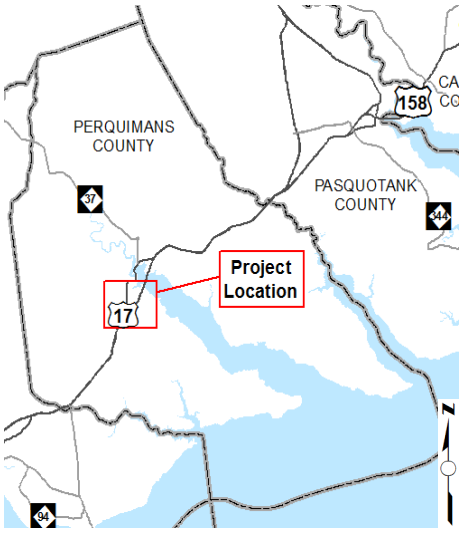
North Carolina Department of Transportation (NCDOT)

NCDOT develops project scoping reports for most of their transportation projects. NCDOT uses GIS data to develop its project scope and has generated a project scoping guideline to help all districts and consultants with their deliverables. In NCDOT, the programming office is responsible for developing the project scoping report, which in the central office and SMEs from different disciplines are part of the scoping process. The NCDOT scoping report includes general project description and background based on GIS data, purpose and need, traffic study, alternative analysis, cost estimates and schedule, existing conditions, responsibilities, and recommendations. An example of NCDOT's one-page project summary for their transportation project's scoping report is below in Table 1.

Louisiana Department of Transportation and Development (LaDOTD)

Similar to other state DOTs such as FDOT, GDOT, and VDOT, LaDOTD documents the transportation projects scoping process and prepares scoping reports for each project that goes through their feasibility stage. LaDOTD SMEs from different disciplines are responsible for scoping projects and documenting their process. LaDOTD completes the preliminary scoping of its transportation project at Stage 0: Feasibility Study. LaDOTD preliminary scoping report includes criteria such as project background information, purpose and need, agency coordination, SMEs team meeting and minutes, public coordination, alternative evaluation and screening, planning assumptions, potential environmental impacts, cost estimates, and project schedule.

SPOT ID: R-5869B (FORMERLY R4459)	FACILITY: US 17 AT SR 1336 (HARVEY POINT ROAD) AND SR 1338 (WYNNE FORK ROAD)	DIVISION: 1	FIRM: AECOM



EXISTING FACILITY CHARACTERISTICS:	PROPOSED FACILITY CHARACTERISTICS:
Existing No. of Lanes: 4	Proposed No. of Lanes: 4
Existing Median: Yes	Addition of Median(s): No
Existing control of access:	Proposed control of access:
☐ No Control	☐ No Control
☒ Partial Control	☐ Partial Control
☐ Limited Control	☐ Limited Control
☐ Full Control	☒ Full Control
ADT: 12,300 - 12,900 (2015)	ADT: 23,900 - 25,100 (2040)
Structures:	Structures:
☐ Culvert(s) Number, Size(s)	☐ Culvert(s) Number, Size(s)
☐ Bridge(s) Number, Size(s)	☒ Bridge(s) 3 Bridges proposed

PROJECT DESCRIPTION: *(Include project scope and location, including Municipality and County. Refer to the attached project location map and photos.)*

The proposed project would convert the at-grade intersections to grade-separated interchanges at US 17 Business and SR 1336 (Harvey Point Road) and SR 1338 (Wynne Fork Road) in the town of Hertford of Perquimans County, North Carolina. See above for the general vicinity map. Figure 1 shows the preliminary conceptual design and location of environmental features within the project area (Appendix B).

PRELIMINARY PURPOSE AND NEED:

Is there preliminary information on the purpose and need for the project included in a CTP, LRTP, or other study? If yes, summarize.

The purpose of the proposed project is to upgrade the at-grade intersections at US 17 Business and SR 1336 (Harvey Point Road) and SR 1338 (Wynne Fork Road) to grade-separated interchanges to improve mobility, connectivity, and safety. Improvements are needed to maintain mobility along the US 17 corridor. The proposed project would upgrade the existing facility to interstate standards. The entire US 13/17 corridor from US 64 in Williamston to Virginia is being evaluated for upgrade to interstate standards as a part of NCDOT feasibility study FS-1501A, which is currently in progress. The 2016 Perquimans County CTP notes that US 17 improvements are needed to maintain mobility along the corridor. The CTP includes a project (PER02-H) to implement upgrades to US 17 to reach interstate standards from Chowan County to Pasquotank County.

COST ESTIMATES:

Right of Way: $ 16,300,000

Utilities: $ 1,500,000

Construction: $40,300,000

FINDINGS AND RECOMMENDATIONS:

Note recommended document type and summarize findings from Screening Checklist.

The proposed project would require the acquisition of right-of-way along the existing roadway as well as in new locations where the proposed alignment may diverge from the existing US-17 alignment and where the proposed access roads would be constructed. The proposed project would involve a change in control of access from partial to full control of access along US-17. While this would promote traffic flow, it would also impact residential and commercial establishments that directly connect to US-17. The proposed project would also come into contact with wetlands and streams at multiple points throughout the project area. Given the proximity of cultural resources to the project area, state funding should be considered due to extensive requirements associated with an Individual Section 4(f) approval.

The type of environmental document anticipated in the next phase of NEPA planning is either a Categorical Exclusion or a State Minimum Criteria Determination.

Table 1: NCDOT Project Scoping Report Summary Page Example

CATEGORY B – CONSULTANTS PROCUREMENT AND MANAGEMENT

BEST PRACTICE #3

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

Key Findings:

- Nationally, the average percentage of state DOT 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 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.

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 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 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 8.

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/or 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.

As an 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 the effectiveness and efficiency of their consultant use.

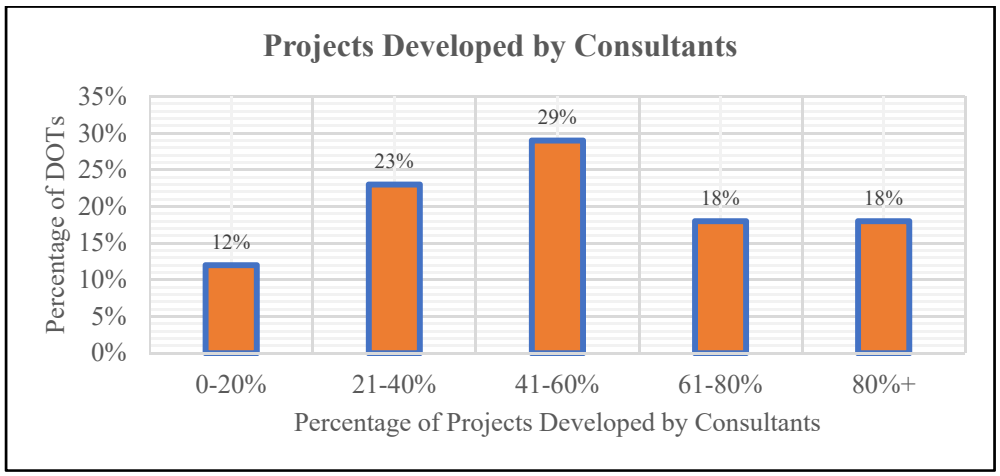


FIGURE 8: Percentage of Projects by Consultants

BEST PRACTICE #4

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

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 that are 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 consultants services 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 view SCDOT deliverables as inconsistent from project to project.

Summary of Findings:

State DOTs professional services and 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 by the research team 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/or prior to completion. All six state DOTs interviewed by the research team have developed and established a set of standard 'global' deliverables for their professional services consultants. These states DOTs are VDOT, GDOT, FDOT, KYTC, LaDOTD, and NCDOT. The global set of deliverables is adjusted for each transportation project based on the deliverables that are 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 project schedule, PDP milestones, and major PDP phases
- Establishment of a standard set of deliverables for both in-house and professional consultants' services (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

By evaluating the interviewed state DOTs documents and interview transcripts, the research team identified the state DOTs standard set of deliverables criteria, differences, consistency, and components, which is discussed below.

Virginia Department of Transportation (VDOT)

The average percentage of professional services consultants use in VDOT is 55% in terms of the number of projects. The locally administered projects are 100% done by consultants. VDOT's professional services consultant use is increasing due to limited resources and staffing by the

legislature. The consultants' involvement depends on what resources and capacities does VDOT has to design and develop the projects. The consultant's deliverables are the same deliverables established for the VDOTs internal project development team. VDOT has developed a checklist of milestones and deliverables called LD-436, used for different types of projects and programs such as roadway design, survey, SUE, hydraulics, environmental, utilities, permits, right-of-way, traffic, and landscape. VDOT uses consultants for the whole project from a coordination standpoint, even if a portion of the project is needed to consult out. The LD-436 deliverables and milestones form are adjusted based on the project type/phase. The deliverables listed in form LD-436 originate from the VDOT PDP flowchart milestones and interim milestones linked with VDOT's schedule templates. The VDOT PDP phases, milestones, and interim milestones are shown in Appendix A: VDOT PDP Flowchart. VDOT has around 54 different schedule templates, which are dynamic, and logic-based for different project/program types. The VDOT standard set of deliverables (LD-436) helps the project development team track the project development schedule, milestones, interim milestones, and evaluate professional services consultants' performance.

Georgia Department of Transportation (GDOT)

In GDOT, 83% of the design development is performed by professional services consultants and is increasing. It is due to the downsizing of GDOT staff by the legislature. The projects are consulted out due to limited in-house resources and expertise. Generally, the projects are consulted out in full, not portions, determined in the scoping phase. GDOT uses its PDP flowcharts milestones and interim milestones as consultants' deliverables. The GDOT PDP flowcharts are shown in Appendix B: GDOT PDP Flowcharts. Like VDOT, GDOT uses the same standard set of deliverables for both in-house and professional services consultants. The standard set of deliverables derived from the PDP flowcharts milestones varies based on different PDP phases, project/program types, and funding sources. The milestones and standard set of deliverables are linked with GDOT's schedule templates and project schedule key milestones and are used to track consultants' tasks and performance. GDOT's standard set of deliverables mirror the evaluation criteria of individual projects, which is reflected in the consultant's monthly progress report.

Florida Department of Transportation (FDOT)

Similar to GDOT, the FDOT professional services consultant use is steadily increasing and around 90%. In FDOT, for a transportation project, every PDP phase, such as planning, design, right-of-way, environmental, etc., has a different professional services consultant on board. Similarly, there are different project managers for each phase of project development. Thus, the FDOT standard set of deliverables varies based on project phases. The standard set of deliverables is also different for each project based on its funding sources and environmental documents. FDOT standard set of deliverables are derived from the PDP flowchart phases and milestones and standard scope of services for each transportation project. It is developed in the FDOT districts (decentralized organization) for each phase of the project. The FDOT PDP flowchart is shown in Appendix C: FDOT PDP Flowchart, which shows different phases of PDP that FDOT uses professional services consultants. FDOT's goal of developing a standard set of deliverables for their consultants and in-house team is similar to VDOT and GDOT, which are: to bound consultants to deliver their tasks, to set consultants' schedules, and to track and evaluate their performance.

OOOOO

Kentucky Transportation Cabinet (KYTC)

The professional services consultant use in KYTC is around 80% looking at the actual dollars, and looking at a numerical number of projects, it is two to one. The professional services consultant use in KYTC is increasing due to limited staff and the number of qualified individuals in KYTC. Usually, large and complicated projects are consulted out, and smaller projects are done in-house. The larger majority (95%) of the contracts are for all-inclusive services for an individual project. Still, KYTC also consults out project phases such as environmental, right-of-way, utility design, Geotech, etc. KYTC has developed a standard set of deliverables and timeframe, which is used for both in-house and professional services consultants. The set of standard deliverables for each project and its phases are derived from a checklist (Exhibit 200-23), which lists the PDP milestones and interim milestones. The checklist/standard set of deliverables is adjusted based on an individual project and its phases. The aim of KYTC's set of standard deliverables for consultants and in-house is similar to other state DOTs mentioned above. The KYTC PDP flowchart is shown in Appendix D: KYTC PDP Flowchart.

Louisiana Department of Transportation and Development (LaDOTD)

The LaDOTD uses professional services consultants on usually large and complex projects. The number of projects that LaDOTD uses consultants is less than 50% because most projects are developed in-house, and these projects are mostly preservation overlays, bridge replacement type projects. Based on the dollar cost of projects, LaDOTD consultant use is 50% because large and complex projects usually have significant costs. The use of consultants is steady in LaDOTD. The agency uses consultants due to the duration of projects because it is difficult to count on having staff available dedicated to a long-term project. LaDOTD mostly consults out the projects as a whole package and has limited occasions to consult out specific to a discipline. LaDOTD has a standard set of deliverables for consultants, specifically for road and bridge projects, where the consultants are expected to complete the deliverable from a fairly standardized PDP chart. The LaDOTD PDP flowchart is shown in Appendix E: LaDOTD PDP Flowchart. The standard set of deliverables are derived from the PDP flowcharts' stages and phases. Uniquely than other state DOTs, LaDOTD has developed and mentioned their standard set of deliverables for each phase of PDP in the LaDOTD Project Delivery Manual. These stages are feasibility, planning/environmental, funding, design, letting, construction, and operation. The standard set of deliverables is specifically written for each phase and their interim PDP milestones, adjusted based on project type. The LaDOTD standard set of deliverables is identified during the project kick-off meeting. It acts as a consultant performance metrics where consultants are expected and evaluated to complete the deliverables based on the standardized PDP chart.

North Carolina Department of Transportation (NCDOT)

The NCDOT professional services consultant use is around 75%, and it is slightly increasing, which is due to the legislation that has mandated the move of more work into the industry. The decision to consultant out the projects is based on in-house staff expertise and schedule requirements. The schedule requirements rules are set with a completion goal of CE in 12 months, EA/FONSI in 24 months, and EIS in 36 months. The projects are either consulted out in full packages or in a portion of what is needed. The NCDOT standard set of deliverables is the same for both in-house and professional services consultants. The standard set of deliverables are

derived from the PDP flowchart, which is shown in Appendix F: NCDOT PDP Flowchart. The deliverables are broken down by discipline, such as traffic, roadway, planning, hydraulics, environmental, utilities, etc. The standard set of deliverables can be adjusted to each project based on their requirements and linked to the project schedule. The NCDOT set of standard deliverables aims to avoid missing steps, maintain the project schedule, and evaluate the in-house and consultants' performance.

BEST PRACTICE #5

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

Key Findings:

- All of the comparable state DOTs (GA, NC, FL, VA, KY, & LA) utilize a prequalification process for their professional services consultants. Comparable state DOTs have developed a prequalification process that complies with the Brooks Act.
- 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 prequalification of professional services consultants is an effective process to streamline and accelerate the consultant procurement timeframe.

Summary of Findings:

FHWA defines Prequalification as 'a procedure to review and evaluate the qualifications of professional and technical firms before their services are needed (prior to RFP) by a state transportation agency.' Prequalification of professional services consultants is a necessary component of the procurement process during which 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 the qualification of consultants to perform a service on a future project and/or 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/or on-call consultants. Comparable state DOTs have developed a prequalification process that complies with the Brooks Act. The objective of the prequalification process is to ensure that the consultant has the technical expertise and sufficient resources to accomplish the service they are proposing. 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 to streamline and accelerate their procurement process. The use of prequalification of consultants in comparable states differs and depends mainly on contracting methods and services provided by the consultants.

QQQQQ

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, types of service and work, 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 and discussed individually under each interviewed state DOTs section.

- 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/or 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

By evaluating the interviewed state DOTs documents and interview transcripts, the research team identified the state DOTs professional services consultants' prequalification criteria, differences, consistency, and criteria, which are discussed below.

Virginia Department of Transportation (VDOT)

VDOT's professional services consultant's procurement process takes six to nine months from a project or service advertisement until the consultant is onboard. VDOT prequalifies consultants performing right of way and utility services by using a prequalification questionnaire. The prequalification questionnaire outlines the minimum qualification VDOT has determined for a consultant to perform these services. The prequalification review committee in VDOT then evaluates all the received submittals and determines whether the consultant is qualified to perform the services for VDOT. In addition to contracting a specific right-of-way or utility service, a consultant can become a prequalified firm by going through the same process for any future services to come. The consultant's criteria evaluated by the prequalification committee include past experience, financial stability, and cost of the service. Then the consultants proceed to the selection phase in which a service is consulted out to one of the prequalified firms.

Georgia Department of Transportation (GDOT)

GDOT's professional services consultants' procurement process takes nine months to one year from identifying the scope of services to Notice to Proceed. GDOT mainly prequalifies professional services consultants who provide design services and support to design work. The purpose of prequalification is to govern whether the professional architectural and engineering firms that perform design and related work governs the minimum qualifications. Also, prequalification is used as a practice to streamline GDOT's consultant procurement process and accelerate the time of procurement. GDOT prequalifies professional services consultants based on classes of work includes different types of services and projects. The prequalification criteria used by GDOT are similar to other state DOTs and require the consultants to fill an application, present their past experience and key employees, be a registered firm in the state, and provide financial information to the consultant prequalification committee. The consultant prequalification committee then decides whether to issue a qualification certificate to the consultants based on the class of work they have applied for. The qualification certificate is given to professional services consultants for three years, and the consultants are responsible for maintaining their qualification status by renewing their certificate.

The minimum qualification requirements vary for different work classes and are comprehensively written in GDOT's Consultant Prequalification Manual. For example, the minimum qualification requirements for the area class of NEPA documentation are different from the area class of urban roadway design. The consultants should have at least two Professional Engineers in their team to meet the minimum qualification for the urban roadway design. The comprehensive method of classifying the minimum qualification requirements based on classes of work in GDOT aims to streamline their PDP and procurement process. GDOT uses both on-call and project-specific services for the classes of work mentioned in their Consultant Prequalification Manual. On-call services are mainly for small projects such as intersection improvements, sidewalks, public involvement assistance, and project-specific services for larger and complex projects. According to GDOT, the use of on-call services is roughly 30% in terms of the number of projects and helps advance GDOT's projects quickly, which minimizes their procurement time and streamline their PDP. Also, to streamline their procurement process, GDOT bundles or batches the procurement projects but requires individual statements of qualifications for each project. The bundles of projects are usually geographically near each other and advertising at the same time.

Florida Department of Transportation (FDOT)

FDOT's professional services consultant's procurement process takes four to six months from the project's advertisement to NTP. FDOT consults out the highest percentage of their work to professional services consultants and uses consultants for every phase of PDP. Prequalification of professional services consultants play an important role in advancing the procurement process and streamlining FDOT's PDP considering the extensive use of consultants and a lesser procurement time than other state DOTs. FDOT uses on-call services as well to advance and accelerate their procurement time. Around 40% of the contract acquisitions in FDOT are on-call services, especially for small projects and the rest are project-specific, which are for larger and complex projects. The use of on-call services has helped FDOT to accelerate its procurement time. By using project-specific contracts, FDOT is maintaining a healthy distribution of work and services to the consultants.

FDOT prequalifies professional services consultants that provide services and practices of architecture, engineering, landscape, surveying, right-of-way, and utilities. FDOT requires consultants to be prequalified for the type of service and work they provide. The criteria that FDOT uses for their prequalification of consultants are similar to most other state DOTs. These criteria include submitting a prequalification application, determining the type of work or service, state license and registration, past performance and key employees, and financial information. The qualification administration in FDOT reviews the applications and related documents to determine whether a consultant meets the requirements and is qualified for the type of service they have applied. FDOT has a comprehensive prequalification application that a consultant must fill and is shown in Appendix G: FDOT Prequalification Application.

Kentucky Transportation Cabinet (KYTC)

Like FDOT, the KYTC procurement time of professional services consultants is less than many other state DOTs, which is roughly four to five months from the advertisement to NTP. Several practices have led KYTC to accelerate its procurement process and to streamline its PDP. These practices are mainly: prequalification of professional services consultants, the use of on-call services, establishing a procurement time goal of 100 days, and establishing an online portal for consultants to facilitate and handle their projects and milestones. The prequalification process of KYTC is similar to other state DOTs. It requires the consulting firms to apply for the specific type of work they provide and be registered and licensed by the state. The requirements of the prequalification process vary based on project/program type (see Appendix H: KYTC Prequalification Project/Program Types). Each specific type of service and project has its criteria for consultant firms to meet to provide services for KYTC. For example, for services related to rural highway design, a consulting firm must submit an application, provide past experience and key employee expertise, provide financial information, and list their resources. The Consultant Prequalification Committee evaluates the application and the consultant firms' requirements to decide whether they can provide the service. The qualified consultant firms can renew their qualification for the same services, and KYTC evaluates their renewal process based on their performance.

Louisiana Department of Transportation and Development (LaDOTD)

LaDOTD procures a professional services consultant within nine months and uses both project-specific and on-call contracts depending on the project or service type and delivery method. Mainly for services like geotechnical investigations, traffic studies, bridge design, etc. LaDOTD uses on-call and IDIQ services, which are also limited by state and federal regulations. The use of on-call and IDIQ services accelerates the procurement process and is mainly used for urgent projects. LaDOTD does not have an official and documented prequalification process for its professional services consultants. The professional services consultant’s selection process is briefly described in the LaDOTD Contract Service Manual, categorized as negotiated and non-negotiated contracts. LaDOTD contracting method is mostly (more than 50%) lumpsum because the process is streamlined due to non-negotiation category selection and the extremely simplified invoicing. The LaDOTD has developed a database system where they have studied in-house efforts for 20-30 years for different project types to establish standard man-hour and times for different work services and types.

The NCDOT professional services consultant procurement time is six months from advertisement to the execution of the contract. The majority of NCDOT professional services consultant contracts are limited services contracts that streamline their procurement process and time. NCDOT requires all the professional services consultants to be prequalified for the services and type of work. Compared to other state DOTs, the NCDOT prequalification and contracting method are different and a work in progress with FHWA to streamline their procurement process and streamline their PDP. NCDOT, with its limited contract service method, selects and prequalifies 10-20 consulting firms per division for engineering services, planning, design, and other services. The firms are required to fill a prequalification application and submit their financial statements, state registration and license, and key employee expertise for consulting firms to provide services for NCDOT. The prequalified consultants can provide services to any district and region once approved by NCDOT prequalification committee. The consultants are required to renew their qualifications annually and requalify every three years. Once the consulting firms are prequalified and selected per each division, NCDOT assigns specific projects to these firms for their services.

BEST PRACTICE #6

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

Key Findings:

- Comparable state DOTs believe that evaluation of 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 in-house development teams and consultants.
- A majority of SCDOT's consultants believe that performance expectations and measurements for consultant performance are not clearly defined.

Summary of Findings:

One of the well-defined and best practices explored with comparable state DOTs during the interview process was the evaluation of their professional services consultants' performance during the project development process. All of the 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. They 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 performance is measured.
- Who is involved in the evaluation.
- How is performance measured (scoring, rating, weighting).
- What performance criteria is measured.

The detailed explanation of these criteria and questions is described individually for each interviewed state DOT. 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 performance evaluation report is used to provide feedback on the consultants' service(s) and is used for consideration of the consultant for future services and the effective management of the current service(s) the consultant is providing.

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 by the research team, almost all of them, such as VDOT, GDOT, KYTC, NCDOT, have similar deliverables and performance metrics for both in-house and consultants. 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.

By evaluating the interviewed state DOTs documents and interview transcripts, the research team identified the state DOTs professional services consultants' performance evaluation criteria, differences, consistency, frequency, rating/scoring, and evaluation data use. The findings are as follows:

Virginia Department of Transportation (VDOT)

VDOT evaluates prime and sub-consultants performance to manage the work quality of their professional engineering services effectively, determine the quality of services consultants provide, and document when there is a need for improvement. Also, VDOT uses its consultant evaluation to provide information to its selection committee members regarding their professional

services consultants' success and failure. In VDOT, the project manager is responsible for evaluating, rating, and scoring their professional services consultant's performance. Each VDOT division project manager is responsible for evaluating and reporting their consultant's performance for their portion of work, at least semi-annually. VDOT project managers are required to do at least one of the following consultant performance evaluation.

- Standard evaluation (which is subject to twice a year for each agreement or project),
- Interim evaluation (before the end of the six-month evaluation period to formally document the deficiency),
- No significant activity evaluation (if there are no project activities).

VDOT evaluates the performance of their professional services consultants based on five criteria. These criteria are management, prosecution and progress, quality of work, cooperation/coordination, and workforce availability. These criteria are rated for each professional services consultant, then approved by a VDOT reviewer, sent to the consultant for signatures, and uploaded in the VDOT system. The criteria rating used by VDOT is a five-point scale, in which "1" indicates poor performance, and "5" indicates exceptional performance. The description of each rating is shown in Figure 9. As a result, the evaluated and rated performance criteria are reported in Consultants Performance Report.

PERFORMANCE EVALUATION SCORING GUIDANCE		
Rating	Score	Description of Rating
Exceptional	5	Performance for the rated evaluation criteria exceeds contract requirements to the Agency's benefit. Extraordinary performance may reflect some of the following achievements: • Cost-savings, added value, innovative options, efficiencies, quality deliverables, quality service and overall the consultant going above and beyond the expectations of the Department, the contract and the Rater.
Exceeds Expectations	4	Performance for the rated evaluation criteria exceeds contract requirements to the Agency's benefit. Extraordinary performance may reflect the some of the following achievements: • Cost-savings, added value, innovative options, efficiencies, quality deliverables, quality service and overall the consultant going above and beyond the expectations of the Department, the contract and the Rater.
Meets Expectations	3	Performance for the rated evaluation criteria meets contract requirements. May have had some problems; however, corrective actions were taken by the Consultant and are satisfactory. Problems have not been repetitive.
Needs Improvement	2	Performance for the rated evaluation criteria does not meet some contractual, technical or professional requirements. Multiple or significant problems; corrective actions have not been satisfactory or have not been fully implemented.
Poor	1	Performance for the rated evaluation criteria does not meet contractual requirements and recovery is not likely in a timely or cost effective manner. Serious problems continue to exist and the contractor's corrective actions have been ineffective.

Figure 9: VDOT Performance Evaluation Scoring Guidance

Like VDOT, GDOT evaluates its professional services consultant's performance individually and based on an established set of criteria. GDOT evaluates professional services consultants' performance to ensure the level that the consultants are achieving their contractual requirements and obligation. In GDOT, the project manager is responsible and required to evaluate consultants' performance at least annually or at any project milestone throughout the project. The main criteria that GDOT measures to evaluate the performance of their consultants are management, prosecution and progress, and quality. Additional criteria for performance measurement that GDOT uses are cooperation, coordination, and availability of the workforce. Each of these measures is rated and scored by the project manager or related SMEs. The GDOT's consultant performance rating is a five-point scale (1 to 5; 1 - Consistently Falls Below; 5 - Consistently Exceeds).

Additionally, each performance criterion or measure has its importance factor or weights. The final performance scoring point is yielded by the sum of the multiplication of all performance criteria ratings to their respective weights. The GDOT's performance evaluation scoring guidance is shown in Figure 10. GDOT uses the performance evaluation scores to identify the consultant's capabilities throughout the project, ensure that consultants achieve their contractual obligations at each project development milestone, and consider the consultants for future service or work that consultants provide.

INDICATE YOUR EVALUATION OF THE CONSULTANT OR SUBCONSULTANTS PERFORMANCE USING A SCALE FROM 1 TO 5 TO ESTABLISH A PERFORMANCE FACTOR **SEE BELOW***	**PERFORMANCE FACTOR** (a)	**IMPORTANCE FACTOR (%)** (b)	**RATING POINTS** (a) x (b)
MANAGEMENT: Understands and effectively manages the project contract, including, but not limited to the following: Accomplishes the intent and scope of the contracted services by managing the personnel, budget, and schedule. Manages subconsultants to ensure performance. Maintains appropriate documentation. Minimizes the involvement of DOT staff in the management of the consultant and subconsultant staff. Maintains appropriate cost records, logs, and other documentation.		25%	0.00
PROSECUTION & PROGRESS: Attains schedule and accomplishes established milestone and completion dates. Adjusts resources in response to demands of the project delivery schedule. Provides timely completion of tasks, including reviews, revisions, and intermediate and final deliverables.		25%	0.00
QUALITY OF WORK: Consistently meets the Department's quality expectations and exercises quality control measures. Applies the Department's established guidelines, standards and procedures, design policies, studies, reports, tests, calculations and/or other available information to produce accurate and technically correct design plans, reports, documents, studies, tests and/or other specified deliverables to the Department.		30%	0.00
COOPERATION/COORDINATION: Works cooperatively with DOT staff, other consultants, local, state and federal agencies, utility companies and/or citizen stakeholders. Proactively coordinates all activities that may impact or interface with the project. Communicates issues and information effectively. Responds to the demands of the project; actively defines problems, suggests alternatives, and recommends solutions.		10%	0.00
ADEQUACY/AVAILABILITY OF WORK FORCE: Possesses and maintains adequate resources to meet the demands of contract, including sufficient numbers of qualified staff, properly equipped and available for the required tasks.		10%	0.00
OVERALL RATING (SUM OF THE ABOVE RATINGS)			0.00

PERFORMANCE FACTORS

1	2	3	4	5
Consistently Falls Below	Frequently Falls Below	Meets	Frequently Exceeds	Consistently Exceeds

Note: An overall point rating of 3 is considered satisfactory performance. The maximum point rating attainable is 5.

Figure 10: GDOT Performance Evaluation Scoring Guidance

Florida Department of Transportation (FDOT)

FDOT evaluates their professional services consultants' performance to effectively manage their quality of work, communicate performance and expectations, provide feedback on their performance, and consider their performance as a factor during future work and services. In FDOT, the project manager is responsible for the interim and final performance evaluation of consultants. FDOT evaluates the performance of its consultants quarterly. The FDOT's established performance evaluation rating criteria include schedule, management, quality, and constructability measured by a five-point scale from 1 to 5 (1 Unacceptable Performance; 5 Outstanding Performance). FDOT also evaluates sub-criteria such as issue identification, issue resolution, communication, coordination, project documentation, effective administration, permit monitoring, the effect on construction time and cost, and proactiveness regarding public concerns. Using the five-point scaling system and the mentioned evaluation criteria, FDOT establishes and calculates a final composite evaluation score for each consultant through Professional Services Information System (PSIS). PSIS is a database maintained by the FDOT's central office, which contains information relevant to professional services consultants. PSIS uses a specific formula that varies based on service or project type to calculate each consultant's composite evaluation. The performance evaluation is finalized once both the project manager and the consultant agree on the standard, expectation, and result.

Kentucky Transportation Cabinet (KYTC)

KYTC measures and evaluates their professional services consultants' performance to create expectations, communicate performance, provide feedback for improvement on subsequent phases and future projects, and consider the consultants in the selection of future work and services. KYTC evaluates and measures the performance of its consultants at three different phases of the project. These phases are Preliminary Design, Final Design, and Final Contract Plans Delivery. The project managers and location engineers are mainly responsible for the performance evaluation of professional services consultants. The performance measures that KYTC uses to evaluate their consultants' performance are technical ability, schedule, quality, customer service, working relationship, scope, budget, and performance with project stakeholders. The scaling system used for the criteria' measurements is a five-point scale starting from 1 to 5 (1 - Lowest Score; 5 – Highest Score). Each criterion is scored separately in three different phases of the project, and the scores are combined at the end of each phase in terms of percentage. For example, if the total possible score a consultant can get is 55, and the consultant's total point is 50, the consultant's performance score is 90% (50/55). Then the three-phase percentages are averaged to determine the final score. Each phase score is used to clear the project expectations and improve consultant performance. The final performance evaluation scores are used for the consultant selection process for future services and works.

Louisiana Department of Transportation and Development (LaDOTD)

Like other state DOTs, LaDOTD evaluates the performance of their professional services consultants to provide feedback related to consultant's performance during PDP, effectively manage the work, and consider the evaluation in the selection of consultants for future work and services. The performance evaluation is done for every consultant on each project. The project manager is responsible for evaluating the performance of their consultants in their portion of work.

The criteria that are used for measurement of consultant performance in LaDOTD include administration of the contract, management issues and resources, communication, documentation, coordination, execution of work, demonstration of knowledge, quality of plans and deliverables, completion of work within the terms of the contract, cooperation, and problem resolution. The mentioned criteria are scored on a scale of 1 to 5 (1 Unacceptable performance; 5 being Outstanding Performance). The scores are then averaged at the end for all criteria, and the final score of consultant performance is calculated. A score of 3 represents satisfactory performance for LaDOTD.

North Carolina Department of Transportation (NCDOT)

NCDOT evaluates its professional services consultants' performance to provide positive feedback and constructive criticism on performance during PDP. The consultant performance evaluation helps NCDOT take necessary steps and corrective measures in areas that need improvement. The project manager is responsible for evaluating the performance of consultants. Usually, NCDOT project managers evaluate the performance of their professional services consultants semi-annually. The NCDOT has a consultant evaluation form that includes basic project information, the type of work being evaluated, and the actual evaluation information. The rating scale used in the evaluation form is a 10-point scale with a description section to explain the reason for the scores provided by the project managers. The project manager's measures and criteria evaluating the consultant based on are mainly quality of work, timely completion of the work, and conformance with established policy. Each performance measure is scored and then averaged at the end. The final performance evaluation scoring and report is shared with the consultants as well for them to review and comment on their performance.

BEST PRACTICE #7

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

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 findings from the national survey, half of the state DOTs have a need and/or 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.

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.

State DOTs PDP 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, which enhances 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.

CATEGORY C – PERFORMANCE MEASUREMENT AND ACCOUNTABILITY

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.

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/or 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.

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 research team heard repetitively from the state DOTs interviewed during this study. According to the SMEs with these state DOTs, 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.

State DOTs interviewed by the research team 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 individual, departmental, and/or agency performance is measured.
- Precisely what performance metrics are to be collected.
- How frequently each performance metric is collected.
- Who has the responsibility for the collection of the performance metric(s).
- Who has the responsibility for evaluation of the performance metric(s).
- How performance information will be shared with agency personnel and/or the public.

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

A detailed explanation of these criteria and questions is provided in the subsequent sections for each state DOT interviewed. 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 to track their progress towards their goals, which is documented in their STIP and other planning efforts. According to the National PDP Survey of State DOTs, the PDP metrics/milestones that 75% or more state DOTs track are shown in Figure 11. 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 DOTs included Advertisement of Eminent Domain, Conceptual Design (10%), and Notice of Intent.

How frequently will each performance metric be collected?

The frequency of performance measurement 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. Detailed

frequency of project development performance measures for the interviewed state DOTs is explained under their sections.

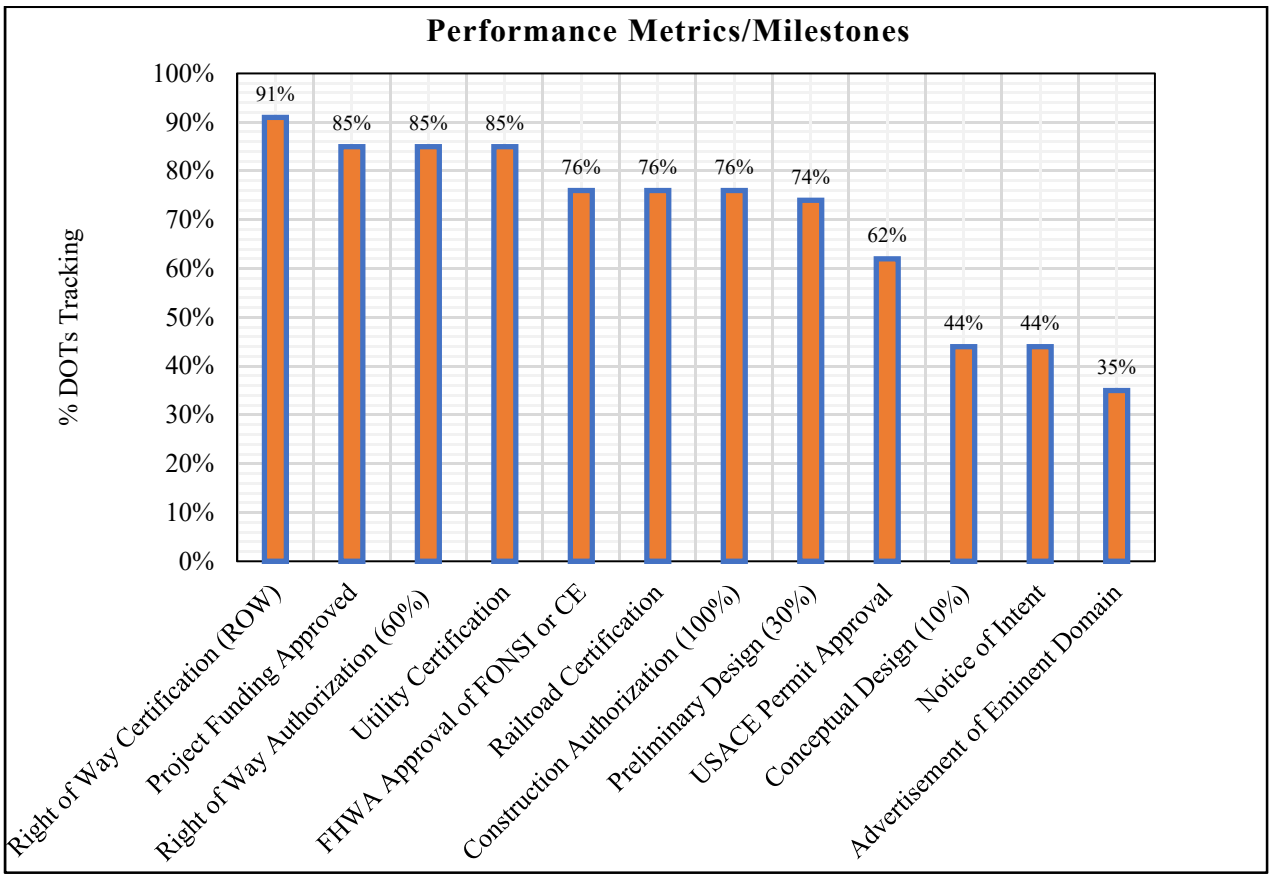


FIGURE 11: Performance Metrics /Milestones Measured by State DOTs

How will individual, departmental, and/or 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 a similar process 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 and/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. PDP performance metrics are also measured by different departments and functional units, which are grouped and combined, so departmental leadership and upper management can track departmental performance. Combining project & 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 2. 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 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/or 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 by 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 performance. A dashboard sharing performance metrics provide exposure for each project and functional unit within the state agency and promote effective and efficient performance agency-wide. A dashboard also provides transparency to the public.

During the state DOT interviews and subsequent review of agency documentation, the following state DOTs performance measurement criteria, metrics, differences, consistencies, frequency, and performance data use were identified. The findings from comparable state DOTs include the following:

Virginia Department of Transportation (VDOT)

VDOT measures and evaluates their project development performance for each transportation project. VDOT project development performance measurement aims to track their progress, gather detailed information to make data-driven and well-informed decisions during PDP, achieve their established goals, and ensure that their transportation systems meet their constituents' needs. VDOT's statewide and national project development targets are indicated in their Six-Year Improvement Plan (SYIP). The SYIP also acts as a baseline to measure VDOT's progress and track their performance.

The project-level and departmental-level performance metrics for projects are driven from VDOTs PDP flowchart (Appendix A) and project schedules. The PDP phases, milestones, and interim milestones are used as performance metrics for individual transportation projects to track their progress. Mainly these metrics represent the cost and timeline of the transportation projects. The individual transportation project-level metrics are then combined and rolled over to present the statewide performance measurement. The statewide performance metrics used in VDOT are 'the project development on-time' and 'the project development on budget.' Also, VDOT measure the project's quality improvement and environmental compliance. These metrics are then combined and grouped for all individual transportation projects in a fiscal year. The statewide project development metrics for VDOT are then published in their dashboard, which is a data-driven integrated reporting platform for key performance indicators from across their agency (see figure 12). VDOT performance dashboard is public and represents transportation project targets indicated and planned in VDOT's SYIP.

The metrics 'project development on-time' measures the performance of meeting project milestones and activities from the time the project PE Funds Approval until the Contract Award to GC. The interim milestones or metrics (time) that are measured at the project-level are Local Agreement, Authorize PE, Determination of Requirements (Scope Project), Public Engagement, Start Purchasing Right-of-Way, Utility Relocation, Right-of-Way Acquisition, Obtain Permits, Advertise Projects, and Start Delivery (Award Contract to GC). These interim phases and milestones are driven from VDOT's PDP flowchart, which is also included in the individual project's schedule. Project phases of development are measured relative to their approved activity schedules and budgets for on-time and on-budget performance. The time or date of these interim milestones acts as project development metrics measured on each project by the project manager.

For all transportation projects in a fiscal year, VDOT combines these interim milestones and metrics to present the project development on-time measure at the organizational level. Similarly, the project development on-budget metrics measure the performance of meeting project milestones and activities budget. The project development on-budget metrics compare the budget with the current estimate for each project at the project level. Combining all the projects shows the measure at the organizational level.

Other than project development metrics, VDOT also measures and evaluates their highway performance, safety, condition, finances, and management to comply with federal and state laws such as MAP-21. MAP -21 requires state DOTs to report 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 highway system. These measures are listed below.

- Highway Performance Measures: Congestion at Various Interstate Location, HOV Travel Speeds, and Travel Times on Key Commuter Routes
- Highway Safety: Crashes, Injuries, Deaths, and Work zone
- Highway Condition: Pavement Condition, Bridge Condition, and Ride Quality
- Citizen Satisfaction Survey: Several Measures such as Quality, Safety, Timeliness, etc.
- Finances: Revenue, Expenses, and Purchase Power (State, Federal, and Local)
- Administrative Management: Emergency Preparedness, Financial Management, Government Procurement, Human Resources, and Information Technology

HHHHHH

Table 2: Interviewed State DOTs PDP Phases and Flowchart Links

State DOTs	**Project Development Process Phases based on State DOTs PDP Flowcharts**												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	See Appendix A
GDOT	Programming and Scheduling	Concept Stage	Environmental Document	Preliminary Design	ROW Plans	Final Design	Construction Authorization						See Appendix B
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					See Appendix C
KYTC	Planning Study	Preliminary Design	Environmental Documentation	Right-of-Way	Utility Coordination	Final Design	PS&E and Letting						See Appendix D
LaDOTD	Feasibility	Planning & Environmental	Funding/Project Prioritization	Final Design Process	Letting	Construction	Operation						See Appendix E
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	See Appendix F

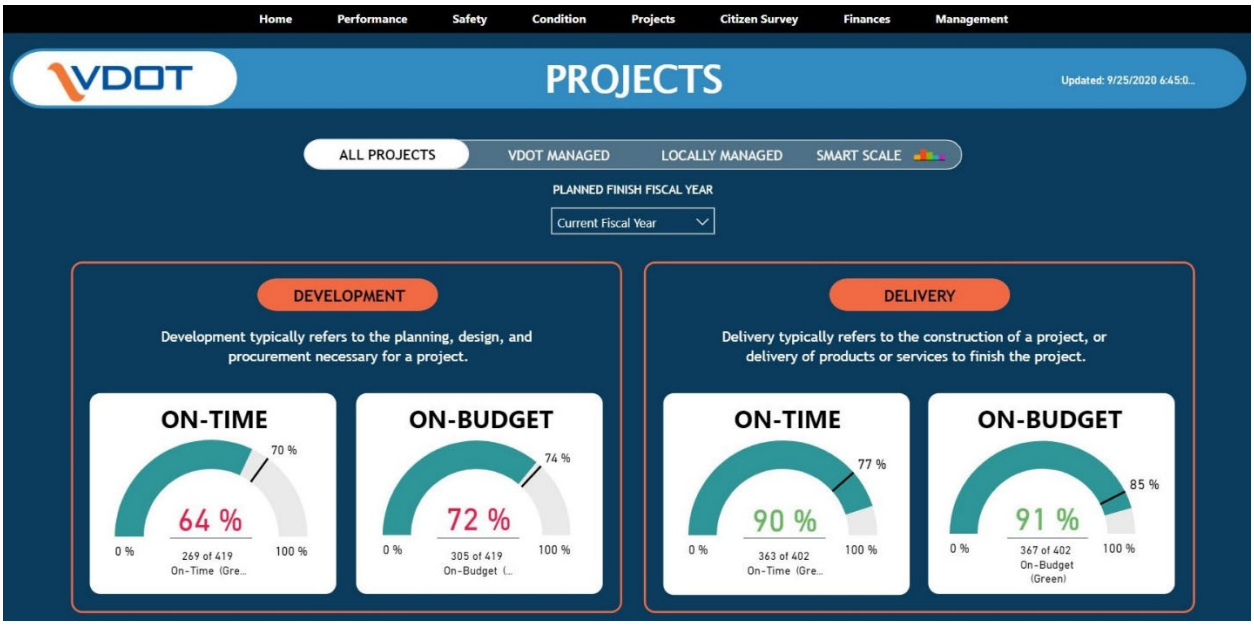


Figure 12: VDOT's Dashboard for Project Development Performance Measurement

Georgia Department of Transportation (GDOT)

Like VDOT, GDOT also measures all individual projects' project development performance to track their progress towards GDOT's goals and objectives. One of GDOT's strategic goals is to plan and construct the best mobility-focused project on-time and on-budget. In addition, GDOT's measure their project development performance to meet their statewide and national targets that are indicated in their STIP and LRTP. GDOT measures both project/departmental and organizational-level performance metrics. The project-level performance metrics are driven from the PDP phases, milestones, and interim milestones (Appendix B). At the project-level, the project manager is responsible for measuring each project's milestones and interim milestones through Primavera P6 software. The project milestones and interim milestones, which act as metrics of time and budget for each project, are measured based on an established baseline. Once the project metrics (such as schedule and cost for different project milestones and interim milestones) are measured for each project, the information feeds into GDOT's Preconstruction Status Report (PSR), which is a summary of project management and key milestones.

All projects' metrics are combined, grouped, and rolled over to represent the GDOT's functional unit's performance and, eventually, the whole organization in terms of development, planning, and construction. The performance data collected in each GDOT department or functional unit is utilized as a performance indicator and report for each functional unit. These performance indicators and reports are prepared quarterly, which is submitted to the commissioner and chief engineer. Every department or functional unit in GDOT has its list of performance metrics, which they evaluate and report their performance to the upper management at different phases of the projects. The analysis of the performance data in GDOT is also used to understand where they are doing well or failing, which leads them to identify the areas for process improvement.

GDOT, like other state DOTs, is also required by law, such as MAP-21 and FAST Act, to apply a transportation performance management approach in carrying out its transportation development

and report its development performance to the public and authorities. GDOT reports its national or organizational performance via a dashboard and its Annual Performance Report. The combined performance metrics data, such as cost and schedule, driven from each project's development, are represented in GDOT's performance dashboard and annual performance report. The performance metrics that GDOT uses to present its statewide planning, development, and construction performance are Percent of Right-of-Way Authorized On-Time, Percent of Construction Authorized On-Time, Percent of Projects Constructed On-Time, and Percent of Project Constructed On-Budget. Aside from the mentioned national performance metrics, GDOT also measures safety, infrastructure, condition, reliability, congestion, maintenance, etc., metrics to comply with the MAP-21 Act.

Florida Department of Transportation (FDOT)

Of the state DOTs interviewed by the research team, FDOT has a very comprehensive and detailed performance measurement system. Similar to other state DOTs, FDOT is also required by MAP-21 to establish performance-based development and planning approach and measure and report their organizational performance. Since FDOT is a decentralized agency, its project development performance measurement occurs at three levels: project-level, district-level, and organizational-level. The project-level performance metrics are measured for individual projects to help the project's efficiency and effectiveness. The project-level metrics are driven from FDOT's PDP milestones and interim milestones (Appendix C). The project manager is responsible for gathering data and information on each metric every quarter. The gathered data supports long-term and short-term decisions, such as alternative analysis, design choices, and program funding. In addition, the measurement of the project development performance acts as an indicator of how FDOT is progressing towards its target and goals, which are indicated in its STIP and LRTP. The project-level and departmental-level metrics are combined and rolled over for each district to present its performance, which eventually presents the whole organization's performance.

To comply with MAP-12, FDOT measures several performance metrics in safety, maintenance, mobility, economy, and environment. The project development metrics are usually driven from the project development and schedule milestones and interim milestones. Some of the project development metrics that FDOT measures are but are not limited to, Consultant Acquisition Dollar and Time, Right-of-Way Certification and Acquisition, Letting Dollars, Percentage of Cost and Time Increase, Percentage of Projects On-Time and Within budget. The overall organizational performance metrics are then reported on FDOT's performance sourcebook, which is developed annually. The purpose of project development performance measurement is to establish standards to fulfill the FDOT’s responsibilities. The evaluation of project development performance measurement leads FDOT to consider the agency's level of involvement, quality of work, consultants’ work reviews, interagency communication and coordination, and actions to expedite the PDP.

Kentucky Transportation Cabinet (KYTC)

KYTC measures and evaluates its project development's performance to comply with MAP-21, support project development decisions, meet its project development target in STIP and LRTP, and address the state and federal requirements. In addition, KYTC performance measurement helps the agency focus on its goals, increase accountability and transparency, and improve

investment decision making. KYTC measures its agency's performance in safety, infrastructure condition, congestion reduction, system reliability, economic vitality, environmental sustainability, and reduced project development and delivery delays. The project development performance metrics are gathered at the project-level by project managers for individual projects and rolled over to the organizational level reported annually in KYTC's Annual Performance and Expenditure Report. The project development performance metrics are driven from KYTC PDP milestones and interim milestones (Appendix D). These metrics are mainly the timeliness and cost of milestones and interim milestones in different project development phases and measured based on established targets (schedule and budget). The combined metrics for all projects are grouped, which represents the KYTC's overall organization level performance.

Louisiana Department of Transportation and Development (LaDOTD)

LaDOTD measures its project development performance annually to track its project's progress and meet its national performance targets indicated in the LaDOTD Strategic Plan for State Fiscal Year (SFY). LaDOTD, like other state DOTs, is also required by MAP-21 to have a performance-based approach and measure their performance in the areas of safety, condition, development and delivery, infrastructure, reliability, environmental sustainability, congestion, and mobility. The project manager is responsible for evaluating and measuring the performance of its developing project. The performance metrics are driven by LaDOTD PDP's different stages, phases, and milestones (Appendix E). Usually, the budget and timeliness of these phases and milestones are tracked and compared against a baseline. The performance data is gathered through the LaDOTD enterprise system. The LaDOTD enterprise's data is used by all agency's functional units and project development teams to review the project's status. The purpose of measuring performance through an enterprise system (dashboard) in LaDOTD is to communicate the issues, evaluate program performance, evaluate individual performance, and improve the project development process. In addition, the data is also presented to the public, legislature, and elected officials to increase accountability and transparency.

North Carolina Department of Transportation (NCDOT)

NCDOT, like VDOT and FDOT, has a very comprehensive and detailed performance measurement system to track the agency's progress and achieve its goal of accountability and transparency. One of the main goals of measuring the project development performance in NCDOT is to develop, deliver, and maintain its transportation infrastructure effectively and efficiently. For project development performance measurement, the metrics are driven from NCDOT's PDP phases, milestones, and interim milestones such as project schedule meetings, notice to proceed, environmental documents completed, right-of-way acquisition complete (Appendix F). The project manager is responsible for tracking project development performance. Still, NCDOT has built technical services division, including office staff, a business officer for all units, and a program analyst to help with the metrics and ensure the right data is collected analyzed to tweak behaviors and processes. The performance metrics data are gathered through the NCDOT dashboard and reported in its Annual Performance Report published on its website.

The project-level performance metrics are grouped and combined to present the organizational-level performance and are represented in NCDOT's dashboard and Annual Performance Report. Figure 13 shows the NCDOTs Performance Scorecard of project development and delivery

metrics. The metrics shown in NCDOT's Performance Scorecard are compared to previous performance results and national targets, indicated in its STIP. As shown in figure 13, the measurement of performance for project development and delivery tracks NCDOT's progress towards the agency's goal of 'deliver and maintain NCDOT's infrastructure efficiently and effectively.' The metrics in figure 13 are gathered through NCDOT's dashboard and projects' monthly progress reports.

2018-19 Performance Scorecard ✓ Measure has been met ✗ Measure has not been met

Performance Measure	How We Measure It	Target	Previous Result	Current Result	Target Met
GOAL 3: Deliver and maintain our infrastructure efficiently and effectively					
Project Development (STIP)	Percentage of STIP projects let on schedule	More than 90%	80%	55%	✗
Project Development (Non-STIP)	Percentage of non-STIP projects let on schedule	More than 90%	97%	65%	✗
Construction Projects—On Schedule	Percentage of construction projects completed on schedule	More than 90%	92%	91%	✓
Construction Projects—On Budget	Total budget overrun for completed construction projects	Less than 5%	-0.3%	1.9%	✓
Bridge Health	Percentage of bridges rated in good condition	More than 80%	76%	77%	✗
Structurally Deficient Bridges	Percentage of bridges that are rated as structurally deficient	Less than 10%	11.56%	9.98%	✓
Pavement Health	Percentage of pavement miles rated in good condition	More than 80%	64%	65%	✗
Roadside Features Condition	Average interstate highway feature condition score (excluding pavement and bridges). An assessment of roadside maintenance elements such as signs, signals, pavement markings, vegetation, drainage systems, shoulders, etc.	More than 84	90.8	Measure Discontinued	n/a
Environmental Compliance	Average statewide environmental compliance score on construction and maintenance projects	More than 7.5	8.5	8.5	✓
Internal Administrative Costs	Percentage of the overall budget for administrative costs	Less than 7.6	5.7%	5.2%	✓

Figure 13: NCDOT Project Development and Delivery Performance Metrics Scorecard

CATEGORY D – PROJECT DEVELOPMENT PROCESS (PDP)

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.

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.

Project Development Process (PDP) – Overview:

Development and mapping of a state agency's PDP phases, tasks, milestones, and activities are among the best practices identified during the survey and state DOTs interview process conducted for this study. An agency'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 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 meet state transportation needs and specific project goals effectively.

State DOTs face several project development challenges and PDP flowchart variations influenced by variables such as project type, environmental considerations, and funding source. An agency's development and mapping of their state DOTs preconstruction PDP identifies 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 (5). 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 (14).

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.

Summary of Findings:

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 2, under section 'Best Practice #8,' shows the PDP phases and relationships for the PDP flowcharts of the state DOTs interviewed by the research team with a well-defined PDP flowchart. The states included VDOT, GDOT, FDOT, KYTC, LaDOTD, and NCDOT. 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

BEST PRACTICE #10

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

Key Findings:

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

OOOOOO

Project Development Process Manual – Overview:

In addition to PDP flowchart development, Top Performing state DOTs develop a comprehensive manual to accompany their Project Development Process. The development of an agency 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 main objectives for the PDP Manual development 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/or new inexperienced personnel are 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.

Summary of Findings:

Most of the state DOTs interviewed by the research team have documented their PDP and developed manuals, including VDOT, GDOT, FDOT, LaDOTD, and NCDOT. 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

BEST PRACTICE #11

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

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 software was effectively utilized to plan preconstruction activities.
- Only 30% of SCDOT's consultants thought that the agency's scheduling process/software was effectively utilized.

PDP Schedule and Activities Duration:

The development of project schedules is a best practice that was supported during the research team's state DOTs interviews. State DOTs develop project schedules to plan and track their PDP activities progress in order 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 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 14.

The average development duration of the preconstruction activities for different project/program types in Figure 14 was collected from the State DOTs National PDP Survey. As shown in Figure 14, the mean duration for all CE project types ranged from 15.5 to 20.0 months. The duration 'mean' for EA/FONSI projects ranged from 27.9 to 33.7 months.

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 15. 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 are determined. A data sort yielded the duration performance results for the top and bottom half of the state DOTs, as shown in Figure 15. The Top

Performers in Figure 15 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 poorer performing state DOTs.

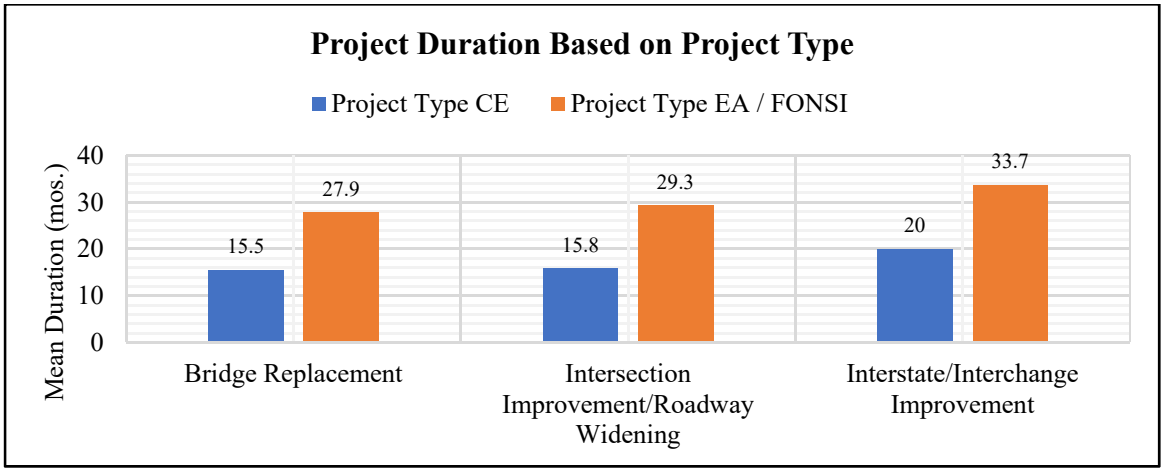


FIGURE 14 Duration based on Project Type

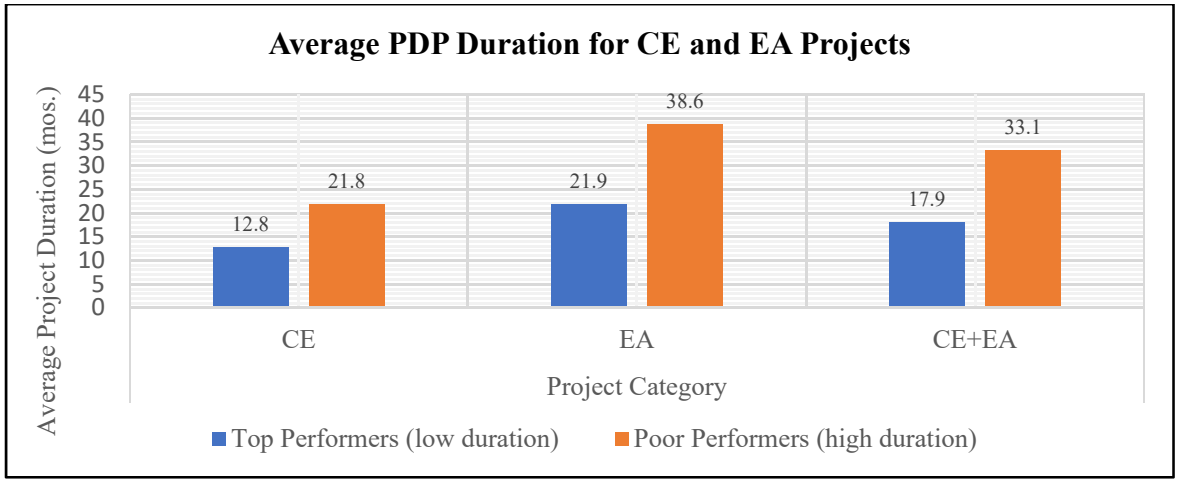


FIGURE 15: State DOTs Project Development Process Duration

As shown in Figure 15, 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 DOTs for CE and EA was 22mos and 39mos, respectively. The PDP for the poorer performing DOTs was almost twice as long as top performers. While most 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.

Summary of Findings:

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 input provided by the project development team. 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/or 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 effectively develop and manage their project schedules.

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.

SSSSSS

- 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

CATEGORY E – PROJECT DEVELOPMENT PROCESS TRAINING

BEST PRACTICE #12

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

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.

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 effectiveness, efficiency, and consistency of the development process. With PDP training, the project managers, departmental unit leads, and professional services consultants gain a better understanding of the development process, its phases and activities, and numerous challenges associated with each phase of the project development. Understanding the PDP provides the insight necessary for project managers to effectively meet a project's scope with quality requirements. 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/or 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/or 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 by the research team during interviews with comparable state DOTs are listed in Table 3. These criteria include the training delivery method, training content, who develops the training material, and those personnel expected to receive the training. As shown in Table 3, 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 an 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 the agency develop a 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 3: Interviewed State DOTs Comprehensive PDP Training Common Criteria