Final Report

Efficiency Study of Design-Build Program

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South Carolina Department of Transportation

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16. Abstract

This report summarizes a two-year study of the South Carolina Department of Transportation (SCDOT) Design-Build Program. The research examined design-build project selection, cost estimating procedures and overall project performance. The study benchmarked the SCDOT Design-Build Program against other state DOT programs through interviews, past project data collection and case studies. The research team concluded that SCDOT, which has been performing design-build projects for almost 30 years, has one of the more mature programs in the country. SCDOT is following best practices in project selection and working closely with FHWA to standardize the procedures at the national level. The cost estimating methods are providing, on average, accurate project cost estimates with some level of conservatism. Continuing to improve its risk-based cost estimating approach will likely yield more accurate cost estimates. When benchmarked against average project performance in a recent FHWA national study and internal SCDOT design-bid-build projects, the research team found that the SCDOT projects outperformed these projects in all estimating, cost and schedule metrics except for schedule growth after contract award. As demonstrated through its leadership in a recent FHWA Design-Build Peer Exchange, the SCDOT Design-Build Program is a national leader. Its commitment to continuous improvement bodes well to maintain this national design-build leadership role.

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Design-Build Efficiency Study Steering Committee

- Chris Gaskins, Chair
- Barbara Wessinger
- Robbie Isgett
- Ben McKinney
- Jae Mattox
- Brad Reynolds
- Claude Ipock (*formerly with SCDOT)*
- Tad Kitowicz (FHWA)

Executive Summary

From March 2018 to December 2020, the University of Colorado Boulder conducted a research study to evaluate the effectiveness of South Carolina Department of Transportation's (SCDOT) Design-Build Program. This evaluation was conducted through interviews, past project data collection and case studies that allowed for thorough benchmarking of the SCDOT's Design-Build Program with other programs across the nation. Specifically, the research examined project selection, cost estimating procedures and overall project performance. In addition to evaluating effectiveness in these areas, the research study makes recommendations of best practices, from within SCDOT and across the nation, to continuously improve the program.

The following is a summary of this study's findings, which are described in detail within the report.

- SCDOT has been conducting design-build project delivery since the mid-1990s. It is one of the most mature programs in the country.
- When benchmarked against average project performance in a recent FHWA national study and internal SCDOT design-bid-build projects, the research team derived the following conclusions from the analysis of five performance metrics:
    - **Award Growth** is a measure of estimating accuracy accounting for the different between the engineer's estimate prior to bid and the contract amount. On average, SCDOT design-build projects outperformed SCDOT design-bid-build projects in the average award growth. SCDOT follows the national trend of having a negative average award growth for design-build projects. This means that the engineer's estimate is higher than the award amount, implying a conservative practice in cost estimating.
    - **Cost Growth** is a measure of contract cost increase from award to completion. SCDOT design-build projects experience lower cost growth from award to project completion when compared to both SCDOT design-bid-build projects and national design-build projects.
    - **Estimate to Final Cost Growth** is the percent change from the revised contract amount (i.e., final cost to deliver the project) and the engineer's estimate prior to bid. SCDOT follows the national trend of having a negative average estimate to final cost growth for design-build projects. The negative value of this metric is mainly driven by a conservative practice cost estimating.
    - **Schedule Growth** is a measure of contract schedule increase from award to project completion. SCDOT schedule growth is higher than desirable. Schedule growth is the one metric where SCDOT design-build projects are not performing as well as the national average. Average schedule growth for SCDOT design-build projects is high for both best-value (33%) and low-bid (17%). This is at least double the national average for design-build projects. However, SCDOT design-build projects are performing better than their design-bid-build counterparts. The average schedule growth for the design-bid-build sample is 29% and the average of best-value and low bid design-build projects is 24%. Design-bid-build projects are performing better than design-build best-value projects but not design-build low bid projects.
    - **Intensity** is a measure of the rate of work put in place over time. SCDOT project intensity performance is relatively similar to national design-build projects and SCDOT design-bid-build projects. On average, SCDOT's project intensity is lower than national

practice for design-build/best-value and higher for design-build/low bid. Conversely, when compared to SCDOT's design-bid-build average project intensity, it is higher for design-build/best-value and lower for design-build/low bid.

- These results show that the SCDOT design-build projects outperform projects from the national study in all but one performance metric (i.e., schedule growth).

The SCDOT Design-Build Program is incorporating best practices from across the country and is a leader in various practices. The following are some of the best practices described in detail with this report.

- SCDOT hosted a recent FHWA design-build peer exchange with design-build managers from across the country.
- Through this research, SCDOT has benchmarked its practices against national practices in the areas of information exchange with design-builders, requests for qualification processes, best-value procurement approaches, risk allocation, quality assurance, design-management issues, levels of bonding and insurance, construction engineering inspection and project management resource allocation. SCDOT is performing at a high level of efficiency in these areas.
- SCDOT is following best practices in project selection and working closely with FHWA on standardizing the procedures at the national level.
- SCDOT is leading best practices for documenting and applying alternative technical concepts (ATCs). It has recently developed a database to incorporate ATCs from past projects on new projects and published this work in national forums.

While the research study provided an opportunity to thoroughly evaluate the SCDOT Design-Build Program performance, the research team recommends the following areas for further study to continuously improve the program.

- Schedule growth is the one metric where SCDOT design-build projects are not performing as well as the national average. The research team would recommend that SCDOT conduct future research to examine the design-build projects with the highest schedule growth to see if there are common causes for this escalation.
- Strive to more closely tie the stated project goals to the evaluation criteria in best-value procurements and carefully examine the weighting between cost and non-cost selection criteria on each project.
- Move towards an Oversight Quality Assurance Organization model where SCDOT's role is to ensure that both the designer and contractor QA plans are effective at meeting the agency's quality requirements (stipulated in the contract) and that the plans are being implemented.
- Continue to improve its risk-based cost estimating approach will likely yield more accurate cost estimates.

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1. Introduction

1.1 Research Project Objectives

The objective of this research is to evaluate the effectiveness of SCDOT's Design-Build Program, review project selection processes, identify best practices, identify cost estimating procedures and develop a process for measuring future effectiveness.

To achieve this overall objective, the University of Colorado performed the following tasks:

- Identified effective design-build tools/processes/best practices along with how and when they are incorporated into the design-build procurement process.
- Identified and suggested improvements to SCDOT's cost estimating process.
- Evaluated SCDOT's project selection process that determines the most appropriate method for project delivery.
- Developed a performance measurement process for SCDOT to evaluate the effectiveness of design-build projects upon completion.

The outcome of this research is an analysis and benchmarking of SCDOT's Design-Build Program performance and a documentation of lessons learned.

1.2 Project Approach

The research solicitation outlined clear objectives, tasks and deliverables. The University of Colorado research team proposed enhancements to these tasks, which were incorporated into the project approach upon execution of the contract. These tasks were further refined through discussions with the Design-Build Efficiency Study Steering Committee in the project kickoff and research charette meeting on May 18, 2018.

Task 1 – Detailed Work Plan

The work plan summarized the research team's approach and schedule. The detailed work plan integrated the research approach presented in the proposal and the discussion with the Design-Build Efficiency Study Steering Committee during the research charrette on May 18, 2018.

Task 2 – Tools, Processes and Best Practices

The Steering Committee identified nine priority sub-tasks for Task 2. Each of these priority areas required different research approaches and had different data requirements. Many of these subtasks required analysis of documentation from other DOTs. The research team conducted a content analysis that consisted of reviewing the state-of-practice through a meta-analysis of existing DOT design-build manuals and project request for proposals (RFP).

The sub-tasks that were identified and prioritized for Task 2 are as follows:

a) Information Exchange with Design-Builders

   The objective of this subtask was to identify, review and assess best practices to improve the information exchange between SCDOT and the design-builders in the pre-procurement and procurement phases.

The research team performed document analysis of design-build manuals to achieve this objective. The team studied the information exchange protocols from these manuals and compared it with SCDOT’s process. This was supplemented with interviews with the SCDOT and other DOT personnel to understand how agencies implement these processes.

b) Request for Qualifications (RFQ)

The objective of this subtask was to review and summarize national DOT methods for using past performance as a grading component in design-build RFQs. This summary aims to provide SCDOT with a framework to evaluate their current practice.

Similar to the previous approach, this sub-task involved a document analysis of DOT’s design-build manuals and current RFQs. The content analysis focused on the processes that DOTs use for past performance evaluation. The team summarized the methods for comparison with SCDOT’s approach.

c) Best-Value Procurement

The objective of this subtask was to analyze, compare and evaluate SCDOT’s best-value procurement against other DOTs and national standards.

The research team performed a document analysis of design-build manuals to analyze DOT best-value procurement approaches. The team also reviewed national guides on this subject. Based on this data, the team benchmarked SCDOT practice and derived recommendations for improvement. Moreover, the team analyzed the best-value scoring methods to determine the impact of non-cost factors on the selection process. With the available data on best-value design-build project selections, the team performed Monte Carlo analysis to simulate different best-value scoring and weighting.

d) Risk Allocation

The objective of this subtask was to evaluate the current SCDOT´s project risk allocation and to propose recommendations to: 1) improve risk templates; 2) make project-to-project adjustments; 3) coordinate risk allocation and RFP development processes; and 4) coordinate risk allocation and cost estimation processes.

The approach for this sub-task included analysis of the SCDOT risk allocation process used in the past projects. This information was compared with the national guides that were available on this topic. The research team reviewed the SCDOT´s risk allocation matrix and derived recommendations to integrate risk allocation into cost estimating and procurement.

e) Design-Build Quality Assurance

The objective of this subtask was to identify and summarize the main decision points for shifting traditional quality assurance from SCDOT to the design-builder.

To achieve this objective, the research team began with a review of recent SCDOT RFPs to determine the quality assurance organizations being used. The current SCDOT practices were compared to other DOTs through the review of design-build manuals and other standard national guides available on this topic. This analysis was supplemented with interviews with selected participants to better understand the current quality assurance practices in SCDOT and DOTs around the United States.

f) Design Management Issues

The objectives of this subtask were: (1) to provide recommendations for improving the Project Definition Report process to support design-build project selection and authoring of RFPs; and (2) to explore the advantages from various levels of design in design-build RFPs.

The research team approached this task by analyzing and comparing SCDOT practices with current nationwide practice using standard national guides. The team also benchmarked the SCDOT process against projects from the FHWA study on the Quantification of Cost, Benefits and Risk Associated with Alternative Contracting Methods and Accelerated Performance Specifications.

g) Level of Insurance and Bonding

This subtask was aimed at exploring and summarizing the current practices on the level of insurance and bonding.

To achieve this task, the team conducted interviews with SCDOT personnel and other DOTs to understand current practices on insurance and bonding. This information was complemented with a content analysis of design-build manuals and design-build RFPs nationwide.

h) Management of Alternative Technical Concepts (ATCs)

The objective of this subtask was to identify and summarize best practices in managing and archiving ATCs.

A document analysis on standard guides was conducted, followed by interviews with selected participants from SCDOT. The research team supported SCDOT with its goal of developing an archive of ATCs to promote innovation and lessons learned on future projects.

i) Construction Engineering Inspection (CEI) and Project Management (PM)

The objective of this subtask was to identify and summarize CEI and PM definitions and functions in design-build projects.

The research team has developed process models for the design-build contract administration process. The team compared the SCDOT design-build process to this generic national process and explored the reasons for differences. The team recommended a set of definitions, roles and responsibilities for SCDOT.

Task 3 – Cost Estimating

The objective of this task was to analyze SCDOT´s cost estimating process for design-build procurement and suggest improvements. The research team reviewed standard national guides regarding cost-estimation and benchmarked the SCDOT's cost estimating practice against national practice, through surveys and follow-up interviews. The data on SCDOT's current cost estimating practices were gathered through a cost estimating template provided by the SCDOT's design-build group and follow-up interviews with selected agency personnel.

Task 4 – Project Delivery Selection process

The objective of this task was to make recommendations to improve the SCDOT´s current project delivery selection process. To achieve this objective, the research team compared the project delivery selection practice of SCDOT with five other DOTs and standard national guides available on this topic. The team also supported the participation of SCDOT in the FHWA Project Delivery Selection tool, which is currently in its pilot state.

The results and recommendations of this task will assist SCDOT in improving the project delivery selection process.

Task 5 – Effectiveness Measurement

The objective of this task was to evaluate the effectiveness of SCDOT design-build projects. The research team benchmarked the performance of SCDOT design-build projects with national practice. The national database was gathered by the research team using the recent FHWA study on the Quantification of Cost, Benefits and Risk Associated with Alternative Contracting Methods and Accelerated Performance Specifications. At the time of analysis, this data formed the largest empirical database of project information exclusive to highway construction. Moreover, the research team compared the cost and schedule performance of SCDOT design-build and design-bid-build projects.

Task 6 – SCDOT Procurement Manual Recommendations

In this final task, the research team derived recommendations for SCDOT's Procurement Manual based on the results obtained from the previous tasks. These recommendations serve the purpose of improving the SCDOT's current design-build practices by offering innovative solutions. These solutions leverage the best practices into an implementable process aimed to benefit the SCDOT Design-Build Program. As part of the recommendations, the research team addressed the following aspects:

- Tools, Processes and Best Practices;
- Cost Estimating; and
- Project Delivery Selection Process.

1.3 Readers Guide to Report

This report is composed of six sections and a series of appendices. The first section introduces the research scope, objectives and approaches that the team followed and applied during the study. Section two describes design-build tools, processes and best practices in areas of interest as defined by SCDOT. Section three provides information on SCDOT design-build cost-estimating practices and how it relates to national best practices. Section four is focused on the project delivery selection process and summarizes the selection methods used by six DOTs around the United States, including SCDOT. Section five discusses the effectiveness of the SCDOT Design-Build Program. This section compares the performance of SCDOT in design-build projects with respect to national performance as well as a comparison between design-build and design-bid-build. Finally, the report concludes with a set of conclusions and recommendations. This concluding section also contains recommendations for changes to the SCDOT procurement manual based upon the results of this research. The appendices include separate technical memoranda for each of the research tasks and subtasks. Additional supporting information and all data associated with this research are in the ProjectWise folder at the following location.

pw:\\SMPPWISE.nts.scdot.net:SCDOT\Documents\-GENERAL FILES\Research\State Planning & Research\SPR 740 - Design-Build\4 - General Notes\Final Report & Project Summary\

2. Tools, Processes and Best Practices

The Steering Committee identified nine priority sub-tasks for Task 2. The results for each of these subtasks is summarized in this section of the report. Technical memoranda with more detail for each sub-task are included in the ProjectWise folder (> University of Colorado > Task 2-Tech Memos) for this study.

2.1 Information Exchange with Design-Builders

The objective of this section is to identify, review and assess best practices to improve the information exchange between SCDOT and the design-builders in the procurement phase. This sub-task focused on the information exchange taking place after the release of the RFP document. In this regard, the Code of Federal Regulation (CFR) defines three types of exchanges after the release of the Request for Proposal (RFP) in design-build Procurement (23 CFR § 636.402).

- Clarifications: Used to clarify certain aspects of a proposal (resolve minor errors, clerical errors, obtain additional past performance information, etc.)
- Communications**:** Used to address issues that might prevent a proposal from continuing forward the evaluation process.
- Discussions: Enhance the contracting agency's understanding of proposals and the offerors' understanding of the scope of work. Discussions are aimed to facilitate the evaluation process. According to 23 CFR § 636.402, discussions take place "after receipt of proposals and after the determination of the competitive range."

This section also includes the possibility of using oral presentations during the procurement (23 CFR § 636.111).

This technical memorandum compares the current SCDOT information exchange process with current practices in other states. Current SCDOT practice is defined by the information included in "Section 5" of the RFP instructions. The research team developed a document analysis of design-build manuals, RFPs and other documentation from 13 other states to compare their processes with South Carolina's. The analysis shows that, although the states generally consider these four concepts, some have developed more detailed definitions.

- Clarifications: All the states include the concept of clarifications in their evaluation process. In 42% of the states, this consideration is more specific and includes details about what agencies should consider a clarification and how they should conduct the process.
- Presentations: Most of the states use interviews, oral presentations, or both during the evaluation process. The procedure for developing these presentations and whether it is a mandatory or a project-specific decision varies between states. Florida, North Carolina, New York and Washington are the states that more precisely define the presentation process in their manuals.
- Communications: Only four out of the 13 states mention using this concept during their evaluation process. Arizona and California briefly mention it in their documents, whereas documents from New York and Virginia provide a more specific definition.
- Discussions: Only the states of Arizona, New York, Colorado and Virginia mention this type of information exchange. Among them, New York is the one that includes a more comprehensive definition.

Recommendations for Information Exchange

In order to develop recommendations for SCDOT, the research team has identified national best practices and compared them with the current SCDOT practice. As a result of the comparative analysis, the recommendations are the following:

Section "5.0 Presentations" of the SCDOT RFP

1. State whether presentations will be before or after the preliminary Evaluation Committee ratings. North Carolina does presentations after the preliminary rating. New York provides the possibility for before or after, but it is clearly stated.
2.
3. Consider being more explicit about what material is permitted in the presentation. For example, Florida DOT specifies:
    - "*An unmodified aerial or map of the project limits provided by the design-build firm is acceptable for reference during the Page-Turn Meeting. The unmodified aerial or map may not be left with the Department upon the conclusion of the Page-Turn Meeting. Use of other visual aids, electronic presentations, handouts, etc., during the Page-Turn Meeting, is expressly prohibited."*
4. Consider recording the presentation. Florida records the meeting and makes it part of the contract documents. The CFR (636.111) indicates that oral presentations may be a substitute for, or augment, written information. However, DOTs must maintain a record of oral presentations to document what information is relied upon in making the source selection decision. The main advantage of recording the presentations is to have additional evidence of all the information shared in these presentations. The recording allows revisiting the whole presentation in case something is not clear. They can also be used if any DOT official is not able to attend the presentation and his/her attendance is needed.

Section "5.0 Clarifications" of the SCDOT RFP

1. Include examples of the types of clarifications that are allowable. For example, California includes allows for resolving any uncertainties or to obtain clarifications concerning the Proposal.
2. Define the procedure for requests for clarification. The reader is referred to current practice in Georgia in Section 4.2.3 Request for clarification from GDOT Design-Build Manual.
3. Consider more specific wording or examples in the following statements:
    - The SCDOT POC shall exchange sufficient information.
    - The SCDOT POC is charged with limiting such exchanges to only the information necessary to determine how to read or interpret language already existing in the Proposal.
    - A proposal is unclear if open to more than one reasonable interpretation or obscure in meaning through indefiniteness of expression. Silence is not unclear.

<u>Section "5.0 Communications" of the SCDOT RFP</u>

1. Consider including details about the communication process. In this regard, the instructions included in the New York Manual could be used as a reference:
   - *"The Department prepares brief written questions that can be sent to the Proposers in order to have them respond with the information that clarifies the ambiguities or addresses the concerns of the Department. The request for Communications should also contain instructions for response and a timeframe in which the response must be received."*

   The communications, in this case, do not become part of the contract. They only serve to clarify information to the Evaluation Committee while they are assessing the proposal. This suggestion was recommended early in the development of the research and SCDOT has implemented communications, which do not become part of the contract.

<u>Section "5. 0 Discussions" of the SCDOT RFP</u>

1. Consider including a specification regarding to what extent discussions will be held with all proposers or not. For example, *"If Discussions are held with one Proposer, they must be held with all Proposers in the Competitive Range."*
2. Provide additional detail about the kind of information included in discussions. For example:
   - Advising the Proposers of significant Weaknesses and/or Deficiencies in their Proposals (relative to the RFP);
   - Attempting to resolve any uncertainties and obtaining any significant clarifications concerning the Proposal;
   - Resolving any suspected mistakes by calling them to the attention of the Proposers as specifically as possible without disclosing information concerning other competing Proposers' Proposals or the evaluation process; and
   - Providing the Proposers a reasonable opportunity to submit any further technical or other supplemental information to their Proposals.
3. Specify that *"No indication will be made to any Proposer of the evaluation status of any other Proposer or Proposal."*
4. Include that discussions will only address specific deficiencies in the Proposer's Proposal. Other changes may be made through the RFP addendum or Best And Final Offer (BAFO).
5. Review whether some of these prohibitions related to the Department personnel should be included in the Manual while holding discussions. For example: *"During Discussions, Department personnel involved in the acquisition are prohibited from engaging in the following conduct that: 1) Favors one Proposer over another; 2) Reveals a Proposer's technical solution, including unique technology, innovative and unique uses of commercial items, or any information that would compromise a Proposer's intellectual property to another Proposer; 3) Reveals a Proposer's price without that Proposer's permission; 4) Reveals the names of individuals providing reference information about a Proposer's past performance, or 5) Knowingly furnishes source selection information in violation of the Department's procurement policies and the laws of the State".*
6. Evaluate the inclusion of information about proposal revisions during discussions. As a reference, New York state includes:
   - *"If the Department decides to enter Discussions with the Proposers in the Competitive Range, they must also request Proposal Revisions from the Proposers in the Competitive Range. Proposers will be requested and/or allowed to revise their Quality and Price Proposals, including the correction of any weaknesses, minor irregularities, errors and/or deficiencies identified to the Proposers by the Department following the initial*

evaluation of the Proposals. The RFP Revisions will allow adequate time for the Proposers to revise their Proposals. Upon receipt of the final Proposal Revisions, the process of evaluation will be repeated for the revised information. The process will consider the revised information and re-evaluate and revise ratings as appropriate."

Other areas of concern related to information exchange

This section summarizes recommendations related to five areas that SCDOT identified of interest: (1) the difference between clarifications and communications; (2) the definition of dispositions of written/comments in all forms of "communications" that become part of the contract; (3) the benefits that other states obtain from presentations; (4) the difference between Q&A sessions and oral presentations; and (5) the definition of the stages where each form of "communications" is applicable.

Difference between Clarifications and Communications

According to the current practice of states such as California, New York, or Georgia, clarifications serve DOTs as a mean to ask for correction of minor errors and/or to determine the responsiveness of the Proposal.

In contrast, communications are used to address or clarify technical concepts. For example, New York uses them to make clear aspects related to the Alternative Technical Concepts while Virginia uses them to a) enhance its understanding of Proposal, b) allow reasonable interpretation of the Proposal, or c) facilitate the evaluation process. These reasons are defined in CFR 636.402.

Communications as Part of the Contract

The only reference about including some form of communication as part of the contract is given by FDOT. Florida includes questions and responses from the Questions & Answers (Q&A) session as part of the contract documents. The Q&A session helps FDOT to obtain clarification and to ask questions to the Proposer regarding the technical Proposal

New York considers any form of communications as part of their records, but not part of the contract.

Benefits of Presentations

The analyzed states highlight the use oral presentations to:

- Provide offerors with an opportunity to explain their technical proposals further and highlight the most significant aspects of it (e.g., NCDOT, WSDOT).
- Familiarize the evaluation personnel with the teams and proposals (e.g., NYSDOT).
- Guide the review committee through the technical Proposal and provide an opportunity for the agency to seek clarification and ask questions (e.g., FDOT, WSDOT).

Q&A sessions and oral presentations

There is no need to decide between one form of information exchange and the other. FDOT, for example, use both of them. They conduct presentations (page-turn meeting) to allow the design-build firms to present and highlight the critical aspects of their proposals. They also hold Q&A sessions in which the Department seeks clarifications and asks questions related to the technical Proposal.

Stages for each form of information exchange

Based on the information analyzed in this tech-memo, the following stages are the ones where each type of evaluation-exchange should be developed:

- Clarifications: after receipt of Proposal
- Communications: after receipt of the Proposal and during the evaluation process

    - Florida: Page-turn meeting happens about a week after the technical Proposal is submitted, while Q&A is scheduled near the end of the technical review and prior to receiving the price proposal.
    - North Carolina: Following a period of preliminary evaluation of the technical Proposal
    - New York: At the beginning of the evaluation process.
- Discussions: after the receipt of proposals and after defining the competitive range.
  23 CFR does not explicitly indicate if the discussions take place after the bid opening. However, in Subpart E—Discussions, Proposal Revisions and Source Selection, some sections suggest that the Proposer's price is an issue that may be addressed in discussions. If this is the case, the price is known by public administrators but remains confidential until the Best and Final Offer.

These recommendations are based on the review of other state documents. The research team has not discussed these recommendations with the states that were reviewed. It should also be noted that the research team has not reviewed any of South Carolina's project-specific source selection plans. Some of the recommendations could be more appropriate for these source selection plans rather than RFPs or the SCDOT Design-Build Manual.

2.2 Request for Qualifications

The objective of this section is to review and summarize national DOTs methods for including past performance in the design-build Request for Qualifications (RFQs). This section summarizes and synthesizes the recommendations contained in the Code for Federal Regulation (CFR) as well as the methods used by six DOTs to assess past performance in design-build RFQs. This summary provides the SCDOT with a framework to evaluate their current practice.

The CFR suggests specifying the following aspects in the past performance evaluation: the timeliness and relevance of the information, the source of information, the context of the data and the general trends in contractor's performance. The CFR also indicates that the solicitation should include a policy for evaluating offerors with no relevant performance history. The solicitation should authorize offerors to provide information on problems encountered on the identified contracts and the offeror's corrective actions. DOTs should use their discretion in determining the relevance of past performance information. Finally, the CFR indicates that the past performance evaluation should include information regarding predecessor companies, key personnel who have relevant experience, or subcontractors that will perform major or critical aspects when such information is relevant to the current acquisition (23 CFR § 636.205).

The research team conducted a document analysis of design-build RFQs from six states, including South Carolina. The criteria to assess RFQs can broadly be grouped in five categories: (1) project understanding; (2) proposer's experience; (3) project team members organization and experience; (4) past performance; and (5) other aspects such as quality programs, suitability, staff accessibility, compliance with formal requirements and safety. The analysis shows that past performance, as an explicit evaluation criterion in the RFQs, is considered in four of the six reviewed states. The two states that do not explicitly include past performance in the RFQ, do consider the experience requirements in the category of Proposer's experience. The study also found differences in the weights given to the past performance criteria.

Table 1 includes a summary of the findings. The first column corresponds to SCDOT's past performance evaluation criteria. The second through sixth columns compare the other states with SCDOT practices to identify differences or similarities with the SCDOT approach.

Table 1. RFQ Past Performance Comparison

South Carolina SCDOT RFQ SC 277 NB over I-77 Bridge replacement (2017)	Georgia GDOT RFQ I-20 at Savannah River (2018)	North Carolina NCDOT RFQ Division 6 Bridge replacement (2018)	Virginia VDOT RFQ Route 7 and Battlefield parkway (2017)	Florida FODT RFQ Generic Florida DOT Webpage*	New York NYDOT RFQ Hunts Point Interstate access improvement project (2018)
Weight					
40/100points	20%	Adjectival	40%**	7/20 points***	35%
Evaluation criteria					
Experience of Proposer's Team					
Lead Contractor or any Major Subcontractors	✓	✓	✓	✓	✓
Lead Design or any Major Design-Subconsultant	✓	✓	✓	✓	✓
Quality of Past Performance					
Successful projects completed on time & schedule	Ask about schedule completion	Ask for satisfactory performance in general	✓	✓	Ask for reasons not accomplished
Records of managing contracts to minimize delays, claims, dispute proceeding, litigation & arbitration.	Not mentioned	Not mentioned	Not mentioned	Through the evaluation system	No records but self-assessment narrative
Quality initiatives including but not limited to cost control, schedule management and adherence, avoidance of claims.	Not mentioned	Not mentioned	Not mentioned		Not mentioned
*Specific information about projects that had have problems**	Not mentioned	✓	Not mentioned		Projects listed by team members
Use of evaluation systems	No	No	No	Yes	No
Comments	GDOT does not ask for specific information on the past performance criteria	NCDOT does not include *past performance* as an evaluation criteria, but includes experience in other sections	VDOT does not include *past performance* as an evaluation criteria, but includes experience in other sections	Evaluation system: - *Contractor grades* (contractor past performance report) *Professional consultant grades*	Additionally, they include safety, experience modification rate and DBE program experience

* http://fdotewp1.dot.state.fl.us/procurement/professionalservices/advertise/advDBLD.shtml
** This weight is referred to as "Experience of Offeror's Team."
*** 7 points are given to "Past performance, design-build experience, organization and staffing."

In order to develop recommendations for SCDOT, the research team has identified national practices and has compared them with the current SCDOT practice. SCDOT's RFQ evaluation practices are in-line with surrounding states and others across the country. The differences appear to be due to preferences and local practices. In comparing SCDOT RFQ evaluation criteria to the information reviewed from Georgia, Florida, New York, North Carolina and Virginia, SCDOT may wish to consider the following suggestions:

- If SCDOT develops a state-wide contractor performance rating system, this can be used for the design-build RFQ process.
- If SCDOT does not move to a contractor evaluation system, they could consider formulating the evaluation criteria in alignment with each project's goals.
- Consider, within the *past performance* requirements, specifying a minimum number of projects developed using design-build.

- Consider additional past performance information in areas like safety, environmental compliance, or Disadvantage Business Enterprise utilization if those aspects are relevant to align the selection with the project's goals.
- The weights and scores ranges used by SCDOT enable an evaluation aligned with the concern of considering the past performance in the SOQ meaningfully.
- SCDOT might wish to consider the following recommendations related to the Work history and quality form—contractor designer:
  - In order to improve the assessment of experience in the past performance evaluation criteria, SCDOT might wish to emphasize that the description of work should be oriented to specific aspects relevant to the project goals. For example, if one of the project goals is to minimize affections to the community affected by the construction, the work description in the "work history form" should emphasize how the proposers accomplished this goal in previous projects.
  - In order to improve the assessment of quality in past performance evaluation criteria, SCDOT might wish to consider:
    - In the quality form—section h, similarly to the previous suggestion, the self-assessment required could be oriented to performance evaluation with an emphasis in specific areas. For example, if SCDOT knows that the project under procurement could have cost overruns and delays associated with particular project items such as utility relocation or environmental issues, the performance evaluation should be focused on these areas.
    - In the quality form—section i, project-specific awards can also be required optionally. For example, having a DBIA award associated with design engineering, process, teaming, or any specific design-build project can be a good signal of past performance quality. The Institute for Sustainable Infrastructure issues project's credentials that might also be considered if sustainability is among the project's goals (https://sustainableinfrastructure.org/project-verification/verify-a-project/). This credential demonstrates the sustainable achievements on the basis of 64 sustainability and resilience indicators organized into five categories: quality of life, leadership, resource allocation, the natural world and climate and resilience.

2.3 Best-Value Procurement

The objective of this section is to analyze, compare and evaluate South Carolina Department of Transportation's (SCDOT) best-value procurement approach against other DOTs and national standards. The first part of the study summarizes and synthesizes the best-value related information included in the Code for Federal Regulation (CFR) and in standard documents (Molenaar and Tran 2015; Scott et al. 2006) as well as the methods used by six DOTs to develop the best-value procurement in design-build projects. This summary aims to provide SCDOT with a framework to evaluate their current practice. The second part aims to analyze SCDOT´s best-value scoring methods to determine the impact of non-cost factors on the selection process using Monte Carlo simulation. As a result of this benchmarking and simulation analysis, the research team includes recommendations to the SCDOT best-value procurement process.

The analysis showed that SCDOT's approach to best-value procurement has evolved and greatly improved throughout its Design-Build Program development. The current approach aligns with federal standards and national best practices. The research team believes that the Weighted Criteria method is the most transparent and accurate method. SCDOT should remain consistent with this approach. All the detailed analysis can be reviewed in the technical memorandum in the ProjectWise folder.

The key findings are summarized as follows:

Goals and Evaluation Criteria

- As described in the *AASHTO Guide for Design-Build Procurement* (AASHTO 2008), project goals can help maximize the possible benefits of design-build. Schedule goals can include minimizing project delivery time or complete the project on schedule. Cost goals can include minimizing project cost, maximize project budget, or complete the project on budget. Please refer to the *AASHTO Guide for Design-Build Procurement* for advice on writing project goals and additional examples.
- SCDOT should strive to more closely tie the stated project goals to the evaluation criteria. The stated project goals should be described in both the Project Definition Report and the RFQ/RFP. While the goals can currently be inferred from the best-value criteria and weighting, they should be more explicitly stated.
- The project goals might be included at the beginning of RFQ and RFP after the general information and the project description.
- Two key aspects should be considered when establishing the evaluation criteria. First, the relationship between project goals and evaluation criteria. Second, the evaluation criteria's capacity to obtain the appropriate information to make a meaningful comparison among the proposers.
- Project's goals should be aligned with the evaluation criteria. The evaluation criteria should be able to be meaningful for the proposers' comparison. The starting point of the cost will depend on the balance that SCDOT wishes to establish between cost and non-cost factors. This might vary from not considering cost in the best-value formula to assign different ranges of weights for cost.

Scoring Systems

- Making meaningful comparisons among proposers depends on the proper formulation of evaluation criteria. The evaluation criteria areas of assessment should enable the evaluation team to differentiate scores among the proposers. Areas, where all the proposers are likely to be at the same level, should be evaluated in a pass/fail format.
- Once the Design-Build Program leadership establishes the areas of assessment, they can decide if the evaluation can be better performed using direct scoring or adjectival scoring.
- Adjectival scoring can help to achieve consensus among the evaluators. However, achieving more separation of the teams in the evaluation does not depend so much on using adjectival or direct scoring but on defining consistent evaluation criteria (i.e., comprehensive, direct, unambiguous and understandable).

Weighted Criteria Formula

- SCDOT has applied various award algorithms in past year. It is currently using the weighted criteria formula. SCDOT should continue to use this approach as it provides the most transparency and alignment with project goals.
- SCDOT should consider normalizing technical scores (e.g., making each proposers' score a ratio of the highest score) similarly as to how cost scores are normalized. This will balance cost and technical factors on similar scales.

- SCDOT should consider a more standard weighting between cost and non-cost criteria. The analysis showed that, under current scoring practices, weights lower than 0.43 and higher than 0.53 do not enable SCDOT to optimize a best-value selection because the selection is skewed toward either non-cost or cost factors. A range of weight of costs between 0.43 and 0.53 allows decision-makers to have chances of having both cost and non-cost selections.

2.4 Risk Allocation

The objective of this section is to evaluate the current South Carolina Department of Transportation (SCDOT) project risk allocation process and to propose recommendations to (1) improve templates used for risk identification, (2) make project-to-project adjustments, (3) coordinate risk allocation and RFP development processes; and (4) coordinate risk allocation and cost estimation processes. Figure 1 shows the process followed to accomplish this objective. This report focuses on the first step of the analysis by benchmarking the current SCDOT's critical risk matrix with the national DOT's practices and standard guides. The analysis was focused on three aspects: (1) risk categorization, (2) risk analysis and (3) risk templates.

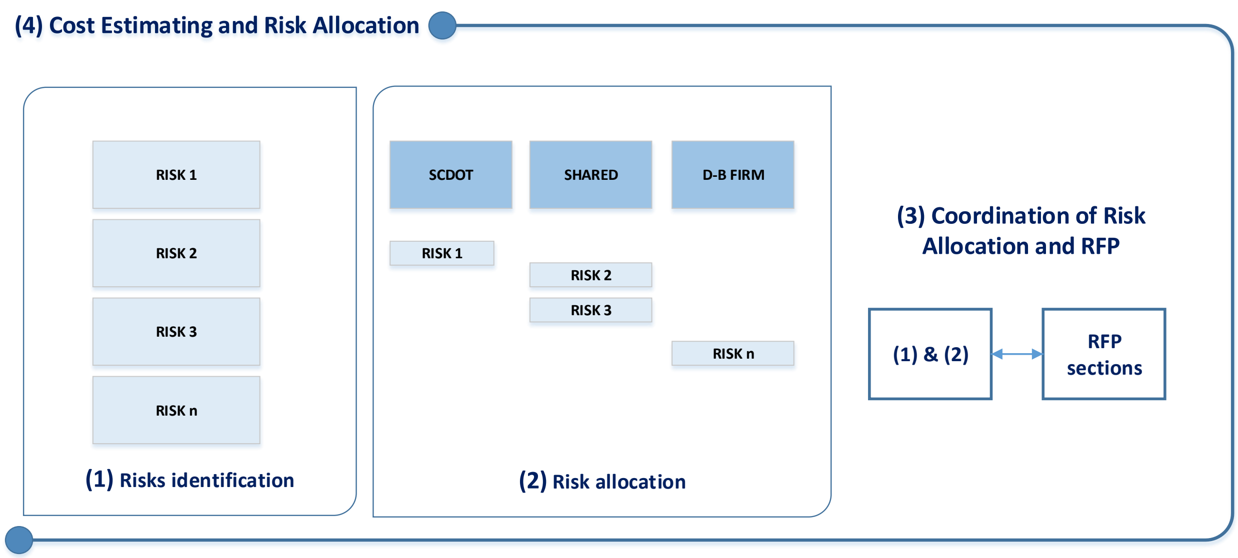

Figure 1. Risk allocation research process

The research team examined the risk categorization practices of six states. Table 2 synthesizes 16 risk categories from the analysis. SCDOT's Manual includes a Risk Matrix; however, it does not define a risk categorization. A detail list of the potential risks associated with each risk category is provided in section 3.2.1 of the technical memorandum in the ProjectWise folder. SCDOT can consider using this list to create a risk breakdown structure (i.e., categorization) that supports the project-based risk identification process.

Table 2. Risk categorization identified in the benchmarking

Risk category	CA	GA	NV	WA	CO	NY
Design	✓	✓	✓	✓	✓	
Environment	✓	✓		✓	✓	✓
Right of Way	✓	✓		✓	✓	✓
Utilities		✓	✓	✓	✓	✓
Railroad		✓	✓	✓	✓	✓
Construction	✓	✓	✓	✓	✓	
Differing Site Conditions/Changed Conditions			✓		✓	✓
Local Agency		✓	✓		✓	
Stakeholders Issues		✓		✓	✓	
Force Majeure/Acts of God			✓		✓	✓
Completion and Warranty			✓		✓	✓
Funding/Financing				✓		✓
Contracting and Procurement Issues		✓		✓		
Geotechnical Issues				✓		✓
Hydraulics				✓	✓	
Project Management	✓			✓		

Once identified, risks should be prioritized through a qualitative and/or quantitative analysis. Qualitative analysis is done through an adjectival rating (e.g., high, medium, low). Quantitative analysis is done by combining separate analysis of the probability of risk occurrence and magnitude of the impact if the risk does occur (probability x impact) (Molenaar, Diekmann and Ashley 2006). Table 3. summarizes the types of analysis performed by six different DOTs. It also shows the DOTs that define a specific criterion to determine the type of analysis that should be done. Section 3.2.2 includes more detail about these approaches.

Table 3. Sample of DOT risk analysis techniques

		CA	GA	NV	WA	CO	NY
Type of analysis	Qualitative Risk Analysis						
	Adjectival risk ratings	✓	✓	✓	✓		
	Quantitative Risk Analysis						
	Risk rating determined by (probability)*(impact occurrence)	✓		✓	✓	✓	✓
Criterion to determine the type of analysis related to project size		✓		✓	✓		

From a document review of these six states, the research team selected templates, as examples, which provide guidance for SCDOT to elaborate its risk management template. These examples are taken from other states' risk management guides and manuals[1]. The selection aims to cover a wide range of examples with varying complexity (Table 4.).

Table 4. Information included in examples of risk management templates

		AASHTO Ex. 1	CA Ex. 2	GA Ex. 3	NV Ex. 4	WA Ex. 5	CO Ex. 6	NY Ex. 7
Risk register & allocation		✓	✓	✓	✓	✓	✓	✓
Type of analysis	Qualitative Risk Analysis							
	Adjectival risk ratings		✓	✓			✓	
	Quantitative Risk Analysis							
	Risk rating determined by (probability)*(impact occurrence)		✓			✓		✓
Risk response			✓			✓	✓	✓
Monitoring and control						✓		

This report constitutes the first step to improve the current SCDOT's risk allocation management. Current practices from six other states have been gathered and benchmarked with SCDOT's practice. From this analysis, SCDOT may wish to consider the following suggestions:

1. SCDOT might wish to elaborate risk identification guidelines in the SCDOT Design-Build Manual to facilitate a more detailed and consistent process.
2. SCDOT might wish to establish a preliminary risk breakdown structure (i.e., categorization) that could serve as a baseline to define the project-based risks. This report includes a compilation of potential risks that could help the SCDOT preliminary risk breakdown structure.
3. SCDOT might wish to define its design-build risk tolerance (i.e., the criteria to determine if the level of risk is "high," "medium," or "low").
4. Review the examples of risk allocation templates included in this report to establish guidelines for the improvement of the SCDOT’s current template.
5. SCDOT should evaluate in a project-by-project basis who is best equipped to handle each risk.
6. The first step for developing a risk assessment tool is to build a sound and comprehensive risk register form that can be easily updated during the project lifecycle. A good start-point might be the Risk Allocation Decision Matrix generated during the Project Delivery Selection Process (FHWA ACM Tool).
7. Once the risks are identified, a more in-depth analysis of these risks should be conducted to properly managed them. This analysis can take different approaches. However, all of them should seek to answer the following risk assessment questions:
    - What can go wrong?

[1] See section 2 for more detail.

- What is the likelihood?
- What are the consequences?

2.5 Design-Build Quality Assurance

The objective of this section is to identify and summarize the decision points for shifting the traditional quality assurance (QA) from the South Carolina Department of Transportation (SCDOT) to the design-builder. The research team concluded its assessment and recommendations based upon the benchmarking conducted on SCDOT practices in the area of Quality Assurance (QA) for design-build projects.

For benchmarking purposes, the research team referred to the NCHRP Report 808 Guidebook on Alternative Quality Management Systems for Highway Construction (Molenaar, Gransberg and Sillars 2015). This report helped identify quality assurance organizations(QAO) models that were essential to the benchmarking process. The research team also compared the SCDOT I-85 and I-77 design-build projects with similar projects from Colorado, Minnesota and Utah. This helped the team to benchmark, analyze and understand the SCDOT Quality Assurance practices. To this end, the research team elaborated the collection of questionnaire responses from the project team members to determine the approach for the QA.

The NCHRP Report 808 summarizes the five QAOs and their range of application (Figure 2). The definition to each approach to quality is as follows:

- **Deterministic**: This is the traditional approach to quality in the highway industry, wherein the agency retains all the responsibility associated with project quality roles, responsibilities and activities.
- **Assurance**: The responsibility of all aspects of quality except design and construction quality control (QC) is retained by the agency.
- **Variable**: Design and construction take different approaches to quality. For example, the agency might appoint an outside party to take responsibility of both design phase QC and acceptance, while the construction phase QC only may also be assigned to an outside party. This is a common approach used in the design-build projects.
- **Oversight**: The agency here assumes an oversight role and assigns responsibilities regarding the design QC, design acceptance, construction QC and construction acceptance to outside parties.
- **Acceptance**: The agency is responsible only for verification testing and final acceptance. All the other responsibilities and roles are assumed by the concessionaire. This is an approach which is limited to the PPP project delivery method.

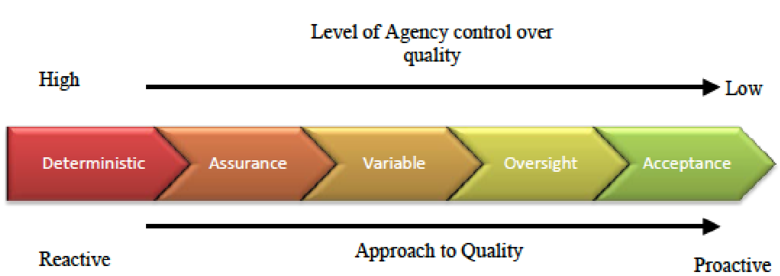

Figure 2. Spectrum of QAOs

The FHWA 2018 study on the risks and benefits of Alternative Contracting Methods (ACMs) for highway construction helped understand the factors influencing the selection of the most appropriate QAO (FHWA, 2018). Table 5 represents the QAO models used with different project delivery methods. 74% of the sampled low-bid design-build projects use traditional (Deterministic and Assurance) QAO approaches, whereas 60% of the sampled best-value design-build projects use traditional QAO approach, which is lower than D-B/L-B.

Table 5. QAO benchmarking by delivery method

Quality Assurance Organization (QAO)	D-B-B N = 49	CM/GC N = 26	D-B/LB N = 19	D-B/BV N = 25	ALL Projects N = 119
Deterministic	17	8	7	6	38
Assurance	24	13	7	9	53
Variable	2	0	1	0	3
Oversight	2	5	1	9	17
Acceptance	4	0	3	1	8

The study also concluded the results of QAO benchmarking with respect to DOTs. Table 6 represents the benchmarking data by agency. As per Table 6, some agencies have implemented the Oversight and Acceptance QAOs for selected ACM projects.

Table 6. QAO benchmarking by agency

QAO	ADOT N = 16	CDOT N = 10	FDOT N = 33	Maryland DOT N = 5	MnDOT N = 9	ODOT N = 9	Ore. DOT N = 4	UDOT N = 26	WSDOT N = 9
Deterministic	3	4	3	4	5	7	0	11	1
Assurance	7	6	20	1	2	1	3	11	2
Variable	0	0	1	0	0	0	0	1	1
Oversight	6	0	4	0	0	1	1	2	5
Acceptance	0	0	5	0	2	0	0	1	0

The research team also analyzed SCDOT design-build projects to compare the QA characteristics with similar projects developed by other DOTs. The two SCDOT projects selected for this purpose were I-85 and I-77 design-build projects. The analysis consisted of understanding project features like project quality profile, QAO model and summary of design and construction quality management roles. A summarized table of results of national benchmarking is represented in Table 7.

Table 7. Benchmarking of QAOs

	SCDOT Project I-85	SCDOT Project I-77	CDOT US 160 4th Lane Addition	UDOT I-15 Widening-Beck Street	MNDOT Hastings River Bridge
Quality Assurance Organization (QAO)	Assurance	Assurance	Assurance	Oversight	Oversight
Design Acceptance	SCDOT	SCDOT	CDOT	Contractor	Contractor
Design QC	Designer	Designer	Designer	Designer	Designer
Construction Acceptance	SCDOT	SCDOT	CDOT	Contractor	Contractor
Construction QC	Contractor	Contractor	Contractor	Contractor	Contractor

Recommendations for Quality Assurance

Based on the national benchmarking, SCDOT may wish to consider the following suggestions:

1. Take on more of an oversight role and still be consistent with other state DOTs, as well as meet Federal regulations.

2. Move to an Oversight QAO model where their role is to ensure that both the designer and contractor QA plans are effective at meeting the agency's quality requirements (stipulated in the contract) and that the plans are being implemented.
3. Review previous experience in Oversight QAO model from ADOT, FDOT, VDOT and WSDOT.

2.6 Design Management Issues

The objectives of this section are to (1) provide recommendations for improving the Project Definition Report process to support design-build project selection and authorizing of design-build request of proposals (RFP); and (2) explore the advantages of using various level of design in design-build RFPs.

The research team approached the first objective by analyzing South Carolina Department of Transportation's (SCDOT) Design-Build Manual and 25 Project Definition Reports. A comparative analysis of these documents was conducted using SCDOT stated procedures and general guidelines provided by the *Guidebook for Selecting Alternative Contracting Methods for Roadway Projects : Project Delivery Methods, Procurement Procedures and Payment Provisions* (Molenaar et al. 2014).

The second objective was accomplished by benchmarking the SCDOT's practices with respect to the current national practices of other DOTs relating to the level of design in design-build RFPs. The research team used data obtained from a national study developed at the University of Colorado Boulder on the risks and benefits of alternative contracting methods (ACMs) for highway construction (FHWA 2018).

Based on the analysis of the SCDOT project definition reports the research team established the following recommendations:

- Consider a larger group of participants to help with completing the report. From the projects analyzed, it appeared that the reports were completed by individuals, or only a small group. The use of a larger, more inclusive group, could contribute to a more comprehensive and innovative completion of the report.
- Consider including the budget and any relevant schedule milestone as part of the project attributes when these are known. The budget can be included as a range.
- Consider reviewing the criteria for section numbering to ensure homogeneity between reports.
- Consider reviewing the current classification of goals to minimize restrictions and assist in selecting the most important ones.
    - Functional goals and constraints: Consider including some insights about the need of innovative solutions to address the functional demands.
    - Quality goals: Consider only those quality goals that go above and beyond the standard quality practices. Standard quality practices can be specified in the contractual obligations.
    - Other goals: Consider eliminating this section, so that the goals and constraints could be classified in one of the other groups.

In regards to the level of design, SCDOT is following national practices in its use of the appropriate level of design in its design-build RFPs. The research team would not suggest designating a specific range of design completion. The national benchmarking shows that DOTs use a wide range of design in the RFPs. The selection of an appropriate level of design should depend on the specific goals, constraints and complexity of the project.

2.7 Level of Insurance and Bonding

The objective of this section is to explore and summarize the current practices on the level of insurance and bonding for design-build projects in different Departments of Transportation (DOTs). This analysis focuses on four types of insurance: design-builder risk, professional liability/errors and omissions, general commercial liability and hazardous materials. Bonding analysis includes proposal, payment, performance and warranty bonds. This section summarizes and compares the insurance and bond amounts that are required in the Request for Proposal (RFP) issued by seven different DOTs, including South Carolina (SCDOT). Tables 8 and 9 show the most relevant results found in this analysis.

Table 8. Benchmark on levels of insurance

Type/State	**South Carolina** RFP I-85 MM 98-MM106 (2017)	**Georgia** RFP SR 21 at I-95 (2015) and Standard Spec Section 103.05	**North Carolina** RFP Buncombe (2011)	**California** RFP I-15/I-25 Interchange Improvements (Devore) (2012)	**Colorado** I-25 North (2012)	**Minnesota** Willmar Wye Roadway (2018)	**New York** Rehabilitation of I-278 Bridges (2018)
Design Build Risk	*Not mentioned (8)*	No specific indication	No specific indication (1)	Not mentioned	Probable Maximum Loss (2)	Not mentioned	Builder's Risk Policy (5)
Professional Liability/Errors and Omissions	*≥10,000,000 per claim and in the aggregate.(9)*	≥1,000,000 per claim (with a maximum of two hundred and fifty thousand dollars ($250,000) deductible per claim)	≥$1,000,000 per claim (with a maximum of two hundred and fifty thousand dollars ($250,000) deductible per claim)	>$2,000,000 per claim	>$10,000,000 per claim an aggregate of at least $10,000,000 (4)	5,000,000 per claim with an annual aggregate of $10,000,000 (4)	Deductible or self-insured retention level of no more than $250,000.00
Commercial General Liability	*$2,000,000 per occurrence $4,000,000 annual aggregate (9)*	Not specific indication about this type of insurance	$5,000,000 per occurrence and general aggregate	Varies from $1,000,000 to $2,000,000 per occurrence depending on the total bid (7)	$1,000,000 each occurrence (3)	25,000,000 each occurrence	> $1,000,000 per occurrence. > $2,000,000 aggregate
Hazardous materials	*Pollution liability ≥1,000,000 per occurrence*	Not mentioned relating to insurance	Not mentioned relating to insurance	Pollution/ Environmental Impairment Liability insurance > 5,000,000 (6)	Pollution Legal Liability Coverage ≥5,000,000 per occurrence & ≥$10,000,000 aggregate.	Not mentioned in insurance coverage	Commercial general liability includes underground hazards

(1) The RFP indicates, "*Providing and maintaining the adequate insurance coverage is a material obligation of the design-build team and is of the essence of this contract*."

(2) Probable Maximum Loss value at all times, including any subsequent contract modifications and cost of materials supplied or installed by others, comprising a total value for the entire project at the site on a replacement cost basis without optimal deductibles.

(3) Products and Completed Operations coverage shall be continued for a minimum of five years from Project Completion

(4) The policy will have a five-year extended reporting period from the Final Acceptance Date with respect to all events that occurred but were not reported during the term of the policy.

(5) The design-builder shall procure and maintain a Builder's Risk policy in a form such as ISO form CP 00 20 10 90 or a policy providing equivalent coverage, covering the perils insured under and including the special causes of loss form, including collapse, water damage and transit and theft of building materials, with deductible not to be less than the amount of the provisions called for in DB 107-27.3 and required under Table 107-1, in non-reporting form, with limits of coverage of not less than the provisions called for in DB 107- 27.3 and required under Table 107-1, covering the total value of work performed and equipment, supplies and materials at the location of the Work as well as at any off-site storage locations (See the RFP for more detail).

(6) This insurance is not referred explicitly to the hazardous materials.

(7) See section 3.1.5 of the technical memorandum in the ProjectWise folder.

(8) SCDOT does not include references to D-B Risk insurance in this RFP. However, SCDOT considers specific language for this type of insurance in their agreement templates. See the technical memorandum in the ProjectWise folder for more detail.

(9) SCDOT does not include references to the extended reporting period of professional liability/Errors and Omissions insurance in this RFP. However, SCDOT should consider specific language for this aspect of the insurance in their agreement templates. See the technical memorandum in the ProjectWise folder for more detail.

Table 9. Benchmark on bonding

Type/State	**South Carolina** RFP I-85 MM 98-MM106 (2017)	**Georgia** RFP SR 21 at I-95 (2015) and Standard specifications section 103.05	**North Carolina** RFP Ville-I-40/I-77 (2018)	**California** RFP I-15/I-25 Interchange Improvements (Devore) (2012)	**Colorado** I-25 North (2012)	**Minnesota** Willmar Wye Roadway (2018) and Mn Standard Specs for Construction	**New York** Rehabilitation of I-278 Bridges (2018)
Proposal (1)	*No required (3)*	*Not mentioned*	5%	10%	5%	5%	5%
Performance (1)	100%	100% (2)	100%	100%	100%	100%	100%
Payment (1)	100%	110% (2)	100%	100%	100%	100%	100%
Warranty	*$5,000,000 3 years from the Final Completion of the project*	Not mentioned	Not mentioned	4% contract price 2 years following Final Acceptance 2% contract price the third year following Final Acceptance	See comment (4) in insurance Table 8	4 % contract price 2 years following Substantial Completion 2% contract price the third year following Substantial Completion	Not mentioned
Amount of contract	*Contract price*	120 % of the original contract amount	Price of winning Proposal	Contract price	Guaranteed Maximum Price	Contract price	Price of winning Proposal

(1) % contract amount
(2) GDOT differentiates between Georgia Resident or non Resident contractor
(3) SCDOT does not include references to proposal bonding in this RFP. However, SCDOT considers specific language for this type of bonding in their agreement templates. See the technical memorandum in the ProjectWise folder for more detail.

2.8 Management of Alternative Technical Concepts

The objective of this section is to identify and summarize best practices in managing and archiving ATCs. South Carolina Department of Transportation has made significant progress in its goal to develop an archive of ATCs to promote innovation and lessons learned on future projects. Given the lead role that the SCDOT team has taken in this section topic, the research team has provided a supporting role. The research team has provided the following support:

- Reviewed and provided input on an ATC data collection questionnaire for SCDOTs national DOT survey;
- Assisted with survey points of contact for alternative contracting managers at DOTs across the country;
- Provided input on the classification approach for ATC lessons learned; and
- Advised on an approach to publishing a Transportation Research Board paper on the overall effort and results.

With this process complete, SCDOT should continue to maintain the database and track success with implemented ATCs. Tracking of ATC approval rates on new procurements will also be beneficial. Finally, SCDOT should consider applying ATC innovations from design-build projects on future design-bid-build projects. The database will serve to be beneficial for this purpose.

2.9 Construction Engineering Inspection and Project Management

The objective of this task is to identify and summarize Construction Engineering Inspection (CEI) and Project Management (PM) definitions and functions in design-build projects. The purpose of this task was to evaluate the current SCDOT's practice concerning CEI and PM with respect to the national standards.

To achieve this task, South Carolina Department of Transportation's (SCDOT) CEI practices were benchmarked against the data collected from the NCHRP Project 20-107 "Effective Construction Project Staffing Strategies for Transportation Agencies". The second objective was achieved by comparing Project Manager's functions performed at SCDOT with the functions carried out by project managers at other DOTs. These DOTs include Colorado, Florida, Georgia, North Carolina and Virginia.

The research team through its analysis (Table 10) found certain drivers that influence the hiring of an external CEI consultant. This is compared with other DOTs like California, Utah, Vermont, Virginia and Florida as per the complexity of the project. The table compares the SCDOT CEI drivers with other states to achieve essential data regarding national benchmarking. The factors mentioned in the table motivate the agency to hire an external CEI. The most common driver that influences this decision is the shortage and need of skills.

Table 10. CEI drivers

Project Complexity	**Most complex**		**Most complex**	**Moderately complex**		**Non-complex**
State	**South Carolina**		**Utah**	**Vermont**	**Virginia**	**Florida**
Project name (type)	**I-85 (Road)**	**I-77 (Road)**	**UT-011 (Road)**	**P-06 (Bridge)**	**VA-045 (Ramps)**	**FL-007 (Ramps)**
Mandates						✓
Shortages	✓	✓		✓		
Skills needed			✓		✓	
Time Constrains					✓	

A comparative study was also conducted to understand the number of CEI consultants for engineering functions (Table 11). The table depicts information regarding the agency staff or CEI consultants working for engineering functions. This is a comparison that is made with respect to project complexity. The table compares these factors against other state agencies to understand how SCDOT practices compares to other projects in the country. The results show that SCDOT uses more CEI consultants than other states.

Table 11. Number of professionals working in-house or as CEI consultants for engineering functions

Project complexity	Most Complex				Most Complex						Moderately Complex				Non-Complex	
States	**South Carolina**				**California**		**Utah**				**Vermont**		**Virginia**		**Florida**	
Project name (type)	**I-85 (Road)**		**I-77 (Road)**		**CA-072 (Road)**		**UT-011 (Road)**		**UT-002 (bridge)**		**P-06 (Bridge)**		**VA-045 (Ramps)**		**FL-007 (Ramps)**	
Positions	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**
Resident Engineer	1		1	-	1	1	1	1	1	-	-	1	1	1	-	-
Surveyor	-	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Senior Construction Inspector	-	10 to 15	1	-	1	-	3	5	3	-	1	-	3	1	-	1
Intermediate Construction Inspector	-	10 to 15	2	1	2	3	2	10	5	-	-	-	2	2	-	-
Junior Construction Inspector	-	Up to 10	1	-	-	-	-	-	5	-	-	-	-	-	-	-
Administrative Staff	-	2	1	-	2	2	1	1	1	-	-	-	1	-	-	-

The research team used the design-build manual as a reference to draft a questionnaire to better understand the functions of in-house and external personnel. Two SCDOT design-build projects were used to survey the PM functions: "I-85 Reconstruction and Widening MM 77-98" and "I-77 Widening and Rehabilitation". Table 12 shows the response from the survey while attempting to summarize the key information from the deign-build manuals. Based on the data collected on these two SCDOT projects, the Table 12 is formulated. It depicts information regarding the PM functions and the personnel responsible for it.

Table 12. PM functions with agency or CEI responsibilities

PM functions	South Carolina			
	I-85 (Road)		I-77 (Road)	
	Agency	CEI	Agency	CEI
Acting as the Department's liaison with the design-build firm during the construction of the project in general and as the person in responsible charge of the project	✓	-	✓	-
Coordinating the review of the design-build firm's submittals by SCDOT during design and construction	-	✓	✓	-
Working with the assigned Right of Way Project Manager to ensure right of way services are provided as specified in the contract and in compliance with applicable state and federal requirements	-	✓	✓	-
Making periodic site reviews	✓	-	✓	-
Reviewing and approving periodic progress payments	✓	-	✓	-
Monitoring MBE/DBE participation	-	✓	✓	-
Ensuring the Department receives final documents as specified in the contract	-	✓	✓	-
Ensuring that proper CEI is performed during construction	✓	-	✓	-
Ensuring Materials Acceptance Program requirements are met		✓	✓	-
Working with appropriate offices to develop supplemental agreements if applicable	✓	-	✓	-
Ensuring that the design-build firm's Quality Control (QC) plan is being followed	-	✓	✓	-
Ensuring that all environmental commitments are followed	-	✓	✓	-
Ensuring that appropriate documentation takes place at each step in the process	-	✓	✓	-
Conducting performance evaluations	✓	-	✓	-
Others. Please, specify:	-	-	-	-

The objective of this task is not fully complete. The research teach suggests that further research is needed. With the available data and benchmarking analysis, the research team hesitates to make any recommendations at this point. It is difficult to ascertain the available data as it apparently indicates SCDOT is using more CEI consultant than other states. It could be possible that other states may be allocating additional responsibilities for QA/QC to the design-builder by paying them additional fees for these services. SCDOT must coordinate the reduction in agency or CEI staffing with respect to the changes in its quality assurance approach.

3. Cost Estimating

The objective of this task was to analyze SCDOT's cost estimating process for design-build procurement and suggest improvements. The scope of this task was to understand the design-build estimating practices used by SCDOT and perform a benchmarking analysis with respect to the national performance. The data on national performance was gathered by the research team using research papers and national guides covering topics essential to the design-build cost-estimation process. The team also conducted follow-up interviews with the selected estimation staff to discuss in-depth the current estimating practices followed at SCDOT.

3.1 Research Approach

The team was provided with an estimating template, which SCDOT generally follows for estimating design-build project cost. This current process was benchmarked using available knowledge of recommended practices depicted in the national standard guides. These guides provided the team with crucial information regarding general recommended estimating practices to be followed by DOTs. The guides included:

- AASHTO Practical Guide to Estimating
- NCHRP Report 574 Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming and Preconstruction
- NCHRP Report 658 Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs

The benchmarking process was supplemented with interviews with the agency personnel responsible for the estimating practices at SCDOT. These interviews focused on gaining additional information regarding the cost estimating guidelines that the staff uses to develop a planning level estimate. These interviews gathered information on the ideation of the guidelines used for the cost estimating process and to get feedback from the department regarding potential recommendations.

The national guides and research papers that the team reviewed helped gain valuable information regarding aspects of estimation at a programming level of the project. These aspects were conceptual estimation, risk-based estimation, cost validation and cost estimation management processes. The research team suggestions to improve estimating practices focus these aspects.

3.2 Recommendations

This research found that SCDOT's design-build cost estimating practices align with national standards and leading DOT practices. SCDOT uses standard templates for design-build estimating and a consistent process that is yielding successful results. This research also found that SCDOT's cost estimating performance is consistent with the national average. Table 13 shows the SCDOT's award growth (difference between engineering estimate and contract award) is within the range of the national average for both best-value and low bid design-build procurements. Please see Task 5 for details on these measurements.

Table 13. SCDOT design-build project award growth vs national averages (see Task 5)

	Award growth	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
SCDOT	Best-value (n=22)	-9	-6	17	-44	16
	Low bid (n=16)	-21	-19	19	-53	20
National	Best-value (n=71)	-7	-7	22	-51	77
	Low bid (n=37)	-5	-6	32	-58	104

While SCDOT practices and performance are aligned with national practices and performance across the Design-Build Program, any one project can experience estimating errors or unexpected design-builder price proposals. To mitigate against potential errors and industry pricing fluctuations, the research team identified four areas that could be considered for SCDOT cost estimating process improvement.

(1) Conceptual estimation: Due to the level of design and engineering at the time of procurement, design-build estimating relies on conceptual estimating techniques, which result in wider ranges of estimating accuracy. SCDOT should examine its practices and policies in comparing these conceptual estimates against the competitive range of design-builders during procurement. Using a 10% differential, as done in traditional design-bid-build projects, is not a good practice for design-build projects where a greater range of accuracy is to be expected.

(2) Risk-based estimation: SCDOT's cost estimating template and risk register approach have resulted in satisfactory cost estimating results across the program. To improve the process and mitigate against inaccurate estimates on anomalous projects, the research team recommends that SCDOT develop wider range of risk-based estimating techniques. Risk-based estimating techniques can be tied to a definition of project complexity.

(3) Peer cost validation: On large and complex projects, peer reviews and validation plans for cost estimates are a best practice nationally. The research team recommends that SCDOT develop a more formal process for when and how to implement peer reviews and cost estimate validation plans. Note that peer reviews are not necessary on all projects – only the most complex..

(4) Cost estimate process and cost estimate management plan: SCDOT should consider incorporation of the high-level cost estimating and cost management processes found in the NCHRP Report 574. SCDOT is already using many of the techniques outline in this national standard. Formally incorporating these practices will help to ensure a consistent practice on design-build estimates.

4. Project Delivery Selection Process

The objective of this task is to make recommendations to improve SCDOT's current project delivery selection process. At the beginning of this research study, SCDOT used a SCDOT-specific project delivery selection approach. This approach was modeled after best practices defined by the FHWA Transportation Management Pooled Fund Project Delivery Selection Matrix. During the course of this project, SCDOT participated in the development of a new FHWA national online standard for project delivery selection, the Alternative Contracting Method Evaluation Toolkit (ACM Toolkit). It is the recommendation that SCDOT move to this new FHWA toolkit when it becomes available in the near future.

4.1 Research Approach

The research team began the process by conducting a document analysis to compare project delivery selection practices across different states. This document review included DOT design-build and alternative project delivery manuals. Another key document in this review was the Guidebook for Selecting Alternative Contracting Methods for Roadway Projects (Molenaar et al. 2014), which is a product of the FHWA Transportation Construction Management Pooled Fund Study. The research team also supported SCDOT as a pilot state in the development of the FHWA Alternative Contracting Method Evaluation Toolkit. This section of the report focuses on the comparison with other states, which was completed prior to SCDOT participation in the new FHWA toolkit.

The research team conducted a document analysis of design-build and alternative contracting manuals from six states (SC, CO, MN, NY, WA, GA). Additionally, the team reviewed reports from project delivery selection workshops available from three states (SC, CO, MN). The research team used three questions to assess the decision process included in the design-build manuals:

1. Who performs the evaluation?
2. What factors are considered to assess the options?
3. How are these factors evaluated?

The analysis shows that three of the DOTs, SCDOT, CDOT and MnDOT, use a form of the Project Delivery Selection Matrix from the FHWA Transportation Management Pooled Fund Study. The other three DOTs, NYSDOT, WSDOT and GDOT, follow different approaches for the selection of project delivery method. Tables 14 and 15 compare the answers to the three questions among the states.

Table 14. Project Delivery Selection Matrix Approach

Aspects analyzed	SCDOT	CDOT	MnDOT
1. Who evaluates?	PM, DM, Director of Construction (DOC) representative and any other necessary technical resources and/or subject matter experts.	Not specified	Not specified
2. What factors are considered?	**Primary factors** Delivery schedule Project complexity and innovation Level of design Cost		
	Secondary factors Staff experience Level of oversight Competition and contractor experience		
3. How are the factors evaluated	Following a flow chart with qualitative comparisons (++, +, -)		

The approaches followed by NYDOT, WSDOT and GDOT are not based on the Project Delivery Selection Matrix. The aim of these approaches is not to decide among different project delivery systems but to assess the suitability that any given project might have to be delivered using design-build.

Table 15. Other Design-Build Suitability Assessment Approaches

	NYSDOT	WSDOT	GDOT
1. Who evaluates?	There is no specific indication on the Manual	Project Engineer with the assistance of Project Development staff for weighting the identified benefit against the risks assessed by the Project Team	The Innovative Project Manager will prepare the DB suitability report and Risk Matrix Template to determine the project's delivery goals and the likelihood that DB will achieve these goals
2. What factors are considered?	• Time • Clarity and consistency of scope • Flexibility • Innovation/creativity and complexity • Current status of design • Approval requirements • Cost/funding • Miscellaneous requirements • Environmental Risk • Potential Proposal cost and stipends	• Savings • Higher quality • WSDOT staff • Impact on public • Completion schedule • Project Complexity • Traffic Management • Project size • Workload leveling • Benchmark projects	**Pass/Fail process** • Legal and statutory requirements • Agency resources and experience • Project funded • Leadership support • DB Marketplace conditions **SWOT analysis** • Project delivery schedule • Innovation • Level of design • Quality • Staff experience • Marketplace conditions, completion and DB team experience
3. How are the factors evaluated	Through discussion of the previous factors	1) Benefit analysis 2) Risks analysis	1) Pass/fail 2) SWOT analysis 3) Risks analysis

4.2 Recommendations

SCDOT's approach to the selection of project delivery systems is aligned with surrounding states and others across the country. While SCDOT's project delivery selection does represent national best practice, the research team would encourage SCDOT to implement the new FHWA ACM Toolkit when it is ultimately released by FHWA. The primary advantage to this new approach is that FHWA will be able to create a national standard for project delivery selection. It will also be able to create a database of projects that have used this tool, which should allow for better project delivery selection and correlation to long-term project performance.

Whether SCDOT continues with its current selection process or fully changes over to the new FHWA process, experience has shown that careful crafting of the participants in a selection workshop is key to success. The research team recommends that SCDOT continues to focus on aligning the number and expertise of workshop participants with the scope and complexity of each new project delivery selection. In order to follow best practices (Molenaar et al. 2014), the selection team should include, at a minimum, the project manager, the project engineer, a representative of the procurement/contracting office and any other highway agency staff that might be crucial to the project. Further, the selection team may need to include representatives from specialty units and from local jurisdictions where the project is located.

5. Effectiveness Measurement

The objective of this section is to evaluate the effectiveness of the SCDOT design-build highway projects program. Project effectiveness can use many different quantitative and qualitative measures. The study takes the approach of quantitatively benchmarking SCDOT design-build projects against both SCDOT design-bid-build projects and a national database of design-build projects. While this approach captures only the quantitative measures, the research team believes that it provides a good indication of SCDOT's overall design-build performance.

5.1 Research Approach

The research team benchmarked the performance of 39 design-build and 22 design-bid-build projects at SCDOT against the national database from the recent study on the Quantification of Cost, Benefits and Risk Associated with Alternative Contracting Methods and Accelerated Performance Specifications (FHWA 2018). This national FHWA study collected a dataset from 291 completed highway projects and quantified the performance of design-build, construction manager/general contractor and design-bid-build highway project delivery. In addition to comparing SCDOT practice against national performance, the study explored the performance of SCDOT projects delivered with design-build and design-bid-build.

The analysis included five primary metrics that align with the FHWA national study: award growth (i.e., variation of cost from engineer's estimate to award), cost growth (i.e., variation of cost from award to completion), estimate to final cost growth (i.e., engineer's estimate to final), schedule growth (i.e., variation of schedule from the planned schedule at the beginning of the contract) and intensity (i.e., final cost/actual project duration).

5.2 Performance Results

Overall, SCDOT average design-build project performance outperforms SCDOT design-bid-build project performance and national design-build project performance in four of the five metrics. Schedule growth is the one metric where SCDOT underperforms and this appears to be true for both design-build and design-bid-build.

The following bullets provide a high-level summary of this analysis. The detailed statistical analysis can be found in the body of this tech memo and in the "Design-Build Project Effectiveness Calculator," which is being provided to SCDOT as an Excel tool for use as new projects are finished.

- **Award Growth (estimate to award)** – On average, SCDOT design-build projects outperformed SCDOT design-bid-build projects in the average award growth. SCDOT follows the national trend of having a negative average award growth for design-build projects. This means that the engineer's estimate is higher than the award amount, implying a conservative practice in cost estimating.
- **Cost Growth (award to final)** – SCDOT design-build projects experience lower cost growth from award to project completion when compared to both SCDOT design-bid-build projects and national design-build projects.
- **Estimate to Final Cost Growth (estimate to final)** – SCDOT design-build projects outperform both their design-bid-build counterparts and the national design-build projects.
- **Schedule Growth –** SCDOT schedule growth is higher than desirable. Schedule growth is the one metric where SCDOT design-build projects are not performing as well as the national average.

Average schedule growth for SCDOT design-build projects is high for both best-value (33%) and low-bid (17%). This is at least double the national average for design-build projects. However, SCDOT design-build projects are performing better than their design-bid-build counterparts. The average schedule growth for the design-bid-build sample is 29% and the average of best-value and low bid design-build projects is 24%. Design-bid-build projects are performing better than design-build best-value projects but not design-build low bid projects.

- **Intensity** – SCDOT project intensity performance is relatively similar to national design-build projects and SCDOT design-bid-build projects. On average, SCDOT's project intensity is lower than national practice for design-build/best-value and higher for design-build/low bid. Conversely, when compared to SCDOT's design-bid-build average project intensity, it is higher for design-build/best-value and lower for design-build/low bid.

6. Conclusions and Recommendations

This section summarizes the analysis of SCDOT design-build best practices and tools, cost estimating, project delivery selection methods and effectiveness. The summary of the key findings is organized based on these four groups.

6.1 Tools and best practices

Information Exchange

This analysis focused on clarifying the SCDOT Design-Build Manual content related to the information exchange forms of presentations, clarifications, communications and discussions. The key findings are summarized as follows:

- The states for each form of information exchange are:
  - Clarifications: after receipt of Proposal.
  - Communications: after receipt of the Proposal and during the evaluation process.
  - Discussions: after the receipt of proposals and after defining the competitive range. The competitive range includes the most highly rated proposals on the basis of the evaluation criteria.
- Clarifications and communications mainly differ in the type of information-exchange content. Clarifications focus on corrections and minor errors while communications address or clarify technical concepts that might prevent the proposal from continuing the evaluation process.
- Including communications as part of the contract is considered by some states but is not a standard practice.
- There is no need to decide between Questions and Answers (Q&A) and oral presentations. Presentations might allow the design-build firms to present and highlight the critical aspects of their proposals. Q&A sessions, on the other hand, might help SCDOT seek clarifications and asks questions related to the technical Proposal.
- The use of presentations before the technical proposal is received might be beneficial in several ways. They provide offerors with an opportunity to explain their technical proposals further and highlight the most significant aspects of it. They Familiarize the evaluation personnel with the teams and proposals. They guide the review committee through the technical Proposal and provide an opportunity for the agency to seek clarification and ask questions.

SCDOT Procurement Manual recommendations related to information exchange are included in section 6.5.

Request for Qualifications (RFQ)

This analysis focused on examining how past performance is considered in the RFQ. The key findings are summarized as follows:

- If SCDOT develops a state-wide contractor performance rating system, this can be used for the design-build RFQ process.
- If SCDOT does not move to a contractor evaluation system, they could consider formulating the evaluation criteria in alignment with each project's goals.
- Consider, within the *past performance* requirements, specifying a minimum number of projects developed using design-build.

- Consider additional past performance information in areas like safety, environmental compliance, or Disadvantage Business Enterprise utilization if those aspects are relevant to align the selection with the project's goals.
- The weights and scores ranges used by SCDOT enable an evaluation aligned with the concern of considering the past performance in the SOQ meaningfully.

SCDOT Procurement Manual recommendations related to past performance in RFQs are included in section 6.5.

Best-Value Procurement

The analysis of best-value procurement focused on analyzing the SCDOT best-value approach. The key findings are summarized as follows:

<u>Goals and evaluation criteria</u>

- As described in the *AASHTO Guide for Design-Build Procurement* (AASHTO 2008), project goals can help maximize the possible benefits of design-build. Schedule goals can include minimizing project delivery time or complete the project on schedule. Cost goals can include minimizing project cost, maximize project budget, or complete the project on budget. Please refer to the *AASHTO Guide for Design-Build Procurement* for advice on writing project goals and additional examples.
- SCDOT should strive to more closely tie the stated project goals to the evaluation criteria. The stated project goals should be described in both the Project Definition Report and the RFQ/RFP. While the goals can currently be inferred from the best-value criteria and weighting, they should be more explicitly stated.
- The project goals might be included at the beginning of RFQ and RFP after the general information and the project description.
- Two key aspects should be considered when establishing the evaluation criteria. First, the relationship between project goals and evaluation criteria. Second, the evaluation criteria's capacity to obtain the appropriate information to make a meaningful comparison among the proposers.
- Project's goals should be aligned with the evaluation criteria. The evaluation criteria should be able to be meaningful for the proposers' comparison. The starting point of the cost will depend on the balance that SCDOT wishes to establish between cost and non-cost factors. This might vary from not considering cost in the best-value formula to assign different ranges of weights for cost.

<u>Scoring systems</u>

- Making meaningful comparisons among proposers depends on the proper formulation of evaluation criteria. The evaluation criteria areas of assessment should enable the evaluation team to differentiate scores among the proposers. Areas, where all the proposers are likely to be at the same level, should be evaluated in a pass/fail format.
- Once the Design-Build Program leadership establishes the areas of assessment, they can decide if the evaluation can be better performed using direct scoring or adjectival scoring.
- Adjectival scoring can help to achieve consensus among the evaluators. However, achieving more separation of the teams in the evaluation does not depend so much on using adjectival or direct scoring but on defining consistent evaluation criteria (i.e., comprehensive, direct, unambiguous and understandable).

Weighted criteria formula

- SCDOT has applied various award algorithms in past year. It is currently using the weighted criteria formula. SCDOT should continue to use this approach as it provides the most transparency and alignment with project goals.
- SCDOT should consider normalizing technical scores (e.g., making each proposers' score a ratio of the highest score) similarly as to how cost scores are normalized. This will balance cost and technical factors on similar scales.

SCDOT Procurement Manual recommendations related to best-value procurement are included in section 6.1

Risk Allocation

The analysis of risk allocation focused on the SCDOT project risk analysis process. The key findings are summarized as follows:

- SCDOT should consider elaborate on risk identification guidelines in the SCDOT Design-Build Manual to facilitate a more detailed and consistent process.
- SCDOT should consider establishing a preliminary risk breakdown structure (i.e., categorization) that could serve as a baseline to define the project-based risks. The technical memorandum on risk allocation includes a compilation of potential risks that could help the SCDOT preliminary risk breakdown structure.
- SCDOT should consider defining its design-build risk tolerance (i.e., the criteria to determine if the level of risk is "high," "medium," or "low").
- SCDOT should evaluate, on a project-by-project basis, who is best equipped to handle each risk (SCDOT, design-builder or third party).
- The first step for developing a risk assessment tool is to build a sound and comprehensive risk register form that can be easily updated during the project lifecycle. A good start-point might be the Risk Allocation Decision Matrix generated during the Project Delivery Selection Process (FHWA ACM Tool).

SCDOT Procurement Manual recommendations related to risk allocation are included in section 6.5.

Design-Build Quality Assurance

The analysis of design-build quality assurance focused on identifying and summarizing the decision points for shifting the traditional quality assurance from SCDOT to the design builder. The key findings in this area are summarized as follows:

- SCDOT could take on more of an oversight role and still be consistent with other state DOTs, as well as meet Federal regulations.
- SCDOT could move to an Oversight QAO model where their role is to ensure that both the designer and contractor QA plans are effective at meeting the agency's quality requirements (stipulated in the contract) and that the plans are being implemented.
- Review previous experience of Oversight QAO models from ADOT, FDOT, VDOT and WSDOT.

Design Management Issues

The analysis of design management issues focused on (1) providing recommendations for improving the Project Definition Report and on (2) exploring the advantages of using various levels of design in design-build RFPs. The key findings in this area are summarized as follows:

Project Definition Report

- Consider a larger group of participants to help with completing the report. From the projects analyzed, it appeared that the reports were completed by individuals, or only a small group. The use of a larger, more inclusive group, could contribute to a more comprehensive and innovative completion of the report.
- Consider including the budget and any relevant schedule milestone as part of the project attributes when these are known. The budget can be included as a range.
- Consider reviewing the criteria for section numbering to ensure homogeneity between reports.
- Consider reviewing the current classification of goals to minimize restrictions and assist in selecting the most important ones.
    - Functional goals and constraints: Consider including some insights about the need of innovative solutions to address the functional demands.
    - Quality goals: Consider only those quality goals that go above and beyond the standard quality practices. Standard quality practices can be specified in the contractual obligations.
    - Other goals: Consider eliminating this section, so that the goals and constraints could be classified in one of the other groups.

Design Level

- SCDOT is following national practices in its use of the appropriate level of design in its design-build RFPs.
- The research team would not suggest designating a specific range of design completion. The national benchmarking shows that DOTs use a wide range of design in the RFPs. The selection of an appropriate level of design should depend on the specific goals, constraints and complexity of the project.

Level of Insurance and Bonding

The analysis of level of insurance and bonding focused on exploring and summarizing the current practices on the level of insurance and bonding for design-build projects in different DOTs. The analysis resulted in a series of tables benchmarking insurance and bonding practices in different DOTs and SCDOT. The SCDOT should review the results in the technical memorandum and consider changes to the types and levels of insurance and bonding. The research team is not knowledgeable enough of SCDOTs risk tolerance and financial situation to make specific recommendations.

Management of Alternative Technical Concepts (ATC)

The analysis of management of alternative technical concepts focused on supporting SCDOT on the ATC management improvement process. SCDOT has developed a database of ATCs in a ProjectWise database. Their system allows for searching based on data type attributes, which allow for in-depth analysis of past ATCs. The SCDOT has implemented the system and found it to be extremely useful. The research team would encourage SCDOT to continue this effort, maintain the database and track success implementing ATCs as well as measuring ATC approval rates.

Construction Engineering Inspection (CEI) and Project Management (PM) Roles

The analysis of CEI and PM roles focused on identifying and summarizing CEI and PM definitions and functions in design-build projects and comparing SCDOT with national practice. The available data for benchmarking does not enable the research team to make recommendations about SCDOT CEI current practice. A high-level suggestion is that SCDOT must coordinate the reduction in agency or CEI staffing with respect to the changes in its quality assurance approach. More analysis can be found in the CEI and PM technical memorandum in ProjectWise.

6.2 Cost Estimating

Overall, SCDOT's design-build cost estimating practices and performance align well with national standards and leading DOT estimating practices. As shown in Task 5, SCDOT design-build projects outperformed SCDOT design-bid-build projects in the average award growth. SCDOT follows the national trend of having a negative average award growth for design-build projects. This means that the engineer's estimate is higher than the award amount, implying a conservative practice in cost estimating. SCDOT cost estimates for design-build with low-bid procurements tended to be more conservative than the national average, but design-build/low-bid procurement is not frequently used in SCDOT, with the exception of emergency projects. While this study has found no need for significant improvements, the analysis identified four areas from national practice standards that from which SCDOT could benefit: (1) conceptual estimation, (2) risk-based estimation, (3) peer cost validation and (4) cost estimate management plan.

Due to the level of design and engineering at the time of procurement, design-build estimates must use conceptual estimating techniques. Engineering estimates will result in a wider range of accuracy when compared to the design-builder proposal prices than will engineering estimates when compared to design-bid-build contractor bids. This does not imply that engineering estimates are inaccurate or that design-builder price proposals are inflated. SCDOT should examine its practices and policies in comparing these conceptual estimates against the competitive range of design-builders during procurement.

SCDOT's cost estimating template and risk register approach have resulted in satisfactory cost estimating results across the program. To improve the process and mitigate against inaccurate estimates on anomalous projects, the research team recommends that SCDOT develop wider range of risk-based estimating techniques. Based on national practice, SCDOT could consider the use of a project complexity categorization process to select from a variety of risk-based approaches to estimate contingency. Smaller, less complex projects warrant a sliding scale risk-based contingency whereas larger complex project warrant a probabilistic, simulation-based approach to cost estimating.

On large and complex projects, peer reviews and validation plans for cost estimates are a best practices nationally. The research team recommends that SCDOT develop a more formal process for when and how to implement peer reviews and cost estimate validation plans. Note that these are not necessary on all projects. For this effort, SCDOT can use the WSDOT CEVP approach as a guiding model. However, the research team would suggest SCDOT employ this model partially and focus on the peer-review process of the base estimate with the participation of experts and professionals from relevant fields (e.g., construction administration, construction planning, procurement, economics and environmental).

Finally, the research team would suggest SCDOT incorporate the high-level cost estimating and cost management processes found in the NCHRP Report 574. SCDOT is already using many of the techniques outline in this national standard. Incorporating these practices will formalize the processes and help to ensure consistency on design-build estimates. Adopting such cost estimation practices and the management plan delineated in the guide can help SCDOT enhance their ability to communicate cost estimates effectively and to update the base estimates when changes in the project requirements occur.

6.3 Project Delivery Selection Methods

SCDOT's approach to the selection of project delivery systems is aligned with surrounding states and others across the country. While SCDOT's project delivery selection does represent national best practice, the research team would encourage SCDOT to implement the new FHWA ACM Toolkit when it is ultimately released by FHWA. The primary advantage to this new approach is that FHWA will be able to create a national standard for project delivery selection. It will also be able to create a database of projects that have used this tool, which should allow for better project delivery selection and correlation to long-term project performance.

Whether SCDOT continues with its current selection process or fully changes over to the new FHWA process, experience has shown that careful crafting of the participants in a selection workshop is key to success. The research team recommends that SCDOT continues to focus on aligning the number and expertise of workshop participants with the scope and complexity of each new project delivery selection. In order to follow best practices (Molenaar et al. 2014), the selection team should include, at a minimum, the project manager, the project engineer, a representative of the procurement/contracting office and any other highway agency staff that might be crucial to the project. Further, the selection team may need to include representatives from specialty units and from local jurisdictions where the project is located.

6.4 Effectiveness Measurement

This tech memo focused on evaluating the effectiveness of the SCDOT design-build highway program. The effectiveness was assessed by (1) comparing current SCDOT design-build projects against the national practice; and (2) comparing SCDOT design-build and design-bid-build practices against five standard performance metrics. Overall, SCDOT average project performance compares favorably with national project performance in four of the five metrics. The key findings and recommendations in each of these areas follows.

Award Growth (estimate to award)

On average, SCDOT design-build projects outperformed SCDOT design-bid-build projects in the samples analyzed in this study. The design-build project estimates were more conservative than the design-bid-build projects with the mean award growth metrics of -14% and 6%, respectively. SCDOT's conservative trend in engineer's estimates followed the national trend. In fact, SCDOT's mean award growth (D-B/BV = -9% and D-B/LB = -21%) was more conservative than the national trends (D-B/BV = -7% and D-B/LB = -5%). Tech Memo 3 provides some recommendations for addressing this conservatism, which include conceptual estimating refinement, risk-based estimating techniques, select peer cost validation and formalized cost estimate management plan.

Cost Growth (award to final)

The analysis of projects in this research found that SCDOT design-build projects experience lower cost growth from award to project completion when compared to both SCDOT design-bid-build projects and national design-build projects. SCDOT design-build projects also have more certainty in cost growth performance when compare to SCDOT design-bid-build projects as seen through the narrower standard deviation of the samples. SCDOT design-build projects have lower cost growth than the national projects in both the best-value and low bid delivery methods.

Estimate to Final Cost Growth (estimate to final)

When comparing engineering estimates to final costs, SCDOT design-build projects outperform both their design-bid-build counterparts and the national design-build projects. The estimate to final cost growth metric is a summation of the award growth and cost growth metrics. Therefore, the comments in the previous two sections hold true for this metric as well.

Schedule Growth

Schedule growth is the one metric where SCDOT design-build projects are not performing as well as the national average. Average schedule growth for SCDOT design-build projects is high for both best-value (33%) and low-bid (17%). This is at least double the national average for design-build projects. However, SCDOT design-build projects are performing better than their design-bid-build counterparts. The average schedule growth for the design-bid-build sample is 29% and the average of best-value and low bid design-build projects is 24%. Design-bid-build projects are performing better than design-build best-value projects but not design-build low bid projects. In any case, SCDOT design-build schedule growth is much higher than desirable. While it is beyond the scope of this research, the research team would recommend that SCDOT examine the design-build projects with the highest schedule growth to see if there are common causes for this escalation.

Intensity

Project intensity provides a relative measure of work put in place over time. This measurement includes the entire duration for engineering and construction from the point of project approval. The project intensity is relatively similar between delivery methods. On average, SCDOT's project intensity is lower than national practice for design-build/best-value and higher for design-build/low bid. Conversely, when compared to SCDOT's average project intensity for design-bid-build, it is higher for design-build/best-value and lower for design-build/low bid. If SCDOT would like to improve its intensity, it could look at ways to shorten the time from project approval to project award or decrease overall schedule growth.

6.5 SCDOT Procurement Manual Recommendations

The scope of the research study requires the research team to make suggestions for changes to the design-build manual. The design-build manual is consistently evolving. The recommendations from the project team should be reviewed by multiple members of SCDOT prior to incorporation into the manual. Appendix A includes potential changes to manual. These changes are based on the conclusions of the various research tasks. Note that most recommendations related to Task 2 Tools, Processes and Best Practices.

6.6 Limitations and Future Research

This two-year study offered the opportunity to evaluate the effectiveness of SCDOT Design-Build Program. It provided an opportunity to look at project selection, cost estimating procedures and overall project performance. While this study provides sound results and recommendations, it does have notable limitations.

A key limitation to the study was the relatively small sample size of completed design-build projects. While SCDOT has been delivering projects through design-build for more than 20 years, projects are unique in scope and size. These facts make performance evaluation difficult at a program level. SCDOT is encouraged to continue collecting data in the quantitative manner as outlined in this report. SCDOT may also wish to conduct more case studies of design-build projects to capture lessons learned.

SCDOT was in the process of incorporating more comprehensive risk management into the design-build process. This includes risk identification, assessment, mitigation and allocation between SCDOT and design-builder. As this process becomes more commonplace on SCDOT design-build projects, a study to capture lessons learned and overall risk management effectiveness is warranted.

Similarly, the SCDOT Design-Build Program has been piloting the new FHWA ACM Toolkit. The research team was not able to study the effectiveness of this tool in the SCDOT environment. SCDOT is encouraged to examine how this new approach changes the current process and how it benchmarks against other states.

Lastly, this research project focused on the project development and procurement phases of design-build delivery. SCDOT would benefit from examining its Design-Build Program contract administration practices. The fact that SCDOT is experiencing higher-than-average schedule growth when compared to national averages provides an indication that some elements of the process could be improved. The exploration of CEI and PM functions in this present study was a start. However, SCDOT would benefit from examining its strategies, methods and tools across the design-build contract administration phase (i.e., from contract award to closeout and warranty) to see if there is potential for learning and improvement.

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Appendix 1 – Suggestions for Changes to Design-Build Procurement Manual

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***Chapter 6. Request for Proposals.* 6.4.3 Clarifications, Minor informalities and Irregularities**

1. Include examples of the types of clarifications that are allowable. For example, California includes the following reasons:
   a) *Resolving any uncertainties or to obtain clarifications concerning the Proposal.*
   b) *Resolving any suspected mistakes by calling them to the attention of the Proposer.*
2. Define the procedure for requests for clarification. The reader is referred to current practice in Georgia in Section 4.2.3 Request for clarification from GDOT Design-Build Manual.
3. Consider more specific wording or examples in the following statements:
   - The SCDOT POC shall exchange sufficient information.
   - The SCDOT POC is charged with limiting such exchanges to only the information necessary to determine how to read or interpret language already existing in the Proposal.
   - A proposal is unclear if open to more than one reasonable interpretation or obscure in meaning through indefiniteness of expression. Silence is not unclear.

Chapter 6. Request for Proposals.6.4.4 Oral presentations

1. State whether presentations will be before or after the preliminary Evaluation Committee ratings. North Carolina does presentations after the preliminary rating. New York provides the possibility for before or after, but it is clearly stated.
2. Evaluate the amount of time. It seems that other states allow longer presentations (between 30 and 60 min).
3. Consider being more explicit about what material is permitted or not in the presentation. For example, Florida DOT specifies:
   - "*An unmodified aerial or map of the project limits provided by the design-build firm is acceptable for reference during the Page-Turn Meeting. The unmodified aerial or map may not be left with the Department upon the conclusion of the Page-Turn Meeting. Use of other visual aids, electronic presentations, handouts, etc., during the Page-Turn Meeting, is expressly prohibited.*"
4. Consider recording the presentation. Florida records the meeting and makes it part of the contract documents. The CFR (636.111) indicates that oral presentations may be a substitute for, or augment, written information. However, DOTs must maintain a record of oral presentations to document what information is relied upon in making the source selection decision. The main advantage of recording the presentations is to have additional evidence of all the information shared in these presentations. The recording allows revisiting the whole presentation in case something is not clear. They can also be used if any DOT official is not able to attend the presentation and his/her attendance is needed.

Chapter 6. Request for Proposals. 6.4.7 Discussions

1. Consider including a specification regarding to what extent discussions will be held with all proposers or not. For example, *"If Discussions are held with one Proposer, they must be held with all Proposers in the Competitive Range."*
2. Provide additional detail about the kind of information included in discussions. For example:
   - Advising the Proposers of significant Weaknesses and/or Deficiencies in their Proposals (relative to the RFP);
   - Attempting to resolve any uncertainties and obtaining any significant clarifications concerning the Proposal;

- Resolving any suspected mistakes by calling them to the attention of the Proposers as specifically as possible without disclosing information concerning other competing Proposers' Proposals or the evaluation process; and
- Providing the Proposers a reasonable opportunity to submit any further technical or other supplemental information to their Proposals.

3. Specify that *"No indication will be made to any Proposer of the evaluation status of any other Proposer or Proposal."*
4. Include that discussions will only address specific deficiencies in the Proposer's Proposal. Other changes may be made through the RFP addendum or Best and Final Offer (BAFO).
5. Review whether some of these prohibitions related to the Department personnel should be included in the Manual while holding discussions. For example: *"During Discussions, Department personnel involved in the acquisition are prohibited from engaging in the following conduct that: 1) Favors one Proposer over another; 2) Reveals a Proposer's technical solution, including unique technology, innovative and unique uses of commercial items, or any information that would compromise a Proposer's intellectual property to another Proposer; 3) Reveals a Proposer's price without that Proposer's permission; 4) Reveals the names of individuals providing reference information about a Proposer's past performance, or 5) Knowingly furnishes source selection information in violation of the Department's procurement policies and the laws of the State".*
6. Evaluate the inclusion of information about proposal revisions during discussions. As a reference, New York state includes:
    - *"If the Department decides to enter Discussions with the Proposers in the Competitive Range, they must also request Proposal Revisions from the Proposers in the Competitive Range. Proposers will be requested and/or allowed to revise their Quality and Price Proposals, including the correction of any Weaknesses, minor irregularities, errors and/or Deficiencies identified to the Proposers by the Department following the initial evaluation of the Proposals. The RFP Revisions will allow adequate time for the Proposers to revise their Proposals. Upon receipt of the final Proposal Revisions, the process of evaluation will be repeated for the revised information. The process will consider the revised information and re-evaluate and revise ratings as appropriate."*

Attachments*. *Work history and quality form—contractor/designer

1. One suggestion to improve the evaluation of experience in the past performance evaluation criteria is to emphasize that the description of work should be oriented to specific aspects that SCDOT considers relevant for the project goals. For example, if one of the project goals is to minimize affections to the community affected by the construction, the work description in the "work history form" should emphasize how the proposers accomplished this goal in previous projects.
2. Some suggestion to improve the assessment of quality in the past performance evaluation criteria are:
    - In the quality form—section h, similarly to the previous suggestion, the self-assessment required could be oriented to performance evaluation with an emphasis in specific areas. For example, if SCDOT knows that the project under procurement could have cost overruns and delays associated with particular project items such as utility relocation or environmental issues, the performance evaluation should be focused on these areas.
    - In the quality form—section i, project-specific awards can also be required optionally. For example, having a DBIA award associated with design engineering, process, teaming, or any specific design-build project can be a good signal of past performance quality. The Institute for Sustainable Infrastructure issues project's credentials that might also

be considered if sustainability is among the project's goals (https://sustainableinfrastructure.org/project-verification/verify-a-project/). This credential demonstrates the sustainable achievements on the basis of 64 sustainability and resilience indicators organized into five categories: quality of life, leadership, resource allocation, the natural world and climate and resilience.

Consideration for RFP authoring

1. Include a new subsection just after “Project Description” and “Project Information”, defining the objectives of the project.
2. In “Technical Proposal Evaluation”, link the evaluation criteria description with the project goals defined previously.

Chapter 3. Project Development Activities. 3.4 Risk Matrix

1. Review the examples of risk allocation templates included in this report to establish guidelines for the improvement of the SCDOT's current template.

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Appendix 2A – Tech Memo on Information Exchange with Design-Builders

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 2. Tools, Processes and Best Practices

Task 2a. Information Exchange with Design-Builders

Prepared by

University of Colorado Boulder

Table of Contents

Contents

1. Executive Summary

The objective of this subtask is to identify, review and assess best practices to improve the information exchange between South Carolina Department of Transportation (SCDOT) and the design-builders in the procurement phase.

This document is focused on the information-exchange taking place after the release of the RFP document. In this regard, the Code of Federal Regulation (CFR) defines three types of exchanges after the release of the Request For Proposal (RFP) in design-build procurement (23 CFR § 636.402).

- Clarifications: Used to clarify certain aspects of a proposal (resolve minor errors, clerical errors, obtain additional past performance information, etc.)
- Communications**:** Used to address issues that might prevent a proposal from continuing the evaluation process.
- Discussions: Enhance the contracting agency's understanding of proposals and the offerors' understanding of the scope of work. Discussions are aimed to facilitate the evaluation process. According to 23 CFR § 636.402, discussions take place "after receipt of proposals and after the determination of the competitive range."

This document also includes the possibility of using oral presentations during the procurement (23 CFR § 636.111)

This technical memorandum compares the current SCDOT information exchange process with current practices in other states. Current SCDOT practice is defined by the information included in Sections 5 of the RFP instructions. The research team developed a document analysis of Design-Build Manuals, RFPs and other documentation from 13 other states to compare their processes with South Carolina's. The analysis shows that, although the states generally consider these four concepts, some have developed more detailed definitions.

- Clarifications: All of the states include the concept of clarifications in their evaluation process. In 42% of the states, this consideration is more specific and includes details about what agencies should consider a clarification and how they should conduct the process.
- Presentations: Most of the states use interviews, oral presentations, or both during the evaluation process. The procedure for developing these presentations and whether it is a mandatory or a project-specific decision varies between states. Florida, North Carolina, New York and Washington are the states that more precisely define the presentation process in their manuals.
- Communications: Only four out of the 13 states mention this concept during their evaluation process. Arizona and California briefly mention it in their documents, whereas the New York and Virginia documents provide a more specific definition.
- Discussions: Only the states of Arizona, New York, Colorado and Virginia mention this type of information exchange. Among them, New York is the one that includes a more comprehensive definition.

In order to develop recommendations for SCDOT to consider, the research team has identified national best practices and has compared the information with the current SCDOT practices. As a result of the comparative analysis, the recommendations are the following:

Section "5.0 Presentations" of the SCDOT RFP

1. State whether presentations will be before or after the preliminary Evaluation Committee ratings. North Carolina does presentations after the preliminary rating. New York provides the possibility for before or after, but it is clearly stated.
2. Consider being more explicit about what material is permitted or not in the presentation. For example, Florida DOT specifies:
    - "*An unmodified aerial or map of the project limits provided by the design-build frm is acceptable for reference during the Page-Turn Meeting. The unmodified aerial or map may not be left with the Department upon the conclusion of the Page-Turn Meeting. Use of other visual aids, electronic presentations, handouts, etc., during the Page-Turn Meeting, is expressly prohibited.*"
3. Consider recording the presentation. Florida records the meeting and makes it part of the contract documents. The CFR (636.111) indicates that oral presentations may substitute for, or augment, written information. However, DOTs must maintain a record of oral presentations to document what information is relied upon in making the source selection decision. The main advantage of recording the presentations is to have additional evidence of all the information shared in these presentations. The recording allows revisiting the whole presentation in case something is not clear. They can also be used if any DOT official is not able to attend the presentation and his/her attendance is needed.

Section "5.0 Clarifications" of the SCDOT RFP

1. Include examples of the types of clarifications that are allowable. For example, California includes allows for resolving any uncertainties or to obtain clarifications concerning the Proposal.
2. Define the procedure for requests for clarification. The reader is referred to current practice in Georgia in Section 4.2.3 Request for clarification from GDOT Design-Build Manual.
3. Consider more specific wording or examples in the following statements:
    - The SCDOT POC shall exchange sufficient information.
    - The SCDOT POC is charged with limiting such exchanges to only the information necessary to determine how to read or interpret language already existing in the proposal.
    - A proposal is unclear if open to more than one reasonable interpretation or obscure in meaning through indefiniteness of expression. Silence is not unclear.

Section "5.0 Communications" of the SCDOT RFP

1. Consider including details about the communication process. In this regard, the instructions included in the New York Manual could be used as a reference:

- o *"The Department prepares brief written questions that can be sent to the Proposers in order to have them respond with the information that clarifies the ambiguities or addresses the concerns of the Department. The request for Communications should also contain instructions for response and a timeframe in which the response must be received."*

The communications, in this case, do not become part of the contract. They only serve to clarify information to the Evaluation Committee while they are assessing the proposal. This suggestion was recommended early in the development of the research and SCDOT has implemented communications, which do not become part of the contract.

Section "5.0 Discussions" of the SCDOT RFP

1. Consider including a specification regarding the extension of discussions with all proposers. For example, *"If Discussions are held with one Proposer, they must be held with all Proposers in the Competitive Range."*
2. Provide additional detail about the kind of information included in discussions. For example:
   - Advising the Proposers of significant Weaknesses and/or Deficiencies in their Proposals (relative to the RFP);
   - Attempting to resolve any uncertainties and obtaining any significant clarifications concerning the Proposal;
   - Resolving any suspected mistakes by calling them to the attention of the Proposers as specifically as possible without disclosing information concerning other competing Proposers' Proposals or the evaluation process; and
   - Providing the Proposers a reasonable opportunity to submit any further technical or other supplemental information to their Proposals.
3. Specify that *"No indication will be made to any Proposer of the evaluation status of any other Proposer or Proposal."*
4. Include that discussions will only address specific deficiencies in the proposer's proposal. Other changes may be made through the RFP addendum or Best And Final Offer (BAFO)..
5. Review whether some of these prohibitions related to the Department personnel should be included in the Manual while holding discussions. For example: *"During Discussions, Department personnel involved in the acquisition are prohibited from engaging in the following conduct that: 1) Favors one Proposer over another; 2) Reveals a Proposer's technical solution, including unique technology, innovative and unique uses of commercial items, or any information that would compromise a Proposer's intellectual property to another Proposer; 3) Reveals a Proposer's price without that Proposer's permission; 4) Reveals the names of individuals providing reference information about a Proposer's past performance, or 5) Knowingly furnishes source selection information in violation of the Department's procurement policies and the laws of the State".*
6. Evaluate the inclusion of information about proposal revisions during discussions. As a reference, New York state includes:
   - o *"If the Department decides to enter Discussions with the Proposers in the Competitive Range, they must also request Proposal Revisions from the Proposers in the Competitive Range. Proposers will be requested and/or allowed to revise*

their Quality and Price Proposals, including the correction of any weaknesses, minor irregularities, errors and/or deficiencies identified to the Proposers by the Department following the initial evaluation of the Proposals. The RFP Revisions will allow adequate time for the Proposers to revise their Proposals. Upon receipt of the final Proposal Revisions, the process of evaluation will be repeated for the revised information. The process will consider the revised information and re-evaluate and revise ratings as appropriate."

The next four sections summarize recommendations related to five areas that SCDOT identified of interest: (1) the difference between clarifications and communications; (2) the definition of dispositions of written/comments in all forms of "communications" that become part of the contract; (3) the benefits that other states obtain from presentations; (4) the difference between Q&A sessions and oral presentations and (5) the definition of the stages where each form of "communications" is applicable.

Difference between Clarifications and Communications

According to the current practice of states such as California, New York, or Georgia, clarifications serve DOTs as a mean to ask for correction of minor errors and/or to determine the responsiveness of the proposal.

In contrast, communications services to address or clarify technical concepts. For example, New York uses them to make clear aspects related to the Alternative Technical Concepts while Virginia uses them to a) enhance its understanding of Proposal, b) allow reasonable interpretation of the proposal or c) facilitate the evaluation process. (These reasons are defined in CFR 636.402).

Communications as part of the contract

The only reference about including some form of communication as part of the contract is given by FDOT. Florida includes questions and responses from the Questions & Answers (Q&A) session as part of the contract documents. The Q&A session helps FDOT to obtain clarification and to ask questions to the proposer regarding the technical proposal

New York considers any form of communications as part of their records, but not part of the contract.

Benefits of presentations

The analyzed states highlight the use oral presentations to:

- Provide offerors with an opportunity to explain their technical proposals further and highlight the most significant aspects of it (e.g., NCDOT, WSDOT).
- Familiarize the evaluation personnel with the teams and proposals (e.g., NYSDOT).
- Guide the review committee through the technical proposal and provide an opportunity for the agency to seek clarification and ask questions (e.g., FDOT, WSDOT).

Q&A and presentation

There is no need to decide between one form of information exchange and the other. FDOT, for example, use both of them. They conduct presentations (page-turn meeting) to allow the DB firms to present and highlight the critical aspects of their proposals. They also hold Q&A sessions in which the Department seeks clarifications and asks questions related to the technical proposal.

Stages for each form of information-exchange

Based on the information analyzed in this tech-memo, the following stages are the ones where each type of evaluation-exchange should be developed:

- Clarifications: after receipt of proposal
- Communications: after receipt of the proposal and during the evaluation process
  - Florida: Page-turn meeting happens about a week after the technical proposal is submitted, while Q&A is scheduled near the end of the technical review and prior to receiving the price proposal.
  - North Carolina: Following a period of preliminary evaluation of the technical proposal
  - New York: At the beginning of the evaluation process.

- Discussions: after the receipt of proposals and after defining the competitive range.
  23 CFR does not explicitly indicate if the discussions take place after the bid opening. However, in Subpart E—Discussions, Proposal Revisions and Source Selection, some sections suggest that the proposer's price is an issue that may be addressed in discussions. If this is the case, the price is known by public administrators but remains confidential until the Best and Final Offer.

These recommendations are based on the review of other state documents. The research team has not discussed these recommendations with the states that were reviewed. It should also be noted that the research team has not reviewed any of South Carolina's project-specific source selection plans. Some of the recommendations could be more appropriate for these source selection plans rather than RFPs or the SCDOT Design-Build Manual.

2. Research Methodology

To accomplish this task, the research team developed a document analysis of design-build manuals, requests for proposals and other documentation. Other documents included source selection plans, white paper and reports. The research team used the software "atlas.ti" for content analysis of these documents. The software allows for coding of text within the document for sorting and analysis. Table 1 summarizes the states and documents in this review.

Table 1. Agency Design-build documentation reviewed.

	AZ	CA	CO	FL	GA	MN	MS	NY	NC	SC	TX	UT	VA	WA
D-B Manuals	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RPF			●	●		●				●		●	●	
Other Docs	●			●	●		●	●		●				

3. Summary of Analysis and Example Text

This summary of the analysis has four sections. Each section corresponds to one of the concepts included in the SCDOT RFP for Industry review document: presentations, clarifications, communications and discussions.

The first sub-section includes the SCDOT section, which wants to be analyzed and improved. The second sub-section shows the information related to this concept and included in Manuals and RFPs of states that have developed them more comprehensively. The third sub-section includes the recommendations based on the comparison between the first and second sub-sections.

3.1 Presentations

South Carolina

South Carolina includes in section *5.4 Presentations* of the RFP for Industry Review the following information:

- Proposers who have submitted responsive Technical Proposals will be invited by the Committee to make a presentation on the date identified in the Milestone Schedule.
- The Committee will be present during the presentations.
- The Committee may prepare questions and these questions may be sent to the Proposers prior to the presentation
- The presentation will be scheduled for 50 minutes. SCDOT will terminate the presentation promptly at the end of the allotted time.
- The format for the Proposer's presentations is:
    - Introduction of key individuals (Proposer)
    - Presentation by Proposer (Proposer)
    - Questions from the Committee on the presentation (SCDOT)
    - Wrap-up (Proposer)
- Presentations have a duration of 1 hour and 20 minutes.
- The Proposer's attendees may consist of the POC, key individuals identified in the Proposer's Statement of Qualifications and other personnel shown on the Proposer's organization chart. However, the number of attendees shall not exceed 12 individuals.
- The presentation will allow the Proposers an opportunity to explain any aspect of their Technical Proposals further but will not be an opportunity to modify the contents of the proposal.
- The presentation shall not be used to fill in missing or incomplete information that was required in the Technical Proposal. The presentation shall not be used as an opportunity by the Proposers to improve or supplement their proposals.
- The presentation will not constitute discussions or negotiations.
- Proposers will not be permitted to ask questions to the Committee during the presentation.

- The Technical Proposal submitted electronically to the SCDOT will be made available to the Proposer via a computer with large monitors suitable for display to the Committee and the Proposer's attendees.
- The Proposers will be able to navigate through their proposal and plans via the SCDOT provided computer access.
- The Proposers shall not bring additional information, including additional copies of the proposal, other plan sheets, design calculations, or handouts of the presentation. They shall limit their discussion to the material provided as a part of their Technical Proposal and any clarifying questions posed by SCDOT.

National Analysis

Arizona, California, Minnesota, Utah, Colorado and Virginia do not add any specific information that could support SCDOT presentation procedures. It is not known whether they have intentionally or unintentionally left this detail out of their Manuals and RFPs. Additional information could be included in their source selection plans on a project-by-project basis.

Florida: FDOT includes within its procurement a Page-Turn Meeting (not mandatory) and a Questions and Answer (Q&A) Session. Highlights to consider include:

- ***The page-turn meeting*** *is a 30 minutes meeting where the design-build firm guides the Technical Review Committee through the Technical Proposals.*
- *Upon conclusion of the 30 minutes, the Technical Review Committee is allowed 5 minutes to ask questions pertaining to information highlighted by the design-build firm.*
- *An unmodified aerial or map of the project limits provided by the design-build firm is acceptable for reference during the Page-Turn Meeting. The unmodified aerial or map may not be left with the Department upon the conclusion of the Page-Turn Meeting.*
  Use of other visual aids, electronic presentations, handouts, etc., during the Page-Turn Meeting, is expressly prohibited
- *The Department will record all or part of the Page-Turn Meeting. All recordings will become part of the Contract Documents.*
- *Participation in the Page Turn Meeting by the design-build firm shall be limited to eight representatives from the design-build firm.*
- *The FHWA will be invited to FA Oversight Projects.*
- *Design-build firms desiring to opt-out of the Page-Turn Meeting may do so by submitting a request to the Department.*

- ***Question and Answer Session,*** *the Department may meet with each Proposer, formally, for a Q&A Session.*
- *The FHWA will be invited to FA Oversight Projects.*
- *The purpose of the Q & A Session is for the Department to seek clarification and ask questions, as it relates to the Technical Proposal of the Proposer.*
- *The Q & A Session will not constitute "discussions" or negotiations.*
- *Proposers will not be permitted to ask questions to the Department except to ask the meaning of a clarification question posed by the Department.*

- *No supplemental materials, handouts, etc. will be allowed to be presented in the Q & A Session. No additional time will be allowed to research answers.*

North Carolina: NCDOT specifies details about their presentation process.

- *Following a period of preliminary evaluation of the Technical Proposals, each short-listed Team will address the Technical Review Committee with a presentation based on their Technical Proposal.*
- *To the greatest extent possible, all Teams will make these presentations on the same day. The Team will field any questions generated by the Technical Review Committee during their preliminary evaluation period or the Teams' technical presentations.*

New York: If NYSDOT decides it is advantageous, the Proposers can be asked to attend individual presentations and interviews as part of the evaluation process.

- *Presentations may take place at two times during the evaluation process:*
    - *Sometimes the Department may wish to begin the evaluation by having the Proposers present a 30 to 60-minute presentation to the evaluation teams and the selection committee focusing on the issues and portions of its Proposal that it feels are especially important. This is done to familiarize the evaluation personnel with the teams and the Proposals.*
    - *Alternately, the Department may wish to have the Proposers make their presentations to the selection committee in conjunction with the interviews as discussed below after the preliminary ratings have been determined so that the selection committee can, with the insight gained from the evaluation process, observe the dynamics of the Proposers as they present what they feel to be the strongest points of their Proposals.*
    - *Although the interviews are considered in the Manual, they are not currently being used.*

- *Interviews normally take place after the evaluation teams and the selection committee have met and determined their preliminary ratings. The selection committee asks a prepared list of questions to which the Proposer must respond.*

The questions are prepared during the evaluation process. They may consist of several general questions that are asked of all Proposers and specific questions that relate directly to each Proposer's Proposal.

Washington: The WSDOT evaluation procedure includes Oral presentations made by Proposers.

- *Approximately one week after the Final Proposal is submitted, each Proposer is allowed to make a one-hour oral presentation to all members of the WSDOT Evaluation Team. The presentations offer the Proposer the opportunity to highlight the significant aspects of their Technical Proposals and their understanding of the RFP requirements.*

- *Oral presentations provide the evaluators an overall perspective of the project and offer a chance for the Evaluation Team to ask clarifying questions.*

Although the oral presentations are included in the Manual, they are no longer a WSDOT practice.

Recommendations for Presentations

Comparing SCDOT presentations sections and the information included in Florida, North Carolina, New York and Washington, the following recommendations are suggested:

1. State whether presentation will be before or after the preliminary Evaluation Committee ratings. North Carolina does presentations after the preliminary rating. New York provides the possibility for before or after, but it is clearly stated.
2. Consider being more explicit about what material is permitted or not in the presentation. For example, Florida DOT specifies:
    - "*An unmodified aerial or map of the project limits provided by the design-build firm is acceptable for reference during the Page-Turn Meeting. The unmodified aerial or map may not be left with the Department upon the conclusion of the Page-Turn Meeting. Use of other visual aids, electronic presentations, handouts, etc., during the Page-Turn Meeting, is expressly prohibited.*"
3. Consider recording the presentation. Florida records the meeting and makes it part of the contract documents.

3.2 Clarifications

South Carolina

South Carolina includes in section *5.5 Clarifications* of the RFP for Industry Review, the following information:

- SCDOT, at its sole discretion, shall have the right to seek clarifications from any Proposer to fully understand the information contained in their responses to the RFP.
- Clarifications mean a written or oral exchange of information that takes place after the receipt of Proposals when award without discussions is contemplated.
- At its discretion, SCDOT may elect to hold discussions, despite conducting clarifications, when circumstances dictate.
- Clarifications do not have to be held with any specific number of Proposes and do not have to address specific issues.
- The purpose of clarifications is to address minor or clerical revisions as well as clarify certain aspects of the proposals.
- The SCDOT POC shall exchange sufficient information with the Proposer to clarify the issues.
- The SCDOT POC is charged with limiting such exchanges to only the information necessary to determine how to read language already existing in the proposal.
- A proposal is unclear if open to more than one reasonable interpretation or obscure in meaning through indefiniteness of expression. Silence is not unclear.
- Clarifications cannot involve an opportunity for proposal revisions.

- Accordingly, clarifications must be limited to determining which reasonable interpretation was intended and should not include new information.
- The SCDOT POC shall have exclusive discretion regarding whether clarification is needed.

National Analysis

Arizona, Florida, Minnesota, North Carolina, Washington, Utah, Colorado and Virginia do not add specific information that could support SCDOT clarifications procedures. Similarly to presentations, it is not known whether this exclusion is intentional or unintentional.

California: Caltrans may issue a request for clarification to individual proposers to clarify or verify certain aspects of the proposal.

- *Caltrans will have the right to contact or submit written questions to the Proposers regarding the Proposals for the following purposes:*
    1. *Resolving any uncertainties or to obtain clarifications concerning the Proposal.*
    2. *Resolving any suspected mistakes by calling them to the attention of the Proposer.*
    3. *Providing the Proposer a reasonable opportunity to submit any revision to its Technical Proposal that may result from the questions.*
- *Those Technical Proposals not responsive to this RFP may be excluded from further consideration and the Proposer will be so advised. Caltrans may also exclude from consideration any Proposer whose Technical Proposal contains a material misrepresentation.*

New York: Within the evaluation process, NYSDOT includes this paragraph for quality and price proposal review:

- *During the evaluation, the evaluators need to determine if there is any information that requires clarification from the Proposers and that falls into the category of minor or clerical revisions that are allowed under Communications. If this information can be corrected through Communications, a brief request for Communications needs to be prepared and issued to the Proposer as discussed below in Section 9.6.3 of this Manual. This title´s section is proposal communications and will be shown in this document communication´s part.*
- *NYDOT uses clarifications only for minor errors or for asking about information that is missing in the proposal. These clarifications are limited to non-technical issues and are managed by the NYDOT Management Group.*

Georgia: GADOT has a specific section for a request for clarifications during the evaluation process that indicates:

- In the event that the Technical Review Committee (TRC) requires clarification of any element contained in the Proposer’s submittal, the following procedures apply:
    1. The Office of Innovative Delivery Project Management (OID-PM) will consult with the Office of Innovative Delivery Office Administration (OID-OA) regarding the TRC’s need for clarification.

2. The OID-OA will prepare a request for a clarification letter and send it by email to the Proposer.
3. The Proposer will send a written response to the OID-OA by the deadline included in the request. The OID-OA will notify the OID-PM of the results who will promptly facilitate a meeting with the TRC.
4. The TRC may request additional clarification, if necessary, or may determine the Proposer's response is adequate or determine the Proposer is non-responsive.

The GDOT State Innovative Delivery Administrator confirmed that the clarification process is only a means to determine if the proposal is responsive.

Recommendations for Clarifications

Comparing the SCDOT clarifications section to the information from California, New York and Georgia, the following recommendations should be considered:

1. Include examples of the types of clarifications that are allowable. For example, California includes the following reasons:
   a) *Resolving any uncertainties or to obtain clarifications concerning the Proposal.*
   b) *Resolving any suspected mistakes by calling them to the attention of the Proposer.*
   c) *Providing the Proposer a reasonable opportunity to submit any revision to its Technical Proposal that may result from the questions.*
2. Define the procedure for requests for clarification. The reader is referred to current practice in Georgia in Section 3.2.2.
3. Consider more specific wording or examples in the following statements:
   - The SCDOT POC shall exchange <u>sufficient</u> information.
   - The SCDOT POC is charged with limiting such exchanges to only the information necessary to determine how to read language already existing in the proposal.
   - A proposal is unclear if open to more than one reasonable interpretation or obscure in meaning through indefiniteness of expression. Silence is not unclear.

3.3 Communications

South Carolina

South Carolina includes in section *5.6 Communications* of the RFP for Industry Review, the following information:

- Communications are exchanges, between SCDOT and Proposers, after receipt of proposals, before the establishment of the competitive range.
- These communications are for the purpose of addressing issues that must be explored to determine whether a proposal should be placed in the competitive range.
- If a competitive range is to be established, these communications:
  - may only be held with those Proposers whose exclusion from, or inclusion in, the competitive range is uncertain;

- may be conducted to enhance the Evaluation Committee's understanding of proposals; allow reasonable interpretation of the proposal; or facilitate the evaluation process;
    - may address ambiguities in the proposal or other concerns (e.g., perceived deficiencies, weaknesses, errors, omissions, or mistakes and information relating to relevant past performance; and
    - shall address adverse past performance information to which the offeror has not previously had an opportunity to comment.
- Such communications shall not be used to cure proposal deficiencies or material omissions, materially alter the technical or cost elements of the proposal and/or otherwise revise the proposal.
- Such communications may be considered in rating proposals for the purpose of establishing the competitive range.

SCDOT presents a comprehensive section and there is only one suggestion from the national analysis.

National Analysis

Only the documents from New York and Virginia provide relevant information relating to communications.

New York: NYSDOT is the state that includes more information about the definition and process associated with communications. This state has a specific section Proposal ***Communications,*** which content is included below:

- *Communications are exchanges between the Department and the Proposers, after receipt of Proposals, which lead to the establishment of the Competitive Range (see 23 CFR 636.103).*

  A) Communications may be conducted with the Proposers to accomplish the following:

  1) Enhance the Department's understanding of the Proposals;

  2) Allow reasonable interpretation of the Proposals; and

  3) Facilitate the Department's evaluation process (23 CFR 636.406).

  B) Communications shall not provide an opportunity for a Proposer to revise its Proposal, but may address the following:

  1) Ambiguities in the Proposal or other concerns of the Department (e.g., perceived Deficiencies, Weaknesses, error, omissions, or mistakes); and

  2) Information relating to relevant past performance (if the information on past performance is the determining factor in their being placed in the Competitive Range and they have not previously had the opportunity to respond to the salient issues) (23 CFR 636.407 and 636.409).

  C) Communications may not be used to do the following:

1) *Cure Proposal Deficiencies or material omissions;*

2) *Materially alter the technical or price elements of the Proposal; or*

3) *Otherwise, revise the Proposals (23 CFR 636.408).*

- *The Department prepares briefly written questions that can be sent to the Proposers in order to have them respond with the information that clarifies the ambiguities or addresses the concerns of the Department.*
- *The request for Communications should also contain instructions for response and a timeframe in which the response must be received.*
- *If Communications are held with one Proposer, then they must be held with all Proposers whose Proposals are susceptible to correction through Communications.*

Communications address technical issues specifically related to the Alternative Technical Concepts (ATC), while clarifications refer to proposal non-technical aspects.

Virginia: VDOT´s manual includes the CFR definition. It also specifies:

- *Pursuant to 23 CFR 636.402, 636.404 and 636.406, prior to VDOT establishing a competitive range, VDOT may hold communications with only those Offeror's whose exclusion from or inclusion in, the competitive range is uncertain.*
- *Communications will*

  a) enhance VDOT's understanding of Proposals;

  b) allow reasonable interpretation of the Proposal; or

  c) facilitate VDOT's evaluation process.

Recommendations for Communications

Comparing the SCDOT communication section and the information included New York and Virginia, the following recommendations should be considered:

1. Consider including details about the communication process. In this regard, the instructions included in the New York Manual could be used as a reference:

"The Department prepares brief written questions that can be sent to the Proposers in order to have them respond with the information that clarifies the ambiguities or addresses the concerns of the Department. The request for Communications should also contain instructions for response and a timeframe in which the response must be received."

Note that this example relates to ATCs, which could be approved (and included in the proposal), rejected, or approved under conditions.

3.4 Discussions

South Carolina

South Carolina includes in section *5.10 Discussions* of the RFP for Industry Review, the following information:

- If necessary, after the Technical and Cost Proposal Analysis, SCDOT may hold confidential discussions with each responsive Proposer relating to aspects of their respective Proposal.
- Discussions are written or oral exchanges with the intent of allowing the Proposers to revise their proposals. However, after Discussions are concluded, SCDOT reserves the right to proceed with award without revisions to the proposals.
- Discussions are tailored to each Proposer's proposal.
- The discussion process is intended to assure that Proposers fully understand the requirements of the RFP and that the evaluation team fully understands each qualified Proposer's Technical Proposal and the Proposer's ability to perform as needed.
- Discussions involve only a limited exchange of information.
- Discussions are not negotiations.
- The SCDOT POC may discuss with each Proposer deficiencies, significant weaknesses and other aspects of a proposal that could be altered or explained in their proposal.
- However, the SCDOT POC is not required to discuss every area where the proposal could be improved.
- The scope and extent of discussions are a matter of the SCDOT POC's judgment.
- If SCDOT determines that discussions are necessary, SCDOT will forward a written invitation to the responsive Proposers.
- SCDOT reserves the right to hold multiple discussions at any length of time with all of Proposers.
- All discussions shall be controlled by the SCDOT POC.
- Proposers shall not communicate with any other SCDOT employees regarding these discussions except at the appropriate discussion meetings.
- If, after discussions have begun, a proposer originally in the competitive range is no longer considered to be among the most highly rated proposers being considered for award, that proposer may be eliminated from the competitive range whether or not all material aspects of the proposal have been discussed, or whether or not the proposer has been afforded an opportunity to submit a proposal revision.
- At the conclusion of discussions, SCDOT may either 1.) proceed with award of the contract to the selected Proposer based on the lowest Total Adjusted Bid; 2.) issue a Request for Best and Final Offers, or 3.) cancel the procurement.

National Analysis

New York: NYSDOT has the most comprehensive statements on the term discussion. Its manual contains a specific section *9.6.6 Discussions*, which is included below:

- *The Department may decide to conduct written and/or oral Discussions with the Proposers in the Competitive Range regarding the content of their Proposal.*
- *If Discussions are held with one Proposer, they must be held with all Proposers in the Competitive Range.*
- *Discussions are negotiations conducted in a competitive acquisition, after the establishment of the Competitive Range and prior to the selection of the design-builder (23 CFR 636 Subpart E). Discussions may include both quality and price issues (23 CFR 636.508).*
- *NYDOT considers that the competitive range is established by the firms that participate in the second stage of the procurement.*

Purpose

- *If the Department determines that Discussions are required, they will be conducted for the following purposes:*
  - *A) Advising the Proposers of significant Weaknesses and/or Deficiencies in their Proposals (relative to the RFP);*
  - *B) Attempting to resolve any uncertainties and obtaining any significant clarifications concerning the Proposal;*
  - *C) Resolving any suspected mistakes by calling them to the attention of the Proposers as specifically as possible without disclosing information concerning other competing Proposers' Proposals or the evaluation process and*
  - *D) Providing the Proposers, a reasonable opportunity to submit any further technical or other supplemental information to their Proposals.*

Procedures

A) The following specific procedures will apply:

1. *Discussions will only be conducted with Proposers in the Competitive Range. All Discussions will be confidential;*
2. *Discussions may be written and/or oral;*
3. *If oral Discussions are held, minutes must be kept.*
4. *No indication will be made to any Proposer of the evaluation status of any other Proposer or Proposal; and*
5. *If Discussions are held with one Proposer, they must be held with all Proposers in the Competitive Range.*

Regarding point 3, NYDOT's Design Build and Consultant Procurement representative clarified to the research team that this point is a state practice and does not respond to a federal requirement.

B) During Discussions, Department personnel involved in the acquisition are prohibited from engaging in the following conduct that:

1. *Favors one Proposer over another;*

2. *Reveals a Proposer's technical solution, including unique technology, innovative and unique uses of commercial items, or any information that would compromise a Proposer's intellectual property to another Proposer;*
3. *Reveals a Proposer's price without that Proposer's permission;*
4. *Reveals the names of individuals providing reference information about a Proposer's past performance; or*
5. *Knowingly furnishes source selection information in violation of the Department's procurement policies and the laws of the State of New York.*

Proposal Revisions

- *If the Department decides to enter Discussions with the Proposers in the Competitive Range, they must also request Proposal Revisions from the Proposers in the Competitive Range.*
- *Proposers will be requested and/or allowed to revise their Quality and Price Proposals, including the correction of any Weaknesses, minor irregularities, errors and/or Deficiencies identified to the Proposers by the Department following the initial evaluation of the Proposals.*
- *The RFP Revisions will allow adequate time for the Proposers to revise their Proposals. Upon receipt of the final Proposal Revisions, the process of evaluation will be repeated for the revised information. The process will consider the revised information and re-evaluate and revise ratings as appropriate.*

It is important to highlight that, according to NYDOT's Design Build and Consultant Procurement representative, this revision refers to the ATC and it can be added to the original proposal. The ATC revision could take up to two months, although it depends on the complexity of the project.

Recommendations for Discussions

Comparing the SCDOT discussion section and the information New York, the following recommendations should be considered:

1. Consider including a specification regarding the extension of discussion with all proposers. For example, *"If Discussions are held with one Proposer, they must be held with all Proposers in the Competitive Range."* O clarify if this is not a requirement.
2. Provide additional detail about the kind of information included in the discussions. For example:
    - Advising the Proposers of significant Weaknesses and/or Deficiencies in their Proposals (relative to the RFP);
    - Attempting to resolve any uncertainties and obtaining any significant clarifications concerning the Proposal;
    - Resolving any suspected mistakes by calling them to the attention of the Proposers as specifically as possible without disclosing information concerning other competing Proposers' Proposals or the evaluation process; and
    - Providing the Proposers a reasonable opportunity to submit any further technical or other supplemental information to their Proposals.

3. Specify that *"No indication will be made to any Proposer of the evaluation status of any other Proposer or Proposal."*
4. Include the prohibitions of the Department personnel while holding discussions. For example: *"During Discussions, Department personnel involved in the acquisition are prohibited from engaging in the following conduct that: 1) Favors one Proposer over another; 2) Reveals a Proposer's technical solution, including unique technology, innovative and unique uses of commercial items, or any information that would compromise a Proposer's intellectual property to another Proposer; 3) Reveals a Proposer's price without that Proposer's permission; 4) Reveals the names of individuals providing reference information about a Proposer's past performance, or 5) Knowingly furnishes source selection information in violation of the Department's procurement policies and the laws of the State".*
5. Evaluate the inclusion of information about proposal revisions during the discussion. As a reference, New York state includes:
   - *"If the Department decides to enter Discussions with the Proposers in the Competitive Range, they must also request Proposal Revisions from the Proposers in the Competitive Range. Proposers will be requested and/or allowed to revise their Quality and Price Proposals, including the correction of any Weaknesses, minor irregularities, errors and/or Deficiencies identified to the Proposers by the Department following the initial evaluation of the Proposals. The RFP Revisions will allow adequate time for the Proposers to revise their Proposals. Upon receipt of the final Proposal Revisions, the process of evaluation will be repeated for the revised information. The process will consider the revised information and re-evaluate and revise ratings as appropriate."*

Appendix 2B – Tech Memo on Requests for Qualifications

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 2b. Tools, Processes and Best Practices

Request for Qualifications

Prepared by

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Table of Contents

1. Executive Summary

The objective of this subtask is to review and summarize national Departments of Transportation (DOTs) methods for including past performance in Design-Build Request for Qualifications (RFQs). This Technical Memorandum summarizes and synthesizes the recommendations included in the Code for Federal Regulation (CFR) as well as the methods used by six DOTs to assess past performance in Design-Build RFQs. This summary provides the South Carolina Department of Transportation (SCDOT) with a framework to evaluate their current practice.

The CFR suggests to specify the following aspects in the past performance evaluation: the timeliness and relevance of the information, the source of information, the context of the data, and the general trends in contractor´s performance. The CFR also indicates that the solicitation should include a policy for evaluating offerors with no relevant performance history. The solicitation should authorize offerors to provide information on problems encountered on the identified contracts and the offeror's corrective actions. DOTs should use their discretion in determining the relevance of past performance information. Finally, the CFR indicates that the past performance evaluation should include information regarding predecessor companies, key personnel who have relevant experience, or subcontractors that will perform major or critical aspects when such information is relevant to the current acquisition (23 CFR § 636.205).

The research team conducted a document analysis of Design-Build RFQs from six states including South Carolina. The criteria to assess RFQs can broadly be grouped in five categories: (1) project understanding; (2) proposer's experience; (3) project team members organization and experience; (4) past performance; and (5) other aspects such as quality programs, suitability, staff accessibility, compliance with formal requirements and safety. The analysis shows that past performance, as an explicit evaluation criterion in the RFQs, is considered in four of the six reviewed states. The two states that do not explicitly include past performance in the RFQ, do consider the experience requirements in the category of proposer´s experience. The study also found differences on the weights given to the past performance criteria.

Table 1 includes a summary of the findings. The first column corresponds to SCDOT's past performance evaluation criteria. The second through sixth columns compare the other states with SCDOT practices to identify differences or similarities with SCDOT approach.

Table 1. RFQ Past Performance Comparison

South Carolina SCDOT RFQ SC 277 NB over I-77 Bridge replacement (2017)	**Georgia GDOT** RFQ I-20 at Savannah River (2018)	**North Carolina NCDOT** RFQ Division 6 Bridge replacement (2018)	**Virginia VDOT** RFQ Route 7 and Battlefield parkway (2017)	**Florida FDOT** RFQ Generic Florida DOT Webpage*	**New York NYDOT** RFQ Hunts Point Interstate access improvement project (2018)
Weight					
40/100points	20%	Adjectival: Exceptional, Good, Acceptable or Unacceptable	40%**	7/20 points***	35%
Evaluation criteria					
Experience of proposer´s Team					
Lead Contractor or any Major Subcontractors	✓	✓	✓	✓	✓
Lead Design or any Major Design-Subconsultant	✓	✓	✓	✓	✓
Quality of Past Performance					
Successful projects completed on time & schedule	Ask about schedule completion	Ask for satisfactory performance in general	✓	✓	Ask for reasons not accomplished
Records of managing contracts to minimize delays, claims, dispute proceeding, litigation & arbitration.	Not mentioned	Not mentioned	Not mentioned	Through the evaluation system	No records but self-assessment narrative
Quality initiatives including but not limited to cost control, schedule management, and adherence, avoidance of claims.	Not mentioned	Not mentioned	Not mentioned		Not mentioned
Specific information about projects that had have problems (see table 3)	Not mentioned	✓	Not mentioned		Projects listed by team members
Use of evaluation systems	No	No	No	Yes	No
Comments	GDOT does not ask for specific information on the past performance criteria	NCDOT does not include *past performance* as an evaluation criteria, but includes experience in other sections	VDOT does not include *past performance* as an evaluation criteria, but includes experience in other sections	Evaluation system: - *Contractor grades* (contractor past performance report) *Professional consultant grades*	Additionally, they include safety, experience modification rate and DBE program experience

* http://fdotewp1.dot.state.fl.us/procurement/professionalservices/advertise/advDBLD.shtml
** This weight is referred to "Experience of Offeror´s Team"
*** 7 points are given to "Past performance, design-build experience and organization, and staffing"

In order to develop recommendations for SCDOT, the research team has identified national practices and has compared them with the current SCDOT practice. SCDOT's RFQ evaluations practices are in-line with surrounding states and others across the country. The differences appear to be due to preferences and local practices. In comparing SCDOT RFQ evaluation criteria to the information reviewed from Georgia, Florida, New York, North Carolina, and Virginia, SCDOT may wish to consider the following suggestions:

1. If SCDOT develops a state-wide contractor performance rating system, this can be used for the Design-Build RFQ process.
2. If SCDOT does not move to a contractor evaluation system, they could consider formulating the evaluation criteria in alignment with each project's goals.
3. Consider, within the *past performance* requirements, specifying a minimum number of projects developed using Design-Build.
4. Consider additional past performance information in areas like safety, environmental compliance, or Disadvantage Business Enterprise utilization if those aspects are relevant to align the selection with the project's goals.
5. The weights and scores ranges used by SCDOT enable an evaluation aligned with the concern of considering the past performance in the SOQ meaningfully.
6. SCDOT Procurement Manual recommendations related to the Work history and quality form—contractor designer:
    - In order to improve the assessment of experience in the past performance evaluation criteria, SCDOT might wish to emphasize that the description of work should be oriented to specific aspects relevant to the project goals. For example, if one of the project goals is to minimize affections to the community affected by the construction, the work description in the "work history form" should emphasize how the proposers accomplished this goal in previous projects.
    - In order to improve the assessment of quality in past performance evaluation criteria, SCDOT might wish to consider:
        - In the quality form—section h, similarly to the previous suggestion, the self-assessment required could be oriented to performance evaluation with an emphasis in specific areas. For example, if SCDOT knows that the project under procurement could have cost overruns and delays associated with particular project items such as utility relocation or environmental issues, the performance evaluation should be focused on these areas.
        - In the quality form—section i, project-specific awards can also be required optionally. For example, having a DBIA award associated with design engineering, process, teaming, or any specific DB project can be a good signal of past performance quality. The Institute for Sustainable Infrastructure issues project's credentials that might also be considered if sustainability is among the project's goals (https://sustainableinfrastructure.org/project-verification/verify-a-project/). This credential demonstrates the sustainable achievements on the basis of 64 sustainability and resilience indicators organized into five categories: quality of life, leadership, resource allocation, the natural world, and climate and resilience.

2. Research Methodology

To accomplish this task, the research team developed a document analysis of Design-Build RFQs and DOTs web pages. The research team used the software "*atlas.ti*" for content analysis of these documents. The software allows codifying the text within the document for sorting and analysis. Table 2 summarizes the states and documents in this review.

Table 2. Agency Design-Build Documentation Review

	GA	NC	VA	FL	NY	SC
RFQ	●	●	●	●	●	●
Generic Template				●		

The research team also include a section to answer SCDOT concern about whether they need to refine what they are asking for in the RFQ or whether they are evaluating the information inadequately.

3. Summary of Analysis

This summary of analysis has three sub-sections. The first one introduces the concept of past performance weight and how each state uses it in the RFQ evaluation. The second one refers to the evaluation criteria, which are explained based on the SCDOT sub-criteria of *experience of proposer team* and *quality of past performanc*e. The third sub-section includes the recommendations developed from this analysis.

3.1 Weights

Because each state has slightly different criteria, it is impossible to directly compare the weights assigned to past performance in each selection. However, the research team considered it appropriate to include a discussion of weights in this report to provide an overview of the different approaches that are currently in use.

SCDOT considers three evaluation criteria in the RFQ: (1) *team structure and project approach,* 20 points; (2) *experience of key individuals*, 40 points; and (3) *past performance*, 40 points. When compared with the other states considering past performance as an evaluation criterion, the following conclusions are observed:

- GDOT assigns a weight that is 20% lower than SCDOT's. GDOT considers two main criteria: (1) *experience and qualifications,* with a weight of 45% and (2) *suitability and past performance*, with a weight of 55%. Within the latter, past performance accounts for 20%. It is important to note that GDOT evaluates past performance from the relevant projects required in the section *experience and qualifications.* Past performance is evaluated through a survey of the project references for the proposed Lead Constructor and Lead Design Consultant. GDOT indicates that "*no additional information should be submitted* *for the past performance requirement*." Additional information about this can be found in the Appendix of the report, Section 4.1.

- On its Design-Build webpage[1], FDOT provides a template with the criteria for evaluating the Phase 1 submittals. FDOT considers three main groups of criteria: (1) *design-build firm and prequalification,* with no scoring; (2) *past performance evaluations, design-build project experience, organization, and staffing*, scored in a range from 0 to 7 points; and (3) *design-build project requirements and critical issues*, scored with up to 13 points. Thus, the weight of the second criteria accounts for 35% of the total score, and this weight includes two additional sub-criteria besides the past performance. All the three sub-criteria can be reviewed in the Appendix of the report, Section 4.2.

- NYDOT considers a weight of 35% for past performance criteria. NYDOT includes in the assessment of RFQ three main criteria: (1) *organization and key personnel,* with a weight of 30%; (2) *experience of the firms*, accounting for 30% of the total score; and (3) *past performance,* representing 35% of the total score. The three sub-criteria considered by NDOT for past performance are described in the Appendix of the report, Section 4.3.

3.2 Evaluation Criteria

This section analyzes the SCDOT past performance evaluation criteria by comparing its requirements with the other five states.

3.2.1 Experience of Proposer´s Team

SCDOT requires from the Lead Contractor with any of its Major Subcontractors, and from the Lead Designer with any of its Major Subconsultants, no more than five projects awarded within the last 10 calendar years. These projects should be those the proposer considers most relevant in demonstrating the qualifications of the team to manage, design, and construct the project.

Each project description should be included in the form "Work History and Quality Form-Contractor/Designer." This form asks for projects' *descriptive information*, like project name and name of lead responsible for the overall project; *client contact information*; *actual or estimated construction completion date and cost*, referred as the dollar value of work performed; and a *narrative describing the work performed*. Any key individual that is part of the proposal should be identified in those projects where they have previously worked.

Additionally, SCDOT requires *project performance information* that is asked through three main statements. First, proposers are asked to self-assess their performance in the projects, identifying the firms or personnel that have successfully completed the projects on time and/or on budget. They should also include references about the records that the firms have to justify project management that had minimized delays, claims, disputes proceedings, litigation, and arbitration.

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[1] http://fdotewp1.dot.state.fl.us/procurement/professionalservices/advertise/advDBLD.shtml

Second, proposers must discuss the initiatives that have developed to control cost, manage the schedule and avoid claims. Third, SCDOT includes a section for the proposers to explain in detail certain aspects of the quality of specific aspects of the past performance. If the project has had any of the situations included in Table 3, those need to be clarified.

Table 3. Past Project Situations Requiring Clarification

Lead Contractor declared delinquent of placed in fault on any project.
Lead Contractor submitted a claim on a project that was litigated and if litigated not resolved in favor of the Lead Contractor
The project has been delayed more than 30 days and liquidated damages were assessed.
Lead Contractor cited by OSHA for violations deemed serious, willful or repeated.
Owner or Lead Contractor filed a claim against the Lead Designer´s Errors and Omissions Insurance
Lead Designer filed legal proceedings against the Lead Contractor or vice versa.
Lead Contractor has been suspended, debarred, disqualified from bidding, or declared ineligible for work by any entity or are any such actions pending against them within the last five years.

Georgia, Florida and New York also include past performance evaluation criteria in their RFQ, but they differ slightly in the way the information is requested.

GDOT does not ask for additional information for past performance, and indicates that "*Past performance will be evaluated through a survey of the project references for the proposed Lead Contractor and Lead Design Consultant*." They use the information included by the proposers in the *Experience and Qualification* evaluation criteria for the Lead Contractor and the Lead Design Consultant. For those, GDOT asks for no less than one design-build project or at least three construction projects delivered using conventional Design-Bid-Build contracting. The proposers should include for these projects' *descriptive information* like project name, location, duration, physical description, services performed, and owner contact information. Regarding project performance information, GDOT requires details of schedule compliance.

FDOT includes in the evaluation criteria concepts of past performance evaluation, Design-Build experience, and Organization and Staffing. They evaluate the past performance using contractor grades, professional consultant grades and performance history with other states or agencies, if none with FDOT. Each of these criteria are described below:

- *Contractor grades*: FDOT uses contractor´s past performance grades both in determining the bidding capacity and in the pre-qualification process. The constructor´s past performance rating takes in account nine criteria[2]: 1) pursuit of the work, 2) proper maintenance of traffic (MOT) and minimize impacts to traveling public, 3) timely and complete submittal of documents, 4) timely completion of the project, 5) coordination/cooperation with CEI personnel, property owners and utilities company, 6) mitigate cost and time overruns, 7) environmental compliance, 8) conformance with

[2] http://www.fdot.gov/construction/cppr/CPPRGuidelinesMain.shtm

contract documents and 9) Disadvantaged Business Enterprises (DBE) utilization. More detail of the report can be reviewed in the Appendix, Section 4.2.

- *Professional consultant grades:* FDOT establishes a work performance grade for each major type of work based on an evaluation of Schedule, Management, and Quality. *"The schedule rating shall be based on the consultant's compliance with the contract schedule. The Management rating shall be based on the consultant's ability to manage all necessary project resources. The Quality rating shall be based on the consultant's attention and concern to the established quality control plan and a quality product. The project manager shall assign the Quality rating to any qualified consultant named in the agreement for any major type of work performed. For all professional services contracts that result in the preparation of construction plans, a constructability rating shall also be assigned. The constructability rating shall be based on the design consultant's ability to develop practical, accurate, complete, and cost-effective construction plans. The rating system for all work types shall be on a 1 to 5 rating scale with 1 equating to poor performance and 5 representing outstanding performance. Ratings will be assigned on a continuum of 1 to 5[3]."*

NYDOT asks for no more than five project descriptions for the Constructor and the Designer firms; and no more than three projects for the Construction Inspection Professional Engineering firm and for the Material testing or Laboratories. All of these projects need to be developed during the last 15 years. This information is required in *the experience of the firm's* evaluation criteria.

North Carolina and Virginia are examples of states that do not include the past performance among the RFQ's evaluation criteria. However, they ask for similar information in other criteria like *proposer´s capabilities* in NCDOT and *experience of offeror´s team* in VDOT. In NCDOT's case, the proposers are asked to discuss the recent relevant experience in projects similar in nature to the proposal´s one. NCDOT indicates that firms are expected to have performed satisfactorily on previous projects. In VDOT's case, the requirements are more specific and related to the Lead Contractor and Lead Designer experience. For both, three projects are required, and besides their descriptive information, VDOT leaves an open statement that allows proposers to include the performance information that they considered appropriate. The statement reads as follows: "*focusing what offeror considers most relevant in demonstrating Lead Constructor/Lead Designer qualifications to serve as the Lead Constructor/Lead Designer for this project.*"

3.2.2 Quality of Past Performance

SCDOT assesses the quality of past performance based on the three aspects introduced in the previous section: (1) *team structure and project approach*; (2) *experience of key individuals*; and (3) *past performance*. In the quality of past performance evaluation criteria, proposers are also asked to include any other project, active or complete that within the last five years have had any of the situations included in Table 3. If any key individual that is part of the proposal worked in any of these projects, he/she should be identified.

[3] Rule 14-75 Florida Administrative Code

GDOT, in contrast with SCDOT, does not include specific questions in the RFQ to evaluate the quality of past performance. Instead, they evaluate each project by surveying the contacts included in the project references.

FDOT uses an evaluation system which takes into account the project performance as a whole. They do not ask for specific information like records of managing contracts to minimize delays, claims, dispute proceeding, litigation, etc. included in Table 3. Instead, they rely on the ratings from their past performance evaluation system.

NYDOT evaluates past performance asking the proposer to provide five groups of requirements. First, they should include a self-assessment of each of the projects included in *experience of the firm's* evaluation criteria. The self-assessment narrative should describe the project performance explaining any cost overruns, schedule delays, claims, litigations, key personnel change assessment fees, and liquidated damages associated with the project. Second, and similarly to SCDOT, NYDOT requires the proposer to submit information about claims, dispute proceedings, litigation, arbitration proceedings, and liquidated damages of all the projects that each Design-Build team member has been involved with over the last 10 years. Third, NYDOT requires safety information regarding each Design-Build team member. Forth, proposers are asked to submit the Constructor and the Construction Inspection Firm´s Experience Modification Rate. Finally, NYDOT requires information about the DBE program experience (similarly to FDOT).

3.2.3 Use of Standard Evaluation Systems

SCDOT does not include any specific evaluation criteria that consider the scores provided by an evaluation system. However, they mention that they could use the following data to support the assessment of the quality of past performance:

- Contractor and Consultant performance evaluation system;
- Lead Contractor and major subcontractor´s and Lead Designer and major subcontractor´s Design-Build Performance Evaluation Scores; and
- References.

By contrast, FDOT bases its assessment of past performance in the grades recorded in their contractors and consultant evaluation system.

3.3 SCDOT analysis on RFQ information and evaluation

This section aims to answer SCDOT concern about whether the Department needs to refine what they are asking for the RFQ or whether they are evaluating the information inadequately.

Base on the analysis of SCDOT RFQ, the research team considers that the information required in the RFQ is comprehensive (
Table 1). SCDOT assesses the past performance of the team on the basis of experience and quality of past performance.

Table 1 Evaluation criteria RFQ

Team Structure and Approach
Organizational Chart and Team Structure
Critical Risks, Project Approach, and Capacity and Resources
Experience of Key Individuals
Project Manager
Design Engineering Team
Construction Management Team
Past Performance of Team
Experience of Proposer's team
Quality of Past performance

The experience of the proposer's team requires firms to provide three (3) and no more than five (5) projects (within the last ten (10) years). In each of the projects, proposers should identify the Lead Contractor, Designer and major subcontractors. The proposers should describe the work performed by these key roles (sections from "a" to "g" in Figure 1).

WORK HISTORY AND QUALITY FORM – CONTRACTOR/DESIGNER
[Name of Lead Contractor/Major Subcontractor – Use for all A fields OR Lead Designer/Major Sub-consultant – Use for all B fields]

a. Project Name & Location (City, State)	b. Name of lead responsible for the overall project design or construction	c. Contact information of the Client & their Project Manager who can verify A's or B's responsibilities	d. Actual or Estimated Construction & Professional Services Completion Date	e. Actual or Estimated Project Construction Cost (in thousands)	f. Dollar Value of Work Performed by A or B (in thousands)
Name: Location:	Name: Contractor should provide name of Lead Designer OR Designer should provide name of Lead Contractor	Name of Owner: Project Manager: Phone: Email:	MM/YYYY MM/YYYY	$	$
g. Narrative describing the work performed by A or B. If submitting work completed by an affiliated or subsidiary company of A, identify the full legal name of the affiliate or subsidiary and their role on the Project. Include the office location(s) where the design work was performed and whether B was the lead designer or a sub-consultant.					

Figure 1 SCDOT SOQ Work history evaluation

One suggestion to improve the evaluation of experience in the past performance evaluation criteria is to emphasize that the description of work should be oriented to specific aspects that SCDOT considers relevant for the project goals. For example, if one of the project goals is to minimize affections to the community affected by the construction, the work description in the "work history form" should emphasize how the proposers accomplished this goal in previous projects.

The evaluation of "quality of past performance" requires proposers to self-assess previous project performance (time, budget) and to identify records of managing contracts to minimize delays, claims, dispute proceedings, litigation, and arbitration. Further, proposers should provide quality initiatives and answer a set of questions related to claims, OSHA violations, and delays, among others (Figure 2).

h. Self-Assessment. The information provided in this section should be a self-assessment of A's or B's performance on the project to identify As or Bs with firms or personnel that have successfully completed projects on time and on or under budget, and to identify As or Bs that have records of managing contracts to minimize delays, claims, dispute proceedings, litigation, and arbitration.
i. Quality Initiatives. Discuss A's or B's quality initiatives including, but not limited to, cost control, schedule management and adherence, avoidance of claims, and other pertinent initiatives enhancing quality on the project.
j. For each question in Section 3.5.2 of the RFQ for which a "Yes" answer was provided, A or B shall provide a detailed explanation below.
Yellow highlighted text can be removed when filling out this form. 1. Reason(s) for delinquent status and/or default on this project, including ultimate resolution. 2. Any claim(s) requiring litigation in which the resolution was not in favor of the Lead Contractor on this project. Provide claim amount(s). 3. Reason for delay longer than 30 days resulting in liquidated damage assessment for this project. Provide total project delays. 4. Any OSHA violation deemed serious, willful, or repeated for this project. 5. The final disposition of any claims filed for errors or omissions on the Lead Designer. 6. Any legal proceedings filed against the Lead Contract by the Lead Designer or vice versa on a design-build contract.

Figure 2 SCDOT SOQ Quality form

Some suggestion to improve the evaluation of quality in the past performance evaluation criteria are:

- In section h, similarly to the previous suggestion, the self-assessment required could be oriented to performance evaluation with an emphasis in specific areas. For example, if SCDOT knows that the project under procurement could have cost overruns and delays associated with particular project items such as utilities relocation or environmental issues, the performance evaluation should be focused on these areas.

- In section i, project-specific awards can also be required optionally. For example, having a DBIA award associated with design engineering, process, teaming, or any specific DB project can be a good signal of past performance quality. The Institute for Sustainable Infrastructure issues project's credentials that might also be considered if sustainability is among the project's goals (https://sustainableinfrastructure.org/project-verification/verify-a-project/). This credential demonstrates the sustainable achievements on the basis of 64 sustainability and resilience indicators organized into five categories: quality of life, leadership, resource allocation, the natural world, and climate and resilience.

With respect to how the information is evaluated, the research team simulated the assessment process of two of SCDOT projects procured in 2017: (1) I-85 widening MM 98-106 and (2) US-21 over Harbor River.

The simulation considered the weights established in each RFQ and the scores' probabilistic distributions obtained based on the SCDOT internal scoring sheets.
Each simulation results are shown in the form of tornado diagrams (Figure 3, Figure 4, Figure 5, Figure 6). These graphs represent how the variation of each evaluation criterion influences the change in the award score's mean.

I-85 Widening MM 98-106

Table 2 shows the weights assigned to each of the evaluation criteria.

Table 2 I-85 Widening MM 98-106 RFQ Evaluation Criteria Weigths

RFQ evaluation criteria	Weight
Team Structure and Approach	**20**
Organizationl Chart and Team Structure	5
Critical Risks, Project Approach, and Capacity and Resources	15
Experience of Key Individuals	**40**
Project Manager	10
Design Engineering Team	15
Construction Management Team	15
Past Performance of Team	**40**
Experience of Proposer's team	10
Quality of Past performance	30

The general tornado diagram (Figure 3) shows that past performance is the most influential evaluation criteria. The specific tornado diagram (Figure 4) shows that within the past performance, the most influential is the quality and not the experience.

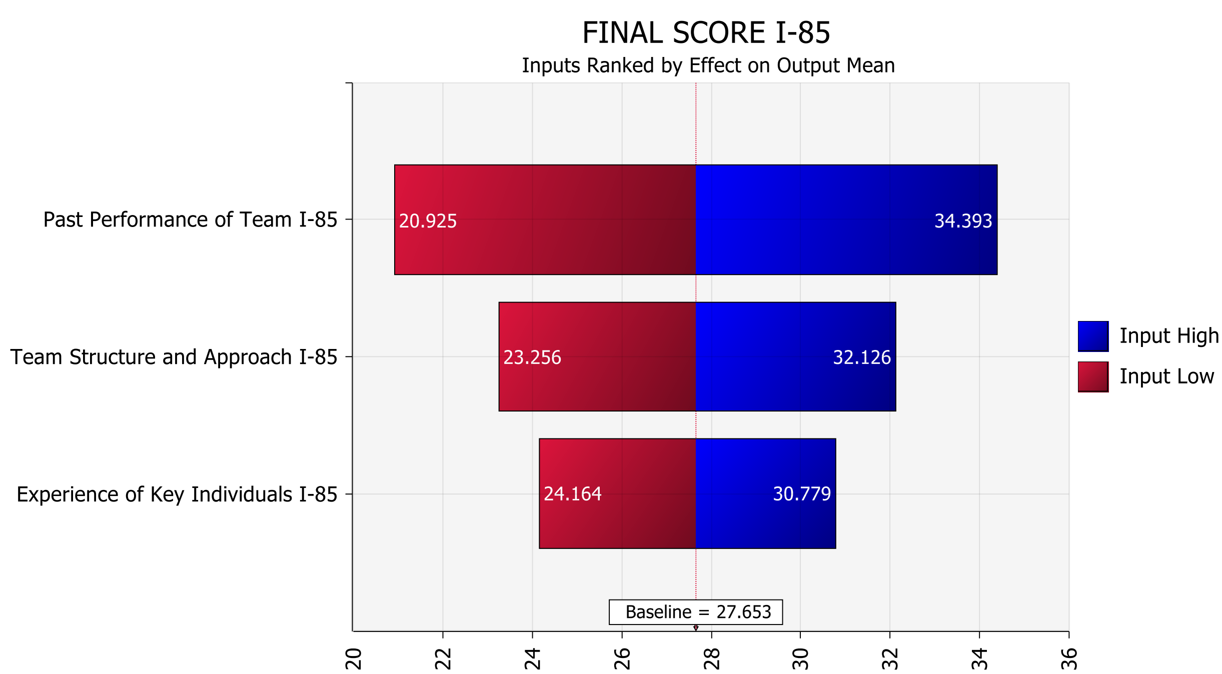

Figure 3 I-85 Tornado diagram. General

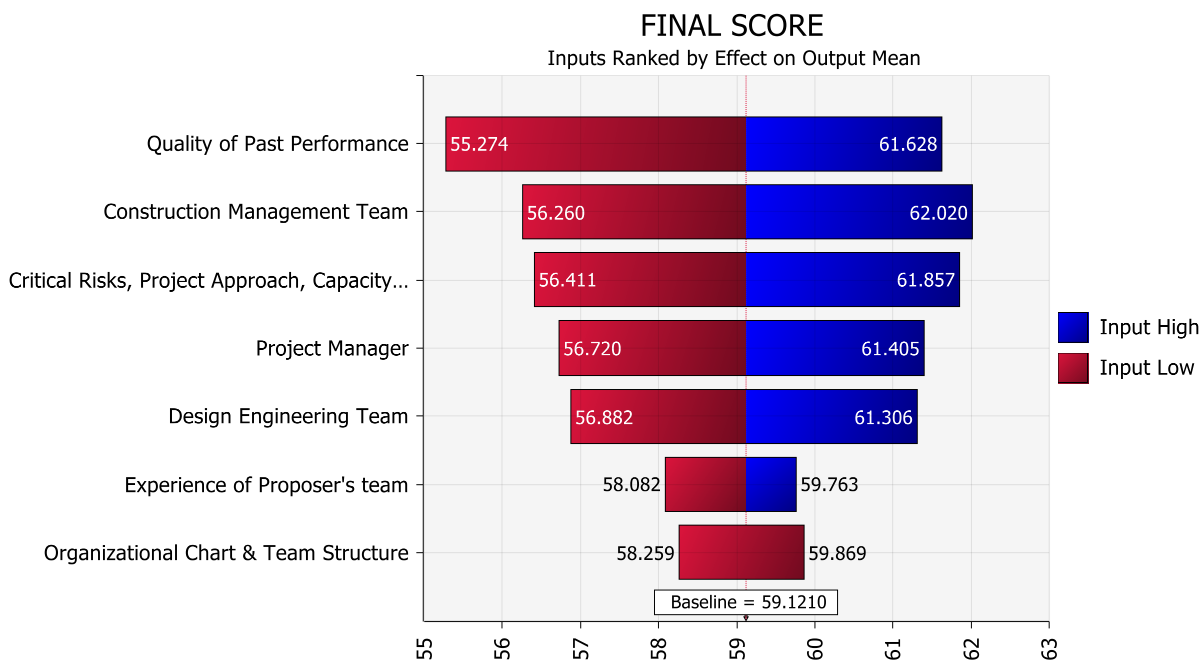

Figure 4 I-85 Tornado diagram. Detailed

US 21 over Harbor River

Table 3 shows the weights assigned to each of the evaluation criteria.

Table 3 US 21 over Harbor River RFQ Evaluation Criteria Weights

RFQ evaluation criteria	**Weight**
Team Structure and Approach	**25**
Organizationl Chart and Team Structure	5
Critical Risks, Project Approach, and Capacity and Resources	20
Experience of Key Individuals	**50**
Project Manager	10
Design Engineering Team	25
Construction Management Team	15
Past Performance of Team	**25**
Experience of Proposer's team	10
Quality of Past performance	15

The general tornado diagram (Figure 5) shows that past performance is now the least influential evaluation criteria, given the change of weighting.

The specific tornado diagram (Figure 6) shows that the quality of past performance is the second evaluation criterion which variance influence the most the mean of the award score.

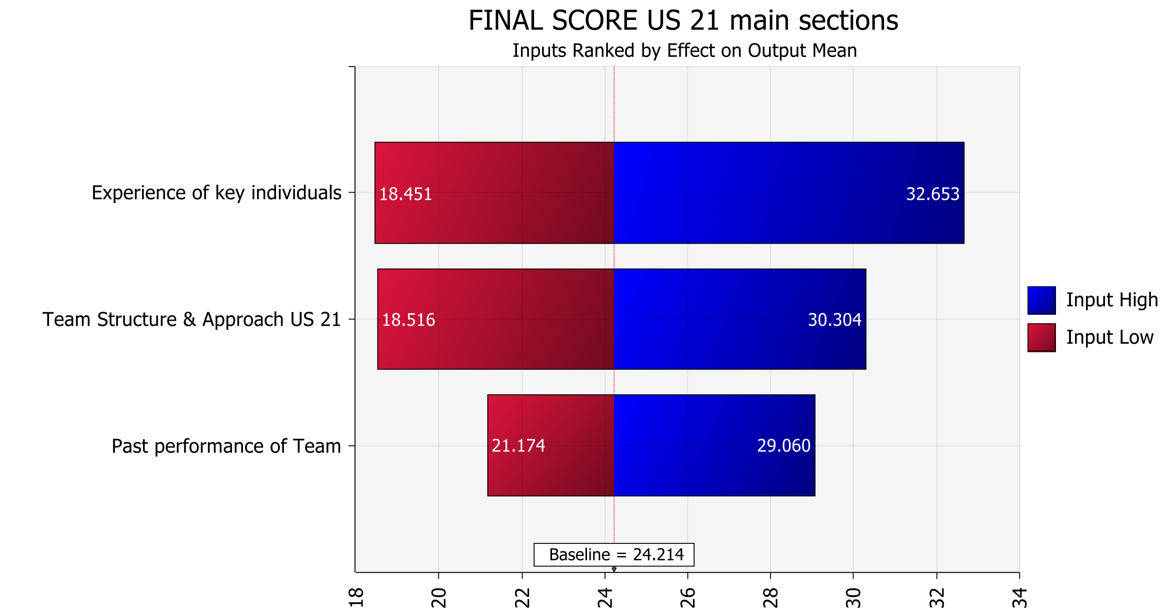

Figure 5 US 21 Tornado diagram. General

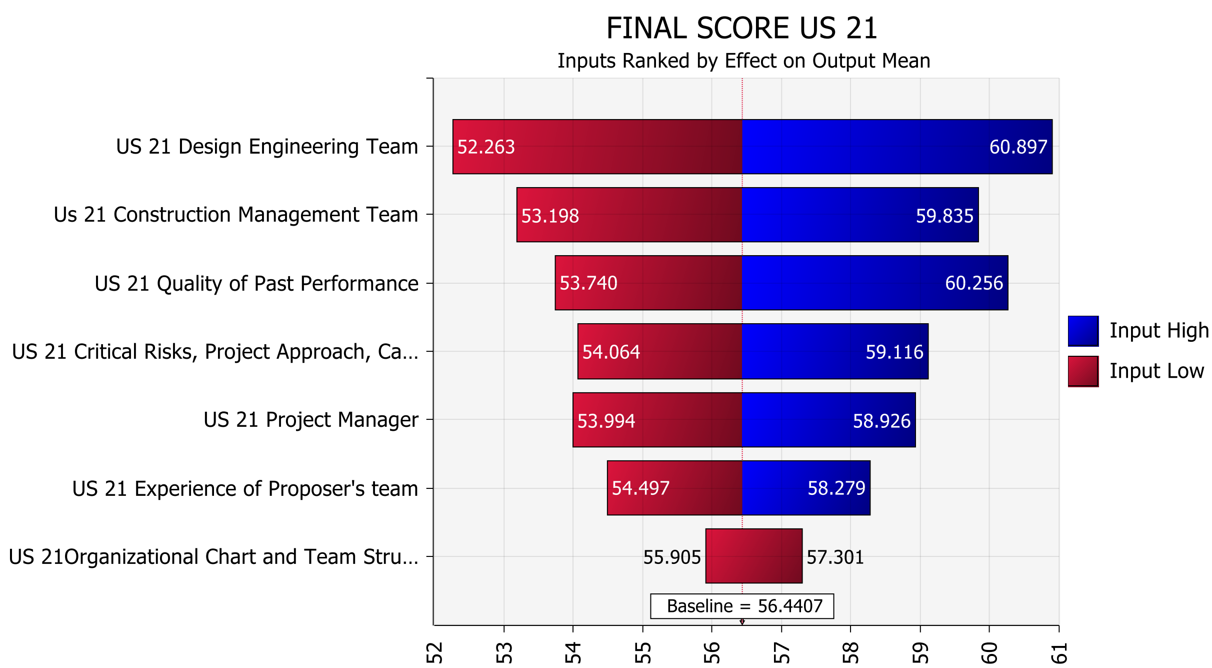

Figure 6. US 21 Tornado diagram. Detailed

The previous simulations illustrate that SCDOT evaluation is adequate and aligned with the concern of considering the past performance in the SOQ meaningfully.

4. Suggestions

SCDOT's RFQ evaluations practices are in-line with surrounding states and others across the country. The differences appear to be due to preferences and local practices. In comparing SCDOT RFQ evaluation criteria to the information reviewed from Georgia, Florida, New York, North Carolina, and Virginia, SCDOT may wish to consider the following suggestions:

1. If SCDOT develops a state-wide contractor performance rating system, this can be used for the Design-Build RFQ process. This has been demonstrated in Florida, but the research team did not find other states using this approach.
2. In reviewing the other states, SCDOT uses more evaluation criteria. SCDOT could consider the use of a fewer criteria to be in alignment with other surrounding states (see Table 1).
3. If SCDOT does not move to a contractor evaluation system or reduce the number of criteria, they could consider a reorganization of evaluation criteria to better link the evaluation objective and weights. The following three groups are suggested: 1) *proposer´s experience*, considering here, the information related to the firms; 2) *team experience and organization*, including in this category the information associated with the team members and their working structure; and 3) *past performance*, that should include the evaluation of the experience regarding the aspects that SCDOT considers more relevant.
4. Consider, within the *past performance* requirements, specifying a minimum number of projects developed using Design-Build.
5. Consider additional past performance information in areas like safety, environmental compliance or Disadvantage Business Enterprise utilization.
6. Overall, the research team recommends SCDOT to review the evaluation criteria and weights considered in specific DB projects in order to ensure their alignment with project goals.

5. Appendix

Georgia

Past performance requirements

Section V-C of the RFQ

"No additional information should be submitted for the Past Performance requirement. Information from the relevant projects listed in Sections V.B.7 and V.B.8 and contact information provided for those projects will be used to fulfill this requirement. Past performance will be evaluated through survey of the project references for the proposed Lead Contractor and Lead Design Consultant. For this reason, attention should be paid to the references provided to ensure that the contact information provided is accurate and the individual references may be contacted by GDOT."

Experience and Qualifications requirements

Section V.B.7

"7. Description of experience for the Proposer's Lead Contractor on projects of similar, size, function, and complexity. Describe no less than one (1) design-build or at least three (3) construction projects delivered using conventional Design-Bid-Build contracting, in order of most relevant to least relevant, which demonstrate the Lead Contractor's required minimum qualifications as listed in Section V.A.9. For each project, the following information should be provided:

a. Project name, location, and dates during which services were performed.

b. Brief description of project and physical description.

c. Services performed.

d. Brief description of schedule compliance including contract completion date and actual completion date.

e. Current Owner contact information including contact names, emails, and telephone numbers for the confirmation of Schedule, QA/QC Compliance, and other assertions made in response to this RFQ."

Section V.B.8

"8. Description of experience for the Proposer's Lead Design Consultant on projects of similar, size, function, and complexity. Describe no less than one (1) design-build project or three (3) design projects delivered using conventional Design-Bid-Build contracting, in order of most relevant to least relevant, that demonstrate the Lead Design Consultant's required minimum qualifications as listed in Section V.A.10. For each project, the following information should be provided:

a. Project name, location, and dates during which services were performed.

b. Brief description of project and physical description.

c. Services performed.

d. Current Owner contact information including contact names, emails, and telephone numbers."

Florida[4]

Criteria for evaluating the Phase I

1. Design-Build Firm Name and prequalification
2. Past Performance Evaluations, Design-Build Project Experience, Organization, and Staffing (0-7 Total Points):
   - Contractor Grades
   - Professional Consultant Grades
   - Performance History with other States or Agencies, if none with the Department
   - Design-Build Project experience of the Contractor and Professional Consultant
   - Similar types of work experience
   - Environmental Record
   - Contractor Experience Modification Rating (Current Year)
   - Design-Build Firm organization
   - Design-Build Firm staffing plan
   - Design-Build Firm coordination plan
3. Design-Build Project Requirements and Critical Issues (0-13 Total Points):
   - Understanding of Design-Build Project Requirements
   - Identification of critical issues
   - Outline for addressing critical issues

Contractor´s past performance report

Include as a pdf document.

New York

Past performance requirements

A) Objective:

1) To identify Proposers with firms or personnel that have successfully completed projects on time and on or under budget, including transportation and infrastructure projects;

[4] http://fdotewp1.dot.state.fl.us/procurement/professionalservices/advertise/advDBLD.shtml

2) To identify Proposers that have records of managing contracts to minimize delays, claims, dispute proceedings, key personnel change assessment fees, litigation, and arbitration;

3) To identify Proposers with a record of providing a safe work environment, and 4) To evaluate the record of DBE compliance for each firm included in the RFQ in terms of achieving or making good faith efforts towards achieving past contract DBE goals.

B) Requirements and information to be submitted:

1) Using Form PP-1 (included at the end of this section), Past Performance, provide the information requested for each project for which Form E-1 was prepared.

The Narrative should be a self-assessment of the Firm's performance on the project, in accordance with Objectives 1) and 2) above. The Narrative should then explain any cost overruns, schedule delays, claims, litigation, key personnel change assessment fees, and liquidated damages associated with the project. Form PP-1 shall not exceed two pages in length per project.

2) All Other Projects:

For all other projects each Design-Build Team member has been involved with over the last 10 calendar years, submit the following information, organized by Design-Build Team member:

a) Claims, dispute proceedings, litigation and arbitration proceedings: Provide an explanation for any claims, dispute proceedings, litigation, and arbitration proceedings that were submitted, over the past ten calendar years, to the NYSDOT Commissioner's office, or other agency's equivalent, as part of a formal dispute resolution process, as outlined in Section 105-14, Disputed Work and Dispute Resolution, of the Standard Specifications (for Design-Bid-Build Projects); and

b) Liquidated damages: Describe any contract which resulted in assessment of liquidated damages against any Design-Build Team member involving amounts in excess of $25,000 for any one project over the past ten calendar years.

Describe the causes of the delays, the length of the delays, and the amounts assessed. Describe any outstanding damage claims by or damages due and owing to any owner/agency.

Provide information relative to past fees assessed to the contractor/designer/CI firm involving key personnel change assessment fees for having changed key personnel following award of a previous Design-Build contract (on-going or completed). Provide the owner's name and the name of its current representative (and current phone and e-mail address) who can be contacted for additional information.

If one or more of the Design-Build Team members have no information to provide in response to this Section, submit a declarative statement to that effect. Each

Design-Build Team member's response to this Section shall not exceed two pages in length.

3) Safety: Submit Form S (Appendix C), Safety Questionnaire, for each Design-Build Team Member in accordance with the instructions at the top of the Form;

4) Experience Modification Rate: Each firm on the Proposer's team shall submit a letter from their current worker's compensation insurance carrier stating the expiration date of the policy and the current EMR rate. The EMR supplied by the Constructor(s) and the Construction Inspection firm(s) for the current year will be scored in the following ranges according to the table below:

Experience Modification Rate (EMR) Most Recent Completed
0.8 or less
Between 0.8 and 1.2
1.2 or greater

If there is more than one Prime Constructor and / or Prime Construction Inspection firm, then the EMR score will be averaged to obtain a single EMR score for the Constructors and / or Construction Inspection firms. A single average weighted EMR score will be determined by combining the EMR score for the Constructor(s) (75% weighting) with the Construction Inspection firm(s) (25% weighting).

5) DBE Program Experience: Submit Form DBE, Record of DBE Program Experience – Tables 1-5, for each Principal Participant, Constructor, Designer, and Construction Inspection Professional Engineering Firm, reflecting a record of compliance with DBE requirements in their contracts for the past five (5) years. The projects listed on Form DBE shall be the most recent of the projects listed on Form E-1 and Form PP. Utilization Reports shall be submitted for all projects listed on Table 4. For closed projects, provide the Final Utilization Report. For ongoing projects, provide the Current Utilization Report.

Form PP

FORM PP

PAST PERFORMANCE

PROPOSER			
Name of firm			
DESCRIPTION OF PAST PROJECT			
Name of project from FORM E-1			
Contract Value as Bid: (US$)		**Final Contract Value (US$):**	
% of total work done by Firm:		**Commencement date:**	
Planned completion date as Bid:		**Actual completion date:**	
Claim Amount (US$)		**Any Litigation?** (yes or no)	
Liquidated Damages >$25k #		**Total (US$)**	
Key Personnel Change Assessment Fee #		**Total (US$)**	

NARRATIVE

1) **Self-Assessment:**

2) **Explanations:**

Use the space below to explain any or all of the following situations if they occurred on the project (Form PP may be up to two pages in length per project if necessary):

a. Final Contract Value or Expected Contract Value exceeds the Contract Value as Bid. Describe the reason(s) why the project costs were over budget.

b. Justification of why the project is/was behind schedule.

c. Amount of Claims is greater than $0. Detail the number and amount of each claim.

d. Litigation. Describe background behind litigation, current status, etc..

e. Amount of Liquidated Damages greater than $25,000. Detail the number of issues and amount of Liquidated Damages for each issue.

Key Personnel Change Assessment Fee – Detail the number of fees assessed and the total value assessed to date.

Appendix 2C – Tech Memo on Best-Value Procurement

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 2. Tools, Processes and Best Practices

Task 2c. Best-Value Procurement

Prepared by

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University of Colorado
Boulder

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Table of Contents

Contents

1. Executive Summary

The objective of this subtask is to analyze, compare, and evaluate South Carolina Department of Transportation's (SCDOT) best-value procurement approach against other DOTs and national standards. This Tech Memo summarizes and synthesizes the best-value related information included in the Code for Federal Regulation (CFR) and in standard documents (Molenaar and Tran 2015; Scott et al. 2006) as well as the methods used by six DOTs to develop the best-value procurement in Design-Build projects. This summary aims to provide SCDOT with a framework to evaluate their current practice. The second part aims to analyze SCDOT´s best-value scoring methods to determine the impact of non-cost factors on the selection process using Monte Carlo simulation. As a result of this benchmarking and simulation analysis, the research team includes recommendations to the SCDOT best-value procurement process.

1.1 Evaluation Criteria

According to NCHRP Synthesis 471 and NCHRP Report 561 (Molenaar and Tran 2015; Scott et al. 2006), four concepts comprise the overall best-value process: (1) best-value parameters, (2) evaluation criteria, (3) evaluation rating system, and (4) award algorithms. The most common parameters are cost, time, qualifications and performance. The section 636.301 of the Code of Federal Regulation (US Federal Goverment 2002) (CFR 636.301 Proposal Evaluation Factors) suggests that evaluation criteria should (1) "*represent the key areas of importance and emphasis to be considered in the source selection decision"*; and (2) "*support meaningful comparison and discrimination between and among competing proposals."*

The findings of the analysis for this SCDOT study show a total of 30 evaluation criteria that could be grouped into 14 categories (or DOT's areas of concern) that are included in Table 1. These results are generally consistent with previous NCHRP research (Molenaar and Tran 2015; Scott et al. 2006).

Table 1 Categories of Evaluation Criteria

Evaluation criteria categories included in RFPs	**South Carolina SCDOT** RFP I-85 MM 98 to 106 (2018)	**Georgia GDOT** RFP I-20 at Savannah River (2018)	**North Carolina NCDOT** RFP I-440/US1 (2018)	**Florida FODT** RFP I-10 Widening I-295 to I-95 (2018)	**New York NYDOT** RFP Rehabilitation of I-278 Bridges (2018)	**Colorado CDOT** RFP I-25 North Design-Build (2017)
Technical criteria						
Design	✓		✓	✓	✓	✓
Maintenance of traffic (MOT)	✓	✓	✓	✓	✓	✓
Environment	✓	✓	✓	✓	✓	✓
Safety			✓	✓		✓
Construction	✓	✓	✓	✓	✓	✓
Long-term maintenance	✓		✓	✓		
Innovation	✓		✓	✓		
Value Added	✓			✓		
Management		✓	✓		✓	✓
Team & Organization	✓				✓	
Schedule	✓	✓	✓		✓	
Other criteria related to the procurement						
RFQ scoring	✓			✓		
Oral interview			✓			
Extra credits			✓			

1.2 Weighting and Scoring

The Code of Federal Regulation, section 636.30 (US Federal Goverment 2002) also discusses rating systems and award algorithms. The Code indicates that DOTs can conduct contractor evaluations using any rating method or combination of methods including color or adjectival rating, numerical weights, and ordinal rankings. The sample of RFPs analyzed for this SCDOT study shows a wide range of methods used to perform the best-value constructor´s evaluation and selection. Table 2 summarizes the findings relating to the technical score systems and award algorithms.

Table 2 Best-Value Technical Scoring and Award Algorithms

DOT	Agency Terminology	Best-Value Award Algorithm	Variables	Components and Scoring of Technical Score
South Carolina RFP I-85 MM 98 to 106 (2018)	Weighted criteria (WC)	$WC: \left(\frac{Alow}{An} * 65\right) + \left(\frac{blow}{bn} * 10\right) + \left(\frac{C}{100} * 5\right) + \left(\frac{D}{100} * 20\right)$	***Low***: the lowest value from the proposal being scored. ***A:*** Total cost to complete all work performed under the contract ***b:*** Construction time ***C:*** SOQ score from RFP phase ***D:*** Technical score	**D:** Project delivery &approach 25 Conceptual road plans 30 Understanding MOP 20 Conceptual bridge plans 10 Innovation & added value 15 Required forms Pass/Fail
Georgia RFP I-20 at Savannah River Replacements	Proposers' combined score (CS)	$CS = 25\%TS + 75\%PS$	***TS:*** Technical proposal score including weight. ***PS:*** Price proposal score including weight (the lowest overall price receives the maximum score)	**TS: (RFP is only given to the short list)** Construction staging and Traffic Management Project schedule Environmental impacts & public outreach Project Management approach
North Carolina RFP I-440/US1 (2018)	Adjusted price (AP)	AP= PP-(QV)	***PP:*** Price Proposal. ***QV:*** Quality Value. (QV=PP*Quality Credits (QC) & QC are directly related to Technical Score (TS))	**TS:** Management 6 Responsiveness to RFP 30 Long-term maintenance 4 Schedule & Milestones 25 Innovation 5 Maintenance of Traffic and safety plan 25 Oral interview 5
Florida RFP I-10 Widening I-295 to I-95 (2018)	Adjusted Score (AS)	AS=BPP/TS	***BPP:*** Bid price proposal. ***TS:*** Technical score (combined Scores from Letters of interest (LOI) and technical proposal.	**TS:** Design 35 Construction 35 Innovation 5 Value added 5 LOI scoring 20
New York RFP Rehabilitation of I-278 Bridges (2018)	Weighted criteria (WC)	WC= 50%PP+50%QE	***PP:*** Proposal price ***QE:*** Quality evaluation	**QE:** Organization and process 20 Approach to the project 40 Schedule 40
Colorado RFP I-25 North Design-Build (2017)	Adjusted Score (AS)	AS=(A+B)/TPS	***A:*** Construction Cost Bid ***B:*** (T* road user costs) **T**: Design-Builder Construction Calendar days **TPS:** Technical Proposal Score	**TPS:** Project Management 50 Maintenance of traffic 20 Environmental Compliance 20 Safety program approach and commitments 10

The research team also performed a detailed analysis of SCDOT's best-value procurement approach to determine if the weighting and scoring methods are providing the desired outcomes. Table 3 lists the projects that were analyzed. Both projects used the weighted criteria formula 1 shown immediately below the table.

Table 3 SCDOT projects procured by best-value procurement

Projects	RFP date	Award method
SC 277 over I-77	04/03/2018	Weighted Criteria
I-85 Widening MM 98-106	06/01/2017	Weighted Criteria

$$WCn = \left(\frac{A_{low}}{A_n} * X_A\right) + \left(\frac{B_{low}}{B_n} * X_B\right) + \left(\frac{C_n}{100} * X_C\right) + \left(\frac{D_n}{100} * X_D\right) + \left(\frac{En}{100} * X_E\right) \quad (1)$$

Where,
WC_n = *Weighted criteria score of proposal n*
A_{low} = *lowest cost of the proposal being scored.*
A_n = *Total cost proposed in proposal n*
B_{low} = *lowest construction time of the proposal being scored*
B_n = *Construction time proposed in proposal n*
C_n= *SOQ score from RFQ phase of proposer n*
D_n =*Technical score of proposal n*
E = *Quality Credit score*
n = *proposer being evaluated*
Xi = *weight of criteria (detailed in* Table 4*).*

The weights (*X*) given to each project are included in Table 4:

Table 4 Weights consider for each weighted criteria project

Evaluation criteria		SC 277 over I-77	I-85 MM98-106
A	Cost ot complete all work	65	65
B	Construction time	0	10
C	SOQ score from RFQ phase	15	5
D	Technical score	15	20
E	Quality credit score	15	0

1.3 Simulation Results

The research team performed a Monte Carlo simulation to evaluate the effect of the evaluation criteria on the final score of the weighted criteria formula. The simulation was developed using a uniform distribution for the scoring of each of the evaluation criteria. This distribution, for each category, adopts the maximum and the minimum values given to the firms in the real procurement. Each iteration takes a random value between these two parameters for each of the evaluation criteria. The uniform distribution treats all values in the range with equal liklihood of occurance in the simulation. Figure 1 shows a “tornado diagram” that graphically depicts the level of impact each weighted criteria value gave on the simulated outcome. The wider the bar in the tornado diagram, the greater the influence on the range of scores.

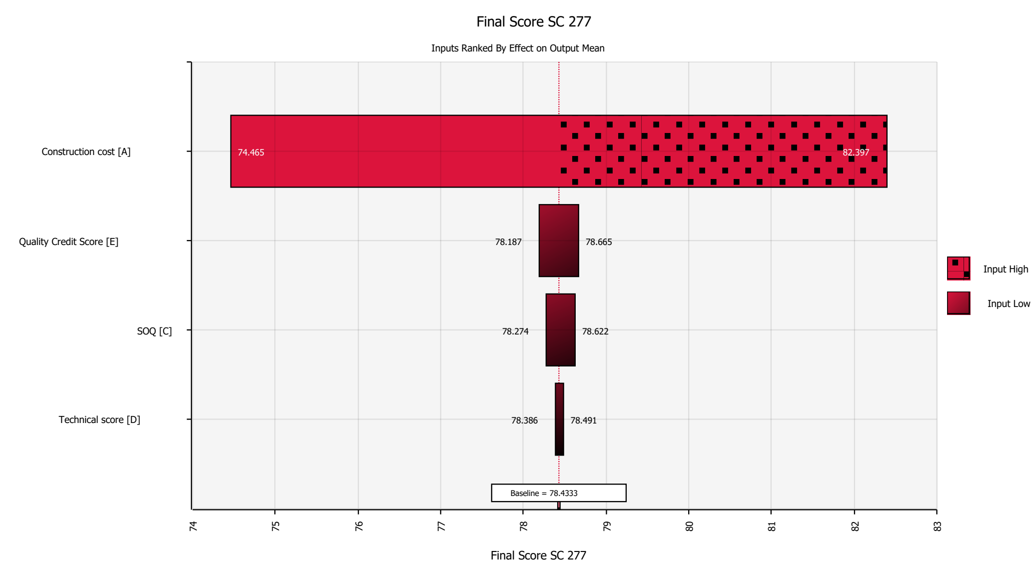
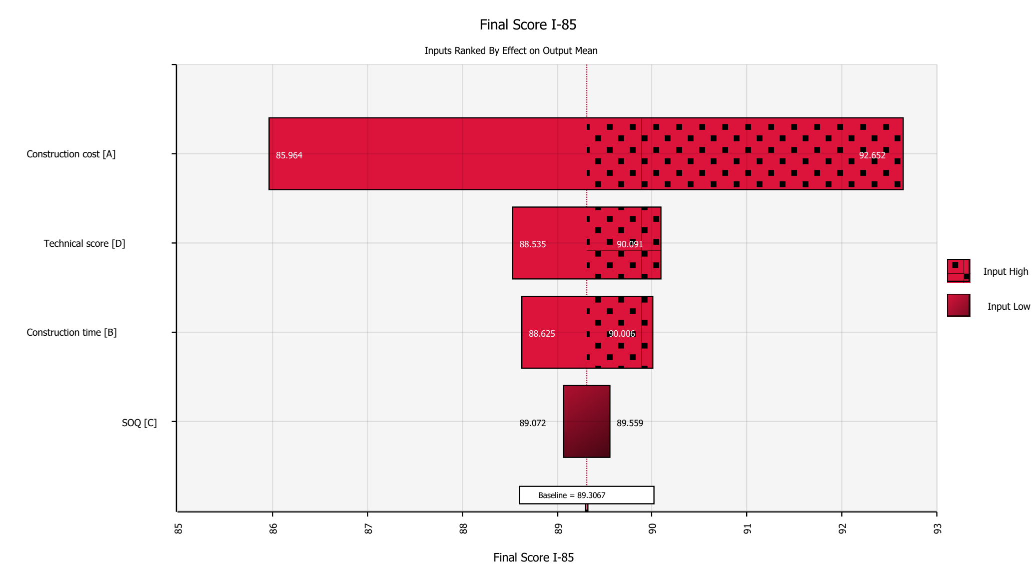
Project	Tornado diagram
SC 277 over I-77	
I-85 MM98-106	

Figure 1 Tornado diagrams for projects SC 277 and I-85

As seen in Figure 1, cost is the most influential evaluation criteria. With thise combination of weightings and scorings, the selection will essentially become a low-bid selection. The impact of technical score, construction time, and design-builder qualifications might not have as much influence on the selection as SCDOT originally desired.

1.4 Conclusions and Recommendations

The purpose of this preliminary analysis was to examine how the current definition of evaluation criteria, scoring criteria, and weighting influence the final best-value score. The following recommendations are proposed for discussion and continuous improvement of the process.

1. SCDOT's approach to best-value procurement has evolved and greatly improved throughout its Design-Build program development. The current approach aligns with federal standards and national best practices.
2. The research team believes that the Weighted Criteria method is the most transparent and accurate method. SCDOT should remain consistent with this approach.
3. SCDOT should revisit the weighting and scoring of the technical scoring criteria. Simulations of past procurements show that the cost is the overriding factor in the last two procurements.
4. SCDOT should strive to more closely tie the stated project goals to the evaluation criteria. The stated project goals should be described in both the Project Definition Report and the RFQ/RFP. While the goals can currently be inferred from the best-value criteria and weighting, they should be more explicitly stated.

2. Research Methodology

To accomplish the first part of this task, related to national benchmarking, the research team developed a document analysis of Design-Build Request for Proposals and other documents[1]. The information was analyzed using the software "*atlas.ti*" for content analysis of these documents. The software allows codifying the text within the document for sorting and analysis. Table 5 summarizes the states and documents considered in this review.

Table 5 Agency Design-Build documentation reviewed.

	SC	GA	NC	FL	NY	CO
RFP	●	●	●	●	●	●
Other docs.		●				

The second part of this task analyzed SCDOT´s best-value scoring methods to determine the impact of non-cost factors on the selection process using Monte Carlo simulation using the

[1] Other documents were reviewed for the case of Georgia, where current RFPs were not publicly available. In this case, the Design-Build Manual and the bid-opening information were analyzed. http://www.dot.ga.gov/PS/Innovative/DesignBuild

software @Risk. The projects used to perform this simulation were: "*SC-277 NB over I-77 Bridge Replacement. Project ID P030487*" (hereinafter referred to as SC-277) and "*Interstate widening MM 98-106. Project ID P027116*" (hereinafter referred to as I-85). For the SC-277 project, the research team analyzed the Bid Summary Report[2] and the Project Definition Report[3]. The information considered in the I-85 project simulation was the Bid Summary Report[4], the SOQ scoring spreadsheet and the evaluation and consensus scoring spreadsheet[5].

This part also includes the answers to the following questions posed by SCDOT:

Goals & Evaluation criteria

1. When establishing criteria, what should the starting point for cost be? How should our goals be incorporated into this?

Scoring systems

1. Can we investigate adjectival scoring to see if that method may provide more separation of teams and ultimately lead to the TS having more impact on the selection process?

Weights and scores

1. Can you provide examples of how the award of the project could be affected by the Quality Scores?
2. Based on previous projects, what cost proposal weight factor would affect the award of the project.
3. SCDOT needs to understand what it would take to flip a bid, if you hold the weights the same and vary the scores in the input. What would it take for low bid cost to be overcome?
4. How should SCDOT assign weights to the individual components used for evaluation? (ie., goals?
5. SCDOT has not experienced having extremely aggressive Scores (SOQ, Tech, Quality Credit) in the past. Should we focus on driving the cost component down, or should we focus on the separation of Scoring?

3. Summary of Analysis

This summary of analysis has two sub-sections. The first one includes the national benchmarking developed on best-value evaluation criteria, rating systems, and award algorithms. The second sub-section analyzes the SCDOT best-value weighted criteria using Monte Carlo simulation.

[2] https://www.scdot.org/business/sc-277.aspx
[3] Information provided by SCDOT through Project Wise
[4] https://www.scdot.org/business/i85-widening.aspx
[5] Information provided by SCDOT through Project Wise

3.1 National Benchmarking

The research team analyzed the best-value evaluation criteria, rating systems and award algorithms of six states, including South Carolina, Georgia, North Carolina, Florida, New York, and Colorado.

3.1.1 Evaluation Criteria

From the evaluation of the RFPs, the research team found 30 evaluation criteria that are currently used to assess the Design-Build proposal. These results are generally consistent with previous NCHRP research (Molenaar and Tran 2015; Scott et al. 2006). These criteria are related to 14 categories that could be interepreted as areas of emphasis for the DOTs. Table 6 shows the relation between the evaluation criteria and these categories. A brief summary of how these categories are considered in the reviewed states follows.[6]

Design

- SCDOT defines two evaluation criteria related to design: "conceptual road plans" and "conceptual bridge plans." These categories aim to evaluate the quality of the plans according to their content and compliance with RFP requirements, including ATC.
- FDOT evaluates the quality and suitability of the following design elements: (1) roadway and drainage design, (2) structures design, (3) signing & pavement markings, signalization, lighting and ITS design, (4) design coordination, (5) design considerations that minimize relocation of utilities,(6) construction coordination plan minimizing design changes, (7) design considerations that minimize impacts to adjacents properties and structures, (8) design considerations that will reduce the intensity and duration of noise and vibrations and, (9) aesthetics. They also include in this category the Mainteinance of Traffic (MOT), the environmental impacts and long-term maintenance.
- NYDOT includes a sub-category for "Design-Build Approach to Design." This criterion considers how the proposers understand the project design challenges, how they fulfill the requirements, how the objectives are met or exceeded and how the design solution benefit the taxpayers and provide long-term solutions.
- NCDOT includes a criterion named " responsiveness to RFP" that includes two aspects, "natural environmental responsibility" and "design features." The design features sub-criteria evaluates the plan view of the design and identifies the more relevant elements.

Maintainance of Traffic (MOT)

- SCDOT includes a criterion of "understanding MOT" where the proposers are asked to provide Conceptual Maintenance of Traffic Plans
- GDOT considers "traffic management" as a category in their evaluation, however it is not possible to include in this report details about scope because the RFP was not available.

[6] More details on the different states' evaluation criteria can be reviewed in the RFPs included the ProjectWise folder: *University of Colorado > Task 2-Tech Memos > Subtask2c Best Value*.

- NCDOT defines a criterion named “maintenance of traffic and safety plan”. For the maintenance of traffic, proposers are asked to provide a Transportation Management Phasing Concept (TMPC).
- CDOT includes a sub-criterion within “project management and approach” named “maintenance of traffic,” where proposers should demonstrate the effectiveness of the Project Phasing Plan to facilitate construction and minimize impacts to the traveling public.

Environment

- GDOT considers an evaluation criteria related to environmental impacts and public outreach.
- NCDOT includes a criterion named “ responsiveness to RFP” that considers two aspects, “natural environmental responsibility” and “design features.” As part of the natural environmental responsibility sub-criterion, proposers need to provide their approach to the environmental concerns.
- CDOT includes a sub-criterion within “project management and approach” named “environmental compliance”, where proposers should present their approach for managing, controlling and monitoring water quality during construction.

Safety

- NCDOT considers a criteria named “maintenance of traffic and safety plan” For the safety plan they ask the proposers to (1) describe the safety consideration specific to the project, (2) discuss the design team's overall approach to safety and (3) describe any proposed improvements that could enhance the safety of the workforce and/or traveling public during and after the construction.
- CDOT includes a sub-criterion within “project management and approach” named “safety program approach and commitments,” where proposers should demonstrate a safety program approach that addresses the specific challenges to the project.

Construction

- FDOT considers in a specific category of “construction”, the following aspects: (1) minimize disruption to traffic, (2) mitigate impacts to other projects, (3) minimize impacts to adjacent properties and the environment, (4) including visual noise, vibrations and dust impacts, (5) provide worker safety and (6) minimize impacts to existing utilities.
- GDOT includes an specific evaluation criteria for detailing the “construction staging.”
- NYDOT includes a sub-criterion within the category “Design-Build approach to the project” related to “construction approach.” This section is devoted to evaluating the means and methods the proposer intends on using for the demolition and construction and staging of the project while protecting existing facilities and minimizing to the greatest extent possible impacts to the traveling public, businesses, and the communities.

Long-term maintenance

- SCDOT evaluates the proposer's ideas to improve long-term pavement performance as part of the "Value-Added and Innovation" criterion.
- NCDOT includes a criterion that addresses the "long-term maintenance." This criterion asks for (1) describing any special materials incorporated into the project that would result in a reduction of long-term maintenance, (2) describing any special design or construction methods that would reduce future maintenance cost to the Department, and (3) estimating a minimum ten-year cost saving resulting from incorporation of these specials materials, design or construction methods into the project.
- FDOT considers the long-term maintenance as part of the "design"criterion.

Innovation

- SCDOT includes in the criterion "Value Added and Innovation" any innovation the proposer introduces in terms of the mean and methods, roadway alignments or approach to the project. Some examples of things SCDOT ask proposers are approaches to: (1) minimize impacts to traffic including traffic shifts, temporary lane closures, construction stages, median access points or traffic impacts to crossing routes, (2) manage risks associated with utilities, (3) minimize right-of-way impacts, and (4) improve long-term pavement performance.
- FDOT considers a specific evaluation criterion for this concept. They ask proposers to produce innovative design approaches, and construction techniques which address the following issues: (1) Minimize or eliminate utility relocations, (2) materials, (3) workmanship, (4) enhance design and construction aspects related to the future expansion of the transportation facility.
- NCDOT defines the criterion "innovation" in which the proposers are asked to identify any aspects of the design or construction elements that the firm considers innovative.

Value-added

- FDOT includes an evaluation criterion for value added. This category reviews if the proposal: (1) broadens the extent of the value-added features of the RFP while maintaining existing threshold requirements, (2) exceeds minimum material requirements to enhance the durability of the project components and (3), provides additional value-added features proposed by the Design-Build firm.

Table 6 Evaluation criteria and main areas of evaluation

DOT RFP	**Evaluation criteria/ Main areas of concern**	**Design**		**MOT**	**Environment**	**Safety**	**Construction**	**Long-term maintenance**	**Innovation**	**Value Added**	**Management**	**Team & organization**	**Schedule**	**Other criteria**
South Carolina RFP I-85 MM 98 to 106 (2018)	Project delivery &approach	✓			✓		✓						✓	
	Conceptual road plans	✓												
	Understanding MOT			✓										
	Conceptual bridge plans	✓												
	Innovation & added value			✓				✓	✓	✓				
	Required forms											✓		
Georgia RFP I-20 at Savannah River (2018)	Construction staging and Traffic Management			✓			✓							
	Project schedule												✓	
	Environmental impacts & public outreach				✓									
	Project Management approach										✓			
North Carolina RFP I-440/US1 (2018)	Management	✓					✓				✓			
	Responsiveness to RFP	✓			✓									
	Long-term maintenance							✓						
	Schedule & Milestones												✓	
	Innovation								✓					
	Maintenance of Traffic and safety plan			✓		✓								
	Oral interview													✓
	Extra credits													✓
Florida RFP I-10 Widening I-295 to I-95 (2018)	Design	✓		✓	✓			✓						
	Construction				✓	✓	✓							
	Innovation								✓					
	Value-added									✓				
	LOI scoring													✓
New York RFP Rehabilitation of I-278 Bridges (2018)	Organization and process											✓		
	Approach to the project	✓		✓	✓		✓				✓			
	Schedule												✓	
Colorado RFP I-25 North Design-Build (2017)	Project Management	✓					✓				✓			
	Maintenance of traffic			✓										
	Environmental Compliance				✓									
	Safety program approach and commitments					✓								

Management

- NYDOT includes an evaluation category for "Design-Build Approach to the project" that contains three sub-criteria (1) project understanding, (2) design-build approach to design, and (3) construction approach. The "project understanding" sub-criterion aims to identify the proposer´s understanding of the management, technical, design, construction, documentation, reporting, environmental and maintenance of the traffic issues and risks associated to the project.
- NCDOT considers a specific criterion for "management" in which they ask to provide a comprehensive organizational chart that identifies the design, quality and construction management, and the relationships with the sub-consultants/subcontractors.
- CDOT includes a sub-criterion within "project management and approach" named "project management". This sub-criterion asks the proposers for a plan to complete the specified work that should include (1) significant design and construction issues and constraints, (2) demonstration of efficient use of construction schemes and techniques for completing the project, (3) demonstration of the proposer´s understanding of critical issues relating to the project goals, and (4) demonstration of the coordination between the proposer, CDOT and stakeholders.

Team and organization

- SCOT includes an evaluation category for "Required forms." This section requires an organizational chart from the proposer´s Statement of Qualifications incorporating any approved changes by the SCDOT.
- NYDOT includes a category for "Design-Build Organization and Process" in which they include two sub-criteria : (1) Key personnel—Including project management, design management, quality manager, resident manager, lead structural engineer, lead civil engineer and project superintendent, and (2) Overall Design-Build Approach to the project –including team organization chart, communication protocol and quality control plan.

Schedule

- SCDOT requires, within the "Project Delivery & Approach" criterion, to identify the proposed schedule for implementing the project. The schedule should include the sequence of construction, segmentation, if any, and material and equipment staging plan. It should also describe any methods considered in the proposal that will allow a reduction in the overall construction schedule.
- GDOT includes and specific criterion for "project schedule."
- NYDOT considers a specific criterion for "schedule" that evaluates the integrated logic and scheduling of design and construction. The schedule should define the start and end dates of work zone traffic protection activities, construction stages, and project completion.
- NCDOT includes a criterion for "schedule and milestones" where the proposers should provide a detailed schedule for the project including both design and construction activities.

Other aspects

RFQ scoring

Within the reviewed projects, the RFQ scoring is only considered by SCDOT and FDOT.

- SCDOT does not include this criterion in the technical score, but it is one of the factors of the weighting criteria formula.
- FDOT considers the RFQ scores as 20% of the total technical score. This is, the technical score is comprised by design (35 points), construction (35 points), added value (5 points), innovation (5 points) and RFQ scores (20 points).

Oral interviews

- NCDOT is the only state evaluating the oral presentation as part of the technical score. The oral interviews consider a brief introduction (no more than 30 min) of the project team and design/construction approach. These interviews provide NCDOT with the opportunity to ask questions and receive answers about the technical proposal, background, philosophies, and project approach. Please see the Tech Memo *Task 2a Information Exchange with Design-Builders* for more detail about how DOTs communicate with Design-Builders during the procurement process.

Extra credits

- NCDOT gives an extra point in their evaluation if the proposers include additional warranty and/or guarantee.

3.1.2 Rating Systems and Award Algorithms

According to Scott et al. (2006) public owners have used a variety of scoring systems that can be categorized in four groups (Figure 2). "Satisficing" is the simplest form of evaluation. Satisficing requires a Design-Build team to meet the minimum evaluation criteria threshold (i.e., pass/fail). Modified Satisficing adds some level of achievement to meeting the minimum evaluation criteria (e.g., a "+" or "-"). Adjectival Rating uses clearly defined adjectives to rate proposals (e.g., meets, exceeds, far exceeds). Direct Scoring uses point values for evaluation against a desired performance level. The RFPs analyzed as part of this research mainly consider direct point scoring for both the Technical and SOQ scoring.

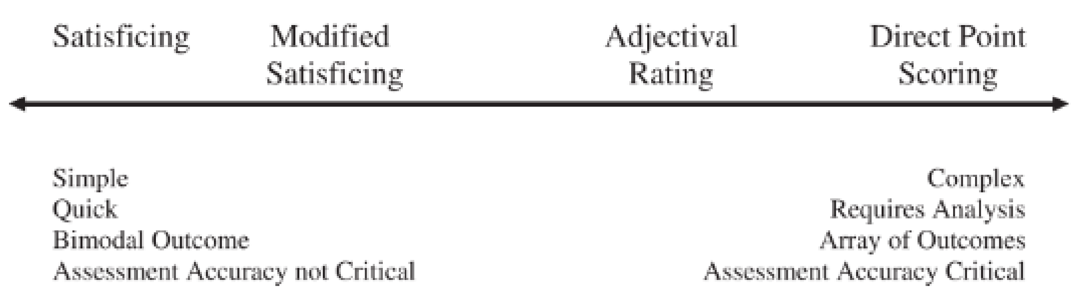


Figure 2 Best-value evaluation rating system continuum

The award algorithms define the steps that DOTs follow to combine the evaluation criteria and rating system to obtain a final award recommendation. Scott et al. (2006) compiled seven types of algorithms: (1) meets technical criteria—low bid, (2) adjusted bid, (3) adjusted score, (4) weighted criteria, (5) quantitative cost—technical tradeoff, (6) qualitative cost –technical tradeoff, and (7) fixed price –best proposal. Table 7 summarizes the award algorithm used by the states analyzed in this review.

Table 7 Evaluation criteria and main areas of evaluation

(2) Adjusted bid	**North Carolina*** RFP I-440/US1 (2018)
	Florida RFP I-10 Widening I-295 to I-95 (2018)
	Colorado RFP I-25 North Design-Build (2017)
(4) Weighted criteria	**South Carolina** RFP I-85 MM 98 to 106(2018)
	Georgia RFP I-20 at Savannah River Replacements
	New York RFP Rehabilitation of I-278 Bridges (2018)

*Adjusted using subtraction instead of division.

Adjusted bid

This award algorithm requires direct numeric scoring. The price proposal is adjusted in some manner using the technical score. This adjustment is usually obtained by dividing the project price by the technical score. The proposer with the lowest adjusted bid will be awarded the project. The advantage of this formula is its similarity to the low bid award (lowest score wins). The disadvantage is that the effective weight of the non-price factors can be difficult for proposers to determine. Figure 3 shows an example of the adjusted bid algorithm. The specific formulas used by the analyzed states are analyzed below.

Algorithm: **AB = P/T**

Award AB_{min}

AB = Adjusted Bid

P = Project Price

T = Technical Score

Figure 3 Example of adjusted bid algorithm

North Carolina
The award algorithm considered by NCDOT is:

Adjusted Price [AP] = PP-(QV)

Where:
PP: Price Proposal.
QV: Quality Value. (QV=PP*Quality Credits (QC))

Table 8 shows the scoring of the sub-criteria included in the Technical Proposal Score criterion:

Table 8 NCDOT technical evaluation criteria scoring

Technical evaluation criteria	**Score**
Management	6
Responsiveness to RFP	30
Long-term maintenance	4
Schedule & Milestones	25
Innovation	5
Maintenance of Traffic and safety plan	25
Oral interview	5

Florida
The award algorithm considered by FDOT is:

Adjusted Score [AS] =BPP/TS

Where:
TS: Technical score (combined Scores from Letters of interest (LOI) and technical proposal.
BPP: Bid price proposal.

Table 9 shows the scoring of the sub-criteria included in the Technical Proposal Score criterion:

Table 9 FDOT technical evaluation criteria scoring

Technical evaluation criteria	**Score**
Design	35
Construction	35
Innovation	5
Value-Added	5
LOI scoring (from RFQ stage)	20

Colorado

The award algorithm considered by CDOT is:

Adjusted Score [AS] = (A+B)/TPS

Where:

TPS: Technical Proposal Score
A: Construction Cost Bid
B: (Time * Road User Costs)
T: Design-Builder Construction Calendar days

Table 10 shows the scoring of the sub-criteria included in the Technical Proposal Score criterion:

Table 10 CDOT technical evaluation criteria scoring

Technical evaluation criteria	Score
Project Management	50
Maintenance of traffic	20
Environmental compliance	20
Safety program approach and commitments	10

Weighted criteria

The weighted criteria algorithm also requires direct numeric scoring. A weight is assigned to the price and each of the technical evaluation factors. The sum of these values becomes the total score. The proposer with the highest total score is selected. The advantage of this formula is its transparency as to the weight of each evaluation criteria. Figure 4 shows an example of weighted criteria algorithm. The specific formulas used by the states analyzed are presented below.

Algorithm: $\mathbf{TS = W_1S_1 + W_2S_2 + \ldots + W_iS_i + W_{(i+1)}PS}$
Award $\mathbf{TS_{max}}$
TS = Total Score
W_i = Weight of Factor i
S_i = Score of Factor i
PS = Price Score

Figure 4 Example of weighted criteria algorithm

South Carolina

The award algorithm used by SCDOT is:

$$WC = \left(\frac{Alow}{An} * 65\right) + \left(\frac{blow}{bn} * 10\right) + \left(\frac{C}{100} * 5\right) + (\frac{D}{100} * 20)$$

Where:

Low: the lowest value from the proposal being scored.

A: Total cost to complete all work performed under the contract

b: Construction time

C: SOQ score from RFP phase

D: Technical score

n: Proposer being evaluated

Table 11 shows the scoring of the sub-criteria included in the Technical Proposal Score criterion:

Table 11 SCDOT technical evaluation criteria scoring

Technical evaluation criteria	**Score**
Project delivery & approach	25
Conceptual road plans	30
Understanding MOP	20
Conceptual bridge plans	10
Innovation & added value	15
Required forms	Pass/fail

Georgia
The award algorithm used by GDOT is:

$$CS = 25\%TS + 75\%PS$$

Where:
TS: Technical proposal score including weight.
PS: Price proposal score including weight (the lowest overall price receives the maximum score)

Table 12 shows the scoring of the sub-criteria included in the Technical Proposal Score criterion:

Table 12 GDOT technical evaluation criteria scoring

Technical evaluation criteria*
Construction staging and Traffic Management
Project schedule
Environmental impacts & public outreach
Project Management Approach

* The scoring was not available

New York
The award algorithm used by NYDOT is:

$$WC = 50\%PP + 50\%QE$$

Where:
PP: Proposal price
QE: Quality evaluation

Table 13 shows the scoring of the sub-criteria included in the quality evaluation criterion:

Table 13 NYDOT quality evaluation scoring

Technical evaluation criteria	**Score**
Organization and process	20
Approach to the project	40
Schedule	40

3.2 SCDOT Best-Value Analysis

SCDOT has developed different best-value approaches over time as shown in Figure 5. Figure 5 shows the evolution of SCDOT's approach, but the analysis for this study focuses on the last two SCDOT projects, which used the weighted criteria approach: SC 277 over I-77 (referred as project P0 in Figure 5) and I-85 Widening MM 98-106 (referred as project P1 in Figure 5).

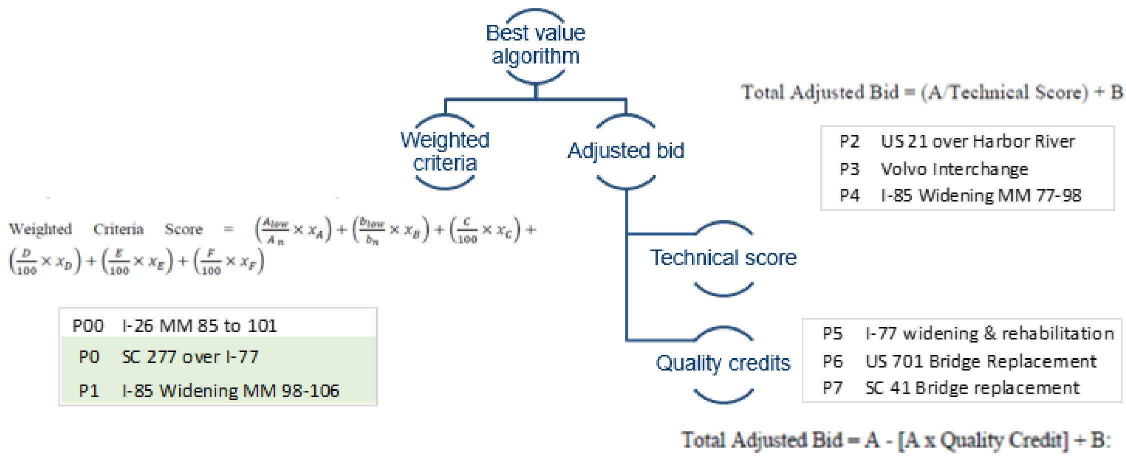


Figure 5 Best-value approaches used by SCDOT

While both projects use a weighted criteria formula, they differed in the evaluation criteria, the weights given to each evaluation criteria, and the range of scoring used to calculate the technical score (D). Table 15 shows these differences.

$$WCn = \left(\frac{A_{low}}{A_n} * X_A\right) + \left(\frac{B_{low}}{B_n} * X_B\right) + \left(\frac{C_n}{100} * X_C\right) + \left(\frac{D_n}{100} * X_D\right) + \left(\frac{En}{100} * X_E\right) \quad (1)$$

Where,
WC_n = *Weighted criteria score of proposal n*
A_{low} = *lowest cost of the proposal being scored.*
A_n = *Total cost proposed in proposal n*
B_{low} = *lowest construction time of the proposal being scored*
B_n = *Construction time proposed in proposal n*
C_n = *SOQ score from RFQ phase of proposer n*
D_n = *Technical score of proposal n*
E = *Quality Credit score*
n = *proposer being evaluated*
Xi = *weight of criteria (detailed* in *Table 14)*

Table 14 Weights considered for each criteria

Evaluation criteria		SC 277 over I-77	I-85 MM98-106
A	Total cost to complete all work	65	65
B	Construction time	0	10
C	SOQ score from the RFQ phase	15	5
D	Technical score	15	20
E	Quality credit score	15	0

Table 15 Scoring considered for RFP and RFQ technical evaluation

<table>
<tr><th colspan="2">Evaluation criteria</th><th>Sub-evaluation criteria</th><th>SC 277 over I-77</th><th>I-85 MM98-106</th></tr>
<tr><td colspan="2" rowspan="5">Technical Score (D)</td><td>Description fo the project delivery & approach</td><td>40</td><td>25</td></tr>
<tr><td>Conceptual Roadway plans</td><td>10</td><td>30</td></tr>
<tr><td>Conceptual Maintenance of Traffic</td><td>20</td><td>20</td></tr>
<tr><td>Conceptual bridge plans</td><td>30</td><td>10</td></tr>
<tr><td>Innovation and Added Value</td><td>0</td><td>15</td></tr>
<tr><td rowspan="7">SOQ score (C)</td><td rowspan="2">Team structure and approach</td><td>Organization chart and team structure</td><td>5</td><td>5</td></tr>
<tr><td>Capacity, resources, and project</td><td>15</td><td>15</td></tr>
<tr><td rowspan="3">Experience of key individuals</td><td>Project Manager</td><td>14</td><td>10</td></tr>
<tr><td>Design engineering team</td><td>13</td><td>15</td></tr>
<tr><td>Construction engineering team</td><td>13</td><td>15</td></tr>
<tr><td rowspan="2">Past performance</td><td>Experience of Proposer´s team</td><td>10</td><td>10</td></tr>
<tr><td>Quality of past performance</td><td>30</td><td>30</td></tr>
</table>

When evaluating the suitability of the best-value approach, it is important to align it with the project goals. For example, if an early completion date is the most important goal for project success, the DOT should reflect this goal in the selection and weighting of the best value evaluation criteria relating to the project completion date. According to Molenaar and Tran (2015), the project goals should be related to best-value evaluation criteria, rating system, and award algorithms, as shown in Figure 6.

Figure 6 Best-value conceptual elements. Source: Molenaar and Tran (2015).

While the direct alignment of project goals with project selection and best-value award criteria is a best practice, few DOTs have matured to a point of transparently following this practice on every project (Molenaar and Tran 2015). SCDOT is moving in this direction. The SC 277 over I-77 project goals, which are listed in Table 16.

Table 16 SC-277 project goals

Schedule	Complete bridge replacement following current widening project schedule to reduce inconvenience to motoring public and avoid a break in construction if DB project let early to allow for design to progress for seamless construction activities.
Cost	BR funds fully available for replacement.
Quality	Minimize impact to traveling public to ensure efficient travel through the corridor, especially with the current interstate widening project that is on-going. Eliminate items to the extent practical on the current widening project to eliminate rework with the bridge replacement project.
Functional	Replace bridge with durable and easily maintainable bridge while maintaining traffic along SC 277 and I-77
Others	Award project in a timely manner to allow for seamless construction activities (i.e., end widening = begin bridge replacement)

The project goals listed in Table 16 generally aling with the evaluation criteria and weighting in Tables 14 and 15. While the research team had access to the SC 277 over I-77 project goals, these were not listed in the RFP for the proposers. SCDOT has all of the pieces in place to align project goals with project selection and best-value award, but it did not combine them transparently in the SC 277 over I-77 or I-85 MM98-106 project RFPs.

3.2.1 Sensitivity Analysis of Evaluation Criteria

The research team performed a Monte Carlo simulation to evaluate the effect of the evaluation criteria on the final score of the weighted criteria formula. The simulation was developed using a uniform distribution for the scoring of each of the evaluation criteria. This distribution, for each category, adopts the maximum and the minimum values given to the firms in the real procurement. Each iteration takes a random value between these two parameters for each of the evaluation criteria. The uniform distribution treats all values in the range with equal liklihood of occurance in the simulation.

SC-277 project

Figure 7 and Figure 8 show the results obtained in the simulation for the SC-277 project. Figure 7 depicts the distribution of the final score obtained through the iterations. The final score for this project ranges between 74.5 and 82.4, with a 90% of confidence. In other words, 9 times out of 10, the simulated score falls between 74.5 and 82.4. The average final score obtained in the simulations is 78.4.

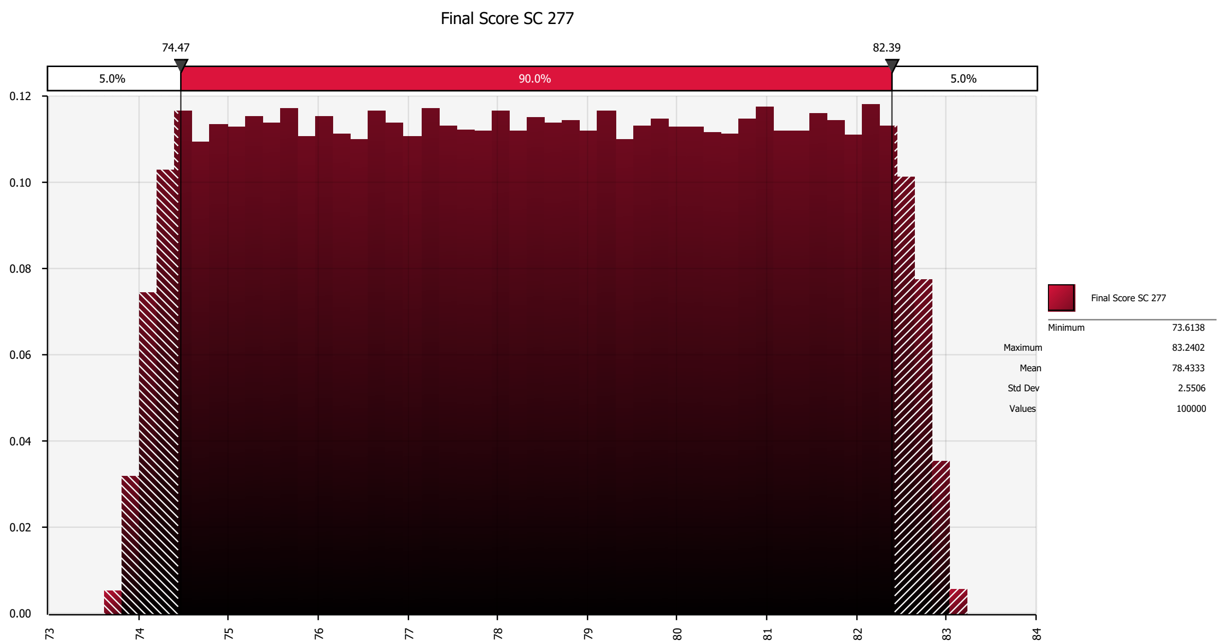


Figure 7 SC-277 project final score distribution

Figure 8 shows a tornado diagram that graphically depicts the level of impact for each weighted criteria on the simulated outcome. The wider the bar in the tornado diagram, the greater the influence on the range of scores. Considering the effect of each evaluation criteria independently, the construction cost [A] is the one having, by far, the highest impact on the final score. The technical score [D] had the least influence due to the "tight" scoring between the proposers.

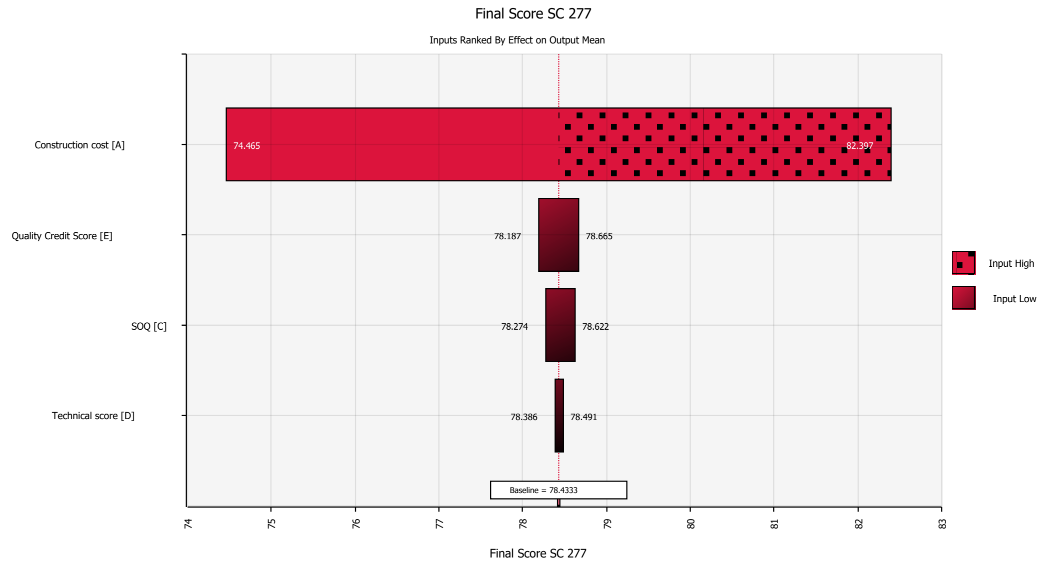


Figure 8 SC-277 project tornado diagram

I-85 project

The research team could perform a more detailed analysis for the I-85 project because we had access to the RFP technical and SOQ scoring spreadsheet. This allowed the team to perform two different simulation analysis: one focused on the evaluation criteria considered in the RFP (similar to the simulation performed for the SC-277 project), and another one analyzing the sub-criteria considered in the SOQ.

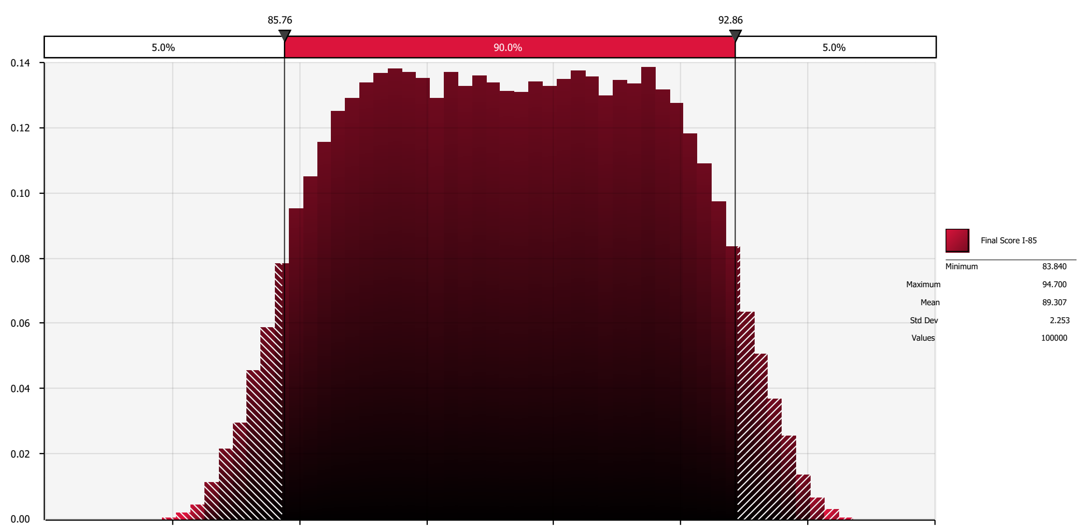


Figure 9 I-85 project final score distribution

The results of the RFP evaluation criteria for the I-85 project are shown in Figure 9, and Figure 10. In this case, the resulting final score average is 89.3, with a range between 85.8 and 92.9 corresponding to the 90% of confidence (Figure 9). In other words, 9 times out of 10, the simulated score falls between 85.8 and 92.9.

Considering the effect of each evaluation criteria independently, the tornado diagram (9) shows that the construction cost [A] is the criterion having a greater impact on the average final score, followed by the Technical Score [D] and Construction Time [B].

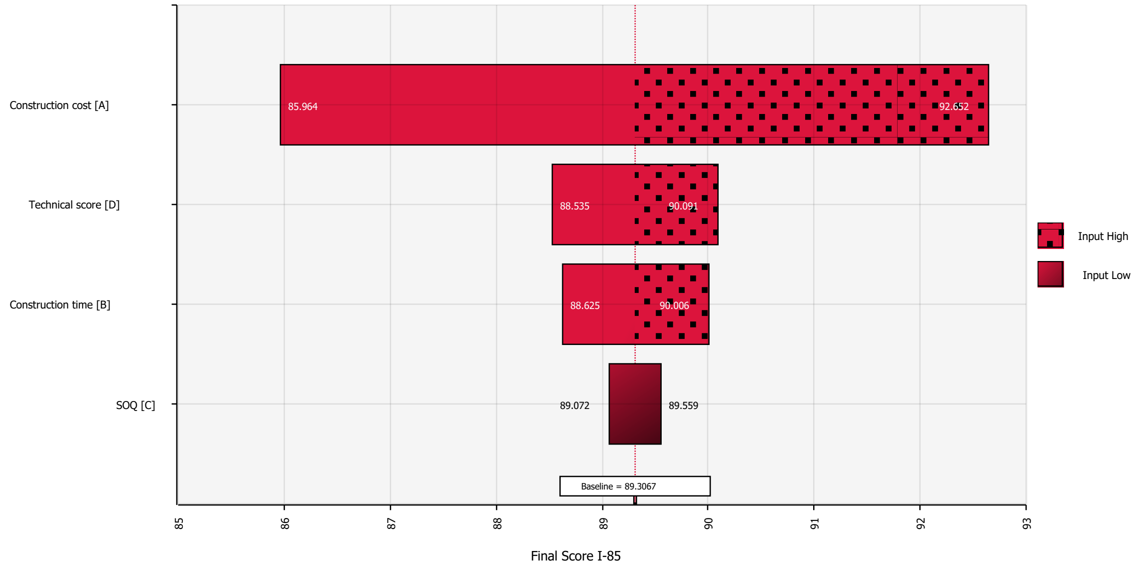


Figure 90 I-85 project tornado diagram

The research team performed an additional simulation for the I-85 project, considering the subcategories of the SOQ [C] and Technical Score [D]. Figure 11 shows the tornado diagram. While the contribution of the cost is the most impactful criterion, the tornado diagram (Figure 101) shows that the most relevant sub-criteria within the Technical Score [D] category is the conceptual road plans.

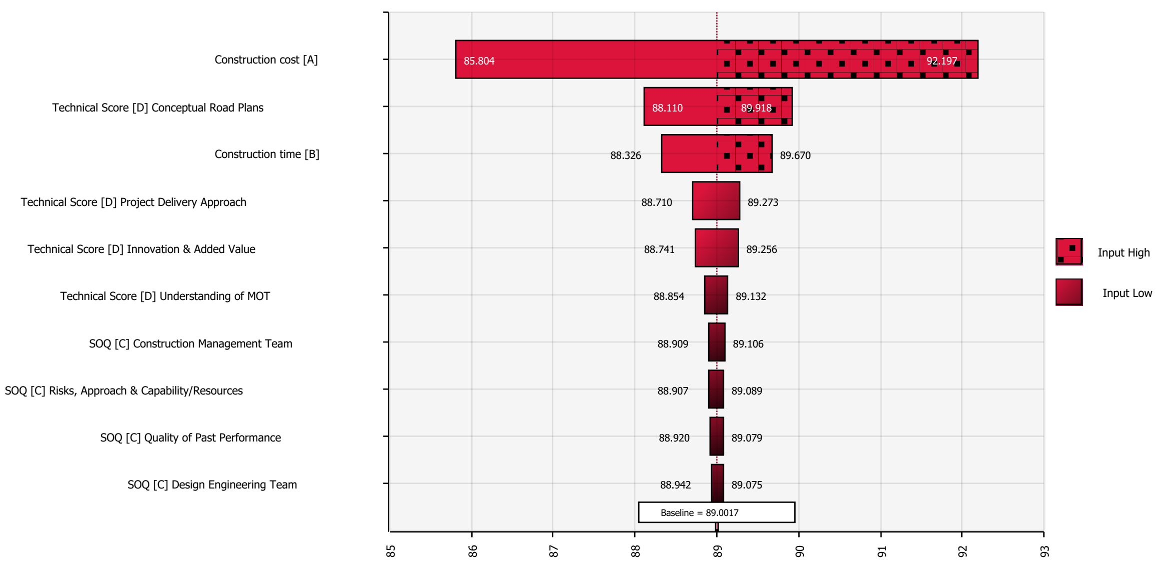


Figure 10 I-85 project tornado diagram including sub-criteria

3.2.2 SCDOT best-value questions analysis

This section analyzes SCDOT's questions related to three main best-value topics: goals and evaluation criteria, scoring systems and weights and scores.

Goals & Evaluation criteria

1. *When establishing criteria, what should the starting point for cost be? How should our goals be incorporated into this?*

According to Molenaar & Tran (2015), best-value procurement is a process to select the most advantageous proposal by evaluating other factors in addition to price. These factors should be determined in alignment with the project's goals and assessed through evaluation criteria (Scott et al. 2006). Two key aspects should be considered when establishing the evaluation criteria. First, the relationship between project goals and evaluation criteria. Second, the evaluation criteria's capacity to obtain the appropriate information to make a meaningful comparison among the proposers.

Relationship between project goals and evaluation criteria: The projects goals should be translated into selection objectives, which will be the basis for defining evaluation criteria. Evaluation criteria measure to what extent the design-builders accomplish the selection objectives by assessing the requirements. For example, one project goal might be to "minimize impacts to the traffic during construction." The selection objective might be "choose the proposer that minimizes peak hour travel times in determined segments." Finally, the evaluation criteria might be "The *design-builder with the fastest total sum of peak hour travel times for roadway segment X will receive the maximum points for that segment. Remaining design-builder's time to be pro-rated against the fastest time.*[7]"

Appropriate information to make meaningful comparisons: Evaluation criteria that should be included in the best-value formula are those that can provide differentiation among the proposers. Technical information that constitutes basic requirements and might be quite similar among proposers do not provide this differentiation.

Overall, evaluation criteria should be aligned with project's goals. The evaluation criteria should be able to be meaningful for the proposers' comparison. The starting point of the cost will depend on the balance that SCDOT wishes to establish between cost and non-cost factors. This might vary from not considering cost in the best-value formula to assign different ranges of weights for cost.

[7] Adapted from NY DOT RFP Route 17

Scoring systems

1. *Can we investigate adjectival scoring to see if that method may provide more separation of teams and ultimately lead to the TS having more impact on the selection process?*

Adjectival scoring can help to achieve consensus among the evaluators. However, achieving more separation of the teams in the evaluation does not depend so much on using adjectival or direct scoring but on defining consistent evaluation criteria.
Consistent evaluation criteria should be comprehensive, direct, unambiguous and understandable evaluation criteria (Belton and Stewart 2002; Keeney and Gregory 2005; Keeney and Raiffa 1976). This is:

- Comprehensive: evaluation criteria need to cover the full range of potential variability of proposals' performance.
- Direct: evaluation criteria establish a direct relationship between its levels (grades), and the requirements asked to measure the evaluated area.
- Unambiguous: evaluation criteria should not be vague or imprecise in their definition.
- Understandable: evaluation criteria assessment should readily be understood and clearly communicated.

SCDOT used adjectival scoring to conduct the internal assessment of the evaluation criteria in the project *Interstate 26 Widening MM 85-101*. The research team analyzed this project's evaluation criterion "Project Delivery Approach" to illustrate how certain aspects in the evaluation criteria formulation might improve separation in the scoring without being directly related with the adjectival score system.

Table 17 Requirements and technical proposal evaluation from I-26 MM 85-101 RFP.

Requirements (Page 16-17 RFP)	**Technical proposal evaluation** (page 23 RFP)
a) Identify the proposed schedule for implementing the project. Include the sequence of construction, segmentation, if any, and material and equipment staging plan. Describe methods that will allow a reduction in the overall construction scheduled for the project. b) Describe the proposed design submittal process and include a chart showing anticipated deliverables in sequence that will allow SCDOT to conduct efficient and complete reviews. Include discussion of how any proposed project phasing/segmentation will be addressed in the design submittal and review process. c) Discuss approach for tying this I-26 mainline widening and associated crossing route improvements to other on-going and upcoming projects within or adjacent to the proposed project limits. Discussion should include, but not be limited to, coordination with the current contractor related to work schedule and traffic control. d) Describe the proposed approach for minimization, a voidance, and mitigation of d. environmental impacts. Describe the plan for obtaining permits and compliance with	A Technical Proposal Narrative outlining the Proposer's Project Approach and Delivery which meets the minimum expectations of SCDOT as described in the RFP will be scored at 30 points. Points will be deducted from the Project Approach and Delivery Technical Narrative and Conceptual Plans for aspects that do not conform to the RFP requirements, have omitted items, and contain deficiencies. At SCDOT's discretion, points will also be deducted for aspects of a Proposal that lack sound engineering judgement, as determined by SCDOT, in accomplishing the scope of work, incorporate minimal design values in areas where higher values are more commensurate with the design context, or provide unsuitable quality.

environmental commitments. Demonstrate knowledge of the critical elements of the compensatory mitigation plan in accordance with the USACOE Charleston District "Guidelines for preparing a compensatory mitigation plan" (latest edition). e) Describe the proposed approach for temporary pavements during construction including proposed design. Include intended use of pavement design and anticipated durations for in place use. Provide materials for use and thicknesses/weights to clearly demonstrate design. f) Describe the proposed approach to Quality Control and understanding of the Quality Assurance Program. Discuss the roles of the Proposer and SCDOT for all aspects of construction of the project. Discuss compliance with required standards, testing laboratories, mix designs and material certifications processes. g) Discuss the proposed approach to addressing any unique characteristics of the project and mitigating any risk items identified by the Proposer.	

Figure 11 depicts the adjectival rating[8] used by SCDOT to evaluate each of the a) to g) points. The graph establishes the guidelines to assess the proposals and categorize them according to a six level qualitative scale.

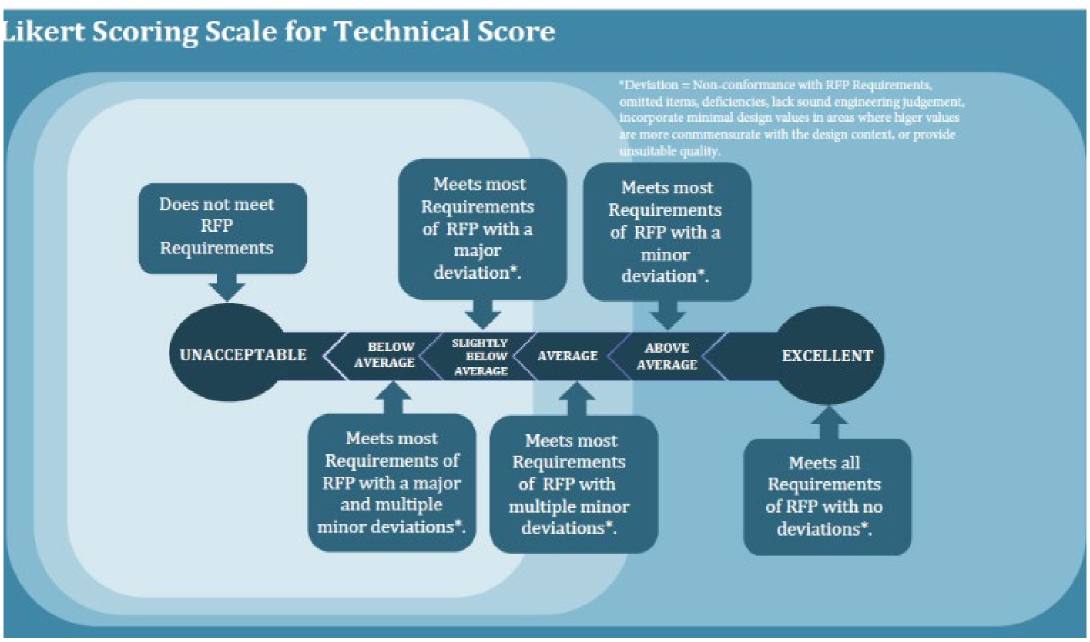


Figure 11 SCDOT's adjectival rating system used in I-26 MM 85-101 project

[8] The numerical conversion to points on this sheet is counting down from 100 points in accordance with the RFP with a 70 being determined a non-responsive technical proposal. The scale used for determining the numerical score is a reduction of 7 points from Excellent to Above Average and then 6 points from each additional category. For example, from Excellent to Above Average you lose 7 points and would be scored at 93. If you received an Unacceptable you have scored a 69 and would be deemed non-responsive.

Based on the requirements, technical proposal evaluation and adjectival rating systems (Table 17 and Figure 11), the research team suggested the following comments:

- The evaluation criteria in the RFP indicates that the maximum points (30) will be given to *Proposer's Project Approach and Delivery which meets the minimum expectations of SCDOT.* This definition decreases the separation among the teams in the evaluation since the proposals will likely meet the minimum expectations.

- The area of Project Approach and Delivery asks for seven requirements for its evaluation. Each requirement has sub-requirements. However, the evaluation criteria focus on whether these requirements are included rather than their quality or effectiveness. For example, in requirement a), the sub-requirements are:
    - Identify proposers schedule
    - Include a sequence of construction, segmentation.
    - Include methods that will allow a reduction in the overall construction schedule.

  Most of the proposers can include these sub-requirements; thus, the evaluation will be very similar among proposers.

1. The adjectival scale used to evaluate the requirements does not substantially help to differentiate the evaluation since it is broad and focused on meet/not meet the requirements. This approach might make it challenging to separate teams in the assessment.

Therefore, some suggestions for achieving more separation in the evaluation of teams might be:

2. Identify areas of assessment aligned with project goals, and that can make the difference among the proposers. Areas in which all the proposers are likely to be at the same level, should be evaluated in a pass/fail format.

3. For each area of assessment, decision-makers need to think about what they want to evaluate to distinguish the proposers. For example, if the evaluation is focused on meet/not meet the requirements, it is unlikely to identify the proposers that offer the best-value. On the contrary, if the evaluation is focused on who best achieves certain specific requirement the comparison might enable decision-makers to separate the proposers better.

Weights and scores

1. *Can you provide examples of how the award of the project could be affected by the Quality Scores?*

To illustrate how the award of the project could be affected by quality scores, the research team considered three SCDOT projects. These projects used the weighted criteria formula (formula 2) and assigned different weights to the Quality credit score (Table 18).

$$AS = \left(\frac{Alow}{An} * WA\right) + \left(\frac{Blow}{Bn} * WB\right) + \left(\frac{C}{100} * WC\right) + \left(\frac{D}{100} * WD\right) + \left(\frac{E}{100} * WE\right) + \left(\frac{F}{100} * WF\right) \quad (2)$$

Table 18 SCDOT's weights in three different projects

			I-26 MM 85-101	I-85 Rocky	SC 277 over I-77
A	Cost to complete	W_A	0	0.5	0.65
B	Time to complete	W_B	0.05	0	0
C	SOQ Score	W_C	0.25	0.1	0.05
D	Technical Score	W_D	0.25	0.2	0.15
E	Quality Credit Score	W_E	0.3	0.2	0.15
F	Variable Scope	W_F	0.15	0	0

The research team used Monte Carlo simulation to evaluate how the variation of the Quality Credit Scores—through four different scenarios—influences the variation of the award score's mean.

Based on SCDOT score's data, the scores in the simulation were modeled using uniform probabilistic distributions (Table 19).

Table 19 SCDOT's scores probability distributions

Scores		Probability distribution	Min	Max
Cost to complete	A_{low}/A_n	Uniform	84.5	100
Time to complete	B_{low}/B_n	Uniform	64.7	100
SOQ Score	C/100	Uniform	55.1	65.79
Technical Score	D/100	Uniform	72.8	98.9
Variable Scope	F/100	Uniform	50	90

The research team considered three scenarios to evaluate the variation of the award score base on the variation of the quality scores. Each scenario considered a different uniform distribution for the Quality Scores. The uniform distributions differed according to the range of variation defined by their maximum and minimum values. Scenario 1 from 0.5 to 0.9; scenario 2 from 0.6 to 0.9 and scenario 3 from 0.7 to 0.9 (Figure 12).

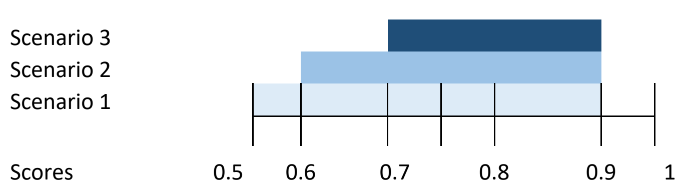


Figure 12 Range of variation of Quality Scores in different scenarios

The simulation results (Table 20) show that the wider range of variation in the Quality Credit score (E) criterion and the higher weight assigned lead to a more significant influence in the variation of the award score mean.

Table 20 E factor ranked by its effect in the variation of the award score mean (1 = greatest influence and 3 equals least influence)

	I-26 MM 85 101	I-85 Rocky	SC 277 over I-77
Weights/Scores	0.3	0.2	0.15
50-90	1	2	2
60-90	1	2	2
70-90	3	3	3

The following graphs show the tornado diagrams associated with each project and scenario of weights. Project I-26 MM 85-101 (Figure 13, Figure 14, Figure 15). Project I-85 over Rocky Creek Bridge (Figure 16, Figure 17, Figure 18). Project SC 277 over I-77 (Figure 19, Figure 20, Figure 21).

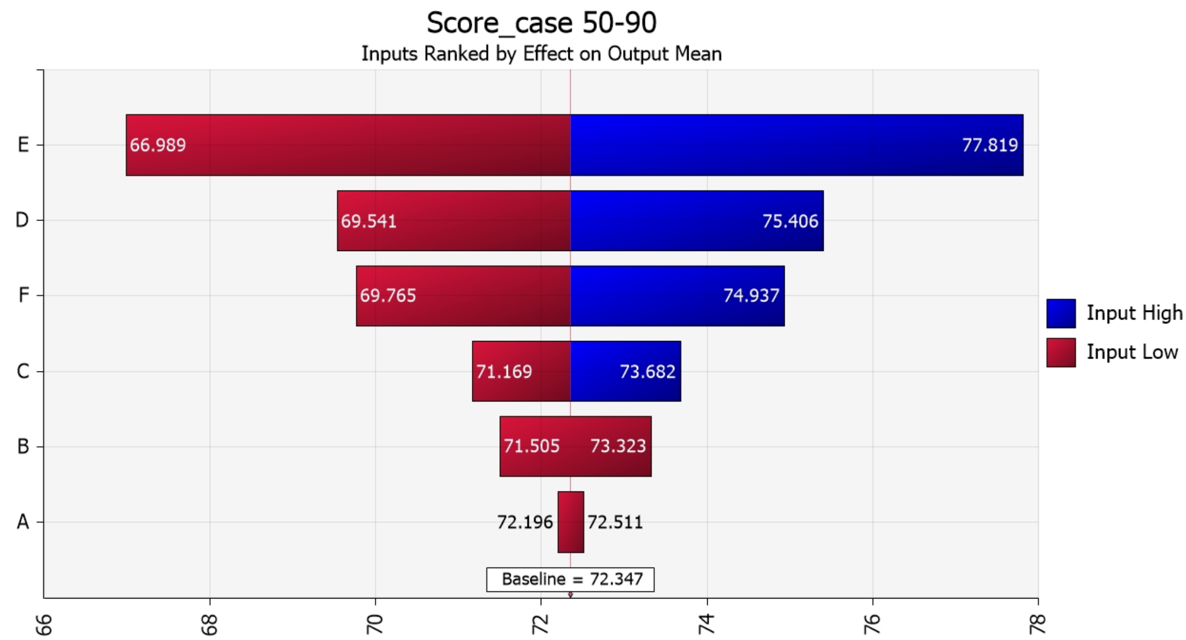


Figure 13 I-26 MM 85-101. Scenario 50-90

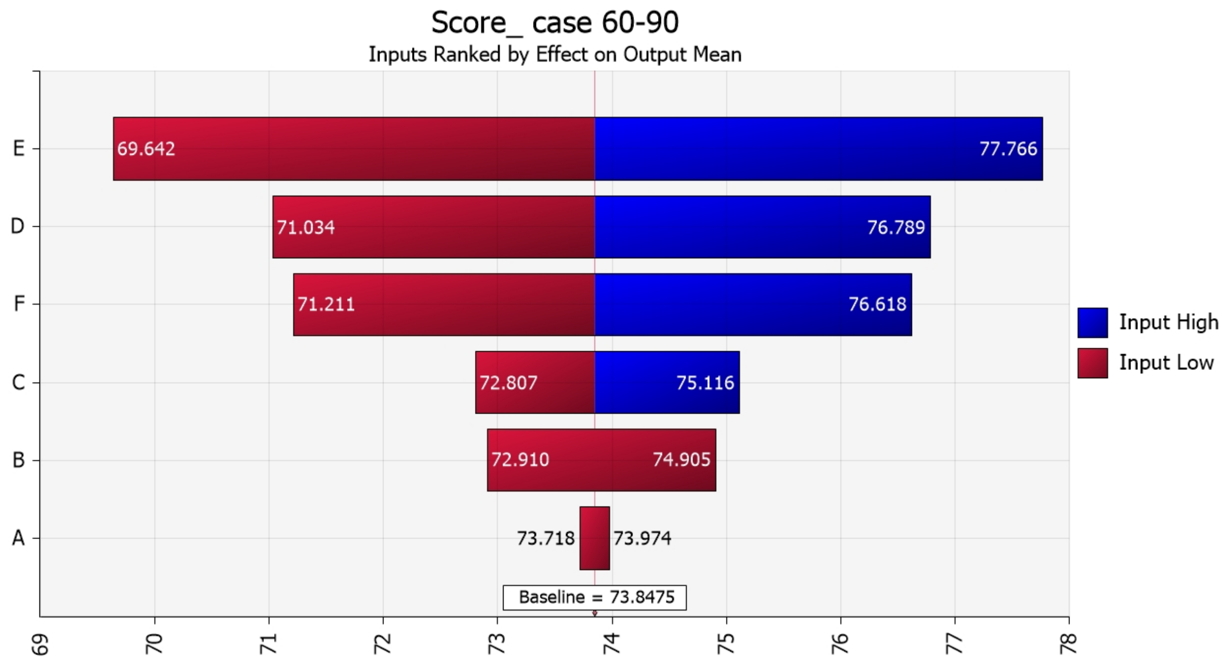


Figure 14 I-26 MM 85-101. Scenario 60-90

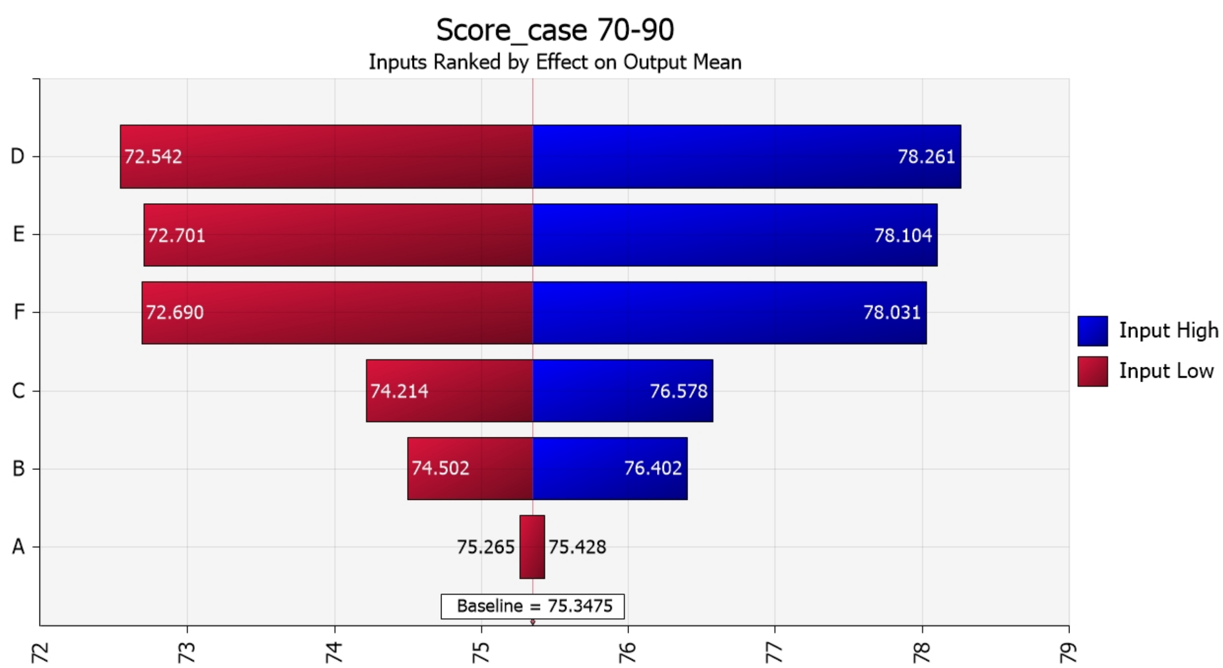


Figure 15 I-26 MM 85-101. Scenario 70-90

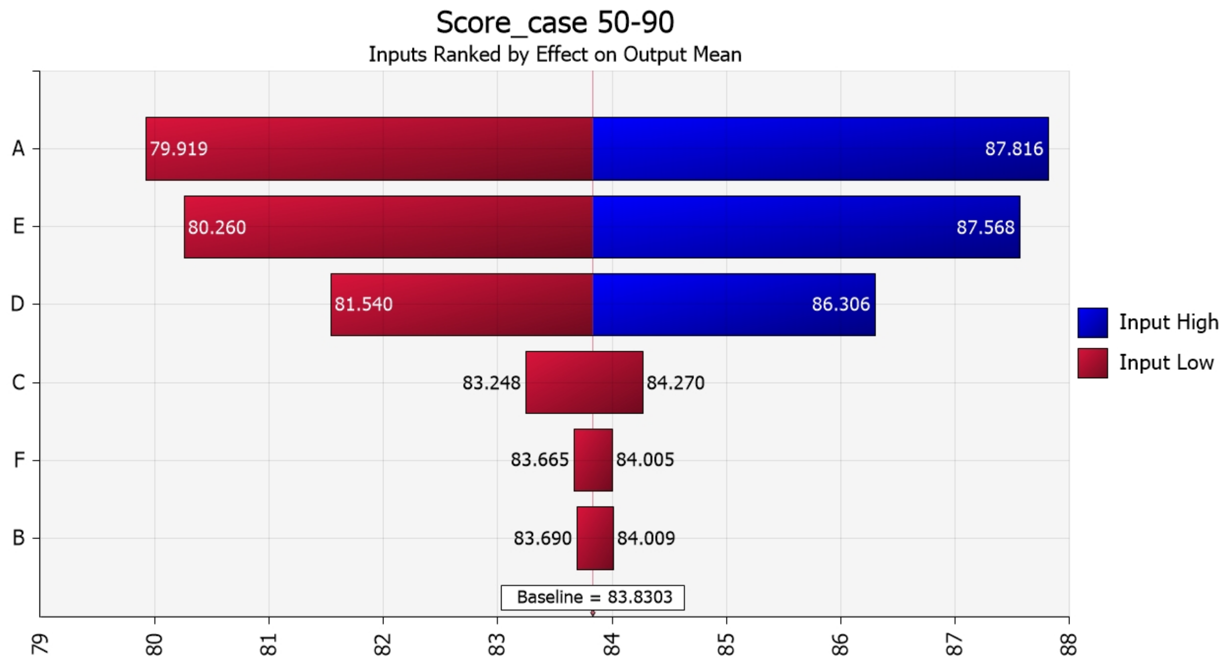


Figure 16 I-85 over Rocky Creek Bridge. Scenario 50-90

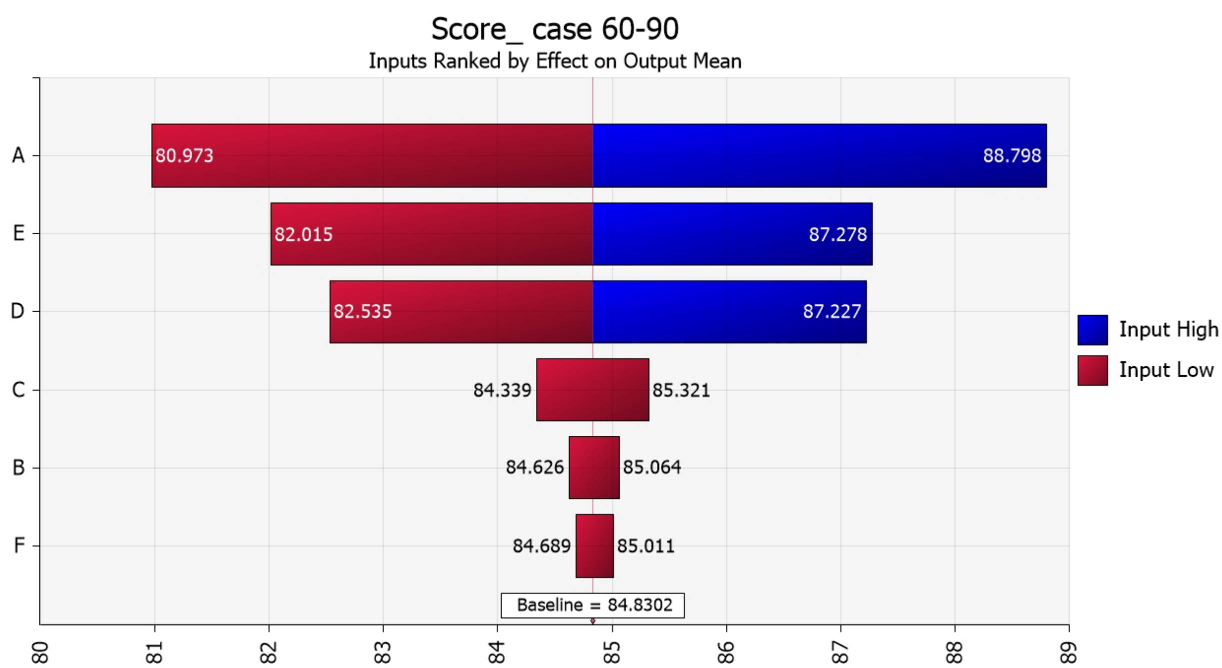


Figure 17 I-85 over Rocky Creek Bridge. Scenario 60-90

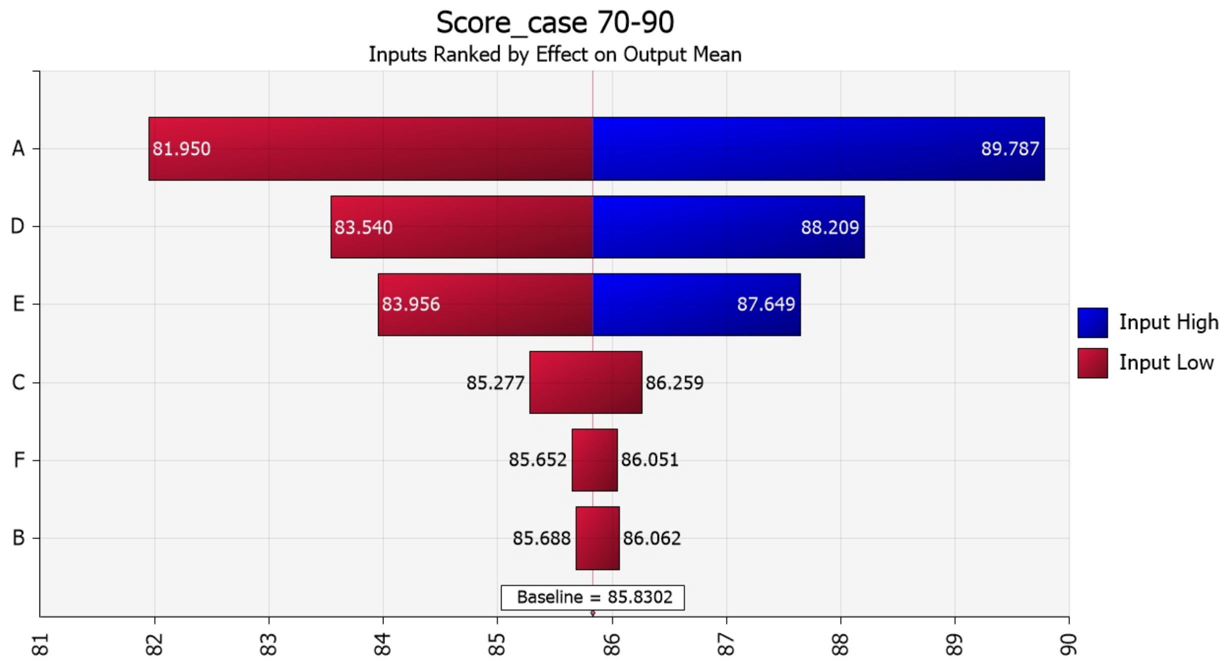


Figure 18 I-85 over Rocky Creek Bridge. Scenario 70-90

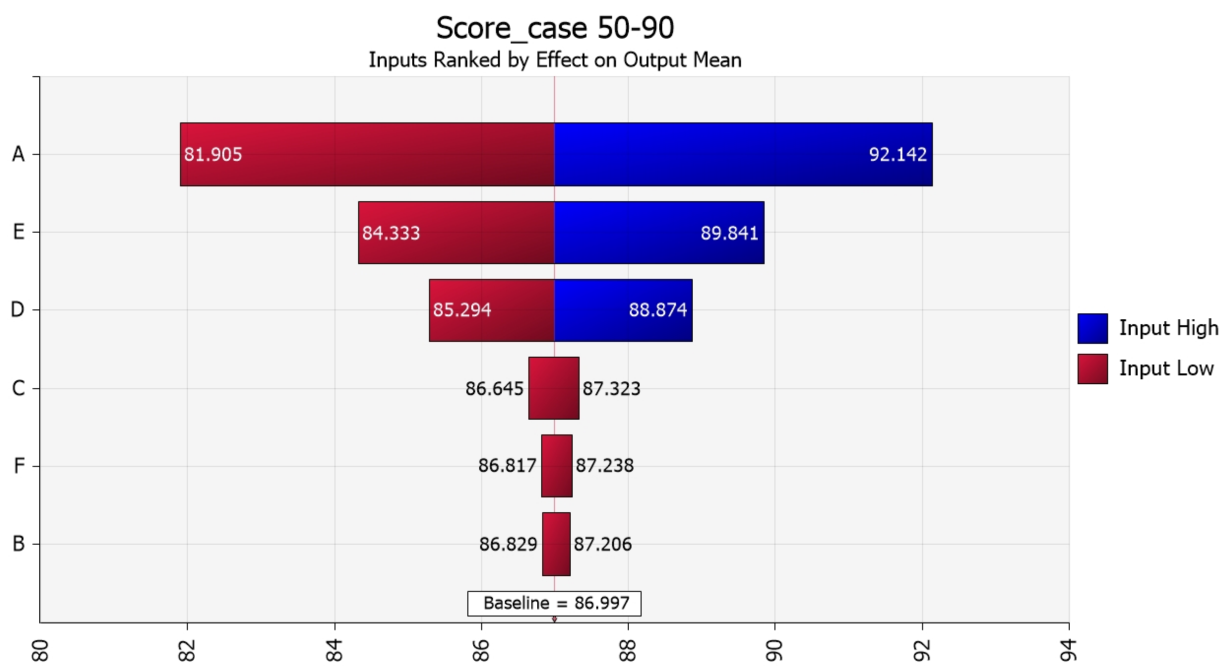


Figure 19 SC 277 over I-77. Scenario 50-90

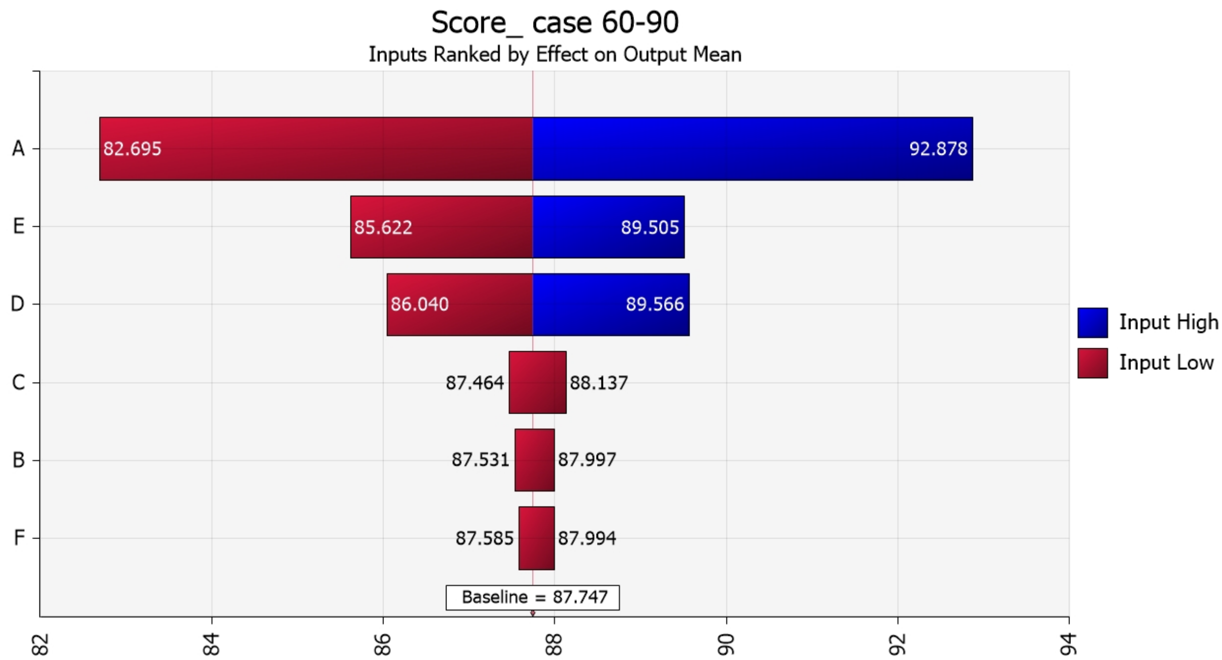


Figure 20 SC 277 over I-77. Scenario 60-90

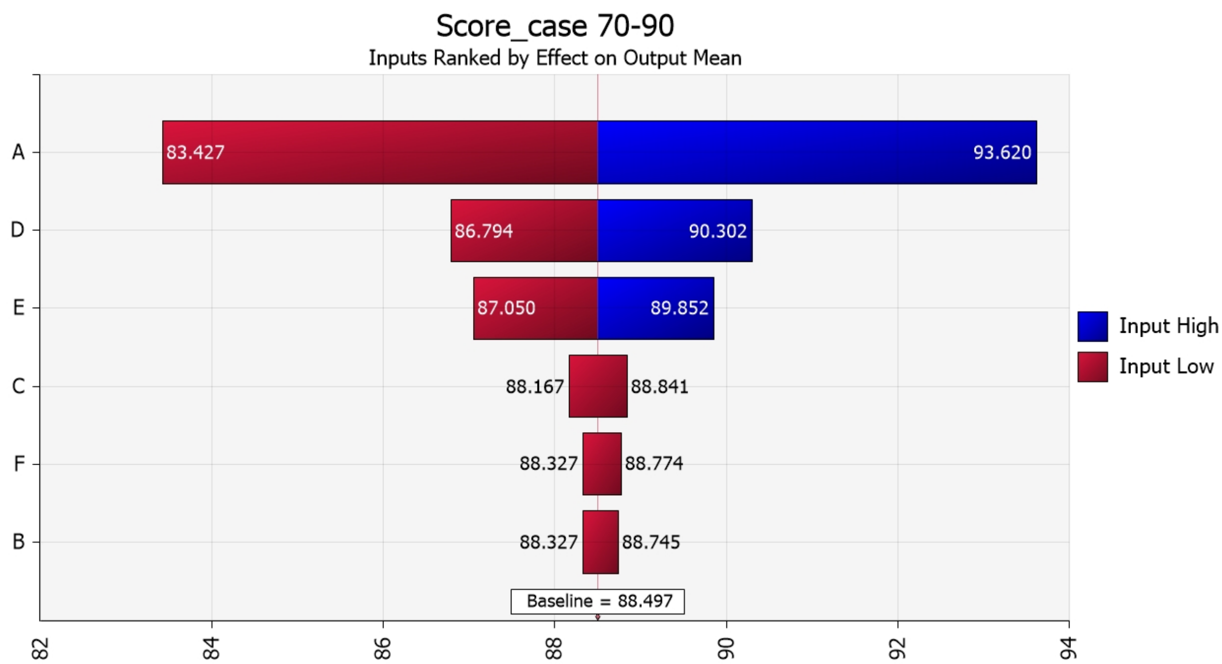


Figure 21 SC 277 over I-77. Scenario 70-90

2. *Based on previous projects, what cost proposal weight factor would affect the award of the project.*

This flipping point that defines whether the award of the project is cost-driven or technical-driven varies depending upon (1) the weight of cost considered and (2) the pattern of the score used for cost and technical components. This section focused on the weight of cost considered.

To illustrate what cost weight factor would determine a cost or technical driven award of the project, the research team considered formula 3.

$$Award\ Score: \left(\frac{Alow}{An} * WA\right) + \left(\frac{T}{100} * WT\right) \qquad (3)$$

Where

$\left(\frac{Alow}{An} * WA\right)$ is the cost component

$\left(\frac{T}{100} * WT\right)$ is the technical component

The flipping point can be defined by formula 4

$$\frac{\left(\frac{T}{100} * WT\right)}{\left(\frac{Alow}{An} * WA\right)} \qquad (4)$$

Where, If the result of formula 4 is

- higher than 1, the technical component is higher than the cost component (technical-driven selection)
- lower than 1, the cost component is higher than the technical component (cost-driven selection)

In formula 3, the research team introduced the probabilistic distributions for cost and technical scores based upon SCDOT's bidding results from DB procurements. Figure 22 shows the range of variation of formula 4's results for different weights of cost.
The weights of 0.43 and 0.53 define the range of weights that should be used for having chance of obtaining both a cost and a technical driven selection.

- If the weight of cost is higher than 0.53, the decision will be always driven by cost with 90% confidence.
- If the weight of cost is lower than 0.43, the decision will be driven by technical factors with 90% confidence.

Within this range of weights, SCDOT has chance for having both types of selection. However, the range of variation for each weight is more skewed toward cost as the weight of cost is higher.

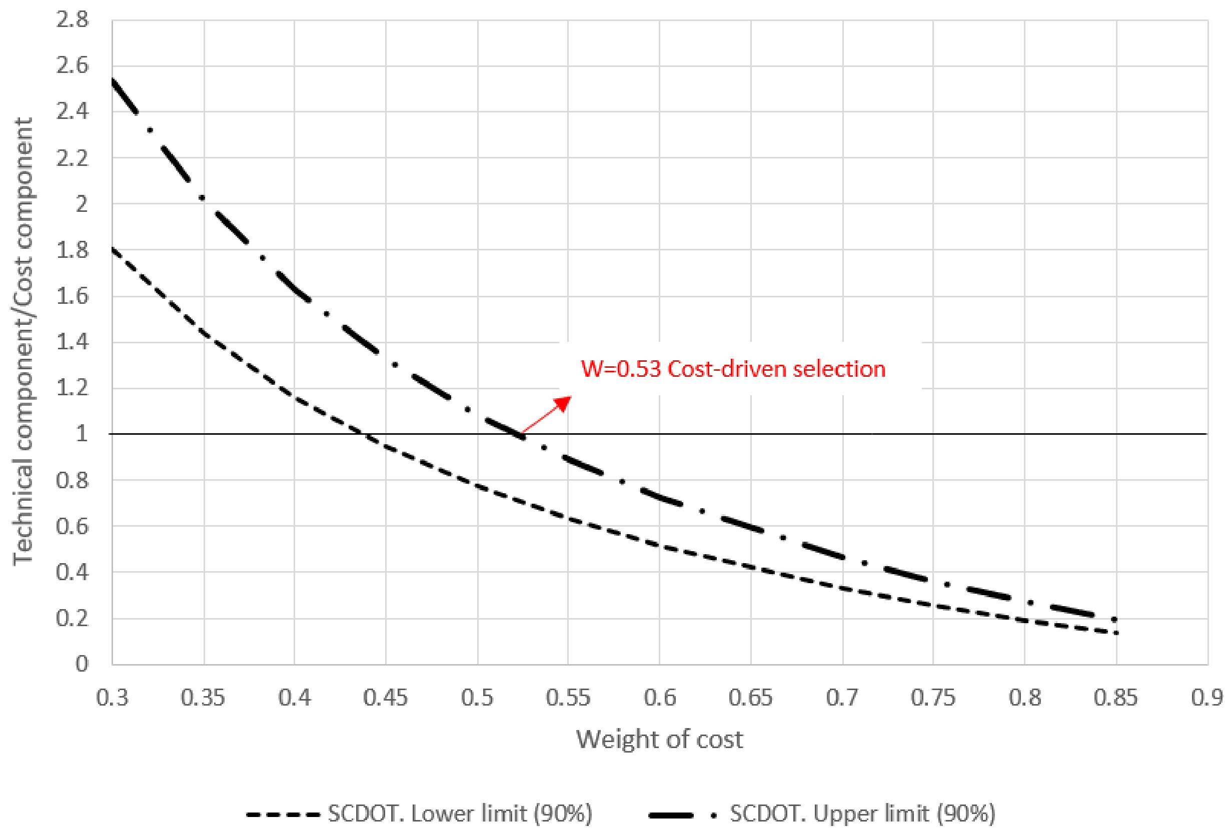


Figure 22 Range of variation of Technical component/cost component

3. *SCDOT needs to understand what it would take to flip a bid, if you hold the weights the same and vary the scores in the input. What would it take for low bid cost to be overcome?*

As it was stated in the previous question, the flipping point that defines whether the award of the project is cost-driven or technical-driven varies depending upon (1) the weight of cost considered and (2) the pattern of the score used for cost and technical components. This section focused on the variation of scores for a given set of weights.

Considering the definitions of cost-driven and technical driven selection based on formula 4, the research team simulated the scenario of weight of cost 50%, weight of technical component 50%. This scenario enables an easy-to-understand simulation since everyone would expect to have same probability for a cost-driven selection than for a technical driven selection. Considering these weights, the team conducted a first simulation using the SCDOT current scoring practice.

The score probabilistic distributions used are the ones that fit current SCDOT cost and technical scores. Figure 23 shows that using this score trends the probability of having a technical-driven selection (corresponding to Formula 4, greater than 1) is 15% (considering weights of 50% cost, 50% technical, that are supposed to balance cost and non-cost factors).

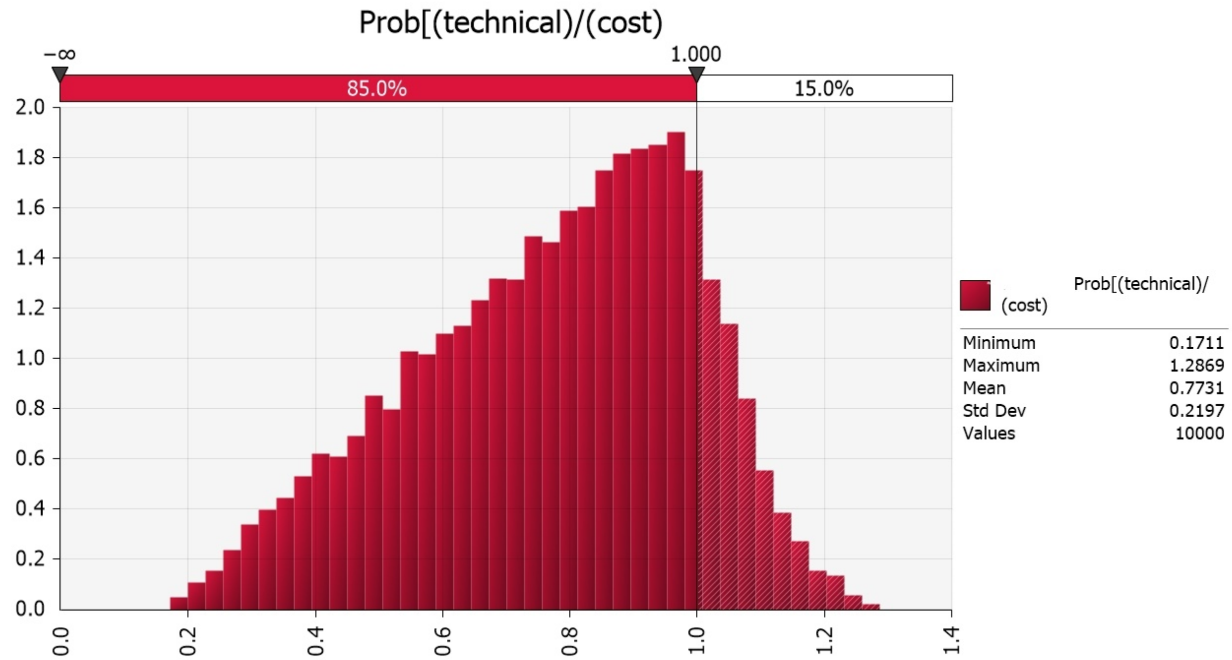


Figure 23 Probabilistic distribution of technical/cost components using current SCDOT scores trends. Cost Weight=Technical Weight=50%

This is happening because SCDOT cost and technical scores are not normalized using a same scale. Cost score is normalized based on the lowest bidder. Thus, the higher score is given to the lowest bid proposal and the other scores are related to how close the other proposers are to the lowest bidder. The technical score should be normalized in the same way giving the higher score to the best technical proposal, and the others proportionally according to their closeness to the best technical proposal. In this way, the weighted criteria algorithm will be balancing cost and technical factors in the same scale.

Formula 5 shows the two factors normalized

$$Award\ Score\ n\colon \left(\frac{Alow}{An} * WA\right) + \left(\frac{Tn}{Thigh} * WT\right) \qquad (5)$$

Where:
Award score n: award score of proposer n
A_{low}: lowest bid among proposers
A_n: cost bid of proposer n
T_n: Technical score of proposer n
T_{high}: highest technical score among the proposers.
W_A: weight of cost
W_T: weight of technical factors

Using formula 5, a firm having the lowest bid and the best technical proposal will always win. The doubt arises when one firm is the best in cost and other the best technically. In this case what ranges of scores determine the winner?

To analyze the flipping point, the research team assumed the assessment of two companies. Company A, which is the lowest bidder (cost score 1), and a company B, which is the best technically (technical score 1). Different scenarios were created based on different weights and thresholds of scores to answer the following question:

If Company B (best technically) has a cost score of X, what minimum technical score should have Company A (lowest bidder) to win? The research team considered the cases of minimum technical score should have Company A (lowest bidder) to win (X) being: 0.7, 0.8 and 0.9. Table 21 shows how depending upon the cost score of the best-technical proposal the technical score for the lowest bidder to win varies between 0 and 0.91. With weights for cost higher than 60% the lowest bidder can win having relatively low technical scores.

Table 21 Technical Score for the lowest bidder to win

			Company A. Cost Score: 1			
			Technical Score for being the winner			
		W_A-W_T	**50-50**	**60-40**	**70-30**	**80-20**
Company B Technical Score: 1	**Cost Score**	**0.7**	0.71	0.56	0.31	0.00
		0.8	0.81	0.71	0.54	0.21
		0.9	0.91	0.86	0.78	0.61

Table 22 shows how depending upon the technical score of the lowest bidder the best technical proposer score of cost varies between 0.71 and 0.99. If the technical score of the lowest bidder is close to 0.9, the firm with the best technical proposal needs to be very close to the lowest bidder (scores between 0.91 and 0.99).

Table 22 Cost Score for the best technically bidder to win

			Company B. Technical Score: 1			
			Cost Score for being the winner			
		W_A-W_T	**50-50**	**60-40**	**70-30**	**80-20**
Company A Cost Score: 1	**Technical Score**	**0.7**	0.71	0.81	0.88	0.94
		0.8	0.81	0.88	0.92	0.96
		0.9	0.91	0.94	0.97	0.99

This section shows the simplified case of two factors in the weighted criteria formula. This example is useful to understand how the difference between cost proposals influences the flipping point for achieving a cost-driven or a technical-driven selection.

4. *How should SCDOT assign weights to the individual components used for evaluation? (i.e.., goals?*

Once a set of evaluation criteria is established, SCDOT should rank them according to their relevance in the selection. This ranking should be based on SCDOT preferences. Weights might be assigned following different strategies. The research team would suggest performing simulation based on historical data and determining the sensibility of different weights in the award score.

5. *SCDOT has not experienced having extremely aggressive Scores (SOQ, Tech, Quality Credit) in the past. Should we focus on driving the cost component down, or should we focus on the separation of Scoring?*

Firstly, it is important to clarify what SCDOT aims by driving the cost component down or separating the scores. The research team considers that the aim is to increase the chance of awarding the contracts to not-lowest-bidder firms (i.e., increase the likelihood of having technical-driven selections.)

As shown previously, a technical-driven selection might occur with weights of cost lower than 60%. Thus, definitely, the cost component should be driven down under this threshold.

The separation of scoring should be pursued since it enables a meaningful comparison among the proposers. If all the proposers earn similar scores, the differentiation based on technical factors will be more difficult.

4. Conclusions and recommendations.

The purpose of this preliminary analysis was to examine how the current definition of evaluation criteria, scoring criteria and weighting influence the final best-value score. The following recommendations are proposed for discussion and continuous improvement of the process.

1. SCDOT should revisit the weighting and scoring of the technical scoring criteria. Simulations of past procurements show that the cost is the overriding factor in the last two procurements.
2. SCDOT should strive to more closely tie the stated project goals to the evaluation criteria. The stated project goals should be described in both the Project Definition Report and the RFQ/RFP. While the goals can currently be inferred from the best-value criteria and weighting, they should be more explicitly stated.
3. The project goals might be included at the beginning of RFQ and RFP after the general information and the project description.
4. Two key aspects should be considered when establishing the evaluation criteria. First, the relationship between project goals and evaluation criteria. Second, the evaluation

criteria’s capacity to obtain the appropriate information to make a meaningful comparison among the proposers.

5. Project’s goals should be aligned with the evaluation criteria. The evaluation criteria should be able to be meaningful for the proposers’ comparison. The starting point of the cost will depend on the balance that SCDOT wishes to establish between cost and non-cost factors. This might vary from not considering cost in the best-value formula to assign different ranges of weights for cost.
6. Making meaningful comparisons among proposers depends on the proper formulation of evaluation criteria. The evaluation criteria’s areas of assessment should make the difference among the proposers. Areas, where all the proposers are likely to be at the same level, should be evaluated in a pass/fail format.
7. Once decision-makers establish the areas of assessment, they can decide if the evaluation can be better performed using direct scoring or adjectival scoring.
8. Adjectival scoring can help to achieve consensus among the evaluators. However, achieving more separation of the teams in the evaluation does not depend so much on using adjectival or direct scoring but on defining consistent evaluation criteria (i.e., comprehensive, direct, unambiguous and understandable)
9. SCDOT should normalize technical scores so that the weighted sum algorithm can balance cost and technical factors in the basis of the same scale.
10. This flipping point that defines whether the award of the project is cost-driven or technical-driven varies depending upon (1) the pattern of the score used for cost and technical components and (2) the weight of cost considered.
11. Scores: the difference between cost and non-cost score patterns bias the proportion established by the weights of these components. This makes that establishing a weight for cost of 50% and for non-cost factors of 50% does not lead to an equal probability of having a cost-driven selection or a technical-driven selection.
12. Weights: weights of cost equal or higher to 53% will always lead to a cost-drive selection.
13. SCDOT Procurement Manual recommendations related to best-value are:
    - Include a new subsection just after “Project Description” and “Project Information”, defining the objectives of the project.
    - In “Technical Proposal Evaluation”, link the evaluation criteria description with the project goals defined previously.

5. References

Molenaar, K. R., and Tran, D. (2015). *NCHRP Synthesis 471. Practices for Developing Transparent Best Value Selection Procedures*.

Scott, S., Molenaar, K. R., Gransberg, D. D., and Smith, N. C. (2006). *NCHRP Report 561. Best-Value Procurement Methods for Highway Construction Projects*.

US Federal Goverment. (2002). *Code of Federal Regulations*. 212–228.

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Appendix 2D – Tech Memo on Risk Allocation

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 2. Tools, Processes and Best Practices

Task 2d. *Risk Allocation*

Prepared by

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Table of Contents

Contents

1. Executive Summary

The objective of this subtask was to evaluate the current South Carolina Department of Transportation (SCDOT) project risk allocation process and to propose recommendations to (1) improve templates used for risk identification, (2) make project-to-project adjustments, (3) coordinate risk allocation and RFP development processes; and (4) coordinate risk allocation and cost estimation processes. Figure 1 shows the process followed to accomplish this subtask. This report focuses on the first step of the analysis by benchmarking the current SCDOT's critical risk matrix with the national DOT´s practices and standard guides. The analysis was focus on three aspects: (1) risk categorization, (2) risk analysis, and (3) risk templates.

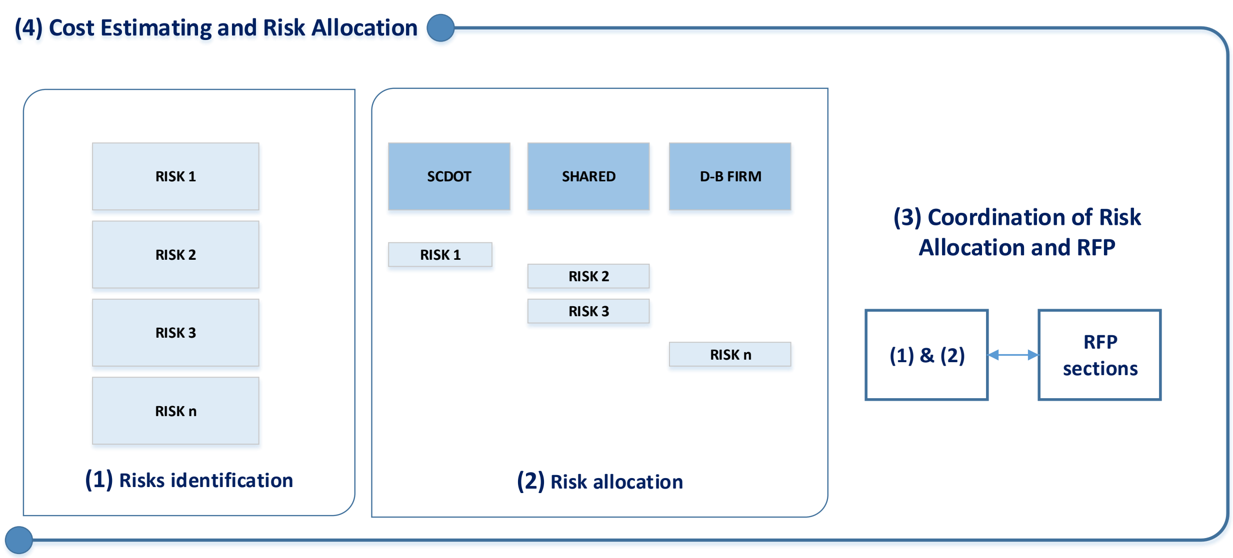


Figure 1 Risk allocation research process

The research team examined the risk categorization practices of six states. Table 1 synthesizes 16 risk categories from the analysis. SCDOT´s Manual includes a Risk Matrix; however, it does not define a risk categorization. A detail list of the potential risks associated with each risk category is provided in section 3.2.1. SCDOT can consider using this list to create a risk breakdown structure (i.e. categorization) that supports the project-based risk identification process.

Table 1 Risk categorization identified in the benchmarking

Risk category	CA	GA	NV	WA	CO	NY
Design	✓	✓	✓	✓	✓	
Environment	✓	✓		✓	✓	✓
Right of Way	✓	✓		✓	✓	✓
Utilities		✓	✓	✓	✓	✓
Railroad		✓	✓	✓	✓	✓
Construction	✓	✓	✓	✓	✓	
Differing Site Conditions/Changed Conditions			✓		✓	✓
Local Agency		✓	✓		✓	
Stakeholders Issues		✓		✓	✓	
Force Majeure/Acts of God			✓		✓	✓
Completion and Warranty			✓		✓	✓
Funding/Financing				✓		✓
Contracting and Procurement Issues		✓		✓		
Geotechnical Issues				✓		✓
Hydraulics				✓	✓	
Project Management	✓			✓		

Once identified, risks should be prioritized through a qualitative and/or quantitative analysis. Qualitative analysis is done through an adjectival rating (e.g., high, medium, low). Quantitative analysis is done by combining separate analysis of probability of risk occurance and magnitude of impact if the risk does occur (probability x impact) (Molenaar, Diekmann and Ashley 2006). Table 2 summarizes the types of analysis performed by six different DOTs. It also shows the DOTs that defines a specific criterion to determine the type of analysis that should be done. Section 3.2.2 includes more detail about these approaches.

Table 2 Sample of DOT risk analysis techniques

		CA	GA	NV	WA	CO	NY
Type of analysis	Qualitative Risk Analysis						
	Adjectival risk ratings	✓	✓	✓	✓		
	Quantitative Risk Analysis						
	Risk rating determined by (probability)*(impact occurrence)	✓		✓	✓	✓	✓
Criterion to determine the type of analysis related to project size		✓		✓	✓		

From a document review of these six states, the research team selected templates, as examples, which provide guidance for SCDOT to elaborate its risk management template. These examples are taken from other states ´risk management guides and manuals[1]. The selection aims to cover a wide range of examples with varying complexity (Table 3). The files can be reviewed in this

[1] See section 2 for more detail.

ProjectWise location: General Files > Design-Build > Design-Build SPR Project Selection Research > University of Colorado > Task 2-Tech Memos > Subtask2d Risk Allocation.

Table 3 Information included in examples of risk management templates

		AASHTO Ex. 1	CA Ex. 2	GA Ex. 3	NV Ex. 4	WA Ex. 5	CO Ex. 6	NY Ex. 7
Risk register & allocation		✓	✓	✓	✓	✓	✓	✓
Type of analysis included	Qualitative Risk Analysis							
	Adjectival risk ratings		✓	✓			✓	
	Quantitative Risk Analysis							
	Risk rating determined by (probability)*(impact occurrence)		✓			✓		✓
Risk response			✓			✓	✓	✓
Monitoring and control						✓		

This report constitutes a first step to improve the current SCDOT's risk allocation management. Current practices from six other states have been gathered and benchmarked with SCDOT's practice. From this analysis, SCDOT may wish to consider the following suggestions:

1. Elaborate risk identification guidelines in the Design-Build Manual to facilitate a more detailed and consistent process.
2. Establish a preliminary risk breakdown structure (i.e. categorization) that could serve as a baseline to define the project-based risks. This report includes a compilation of potential risks that could serve the SCDOT preliminary risk breakdown structure.
3. Define SCDOT's design-build risk tolerance (i.e. the criteria to determine if the level of risk is "high," "medium" or "low").
4. Review the examples of risk allocation templates included in this report to establish guidelines for the improvement of the SCDOT's current template.
5. SCDOT should evaluate in a project-by-project basis who is best equipped to handle each risk.
6. The first step for developing a risk assessment tool is to build a sound and comprehensive risk register form that can be easily updated during the project lifecycle. A good start-point might be the Risk Allocation Decision Matrix generated during the Project Delivery Selection Process (the Federal Highway Administration's Contracting Alternatives Suitability Evaluator (CASE) Webtool).
7. Once the risk are identified, a more in-depth analysis of these risks should be conducted to properly managed them. This analysis can take different approaches. However, all of them should seek to answer the following risk assessment questions:
    a. What can go wrong?
    b. What is the likelihood?
    c. What are the consequences?

2. Research Methodology

To accomplish this task, the research team developed a document analysis of design-build manuals and project risk management guidelines and templates. Of note are the Caltrans Project Risk Management Guidebook (Caltrans 2012), the GDOT Design-Build Suitability Assessment and Risk Management template (GDOT n.d.), the NVDOT Risk Management and Risk-Based Cost Estimation Guideline (NVDOT 2012), and the WSDOT Project Risk Management Guide (WSDOT 2018). The research team used the software "atlas.ti" for content analysis of these documents. The software allows for text coding for sorting and analysis. Table 4 summarizes the states and documents included in this review. These documents can be reviewed in this ProjectWise location: University of Colorado > Task 2-Tech Memos > Subtask2d Risk Allocation

Table 4 Agency Design-Build documentation reviewed

	CA	GA	NV	WA	CO	NY	SC
D-B Manuals	●	●	●	●	●	●	●
Other Docs	●	●	●	●			●

3. Summary of Analysis

This summary of analysis has two sub-sections. The first introduces the importance of risk allocation and includes two pieces of SCDOT's information related to risk management: the Design-Build Manual reference and an example of a specific project template. The second part analyzes the other states' practices regarding with risks categorization, risk analysis, and the use of templates for risk management.

3.1 Background

According to Molenaar and Tran (2015) "*Appropriate allocation of project risks is critical when developing any project contract. Risk allocation is even more critical for design-build contracts because many of the risks traditionally managed by the agency can and do become the responsibility of the design-builder*". Multiple sources of information are available to identify risks and multiple risk identification techniques can be used. Molenaar and Tran (2015) summarized the following list of risk-identification techniques and related databases gathered from different sources:

- ***Project examination***
  - Project goals
  - Project characteristics
  - Stakeholder characteristics
- ***Document examination***
  - Preliminary design (scoping, environmental or engineering)
  - Historic data
  - Preliminary test data
  - Project management plan
- ***Personal experience and insight***

- Brainstorming
- Interviews
- ***Risk categorization***
  - Organization of risks
  - Future reference database

In its Project Risk Management Guide, WSDOT identifies the similar techniques for risk identification: (1) brainstorming, (2) checklist and/or questionnaires to "specialty groups," (3) examination of past similar projects, and (4) a combination of the previous methods. Additionally, to those included by WSDOT, NVDOT suggests the use of (5) assumptions and constraints analysis and (6) cause and effect diagrams.

The SCDOT Design-Build Procurement Manual[2] indicates the following in Section 3.4 Risk Matrix:

> *"A Risk Matrix should be developed which identifies risks in three categories: high, moderate, and low with the "high" risks being those that are most relevant and critical to the success of the project. The PM should solicit feedback from each of the following disciplines: roadway, structures, hydraulics, geotechnical, traffic, environmental, ROW, utilities, and construction. The Risk Matrix should assign the risk to the SCDOT, Design-Build Team, or both, and the PM and DM should discuss mitigation strategies to assign the overall risks. Mitigation strategies could result in additional work by the SCDOT and/or its consultant that would typically be the responsibility of the Design-Build Team or vice versa*."

The SCDOT Risk Matrix example associated with the "*US 21 Bridge Replacement over Harbor River*" project is shown in Table 5, Table 6 and Table 7.

[2] Version 1.0. February 28, 2017.

Table 5. US 21 Bridge Replacement over Harbor River project (high risks)

High (X pts)			
Risk[3]	**Impact[4]**	**Mitigation[5]**	**Roles[6]**
Working in salt marsh because regulatory agencies could stop the project if the work damages marsh.	delay and delay cost	Environmental personnel on-site, appropriate coverage in permit, use trestle and barges for access.	contractor
Resource Availability / Labor & Material Limits (lack of suitable fill material within a reasonable haul distance, Rental equipment, and qualified labor, lack of raw materials for concrete, long distance to concrete plants)	delay and material/labor costs	on-site batch plant, on-site material storage, possible floating/barge delivery, and storage	contractor
Difficult Subsurface Conditions (Geotechnical anomalies that require an unanticipated depth of mucking or additional ground modifications)	cost and schedule	perform an adequate subsurface investigation and have an appropriate plan in place	contractor
Difficult Subsurface Conditions, challenging static and seismic soil conditions (complex foundation and roadway embankment design required)	Cost	perform an adequate subsurface investigation, have an appropriate plan in place, utilize specialists	contractor
Material delivery because existing bridge use may be limited. Continued deterioration of the existing bridge.	delay, material cost	have an appropriate plan for delivery and several options for delivery, determine appropriate load limits on existing	contractor & SCDOT
A difficult marine environment with a large difference in high/low tide and high frequency of violent storms.	delay, means & methods cost	have an appropriate plan for difficult conditions, including staff, equipment, and contingency plans	contractor
Limited or no material storage/lay down area at the site. Limited construction access from uplands.	delay and material/labor costs	possible floating/barge storage; use of temporary work bridges/trestles	contractor

Table 6 US 21 Bridge Replacement over Harbor River project (moderate risks)

Moderate (X pts)			
Risk	**Impact**	**Mitigation**	**Roles**
Environmental Compliance (Compliance with project commitments). i.e., Drainage / Water Quality encounters with marine wildlife, etc.	schedule & cost	appropriate plans in place, open communication w/ resource agencies, training contractor staff, on-site specialists	contractor
Weather anomalies such as hurricanes or flooding	schedule	appropriate plans in place	contractor
Keeping the navigational channel open & working over/around existing swing span.	schedule and cost	appropriate plans in place	contractor, scdot, uscg
Unable to meet DBE goal due to limited DBE participation	schedule & Cost	use multiple subs rather than a single sub, use appropriate justification for not meeting the goal	contractor
Drilled shaft slurry containment over open water.	cost	appropriate plans in place, use of barge containment	contractor
Removal of Existing Structure	cost & schedule	specialized swing span removal such as floating and dismantling off-site; specialized underwater demolition	contractor

[3] Describe why the risk is critical.
[4] Indicate the impact that risk will have on the project.
[5] Discuss the mitigation strategies the Proposer's team.
[6] Describe the role that the Proposer expects SCDOT or other agencies to have.

Table 7 US 21 Bridge Replacement over Harbor River project (Low risks)

Low (X pts)			
Risk	**Impact**	**Mitigation**	**Roles**
Obtaining USACE permit	schedule	correct submittal on the first round	contractor
Utility coordination	schedule	Avoidance of impacts to utilities.	contractor & utilities
Encountering historical, archaeological remains/artifacts	schedule	Have a plan in place for identifying/handling/moving	SCDOT & Contractor
Delay in completing RFC Plans	schedule	Submit correct plans on the first round.	Contractor
Worker Safety in a marine environment	schedule & cost	qualified contractors should have appropriate plans in place	Contractor
mitigation of marsh impacts	schedule & cost	SCDOT to purchase from available banks	SCDOT

3.2 Analysis

From the review of the SCDOT's information, the research team established three areas of study: (1) risk categorization, (2) risks analysis, and (3) templates.

3.2.1 Risk categorization

According to Molenaar et al. (2005) "*appropriately categorizing risks has three primary purposes. The first is to enhance efficiency in the subsequent risk allocation process. The second is to help identify any previously omitted risks by tracking the missing piece in the organized set of risks. When all the risks previously identified are categorized and listed, omitted, or overlapping risks become more apparent. The third is to create a historic database of risks that can be used in future design-build projects".* Section 3.2.2 example 1 "*suggests an appropriate risk categorization matrix that is also being used for risk identification and risk allocation."*

Caltrans, Georgia, Nevada, Washington, Colorado, and New York include different risk categories[7] in their guidance documents. From the analysis of these documents, 16 risk categories were compiled. The next sections include the potential risks that can be associated with each category. This compilation can provide SCDOT with preliminary risk categorization and set of risks that will aid in determining risks on individual projects.

Design

This category is one of the main categories, including numerous potential risks. Table 8 compiles the risks found in the document analysis.

[7] The documents reviewed in this subtask are located in ProjectWise: University of Colorado > Task 2-Tech Memos > Subtask2d Risk Allocation

Table 8 Design risks

Caltrans	
Design incomplete	Bridge site data incomplete
Unexpected geotechnical or groundwater issues	Hazardous waste site analysis incomplete
Inaccurate assumptions on technical issues in planning stage	Unforeseen design exceptions required
Surveys incomplete	Consultant design is up to Department standards
Changes to materials/geotechnical/foundations	Unresolved constructability items
Complex hydraulics features	Project in critical water shortage area and a water source agreement required
Unable to meet Americans with Disabilities Act requirements	Incomplete quantity estimates
New or revised design standards	Unforeseen construction window and/or rainy season requirements
GDOT	
Conduct preliminary surveys/develop base map	Lighting design
Conduct Geotech investigation- initial borings based on costing plans/original bridge layouts	Ensure conformance to design criteria
Conduct Geotech investigation- initial borings based on proposal	Perform design review
Establish/define initial subsurface conditions	Conduct QC
Perform initial project geotechnical analysis based on preliminary design	Conduct AQ
Develop proposal specific geotechnical analysis/report	Communicate changes in design criteria
Hydraulic report	Manage hazardous waste site/contaminated materials
Ensure plan conformance with regulations/guidelines/RFP	Conform with changes in design criteria
Ensure plan accuracy	Pavement design
Establish design criteria	
NVDOT	
Definition of scope	Plan accuracy
Project definition	Design criteria
Establishing performance requirements	Conformance to design criteria
Preliminary survey/base map	Design review process
Geotech investigation – initial borings based on preliminary design	Design QC
Geotech investigation – initial borings based on proposal	Design QA
Establish/Define initial surface conditions	Owner review time
Initial project geotechnical analysis/report based on preliminary design	Changes in scope
Proposal specific Geotechnical Analysis/Report	Constructability of design
Plan conformance with regulations/guidelines/RFP	Contaminated materials
WSDOT	
Design changes	Changes to design of traffic items
Deviation’s Approval	Design reviews
Architecture or landscape changes	Projects by other agencies affected
CDOT	
Project scope definition	Geotech investigation – initial borings on proposal
Design criteria	Plan conformance with regulations/guide/RF
Geotech investigation – initial borings on preliminary design	

Contracting Procurement Issues

GDOT and WSDOT consider this category. Table 9 lists the potential risks.

Table 9 Contracting procurement risks

GDOT	
Address issues related to contract language (warranties, bonding, etc.)	Avoid delays in procurement of specialty materials or equipment
Prevent delays in an ad/bid/award process (addenda, protests, etc.)	Procure long lead equipment or items as soon as possible
Ensure competitive procurement	Ensure contractor's compliance with performance expectations
WSDOT	
Change in delivery method	Delays in procurement
Contract language	Contractor non-performance
Delays in Ad/Bid/Award	Market conditions

Environmental

The majority of the states consider this category. Table 9 includes potential risks.

Table 9 Environmental risks

Caltrans	
Environmental analysis incomplete	Unexpected Native American concerns
Availability of project data and mapping at the beginning of the environmental study is insufficient	Unforeseen Section 4(f) resources affected
New information after Environmental Document is completed may require re-evaluation or a new document (i.e., utility relocation beyond document coverage)	Project may encroach into the Coastal Zone
New alternatives required to avoid, mitigate or minimize impact	Project may encroach onto a Scenic Highway
Acquisition, creation or restoration of on or off-site mitigation	Project may encroach to a Wild and Scenic River
Historic site, endangered species, riparian areas, wetlands and/or public park present	Unanticipated noise impacts
Design changes require additional Environmental analysis	Project causes an unanticipated barrier to wildlife
Unforeseen formal NEPA/404 consultation is required	Project may encroach into a floodplain or a regulatory floodway
Unforeseen formal Section 7 consultation is required	Project does not conform to the state implementation plan for air quality at the program and plan level
Unexpected Section 106 issues expected	Unanticipated cumulative impact issues
GDOT	
Define initial project environmental impacts	Obtain environmental approvals—construction related
Define parameters for impacts	Mitigate wetlands/stream/habitat issues
Conduct environmental investigations	Mitigate permanent noise issues
Acquire environmental permits	Address archaeological, cultural, historical discoveries
Manage/implement environmental mitigation process	NEPA compliance
Ensure environmental compliance	Stream buffer variance
Mitigate known hazardous waste	MS4
Mitigate unknown/non-defined hazardous waste	
WSDOT	
NEPA/SEPA	Wetland habitats
ESA issues	Stormwater potential
Environmental Permitting	Impacts during construction
Archaeological permitting	Permanent noise mitigation
Hazardous materials	Other issues
CDOT	
NEPA/SEPA	Final design environmental approvals
Environmental Mitigation Commitments	Permitting

Right of Way (ROW)

The majority of the states consider this category. Table 10 includes potential risks.

Table 10 ROW risks

Caltrans	
Utility company workload, financial condition or timeline	Inadequate pool of expert witnesses or qualified appraisers
Expired temporary construction easements	
GDOT	
Establish ROW limits	Acquire ROW
WSDOT	
ROW plan	Managed Access Appeal
Inflation	Acquisition issues
Limited access	Additional ROW is required
CDOT	
Establishing Right of Way limits	Acquire right of way

Utilities

Georgia, Nevada, Washington, and Colorado consider this category. Table 11 includes potential risks.

Table 11 Utility risks

GDOT	
Establishing initial utility locations	Relocation of utilities included in the contract
Identify initial utility impacts from preliminary design	Modify agreement with private utility based on final design
Define required utility relocations from preliminary design	Modify agreement with public utility based on final design
Mitigate damage to utilities under construction	Verify utility locations/conditions
Coordinate with utility relocation efforts during contract	Address utility owner/third party caused/related delays
Prevent delays caused by utility involvement issues	Prevent utility delays resulting from proposal/modified design
NVDOT	
Identification of initial utility impacts from preliminary design	Relocation of utilities prior to contract
Establishing initial utility locations/conditions	Relocation of utilities under agreement during contract
Defining required utility relocations from preliminary design	Modify agreement with private utility based on final design
Damage to Utilities under Construction	Modify agreement with public utility based on final design
Verification of utility location/condition	Coordination with Utility Relocation efforts during contract
Unforeseen delays- Utility/third party	Utility/third party delays resulting from proposal/modified design
WSDOT	
Coordination	Conflicts
CDOT	
Establish initial utility locations/conditions	Relocation of utilities under agreement during contract
Modified agreement with private utility based on final design	

Railroad

Georgia, Nevada, Washington, and Colorado consider this category. Table 12 lists the potential risks.

Table 12 Railroad risks

GDOT	
Railroad coordination (pre-let)	Railroad coordination (post-let)
NVDOT	
Identification of railroad impacts	Obtaining initial railroad agreement based on preliminary design
Coordinating with a railroad under agreement	
WSDOT	
Design coordination	Construction coordination
Right of entry	
CDOT	
Obtain initial railroad agreement based on preliminary design	Coordination with railroad under agreement

Construction

The majority of the states consider this category. Table 13 lists potential risks.

Table 13 Construction risks

Caltrans	
Inaccurate contract time estimates	Permit work window time is insufficient
Change requests due to differing site conditions	Temporary excavation and shoring system design is not adequate
Falsework design is not adequate	Unidentified utilities
Buried human-made objects/unidentified hazardous waste	Dewatering is required due to change in water table
Temporary construction easements expire	Electrical power lines not seen and in conflict with construction
Street or ramp closures not coordinated with local community	Insufficient or limited construction or staging areas
Changes during construction require additional coordination with resource agencies	Late discovery of aerially deposited lead
Experimental or research features incorporated	Unexpected paleontology findings
Delay in demolition due to sensitive habitat requirements or other reasons	Long lead time for utilities caused by design and manufacture of special components (steel towers or special pipe)
GDOT	
Address traffic control and staging issues	Acquire construction permits
Ensure safety/conduct safety QA	Establish/comply with traffic control requirements
Address change orders/claim	Plan/coordinate construction staging issues
Ensure construction quality/workmanship	Comply with project schedule
Control/ensure materials quality	Maintain materials documentation
Ensure materials availability	Develop/comply final construction/materials QC/QA plan
Conduct construction/materials QA	Conduct construction QC
Conduct construction AQ/procedural compliance auditing	Conduct construction IA testing/inspection
Perform construction staking	Carry out erosion control
Perform spill prevention	Prevent accidents within work zone/ liability
Avoid third-party damages	Manage traffic in construction zones
Prevent damage to utilities under construction	Avoid falsework/rework
Develop shop drawings	Mitigate equipment failure/breakdown
Manage community relations	Ensure performance of defined mitigation measures
Provide warranty	Coordinate street/ramp closures
Develop construction staging plans	Comply with DBE requirements
Assume long-term ownership/final responsibility	
NVDOT	
DBE compliance	Safety/Safety QA
Construction Quality/Workmanship	Schedule
Material quality	Materials documentation
Materials availability	Initial performance requirements of QA plans
Final Construction/Materials QC/QA plan	Construction/Material QA
Construction QC	Construction QA procedural compliance auditing
Construction IA testing/Inspection	Construction Staking
Erosion control	Spill prevention
Accidents with work zone/liability	Third party damages
Operations and Maintenance during construction	Maintenance under construction—new features
Maintenance under construction—existing features	Maintenance of Traffic
Quantity/Cost of Nevada State Patrol Callbacks	Availability of Nevada State Patrol Callbacks
Damage to utilities under construction	Falsework
Shop drawings	Equipment failure/breakdown
Work methods	Early construction/At-Risk Construction
Community relations	Performance of defined mitigation measures
Warranty	
WSDOT	
Traffic Control and staging	Construction permitting
Work Windows	Schedule uncertainty
Marine construction	Earthwork issues
Coordination with adjacent properties	Contractor access
Construction accidents	Others issues
CDOT	
Initial performance requirements	Final construction/materials QA/QC Plan
Material Quality	Construction quality and safety

Differing Site Conditions/Changed Conditions

NVDOT, CDOT, and NYDOT include this category. However, they do not list any specific risks. Note that Caltrans considers the risk “changes due to differing site condition request” in its construction risks.

Local Agency

Table 14 shows some examples of potential risks that Georgia, Nevada, and Colorado include in this group.

Table 14 Local Agency Risks

GDOT	
Identify/obtain local agency impacts/permits/requirements	
NVDOT	
Identification of initial local agency impacts	Obtaining initial local agency permits
Establishing initial local agency requirements	Establishing final/actual local agency impacts
Modification to existing local agency permits	
CDOT	
Identification of initial local agency impacts	Establish final/actual local agency impacts
Modification to existing local agency permits	

Stakeholder’s Issues

Georgia and Washington consider this category. Table 15 lists some of the potential risks. Note that CDOT considers “third party involvement” as one of the typical Design-Build risks in transportation projects.

Table 15 Stakeholders risks

GDOT	
Prevent delays caused by third party involvement issues	Prevent third-party delays resulting from proposal/modified design
Obtain third-party agreements (fed, local, private, etc.)	Coordinate with third parties under agreement
Coordinate with other projects	Coordinate with adjacent property owners
WSDOT	
Tribal issues	Public involvement
Additional scope for third parties	

Force Majeure/Acts of God

Nevada and Colorado consdier this category. Table 16 lists the potential risks.

Table 16 Force Majeure/Acts of God Risks

NVDOT	
Strikes/Labor disputes- on-site labor	Tornado/Earthquake
Epidemic, terrorism, rebellion, war, riot, sabotage	Archaeological, paleontological discovery
Suspension of any environmental approval	Changes in law
Lawsuit against the project	Storm/Flooding
Fire or other physical damage	
CDOT	
Natural hazard (tornado, earthquake, etc.)	Change in law

Completion and Warranty

Table 17 shows some examples of potential risks that Nevada and Colorado include in this group.

Table 17 Completion and warranty risk

NVDOT	
Establishment/definition of any risk pool	Long-term ownership/final responsibility
Insurance	
CDOT	
Long-term ownership/final responsibility	Insurance

Funding/Financing

WSDOT considers one risk in this category, “cash flow restrictions.” NYDOT defines the category but does not suggest any risks within it.

Geotechnical issues

Some states include this category within the design. WSDOT and NYDOT consider it as an independent group. WSDOT includes two aspects that can be produced by geotechnical issues: “design changes” and “changes in the design criteria.” NYDOT´s manual mentions this category without defining any specific risks. The research team is suggesting this as a risk category, but SCDOT may wish to include it as a risk(s) under design.

Hydraulics

Hydraulics is considered to be a category by some DOTs and as a risk by others. WSDOT considers a risk named “Environmental and Hydraulics” that includes the potential risks listed in Chapter 3 its WSDOT Design-Build Manual. CDOT’s Design-Build Manual states that “Drainage and Water Quality” is one of the typical risks on transportation projects. They indicate that: “*Often project drainage facilities receive flows from outside the project limits and/or release flows to outside the project limits. When the project design is likely to change historic flow patterns or release volumes, it is necessary to negotiate with adjacent owner agencies for the revised conditions. Permanent Water Quality (PWQ) requirements are continually evolving and are frequently difficult to define and assess. As a result, PWQ is often a high-risk item for the Design-Builder*.” The research team is suggesting this as a risk category, but SCDOT may wish to include it as a risk(s) under design.

Project Management
Caltrans and WSDOT consider this category. Table 18 lists the potential risks.

Table 18 Project management risks

Caltrans	
Priorities change on existing program	Inconsistent cost, time, scope, and quality objectives
WSDOT	
Management change	Political/Policy changes
Delayed decision making	State workforce limitation

3.2.2 Risk analysis

Once the risks are identified, it is necessary to prioritize them. This prioritization can be performed using qualitative or quantitative analysis. Qualitative analysis rates risks by adjectives (e.g., high, medium, low). Quantitative analysis assigns a numeric value for probability of risk occurrence and magnitude of impact if the risk does occur.

It should be noted that quantitative risk analysis may also include Monte Carlo simulation. WSDOT performs Monte Carlo risk analysis through its Cost Risk Assessment (CRA) and Cost Estimating Validation Process (CEVP). FHWA supports states in this analysis through its Cost Estimating and Risk (CER) process. Various consulting firms perform Monte Carlo analysis or have helped DOT develop their own unique Monte Carlo risk analysis processes. The discipline is rapidly evolving. This research study will explore Monte Carlo analysis practices and techniques in more depth during the Task 3 Cost Estimating portion of the study.

The DOTs analyzed in this task of the research study take different approaches for qualitative and quantitative risk analyses. Caltrans, Washington, and Nevada establish ranges of project sizes to determine the type of analysis that should be performed. A summary of these considerations are included in Table 19, Table 20, and Table 21.

Table 19 Caltrans risk management requirements by scalability level

Scalability Level	Estimated Cost (Capital and Support)	Risk Management Requirements
	Minor A, Minor B, and other projects less than $1 million	Risk register encouraged
1	Less than $5 million	Risk register
2	$5 million to $100 million	Risk register with qualitative analysis
3	Greater than $100 million	Risk register with quantitative analysis

Table 20 GDOT levels of Risk-Based Estimating in Support of Risk Management

Project Size ($M)		Required Process*
Quantitative	$10M to $25M	Informal workshop using the self-modeling spreadsheet[1][3]
	$25M to $100M	Cost Risk Assessment (CRA) Workshop[1][2]
	Greater than 100M	Cost Estimate Validation Process® (CEVP®) Workshop[2]

[1] In some cases, it is acceptable to combine the Value Engineering Study and Risk-Based Estimating Workshop.

[2] Projects $25M and over should use the self-modeling spreadsheet in the scoping phase risk-based estimating process, followed up by the more formal CRA or CEVP® process during the design phase.

[3] An informal workshop is comprised of the project team (or key project team members); other participants may be included as the Project Manager/project team deem necessary.

Note: For projects less than $10M, qualitative analysis is sufficient, although a higher level may be used if desired.

Table 21 NVDOT Risk Management Process

Project Size ($)	Required Process	Suggested Process
< $10 M	Qualitative Assessment	Qualitative Assessment
$10 M to $25 M	Qualitative Assessment	Informal quantitative workshop using the "NDOT Risk Tracking and Analysis Tool for Small and Medium Size Projects"
$25 M to $100 M	Qualitative Assessment	Cost Risk Assessment (CRA)
> $100 M	Cost Risk Assessment (CRA)	N/A

A brief discussion of qualitative risk analysis is warranted here. A *first level qualitative analysis* only assigns a risk rating to each risk. The rating determines where the greatest effort should be focused on responding to the risks. According to Caltrans Project Risk Management Handbook (Caltrans 2012), the qualitative analysis facilitates structured risk response action and resource allocation. The rating usually is: (1) "high"—first priority of risk response, (2) "medium"—risk response as time and resources permit, and (3) "low"—no risk response required at this time.

Chapter 3 of the WSDOT's Project Risk Management Guide (WSDOT 2018) includes the following guidelines to perform a Qualitative Risk Analysis: *"Once a risk is identified, write a thorough description of the risk and risk triggers — this aids in characterizing the risk regarding probability of occurrence and the consequence.*

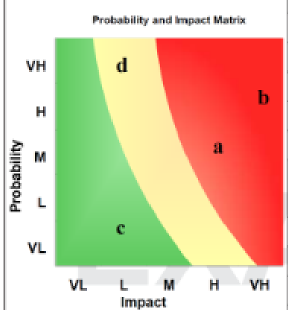
1. *Gather the project team and appropriate persons to discuss project risk. Establish which of the qualitative risk matrices you intend to use and define the terms you plan to use (Very High, High, Medium, Low, etc.).*
2. *Review the risk information from the risk identification step.*
3. *Discuss the risk with the group.*
4. *Evaluate the likelihood of the risk occurring by asking the group "How likely is it that this risk will occur?" Record the result that the group agrees on.*
5. *Evaluate the consequences if the risk does occur by asking the group "What will be the impacts if this risk does occur?" Record the result that the group agrees on.*

6. *Prioritize the risks based on the results of the qualitative analysis. If it is desirable, the risks can also be grouped by category (e.g., Environmental, Structures/Geotech) and ranked within each category."*
7. Define Risk Assignment (Not included in WSDOT's Project Risk Management Guide)

An example of a probability impact matrix from WSDOT is shown in Figure 2.

Qualitative Risk List

count	T/O	RBS #	Risk Title	Probability	Impact
a	T	ENV 30.1	Permits and Permit Appeals	Medium	High
b	T	UTL 20.1	Unidentified Utility Conflicts	High	Very High
c	T	STG 20.4	Change to Substructure Assumptions	Very Low	Low
d	T	ROW 40.1	Managed Access challenge	Very High	Low



Probability (Likelihood)	Synonyms		[1]Approximate %
Very high	Almost certain	Very Sure	≥ 90%
High	Likely	Pretty Sure	80%
Medium	Possible	Maybe	50%
Low	Unlikely	Seldom	20%
Very Low	Rare	Improbable	≤ 10%
Consequence (Impact)	**Synonyms**		**[1]Approximate % of Phase (PE, RN, CN)**
Very high	Very Critical	Very Strong	≥ 10%
High	Critical	Strong	8%
Medium	Moderate	Average	4%
Low	Slight	Mild	2%
Very Low	Very Little	Very Mild	≤ 1%

[1]Suggested percentages; project teams may adjust if they desire.

Figure 2 Probability impact matrix in WSDOT

Figure 3 depicts the process for risk assessment included in CDOT's Design-Build Manual.

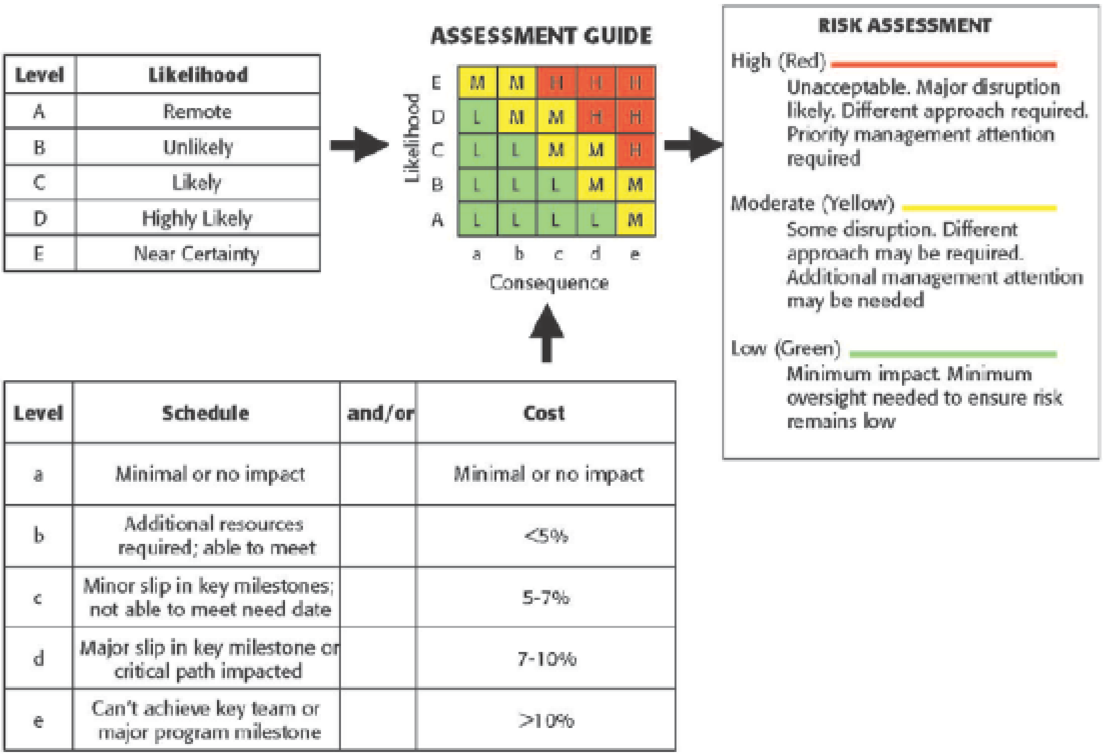


Figure 3 CDOT process for risk assessment

Caltrans's Project Risk Management Handbook includes a standard definition of risk, probability and impact rating. *"The ratings for the project serve as a consistent frame of reference for the Project Risk Management Team (PRMT) in assessing the risks during the life of the project. Table 22 is intended as a guide – the PRMT may define dollar and time ranges as appropriate for the project. The impacts are to the overall project. Schedule delay applies to risks that are on the critical path (the longest path). During the Planning and Design phase, delay impacts to Ready to List (RTL) may be of primary interest. During construction, delays impact project completion. Cost impacts are based on the sum of Capital Outlay (CO), and Capital Outlay Support (COS) costs." Table 22* shows the definitions of impact and probability ratings.

Table 22 Caltrans definitions of impact and probability ratings

Rating -->	Very Low	Low	Moderate	High	Very High
Cost Impact of Threat (CO + COS)	Insignificant cost increase	<5% cost increase	5-10% cost increase	10-20% cost increase	>20% cost increase
Cost Impact of Opportunity (CO + COS)	Insignificant cost reduction	<1% cost decrease	1-3% cost decrease	3-5% cost decrease	>5% cost decrease
Schedule Impact of Threat	Insignificant slippage	<1 month slippage	1-3 months slippage	3-6 months slippage	>6 months slippage
Schedule Impact of Opportunity	Insignificant improvement	<1 month improvement	1-2 months improvement	2-3 months improvement	>3 months improvement
Probability	1–9%	10–19%	20–39%	40–59%	60–99%

Figure 4 depicts the risk matrix used by Caltrans

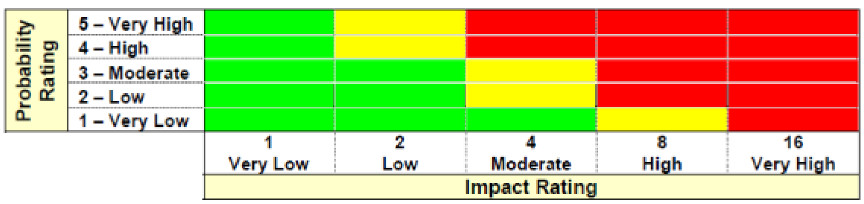


Figure 4 Caltrans Risk Matrix

NYDOT includes the following steps for risk analysis and defines the risk analysis matrix as it is shown in Figure 5.

1. *Assess the likelihood (probability) a risk event of the nature listed and defined will occur throughout the contract, including Warranty periods. The probability should be rated on a scale of 1 to 3, with 3 representing the highest probability.*
2. *Assess the degree of impact (severity) the occurrence of an identified risk event would have on the Project. The impact should be rated on a scale of 1 to 3, with 3 representing the highest impact.*
3. *The overall risk rating is determined by multiplying the probability rating by the severity rating, resulting in a range of 1 to 9 for the overall risk rating.*

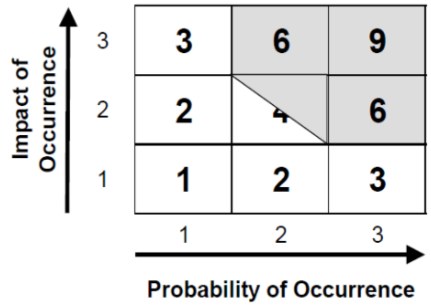


Figure 5 NYDOT Risk analysis matrix

3.2.3 Example Excel templates

The research team selected some templates as examples for SCDOT review. The selection aims to cover a wide range of variety and complexity. The files can be reviewed in this ProjectWise location: General Files > Design-Build > Design-Build SPR Project Selection Research > University of Colorado > Task 2-Tech Memos > Subtask2d Risk Allocation.

3.3 Suggestions

This report constitutes a first step to improve the current SCDOT's risk allocation management. Current practices from six other states have been gathered and benchmarked with SCDOT's practice. From this analysis, SCDOT may wish to consider the following suggestions:

1. Elaborate risk identification guidelines in the Design-Build Manual to facilitate a more detailed and consistent process.
2. Establish a preliminary risk breakdown structure (i.e. categorization) that could serve as a baseline to define the project-based risks. This report includes a compilation of potential risks that could serve the SCDOT preliminary risk breakdown structure.
3. Define SCDOT's design-build risk tolerance (i.e. the criteria to determine if the level of risk is "high," "medium" or "low").
4. Review the examples of risk allocation templates included in this report to establish guidelines for the improvement of the SCDOT's current template.
5. SCDOT should evaluate in a project-by-project basis who is best equipped to handle each risk.
6. The first step for developing a risk assessment tool is to build a sound and comprehensive risk register form that can be easily updated during the project lifecycle. A good start-point might be the Risk Allocation Decision Matrix generated during the Project Delivery Selection Process (FHWA ACM Tool).
7. Once the risks are identified, a more in-depth analysis of these risks should be conducted to properly managed them. This analysis can take different approaches. However, all of them should seek to answer the following risk assessment questions:
    a. What can go wrong?
    b. What is the likelihood?
    c. What are the consequences?

4. References

Caltrans. (2012). “Project Risk Management Handbook: A Scalable Approach.”

GDOT. (n.d.). “Design Build Suitability Report and Risk Matrix Template.”

Molenaar, K.R., Diekmann, J.E, and Ashley, D.B. (2006). Guide to Risk Assessment and Allocation for Highway Construction Management, *Report # FHWA-PL-06-032, Federal Highway Administration, U.S. Department of Transportation, American Association of Stare Highway Transportation Officials, and the National Cooperative Highway Research Program,* Washington, DC, October 2006, 73 pp.

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Molenaar, K. R., and Tran, D. (2015). *NCHRP Synthesis 471. Practices for Developing Transparent Best Value Selection Procedures*.

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Appendix 2E – Tech Memo on Design-Build Quality Assurance

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 2. Tools, Processes and Best Practices

Task 2e. Design-Build Quality Assurance

Prepared by

University of Colorado Boulder

University of Colorado Boulder

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Table of Contents

Contents

1. Executive Summary

The objective of this subtask is to identify and summarize the main decision points for shifting traditional quality assurance (QA) from SCDOT to the design-builder. The research team benchmarked SCDOT's QA and quality control (QC) processes for both design and construction against the NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction. The research team also compared the SCDOT I-85 and I-77 Design-Build projects with similar projects from Colorado, Minnesota and Utah. Based upon this benchmarking, a high-level summary the findings is as follows.

1. SCDOT is conducting Design-Build QA consistently with other state agencies from across the nation.
2. SCDOT is applying the "Assurance" model, which transfers the traditional QC to the design-builder, but retains QA with the agency.
3. SCDOT can choose to transfer more QC and QA tasks to the design-builder. SCDOT can take on more of an oversight role and still be consistent with other state DOTs, as well as meet Federal requirements.

2. Research Methodology

To accomplish this task, the research team reviewed two SCDOT projects and collected questionnaires from the project team members to determine the approach to QA. The SCDOT practices were compared to similar projects from Colorado, Minnesota, and Utah using the QA models documented in *NCHRP Report 808 Guidebook on Alternative Quality Management Systems for Highway Construction*. The research team's assessment and recommendations are made based upon this benchmarking and research team's experience in the evolving area of QA for Design-Build projects across the country.

3. Summary of Analysis

This section reviews the different models of alternative quality assurance organizations (QAO) in use by DOTs across the country. Factors influencing the selection of the most appropriate QAO are then presented. Finally, two projects from SCDOT "I-85 MM 77-98" and "I-77 Widening and Rehabilitation" are analyzed and benchmarked with the models currently used by other DOTs.

3.1 Quality Assurance Models (QAO) Models

NCHRP Report 808 identifies QAO models for highway construction (Molenaar, Gransberg, and Sillars 2015). The different QAO models range from the agency-dominated system of quality management, associated with the traditional D-B-B method, to the public-private partnership (PPP) agreement system where the responsibility for quality management is almost completely that of the concessionaire.

The QAO models presented in this section are intended to provide SCDOT a framework to better understand their current QA practice in Design-Build projects. NCHRP Report 808 presents five fundamental QAOs for highway design and construction. The definitions follow and their range of application is shown in Figure 1.

- **Deterministic.** The traditional approach to quality within the highway industry, in which the agency retains responsibility over all project quality roles, responsibilities, and activities.
- **Assurance.** The agency is responsible for all aspects of quality except for design and construction quality control (QC).
- **Variable.** Design and construction take different approaches to quality. For example, the STA may assign both design phase QC and acceptance to an outside party, while the construction phase QC only may be assigned to an outside party. This approach is primarily found on Design-Build projects.
- **Oversight.** The agency takes on an oversight role by assigning design QC, design acceptance, construction QC, and construction acceptance to outside parties.
- **Acceptance.** The agency is responsible only for verification testing and final acceptance. All other quality roles and responsibilities are assigned to the concessionaire. This variation is generally limited to PPP arrangements.

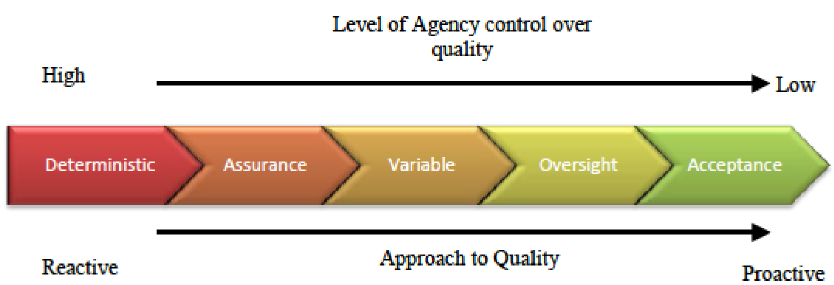

Figure 1. Spectrum of QAOs

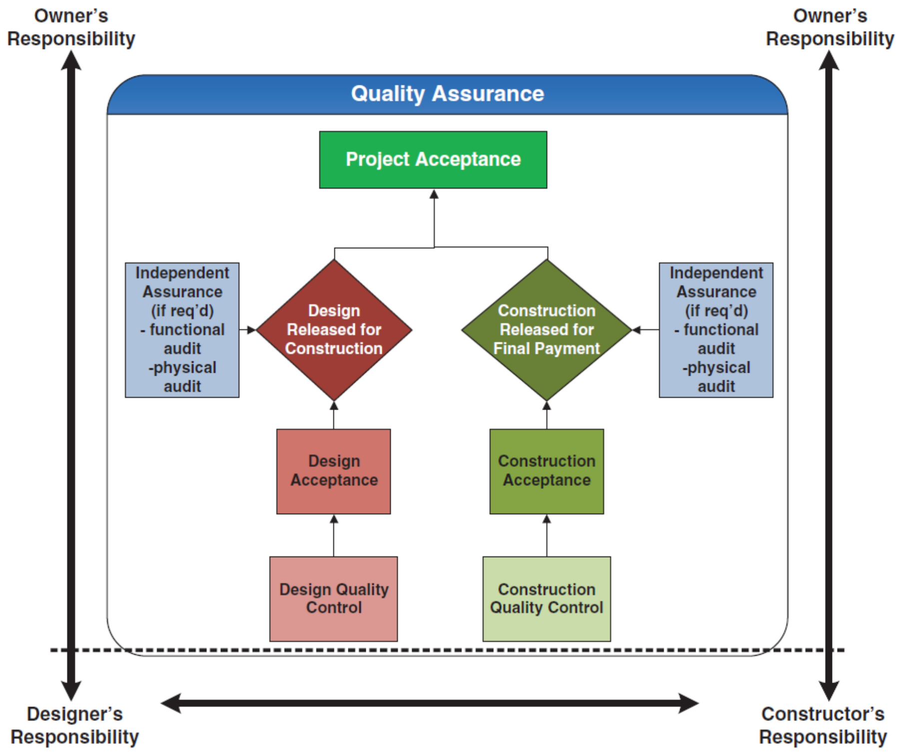

Figure 2. Generic QAO Model (NCHRP Report 808)

The generic model, shown in Figure 2, depicts all of the project quality roles, their relationships, and the surrounding project quality activities that should be considered when designing a complete QAO, including both design and construction. Design quality has not been traditionally included in highway QA discussions, but is required for the alternative delivery methods. In the variants presented in this section, a dotted line is used to indicate whether the agency, contractor, designer, concessionaire, or design builder is responsible for a project quality role. Items appearing above a dotted line are the responsibility of the agency. A vertical dotted line appearing below a horizontal dotted line separates the responsibilities of the designer and the contractor. The appendix of this document includes a more detailed description of the different types of QAOs

3.2 Factors Influencing QAO Selection

This section summarizes the factors influencing the selection of the most appropriate QAO. The results presented in this section come from a national study developed at the University of Colorado on the risks and benefits of Alternative Contracting Methods (ACMs) for highway construction (FHWA, 2018). This study collected performance data from 291 US highway projects that were completed between 2004 and 2015. These projects were collected from DOTs and the FHWA Office of Federal Lands Highway. The data collection involved 26 states who were determined to be using ACMs through a national survey of all DOTs. The ACMs included Design-

Bid-Build (DBB), Construction Manager/General Contractor (CM/GC), and Design-Build (using both low bid (LB) and best-value (BV)) procurement approaches.

The data in Table 1, indicates that 76% of the sampled projects (91/119) use either the traditional Deterministic or Assurance QAOs. For Design-Build/LB projects, where the DOT provides a relatively high level of preliminary design and selection is based on low bid similar to DBB, 74% of the sampled projects use the more traditional (Deterministic and Assurance) QAO approaches where the DOT has primary responsibility for quality management. Design-Build/BV projects, where DOTs provide lower levels of preliminary design and the industry takes primary responsibility for design, a lower number (60%) of the sampled projects use traditional QAOs.

Table 1. QAO benchmarking by delivery method

Quality Assurance Organization (QAO)	**D-B-B N = 49**	**CM/GC N = 26**	**D-B/LB N = 19**	**D-B/BV N = 25**	**ALL Projects N = 119**
Deterministic	17	8	7	6	38
Assurance	24	13	7	9	53
Variable	2	0	1	0	3
Oversight	2	5	1	9	17
Acceptance	4	0	3	1	8

Table 2 provides a breakdown of QAOs by agency. Several of these agencies (ADOT, FDOT, MnDOT, and WSDOT), have mature Design-Build programs and have used ACMs (i.e. D-B, CM/GC, and P3) for more than 15 years. As noted in Table 2 these agencies have implemented Oversight or Acceptance QAOs for selected ACM projects.

Table 2. QAO benchmarking by agency

QAO	**ADOT N = 16**	**CDOT N = 10**	**FDOT N = 33**	**Maryland DOT N = 5**	**MnDOT N = 9**	**ODOT N = 9**	**Ore. DOT N = 4**	**UDOT N = 26**	**WSDOT N = 9**
Deterministic	3	4	3	4	5	7	0	11	1
Assurance	7	6	20	1	2	1	3	11	2
Variable	0	0	1	0	0	0	0	1	1
Oversight	6	0	4	0	0	1	1	2	5
Acceptance	0	0	5	0	2	0	0	1	0

3.3 SCDOT Project Analysis

The research team conducted a survey of two SCDOT projects aiming to compare their QA characteristics with similar projects developed in other states. The survey is included in the Appendix. The following sections summarize the main project features.

3.3.1 I-85 Reconstruction and Widening MM 77-98, South Carolina

Project Name: I-85 Reconstruction and Widening MM 77-98

Name of Agency: SCDOT

Location: Spartanburg and Cherokee counties.

Project Delivery Method/Procurement/Contract Type: Design-Build/Adjusted Score/Lump Sum

Project Description: The project includes improvements to an approximately 21-mile long section of the I-85 corridor designed to rehabilitate asphalt, increase capacity, and upgrade interchanges and overpass bridges to meet state and federal design requirements.

Project Quality Profile: SCDOT is responsible for all QA and independent assurance (IA) on the project. The design-builder is responsible for all QC, both design and construction. SCDOT performs routine construction inspection, QC testing, IA, acceptance testing, and reporting of nonconforming work or punch list through an independent quality consultant.

QAO: Figure 3 shows that the QAO for this project was Assurance.

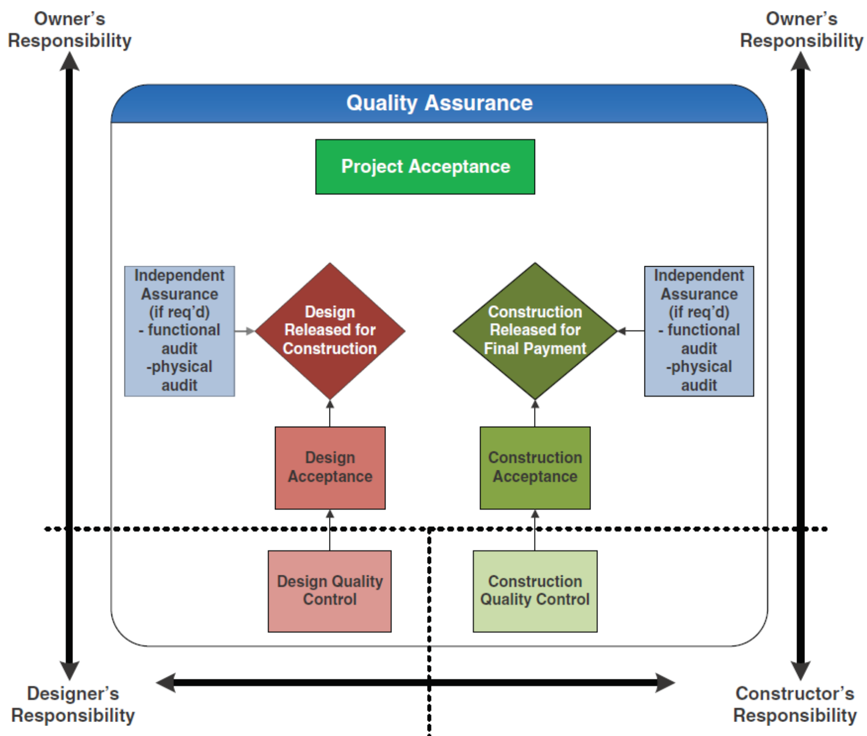

Figure 3. I-85 QAO Model

QA/QC Plans: In design, the design team develops the design Quality Control Plan for this project. SCDOT receives this document and reviews it for compliance with the RFP. In construction, SCDOT hires and independent quality consultant who performs routine construction inspection, QA testing, IA, and acceptance testing. The consultants also report work or punch list non-conformities.

Quality Management Responsibility Allocation:

Table 3. Summary of design and construction quality management roles

Responsibility allocation for design management tasks	**Agency personnel**	**Consultant design staff**	**Constructor's preconstruction staff**	**Agency-hired QA/oversight consultant**
Technical review of design deliverables		✔		
Checking of design calculations		✔		
Checking of quantities		✔		
Acceptance of design deliverables	✔			
Review of specifications	✔			
Approval of final construction plans & other design documents	✔			
Approval of progress payments for design progress	✔			
Approval of post-award design QM/QA/QC plans	✔			
Responsibility allocation for construction management tasks	**Agency personnel**	**Consultant design staff**	**Constructor's construction staff**	**Agency-hired QA/oversight consultant**
Technical review of construction shop drawings	✔			
Technical review of construction material submittals	✔			
Checking of pay quantities	✔			
Routine construction inspection				✔
Quality control testing			✔	
Verification testing	✔			
Acceptance testing	✔			✔
Approval of progress payments for construction progress	✔			
Approval of construction post-award QM/QA/QC plans	✔			
Report of nonconforming work or punch list.	✔			✔

3.3.2 I-77 Widening and Rehabilitation, South Carolina

Project Name: I-77 Widening and Rehabilitation

Name of Agency: SCDOT

Location: The project begins between SC 12 (Percival Road) and I-20 and terminates at the Killian Road Interchange.

Project Delivery Method/Procurement/Contract Type: Design-Build/Adjusted bid/Lump Sum

Project Description: The project includes widening of I-77 with an additional lane in each direction. The project also includes pavement rehabilitation and cross slope verification/correction of the existing lanes of I-77. The pavement for the project will consist of both concrete and asphalt.

Project Quality Profile: SCDOT retains traditional QA and IA roles, with the exception QC/QA testing with asphalt paving, which is responsibility of the contractor. QC is performed by the contractor.

QAO: Figure 4 shows that the QAO for this project is Assurance.

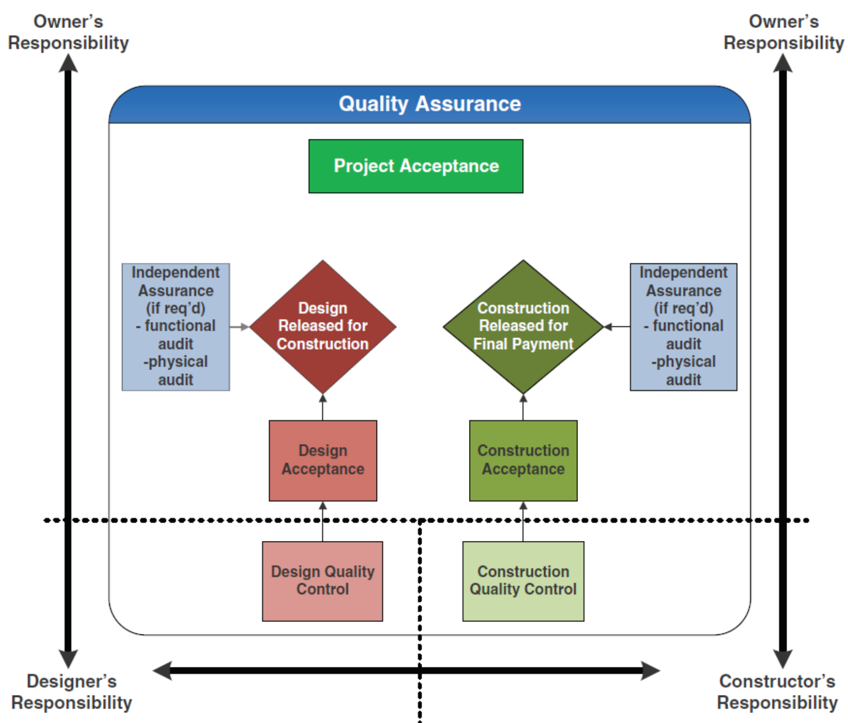

Figure 4. I-77 QAO Model

QA/QC Plans: SCDOT does not use the same quality management system across all projects, regardless of delivery method. For this Design-Build project, "*the contractor must submit a very thorough QC Plan for design and all major construction phases. The QC Plan is required to include onsite inspection and testing by SCDOT-certified inspectors, which typically is not needed for operations other than contractor-performed QA/QC testing for asphalt paving. The QC Plan is* *updated during the life of the project as plans are finalized and new subcontractors come on board”*

Quality Management Responsibility Allocation:

Table 4. Summary of design and construction quality management roles

Responsibility allocation for design management tasks	**Agency personnel**	**Consultant design staff**	**Constructor’s preconstruction staff**	**Agency-hired QA/oversight consultant**
Technical review of design deliverables	✔			
Checking of design calculations	✔			
Checking of quantities*				
Acceptance of design deliverables	✔			
Review of specifications	✔			
Approval of final construction plans & other design documents		✔	✔	
Approval of progress payments for design progress	✔	✔	✔	
Approval of post-award design QM/QA/QC plans	✔		✔	
Responsibility allocation for construction management tasks	**Agency personnel**	**Consultant design staff**	**Constructor’s construction staff**	**Agency-hired QA/oversight consultant**
Technical review of construction shop drawings	✔	✔	✔	
Technical review of construction material submittals	✔	✔	✔	
Checking of pay quantities*	✔		✔	
Routine construction inspection	✔		✔	
Quality control testing			✔	
Verification testing (referred as IA in SCDOT terminology)	✔			
Acceptance testing (referred as QA and QC in SCDOT terminology)	✔			
Approval of progress payments for construction progress	✔			
Approval of construction post-award QM/QA/QC plans	✔			
Report of nonconforming work or punch list.	✔			

* The research team needs to verify these responsibilities with SCDOT.

3.3.3 S. 160 4th Lane Addition, Colorado

Project Name: U.S. 160 4th Lane Expansion

Name of Agency: Colorado Department of Transportation (CDOT)

Location: U.S. 160 at Farmington Hill Interchange/Wilson Gulch in Grandview Colorado just east of Durango, CO

Project Delivery Method/Procurement/Contract Type: Modified Design-build (Low bid procurement)

Note: Modified Design-Build is a CDOT alteration on standard practice for Design-Build. Modified Design-Build contains a higher level of initial design and is awarded on a low-bid best value basis. For the remainder of this report, this case study will be listed simply as using a Design-B delivery method.

Project Description: The project included the design and construction of four bridges in mountainous terrain and crossing U.S. 160 and the environmentally-sensitive Wilson Gulch. Highly-curved ramp geometries, high settlement soils and a limited construction season created design challenges which were overcome to deliver a successful design.

Project Quality Profile: CDOT was responsible for all QA and independent assurance on the project. The design builder was responsible for all QC, both design and construction. Outside of the design builder having the responsibility for design QC, the project quality management was no different than a design-bid-build project. CDOT does use the same quality management system across all project, regardless of delivery method. CDOT performed testing on all materials; it appears that quality management system for the construction was heavily directed by the agency. The lack of a design builder created construction QC plan is further evidence that the construction quality management was directed by CDOT.

QAO: Figure 5 shows that the QAO for this project was Assurance.

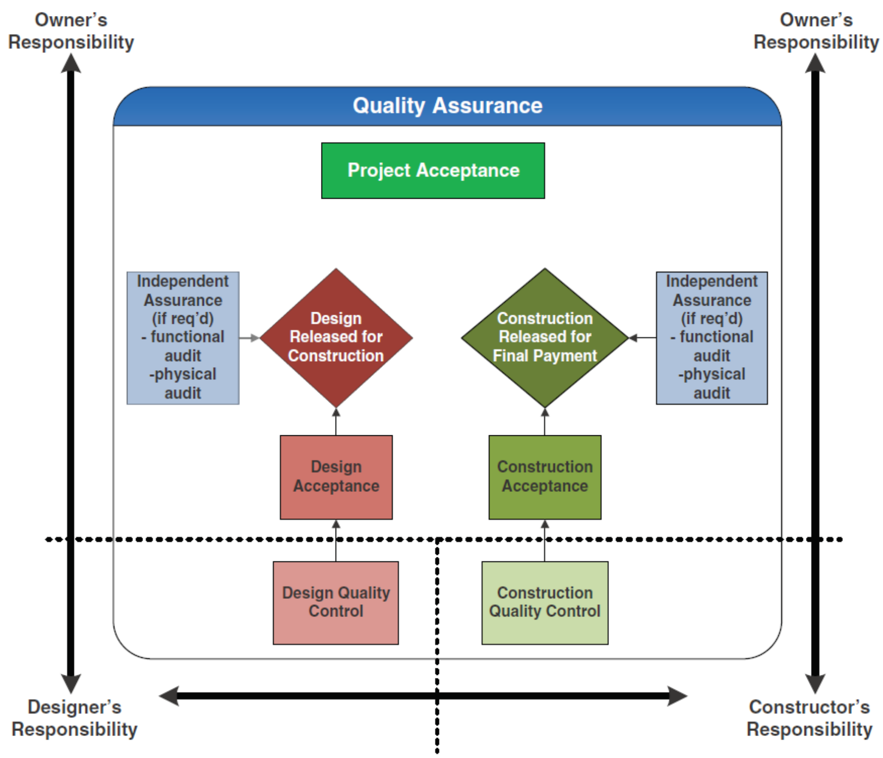

Figure 5. U.S. 160 4th Lane Addition QAO Model

QA/QC Plans: The primary quality management plan in place for this project was the design quality control plan (DQCP) which was created by the designer on the design build team. This plan had to be submitted and approved by CDOT before any work could begin. CDOT required a QC plan to be created by the design builder, but it appears that the DQCP was the document that was what all parties referred to when asked about QA/QC plans for the project.

Quality Management Responsibility Allocation:

Table 5. Summary of design and construction quality management roles

Responsibility allocation for design management tasks	**Agency personnel**	**Consultant design staff**	**Constructor's preconstruction staff**	**Agency-hired QA/oversight consultant**
Technical review of design deliverables	✔	✔		
Checking of design calculations			✔	
Checking of quantities	✔	✔	✔	
Acceptance of design deliverables	✔			
Review of specifications		✔		
Approval of final construction plans & other design documents	✔			
Approval of progress payments for design progress	✔			
Approval of post-award design QM/QA/QC plans	✔			
Responsibility allocation for construction management tasks	**Agency personnel**	**Consultant design staff**	**Constructor's construction staff**	**Agency-hired QA/oversight consultant**
Technical review of construction shop drawings	✔	✔		
Technical review of construction material submittals	✔	✔		
Checking of pay quantities	✔			
Routine construction inspection	✔			
Quality control testing	✔			
Verification testing	✔		✔	
Acceptance testing	✔			
Approval of progress payments for construction progress	✔			
Approval of construction post-award QM/QA/QC plans	✔			
Report of nonconforming work or punch list.	✔			

Effective QM Practices: Design QC forms that were included as parts of the appendix of the DQCP were very effective in tracking and organizing the various Design QC processes.

3.3.4 I-15 Widening, Beck Street Project, Utah

Project Name: I-15; Widening, 500 North to I-215

Name of Agency: Utah Department of Transportation (UDOT)

Location: I-15, 500 North to I-215, Utah

Project Delivery Method/Procurement/Contract Type: Design-Build/Best-Value/Lump Sum

Project Description: The project consists of the reconstruction of Interstate 15 from 500 North in Salt Lake City to the I-215 overpass in Davis County. The project includes the design, reconstruction, and widening of the mainline highway to include an Express Lane and three general purpose lanes in each direction. The work includes the total reconstruction of Mainline I-15 between 500 North and the I-215 overpass.

Project Quality Profile: The Quality Management plans used on this project were the same as those used on traditional UDOT projects, except the tracking and administration was handled differently. This was because the goals were the same with regards to testing requirements etc. except payment was not by quantity. Lump Sum payment was used; therefore quantities were recorded separately for verification testing.

QAO: Figure 6 shows that the QAO for this project was Oversight.

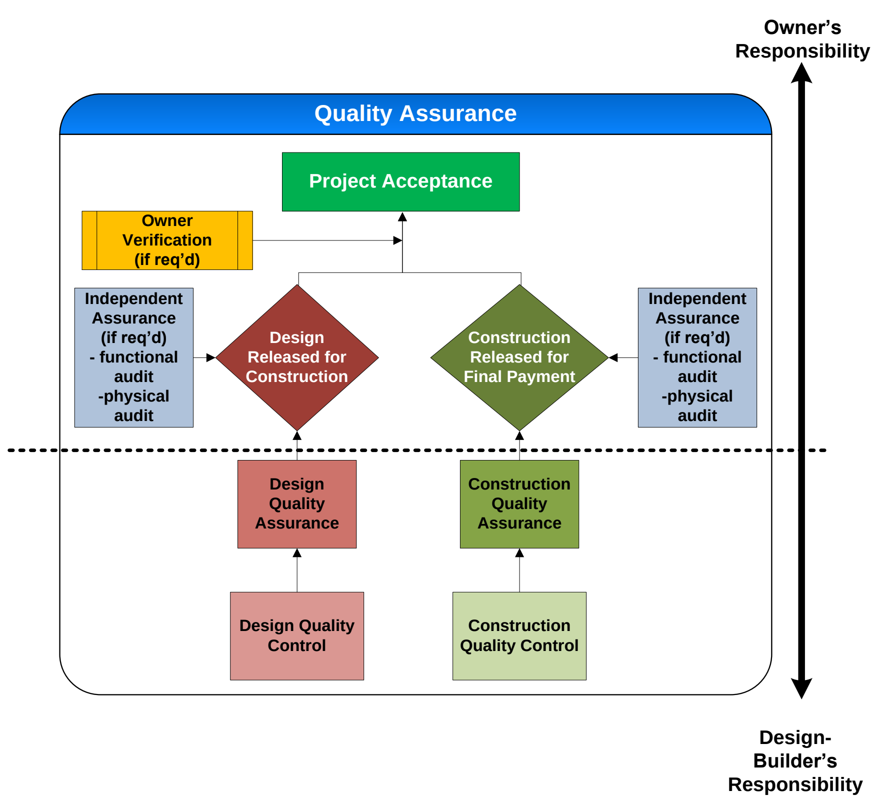

Figure 6. I-15 Widening QAO Model

QA/QC Plans: UDOT specified that the Quality Management Plan had to include procedures for design-builder construction QC, design QC and assurance, and Agency inspection and testing. The Design-Builder had the primary responsibility for the overall quality of the work including the quality of work produced by subcontractors, fabricators, suppliers, and vendors. An IQF was not required for this project. UDOT was to conduct oversight and inspection for the project.

Quality Management Responsibility Allocation:

Table 6. Summary of design and construction quality management roles

Responsibility allocation for design management tasks	**Agency personnel**	**Consultant design staff**	**Constructor's preconstruction staff**	**Agency-hired QA/oversight consultant**
Technical review of design deliverables	✔	✔	✔	
Checking of design calculations		✔		
Checking of quantities		✔		
Acceptance of design deliverables	✔			
Review of specifications	✔	✔	✔	
Approval of final construction plans & other design documents	✔			
Approval of progress payments for design progress	✔			
Approval of post-award design QM/QA/QC plans	✔			
Responsibility allocation for construction management tasks	**Agency personnel**	**Consultant design staff**	**Constructor's construction staff**	**Agency-hired QA/oversight consultant**
Technical review of construction shop drawings	✔			
Technical review of construction material submittals	✔			
Checking of pay quantities	✔			
Routine construction inspection	✔			
Quality control testing			✔	
Verification testing			✔	
Acceptance testing	✔			
Approval of progress payments for construction progress	✔			
Approval of construction post-award QM/QA/QC plans	✔			
Report of nonconforming work or punchlist.	✔			

Effective QM Practices: The following procurement and project practices helped the project achieve enhanced quality:

- One-on-One Meetings - The Agency conducted one-on-one meetings with each Proposer to discuss issues and clarifications regarding the RFP and Proposer's ATCs.
- Alternative Technical Concept (ATCs) Process - A process for pre-Proposal review of ATCs that conflict with the requirements for design and construction of the Project, or otherwise require a modification of the technical requirements of the Project.
- Summary of Innovation and Enhanced Quality - The Proposers were to prepare a summary of no more than three pages that outlined the specific areas in which the Proposer had introduced innovation and provided enhanced quality in long-term performance, durability, or maintainability.
- Document Control - The QMP had to specify procedures for meeting documentation requirements, for document control and for the specific responsibilities of personnel to satisfy these requirements.
- Over-the-Shoulder Design Reviews - The DQM was to conduct design reviews.
- Milestone (30% and 60%) Reviews - The DQM was to conduct formal milestone reviews.

3.3.5 Hastings Bridge Project, Minnesota

Project Name: TH61 Hastings Bridge Design-Build Project

Name of Agency: Minnesota Department of Transportation (MnDOT)

Location: T.H. 61 over the Mississippi River along the border of Washington and Dakota County, Minnesota within and near the City of Hastings.

Project Delivery Method/Procurement/Contract Type: Design-Build/Best-Value/Lump Sum

Project Description: The Project scope is to design and construct a new four-lane bridge over the Mississippi River, remove the existing 2-lane bridge, and construct the approaches on the north and south sides of the bridge.

Project Quality Profile: The overall quality approach required the Contractor to develop, implement, and maintain a quality management system that encompassed the design and construction quality aspects, and documentation requirements for the Project. In addition, ATCs were used to permit the design-builder to propose changes to the design quality criteria and the process for submitting and evaluating them was set forth in the Instructions to Proposers (ITP).

QAO: Figure 7 shows that the QAO for this project was Oversight.

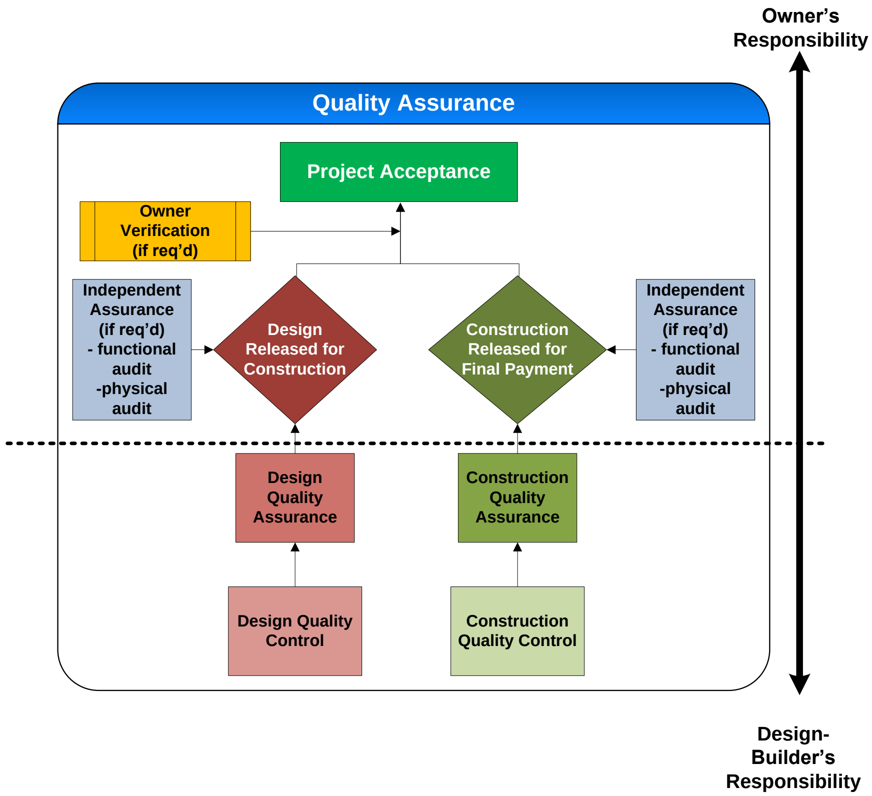

Figure 7. Hastings Bridge QAO

QA/QC Plans: The quality management process used on this project was a formal one that was project specific. The Contractor's quality management system had to contain a Quality Manual that encompassed all Contract requirements with regard to design, construction, and documentation for all quality processes. The Quality Manual also included an Inspection and Testing Plan describing all of the proposed inspections and tests to be performed throughout the construction process. MnDOT had provided a Construction Quality Inspection and Testing Plan in the Quality Manual Template. The Contractor was to tailor the Inspection and Testing Plan to meet the Project requirements.

Quality Management Responsibility Allocation:

Table 7. Summary of design and construction quality management roles

Responsibility allocation for design management tasks	Agency personnel	Consultant design staff	Constructor's preconstruction staff	Agency-hired QA/oversight consultant
Technical review of design deliverables	✔	✔		
Checking of design calculations		✔		
Checking of quantities		✔		
Acceptance of design deliverables	✔			
Review of specifications		✔		
Approval of final construction plans & other design documents	✔			
Approval of progress payments for design progress	✔			
Approval of post-award design QM/QA/QC plans	✔			
Responsibility allocation for construction management tasks	**Agency personnel**	**Consultant design staff**	**Constructor's construction staff**	**Agency-hired QA/oversight consultant**
Technical review of construction shop drawings	✔	✔		
Technical review of construction material submittals	✔			
Checking of pay quantities				
Routine construction inspection	✔		✔	
Quality control testing			✔	
Verification testing	✔			
Acceptance testing	✔			
Approval of progress payments for construction progress	✔			
Approval of construction post-award QM/QA/QC plans	✔			
Report of nonconforming work or punchlist.	✔		✔	

Effective QM Practices: The following practices were implemented for the project and contributed to managing the quality of the project:

- ATC/PAE Process - Approved ATCs were known as Pre-Approved Elements (PAEs). MnDOT then conducted one-on-one meetings with proposers to discuss ATCs and the Proposers were able to incorporate one or more acceptable ATCs in to their proposal.
- Disciplinary Task Forces - Each task force will focus on a specific discipline of work.
- Over-the-shoulder design reviews - Informal examinations by MnDOT of design documents during the project design process.
- In-Progress Design Workshops - Throughout the design process, the Contractor or MnDOT could request in-progress design workshops to discuss and verify design progress and to assist the Contractor and/or its designer(s) in resolving design questions and issues.

- Quality Oversight Visits - During the design process, MnDOT could make oversight visits to discuss and verify design progress and ascertain the overall progress of the Project with respect to the Contractor's Quality Manual.
- Disincentive - Subject to MnDOT's determination, MnDOT could assess the Contractor a $100-per-hour monetary deduction for failure to facilitate satisfactory progress or completion of the Work.

4. Summary and Conclusions

The research team analyzed and compared the project in the basis of 1) the QAO, 2) Design Acceptance, 3) Design QC, 4) Construction Acceptance and 5) Construction QC. Table 8 shows the different data across the Agencies.

Table 8. Benchmarking of QAOs

	SCDOT **Project I-85**	**SCDOT** **Project I-77**	**CDOT** **US 160 4th Lane Addition**	**UDOT** **I-15 Widening-Beck Street**	**MNDOT** **Hastings River Bridge**
Quality Assurance Organization (QAO)	Assurance	Assurance	Assurance	Oversight	Oversight
Design Acceptance	SCDOT	SCDOT	CDOT	Contractor	Contractor
Design QC	Designer	Designer	Designer	Designer	Designer
Construction Acceptance	SCDOT	SCDOT	CDOT	Contractor	Contractor
Construction QC	Contractor	Contractor	Contractor	Contractor	Contractor

As seen in Table 8, SCDOT is conducting Design-Build QA consistently with other state agencies from across the nation. It is not using the Deterministic model that is traditional for D-B-B project and some low-bid Design-Build projects. It is transferring QC for both design and construction to the design builder.

SCDOT is applying the Assurance QAO model. In this model, SCDOT is performing, with its own staff or through its independent consultant, independent assurance and testing to verify the design-builder's QC tests. The designer and the contractor are responsible for performing QC of their respective areas, but SCDOT is still responsible for all acceptance on the project. This model is used by many other DOTs, but it is a labor-intensive model for SCDOT and it can create some redundancy in QC and QA activities.

Based on the national benchmarking, SCDOT could choose to transfer more QC and QA tasks to the design-builder. SCDOT can take on more of an oversight role and still be consistent with other state DOTs, as well as meet Federal regulations. For example, SCDOT could move to a Variable QAO model and allocate more QA responsibility to the design-builder. SCDOT could even move to an Oversight QAO model where their role is to ensure that both the designer and contractor QA plans are effective at meeting the agency's quality requirements (stipulated in the contract) and that the plans are being implemented. If SCDOT is willing to move to an Oversight approach, they could review previous experiences from ADOT, FDOT, and WSDOT (see Tables 1 and 2). Although VDOT was not included in this analysis, they stated that they use the Oversight QAO in a recent Design-Build peer exchange.

5. References

Federal Highway Administration. *Alternative Contracting Method Performance in U.S. Highway Construction*. Federal Highway Administration Project, Publication Number FHWA-HRT-17-100, 2018.

Gransberg, D. D., J. Datin, and K. Molenaar, *NCHRP Synthesis 376: Quality Assurance in Design-Build Projects*, Transportation Research Board of the National Academies, Washington, D.C., 2008, 130 pp.

Molenaar, K. R., D. D. Gransberg, and D. N. Sillars, *NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction*, Transportation Research Board of the National Academies, Washington, D.C., 2015, 92 pp.

6. Appendix.

6.1 QAO Models

Deterministic QAO

Figure 8. shows the traditional quality organization on highway construction projects and is well understood by the primary parties involved in a project: agency, contractor, and designer. The agency's roles in the Deterministic QAO include design QC, design acceptance, construction QC, and construction acceptance. The agency can use third-party consultants to perform any of their roles, but the agency is ultimately responsible for ensuring these roles are successfully completed on the project. The STA provides guidelines to the contractor as to possible necessary tests and inspections appropriate for the project, but the contractor is primarily reacting to the agency's direction through the specifications of the project.

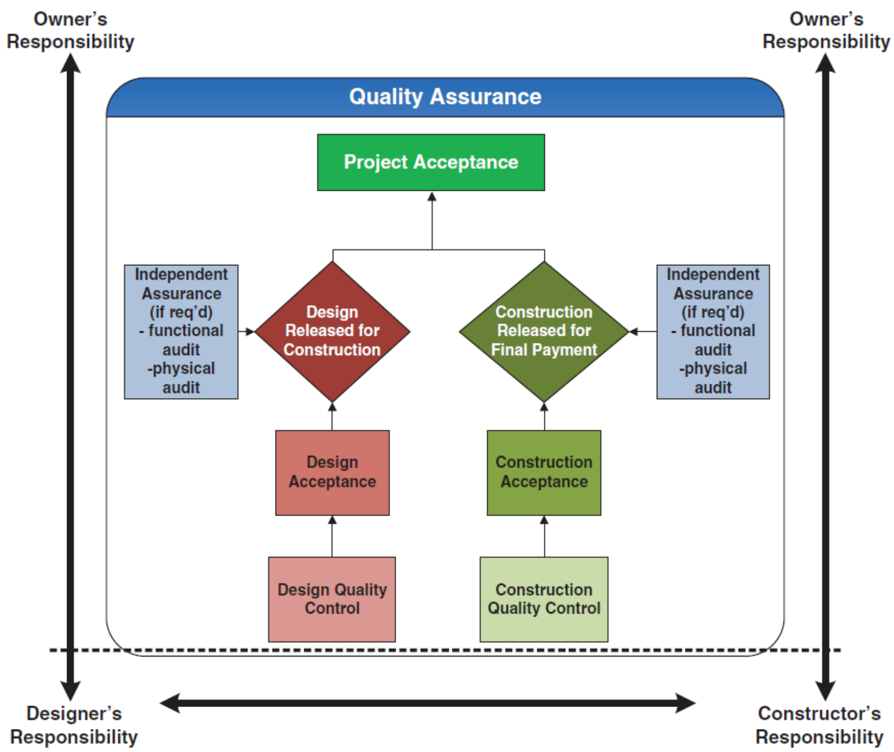

Figure 8. Deterministic QAO Model (NCHRP Report 808)

The Deterministic QAO is most often implemented on D-B-B projects, especially when the design is performed within the agency. The Deterministic QAO is not well suited for a Design-Build project because the Design-Build delivery method requires the agency to transfer some of the risks associated with the quality of design and construction, which requires a shift in authority for each of these tasks. Applying the Deterministic QAO to a Design-Build project means that the agency retains the quality authority for design and construction, which no longer allows the design builder to manage and assume the risks associated with those tasks (Gransberg, Datin, and Molenaar 2008).

Assurance QAO

In the Assurance QAO, the designer and the contractor are responsible for performing QC of their respective areas because the agency is still responsible for all acceptance on the project. The agency has the responsibility for acceptance of design and construction and the decisions to release the design for construction and to release construction for final payment. While the contractor and the designer perform their own QC, typically the agency will perform independent assurance and testing to verify the QC tests results (Gransberg, Datin, and Molenaar 2008). These responsibilities can be performed in house or by an independent consultant/engineer.

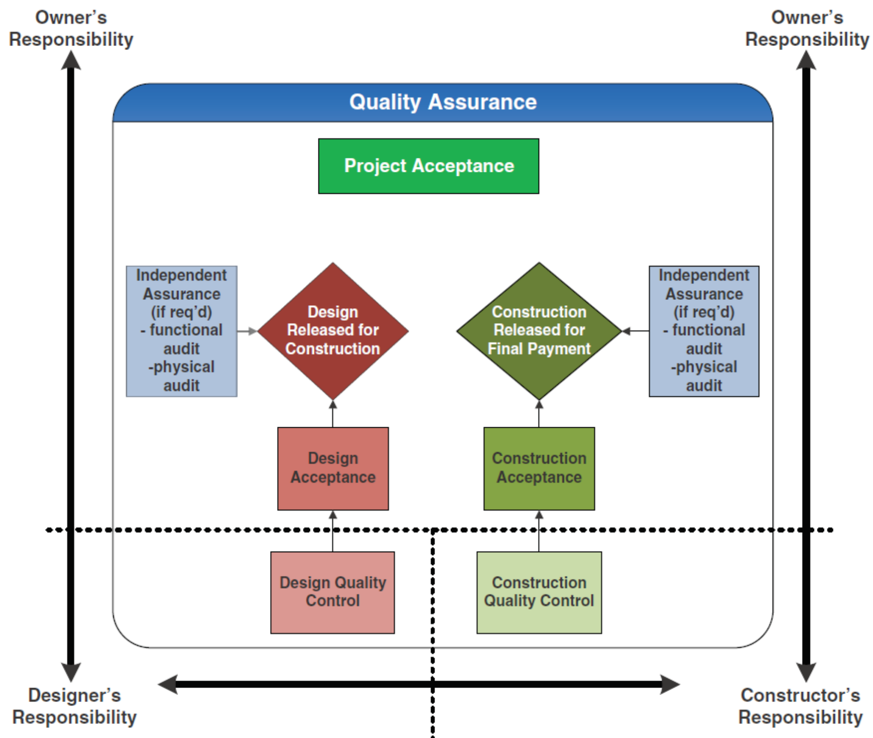

FIGURE 9. Assurance QAO Model (NCHRP Report 808)

The Assurance QAO has been applied to both D-B-B and Design-Build projects. When applied to D-B-B projects, as shown in **FIGURE 9.** Assurance QAO Model (NCHRP Report 808), the QC activities above the dotted line are the agency's responsibility, and the vertical dotted line represents the separate design and construction contracts. When applied to the Design-Build delivery method, with a single contract for design and construction, all QC activities are the responsibilities of the design builder. Gransberg, Datin, and Molenaar (2008) suggested that agencies with limited Design-Build experience apply these types of quality management policies and procedures because the agencies are still evolving from the D-B-B method where the contractor controls construction QC and the STA has control over all acceptance functions and over design QC.

Variable QAO

The Variable QAO differs from the others because the design and construction approach to quality may take on one of several variations. An example of this method has been found on Design-Build projects where the agency is responsible for the construction acceptance but not design acceptance, as shown in Figure 10.

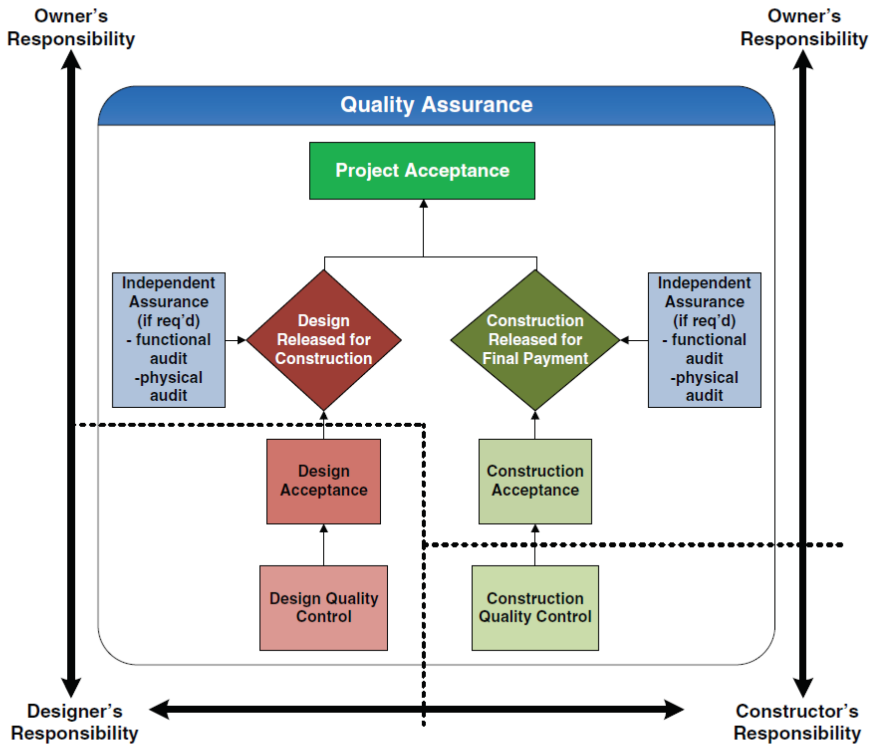

Figure 10. Variable QAO Model (NCHRP Report 808)

Because the agency is no longer responsible for design acceptance, the contractor must perform project acceptance on the design side of the project (Gransberg, Datin, and Molenaar 2008). For the example considered in **Figure 10.** Variable QAO Model (NCHRP Report 808)

the agency is taking a different approach to quality in the design phase than it is taking in the construction phase. This results in implementing two different approaches to quality across not only the agency but also the design builder, which can complicate attempts at creating continuity across the project. Another example of the Variable QAO is when the responsibilities of the agency include design QA, but do not include construction acceptance and QC.

Oversight QAO

In the Oversight QAO shown in **Figure 11.** Oversight QAO Model (NCHRP Report 808)

, the agency is responsible for the decisions to release the designs for construction and to release construction for final payment. The designer is responsible for design QC and acceptance, while the contractor is responsible for construction QC and acceptance. In the Oversight QAO, the agency no longer has direct control over the day-to-day quality management of the project and is no longer dictating how to produce the quality required by the project scope. Rather, the agency's role is to ensure that both the designer and contractor QA plans are effective at meeting the agency's quality requirements (stipulated in the contract) and that the plans are being implemented.

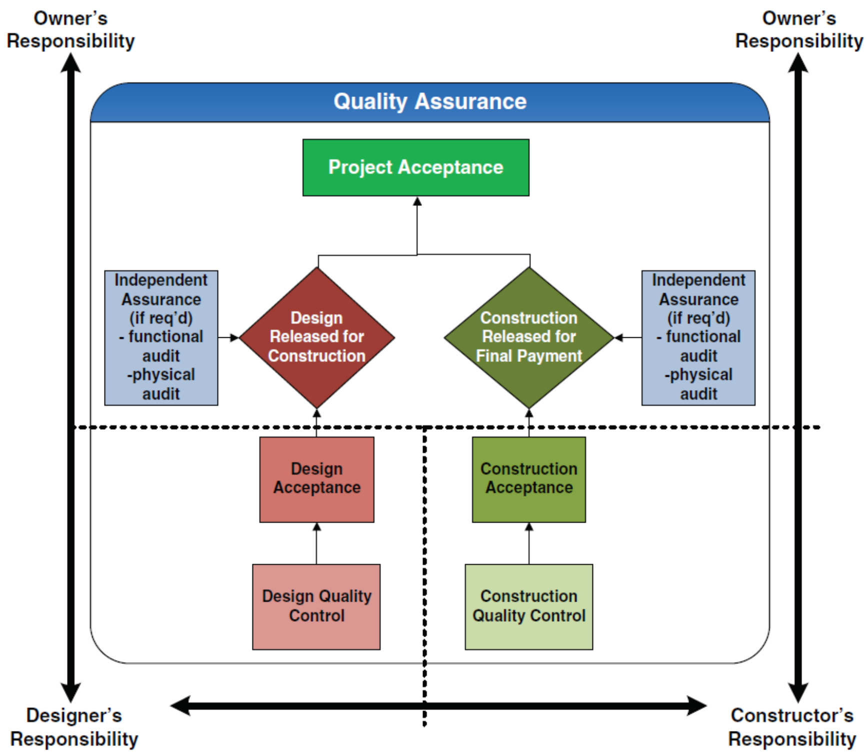

Figure 11. Oversight QAO Model (NCHRP Report 808)

Because of the high level of collaboration required by the Oversight QAO, it would be difficult to implement on a project with a linear approach, where the designer and the contractor are not involved early in the project; thus, the Oversight QAO would not be a good choice for a D-B-B project. However, for project delivery methods in which the designer and contractor are brought in early on a project, such as Design-Build, the Oversight QAO is complementary to the inherent collaboration of the methods. In a Design-Build project, all QC and acceptance for the project would fall to the design builder.

Acceptance QAO

The Acceptance QAO is specific to PPP projects. In this organization, the owner has responsibility only for final project acceptance and owner verification testing. The party contracted to complete the project, typically the concessionaire, is responsible for all other quality activities on the project, as shown in **Figure 12.** Oversight QAO Model (NCHRP Report 808)

Since the agency is no longer providing 100 percent of the financing for design, construction, operations, and maintenance, there is a shift in financial liabilities, which also pertains to the shift in quality responsibilities (Gransberg, Datin, and Molenaar 2008).

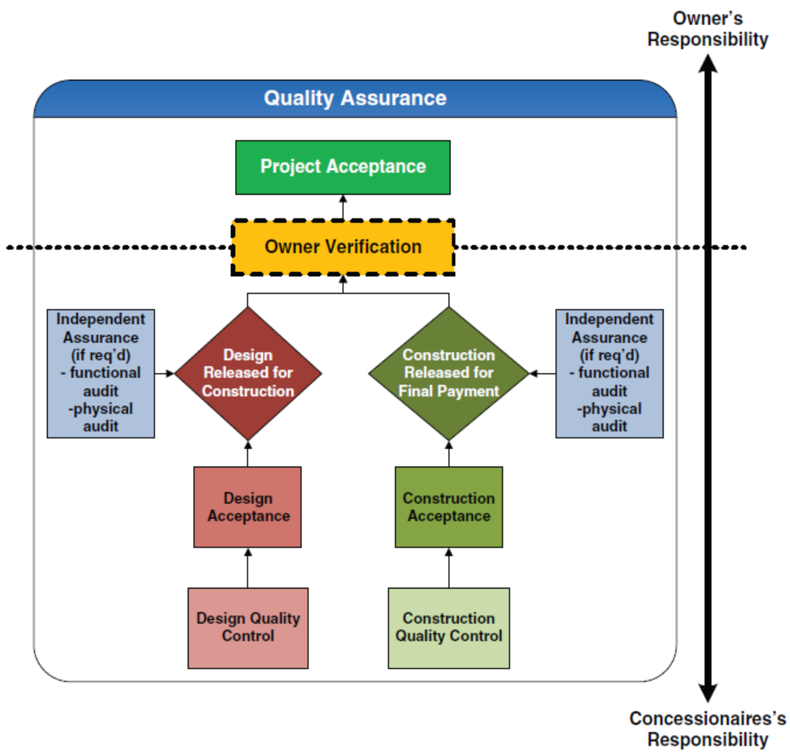

Figure 12. Oversight QAO Model (NCHRP Report 808)

Of all the QAOs, the Acceptance QAO provides the agency with the least amount of direct control over the QA of a project. The agency's primary focus, as required by FHWA Technical Advisory 6120.3, is to perform oversight of the design and construction quality management efforts to satisfy their legal responsibilities to the public (Gransberg, Datin, and Molenaar 2008). This requires the agency to perform owner verification testing, which is commonly performed by an independent engineer. The independent engineer is hired jointly by the concessionaire and the agency and performs not only owner verification testing but also independent assurance and any other acceptance activities that are part of the concessionaire's responsibility.

6.2 Questionnaire

SCDOT Efficiency Study of Design-Build Program

Subtask 2d. Design-Build Quality Assurance

Project Questionnaire

INTRODUCTION/BACKGROUND

The purpose of this questionnaire is to identify how SCDOT has implemented alternative Quality Assurance (QA) programs and compare them to commonly used practices with other states nationwide. The questionnaire on the following pages is a version of the one that we used in developing NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction.

DEFINITIONS

The research will use TRB Circular E-C074, *Glossary of Highway Quality Assurance Terms* to standardize its terminology. The following are terms that must be carefully understood to properly complete this survey.

Quality: (1) The degree of excellence of a product or service. (2) The degree to which a product or service satisfies the needs of a specific customer. (3) The degree to which a product or service conforms with a given requirement.

Quality Assurance (QA): All those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service. [QA addresses the overall problem of obtaining the quality of a service, product, or facility in the most efficient, economical, and satisfactory manner possible. Within this broad context, QA involves continued evaluation of the activities of planning, design, development of plans and specifications, advertising and awarding of contracts, construction, and maintenance, and the interactions of these activities.]

Quality Control (QC): Also called process control. Those QA actions and considerations necessary to assess and adjust production and construction processes, so as to control the level of quality being produced in the end product.

Quality Management (QM): The overarching system of policies and procedures that govern the performance of QA and QC activities. The totality of the effort to ensure quality in design and/or construction.

Design-Bid-Build (DBB): A project delivery method where the design is completed either by in-house professional engineering staff or a design consultant before the construction contract is advertised. Also called the "traditional method."

Design-Build (DB): A project delivery method where both the design and the construction of the project are simultaneously awarded to a single entity.

Design deliverable: A product produced by the design-builder's design team that is submitted for review to the agency (i.e., design packages, construction documents, etc.).

Construction deliverable: A product produced by the design-builder's construction team that is submitted for review to the agency (shop drawings, product submittals, etc.).

Case Study Project Information and Data

1. Project Name and location:
2. Project scope of work
3. Original Total Awarded Value of project: $ 466,809,956.85 Final Total Value of project: $
4. Date preliminary design contract awarded for RFP development:
5. Date project advertised:
6. Date final design-build contract awarded: 09/28/16

7. Which of the following were reasons why SCDOT selected the delivery method used for this project? Check all that apply.

☐Reduce/compress/accelerate project delivery period

☐Establish project budget at an early stage of design development

☐Get early construction contractor involvement

☐Encourage innovation

☐Facilitate Value Engineering

☐Encourage price competition (bidding process)

☐Compete different design solutions through the proposal process

☐Redistribute risk

☐Complex project requirements

☐Flexibility needs during construction phase

☐Reduce life cycle costs

☐Provide mechanism for follow-on operations and/or maintenance

☐Innovative financing

☐Other: Explain

8. Which of the above was the single most significant reason for the delivery method decision on this project?

Project Quality Management Policy/Procedures Information:

The following questions will break up the quality management process into the subsequent four phases:

- Design Phase (in-house): Actions taken after approval to start design work regarding ensuring the quality of the design deliverables as well as that the final design complies with contractual requirements. ***OR***
- Design Phase (out-source): Actions taken after design contract award regarding ensuring the quality of the design deliverables as well as that the final design complies with contractual requirements.
- Construction Phase: Actions taken after contract award regarding the quality of the final constructed product to ensure that it complies with both the completed design and other contractual requirements.

The research team understands that the term “Approval” has a variety of slightly different meanings from state to state. It is used here to indicate the process by which the agency express that it is satisfied with the quality of the design or construction deliverable and is willing to make payment for satisfactory completion of that task if asked.

Design Phase:

1. Did this project have a formal design quality assurance program for any design performed in-house? ☐Yes ☐No
2. Did this project have a formal design quality assurance program for design performed by design consultants? ☐Yes ☐No
3. For this project who performed the following design quality management tasks? (Check all that apply)

For this project who performed the following design quality management tasks? (Check all that apply)	**Does not apply**	**SCDOT design staff**	**SCDOT project manage-ment staff**	**DB design consult-ant**	**DB con-struction staff**	**Indepen-dent quality consultant**	**Other Please specify below**
Technical review of design deliverables	☐	☐	☐	☐	☐	☐	☐
Checking of design calculations	☐	☐	☐	☐	☐	☐	☐
Checking of quantities	☐	☐	☐	☐	☐	☐	☐

Acceptance of design deliverables	☐	☐	☐	☐	☐	☐	☐
Review of specifications	☐	☐	☐	☐	☐	☐	☐
Approval of final construction plans & other design documents	☐	☐	☐	☐	☐	☐	☐
Approval of progress payments for design progress	☐	☐	☐	☐	☐	☐	☐
Approval of post-award design QM/QA/QC plans	☐	☐	☐	☐	☐	☐	☐

Other:

Construction Phase:

4. For this project who performed the following Construction quality management tasks? (Check all that apply)

For this project who performed the following construction quality management tasks? (Check all that apply)	**Does not apply**	**SCDOT design staff**	**SCDOT project manage-ment staff**	**DB design consult-ant**	**DB con-struction staff**	**Indepen-dent quality consultant**	**Other Please specify below**
Technical review of construction shop drawings	☐	☐	☐	☐	☐	☐	☐
Technical review of construction material submittals	☐	☐	☐	☐	☐	☐	☐
Checking of pay quantities	☐	☐	☐	☐	☐	☐	☐
Routine construction inspection	☐	☐	☐	☐	☐	☐	☐
Quality control testing	☐	☐	☐	☐	☐	☐	☐
Verification testing	☐	☐	☐	☐	☐	☐	☐
Acceptance testing	☐	☐	☐	☐	☐	☐	☐
Approval of progress payments for construction progress	☐	☐	☐	☐	☐	☐	☐
Approval of construction post-award QM/QA/QC plans	☐	☐	☐	☐	☐	☐	☐
Report of nonconforming work or punch list.	☐	☐	☐	☐	☐	☐	☐

Other:

Quality Management Planning: Please answer the following questions about the project based on your experience.

1. Are the design QM plans used on this project different from the QM plans used on traditional design projects?

   ☐No ☐Yes

If yes, what is the major difference? Click here to enter text.

2. Are the construction QM plans used on this project different from the QM plans used on traditional DBB construction projects?

   ☐No ☐Yes

   If yes, what is the major difference? Click here to enter text.

3. Did SCDOT mandate the use of standard agency specifications?

   ☐No ☐Yes

4. Did SCDOT mandate the use of standard agency design details?

   ☐No ☐Yes

5. Did SCDOT mandate the use of standard agency construction means and/or methods?

   ☐No ☐Yes

   If no, what was required in their place?

6. Did SCDOT mandate a specific set of qualifications for the quality management staff of design consultants and construction contractors on this project?

   ☐No ☐Yes

   If yes, what are those qualifications? Click here to enter text.

7. Did SCDOT utilize contractor quality assurance test results for acceptance on this project?

   ☐Yes ☐No

Quality Management Procedures:

8. Do you think that SCDOT held the design-builder's design/construction quality management staff to a higher standard of care than it sets for its internal staff?

   ☐Yes ☐No

   Comments? Click here to enter text.

9. Does SCDOT have a document that outlines its approach to quality assurance on the project?

   ☐Yes ☐No

   If yes, was it used on this project? If no, what was used in its place?

10. Does SCDOT use an approach to quality management that is substantially different than that used by other agencies and might be considered an “alternative QM system”? (i.e., statistical analysis of material test reports that eliminates the need for agency acceptance testing)

☐Yes ☐No

Describe:

11. Which of the below best describes SCDOT’s approach to QA on this project?

DB
☐ Design-builder primarily responsible for QA/Agency audits design-builder’s program
☐ SCDOT retains traditional QA roles
☐ SCDOT retains an independent party to perform QA roles
☐ SCDOT uses two or more of the above depending on the project
☐ None of the above

If “None of the above” was selected, please describe the approach that was used instead:

12. What was the biggest quality challenge in the procurement phase?
13. What was the biggest quality challenge in the design phase?
14. What was the biggest quality challenge in the construction phase?
15. Please rate the following factors for their impact on the quality of this project:

Factor	**Very High Impact**	**High Impact**	**Some Impact**	**Slight Impact**	**No Impact**
Qualifications of SCDOT design staff	☐	☐	☐	☐	☐
Qualifications of SCDOT project management staff	☐	☐	☐	☐	☐
Qualifications of SCDOT construction staff	☐	☐	☐	☐	☐
Qualifications of the design consultant's staff	☐	☐	☐	☐	☐
Design consultant's past project experience	☐	☐	☐	☐	☐
Qualifications of the construction contractor's staff	☐	☐	☐	☐	☐
Construction contractor's past project experience	☐	☐	☐	☐	☐
Submittal of Quality management plans prior to work start	☐	☐	☐	☐	☐
Level of SCDOT involvement in the QM process	☐	☐	☐	☐	☐
Use of SCDOT specifications and/or design details	☐	☐	☐	☐	☐
Level of detail expressed in the procurement documents (IFB/RFQ/RFP)	☐	☐	☐	☐	☐
Use of manuals, standards, and specifications developed for DBB type projects	☐	☐	☐	☐	☐
Allowing flexibility in the choice of design standards and construction specifications	☐	☐	☐	☐	☐
Use of performance criteria/specifications	☐	☐	☐	☐	☐
Detailed design criteria	☐	☐	☐	☐	☐
Warranty provisions	☐	☐	☐	☐	☐
Incentive/disincentive provisions	☐	☐	☐	☐	☐
Follow-on maintenance provisions	☐	☐	☐	☐	☐

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Appendix 2F – Tech Memo on Design-Management Issues

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 2. Tools, Processes and Best Practices

Task 2f. Design Management Issues

Prepared by

University of Colorado Boulder

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1. Executive Summary

Subtask 2f Design Management Issues has two objectives. The first is to provide recommendations for improving the Project Definition Report process to support design-build project selection and authoring of Design-Build requests for proposals (RFP). The second is to explore the advantages of using various levels of design in Design-Build RFPs.

1.1 Project Definition Report Process

SCDOT is following national best practices with its Project Definition Reports. The Project Definition Reports are extremely well structured and comprehensive. The reports are beneficial for supporting the project delivery selection process. SCDOT may wish to consider the following improvements. Additional minor recommendation are provided at the end of this technical memo.

- Consider a larger group of participants to help with completing the report.
- Consider including the budget and any relevant schedule milestone as part of the project attributes when these are known.
- For functional and quality goals, consider only including those goals that go above the contract requirements. Meeting contract requirements need not be a goal.

1.2 Level of Design in Design-Build RFPs

SCDOT is following national practices in its use of the appropriate level of design in its Design-Build RFPs. The research team would not suggest limiting projects to a specific range of design completion. The national benchmarking shows that DOTs use a wide range of design in the RFPs. The selection of an appropriate level of design should depend on the specific goals, constraints, and complexity of the project.

2. Research Methodology

To accomplish the first objective, the research team analyzed South Carolina Department of Transportation's (SCDOT) Design-Build Manual and 25 Project Definition Reports, which were provided by SCDOT.[1] We compared the content and format of these documents with SCDOT stated procedures and the more general guidelines established by Molenaar et al. (2014) in the *Guidebook for Selecting Alternative Contracting Methods for Roadway Projects : Project Delivery Methods , Procurement Procedures, and Payment Provisions*.

To accomplish the second objective, the research team summarized current national practices of different state DOTs relating to the level of design in Design-Build RFPs. The research team used the data obtained from a national study developed at the University of Colorado on the risks and benefits of alternative contracting methods (ACMs) for highway construction (FHWA 2018). This study collected performance data from 291 US highway projects that were completed between

[1] These reports can be found in ProjectWise folder *University of Colorado > Task 2- Tech Memos > Subtask2f Design Management*

2004 and 2015. These projects were collected from DOTs and the FHWA Office of Federal Lands Highway. The data collection involved 26 states who were determined to be using ACMs through a national survey of all DOTs. The research team used this information to benchmark SCDOT's practices and make recommendations.

3. Summary of Analysis

This summary of analysis has two sections. The first section corresponds to the Project Definition Report process and the second is related to the level of design in Design-Build RFPs.

3.1 Project Definition Report Process

3.1.1 Background

SCDOT's Design-Build Manual describes the Project Definition Report in Section 2.1 Project Selection Process. The Manual states:

> "*to determine if design-build delivery is appropriate, the goals of the project have to be known and the outcomes defined. The Director of Preconstruction will provide a Project Definition Report when a project evaluation is requested. If the report is incomplete, the Design-Build engineer should convene a meeting consisting of the Director of Preconstruction, Regional Production Engineer, Office of Planning representative, Director of Maintenance representative, Office of Materials and Research representative etc., to finalize the report and verify the screening level cost estimate*".
>
> "*Once the Project Definition Report has been finalized and the candidate project has been screened based on cost, the Design-build Engineer should convene a project delivery selection workshop consisting of a PM, DM, Director of Construction (DOC) representative and any other necessary technical resources and/or subjects matter experts".*

SCDOT's Project Definition Report template, includes the next sections and definitions:

> Step 1: Project Description
> Provide information on the project. This includes size, type, funding, obstacles, etc. <u>Obstacles are major challenges or conflicts</u> that may guide development of goals, constraints and/or risks. Purpose and need are developed in this step.
>
> Step 2: Project Goals
> A careful determination of the project goals is an instrumental first step in defining the desired outcome of the project. <u>Goals are desires but not mandates on a project</u>, such as avoiding a certain property, avoiding hazardous materials, minimizing ramp closures, etc.

Step 3: Project Constraints

Carefully review all possible constraints to the project. These constraints can potentially eliminate certain design alternatives and may also guide the project to a specific conclusion. Constraints are mandates which must be met such as avoiding a cemetery, maintaining a minimum number of lanes, keeping a ramp open, etc.

Step 4: Project Risk

Risk is an uncertain event or condition that, if it occurs, has an effect on achieving the goals of the project. Identify project risks using data developed in previous steps and through known project obstacles. Items of risk should be prioritized in this section.

Step 5: Project Summary

Summarize major elements of the preliminary scope and identify the critical strategies necessary to meet the project's purpose and need taking into consideration the identified goals, constraints, and risks. Prepare the Screening Level Cost Estimate based on the preliminary scope and strategies.

3.1.2 Analysis of Existing Reports

The SCDOT Design-Build Manual describes a process that involves the Director of Preconstruction and other department representatives to complete the Project Definition Report. The Project Definition Report supports the project delivery selection workshop. However, it is somewhat difficult to track the alignment of this process from a review of the Project Definition Reports in the database. For example, the list of the participants is generally missing in the cover of the documents, which brings into question who participated in developing the reports.

Table 1 shows the participants in each of the Project Definition Reports that the research team reviewed. The list of the participants is included in nine of the 24 documents analyzed. For almost half, there was only one participant.

Table 1 Participants information included in the project definition reports

PDR project		County	Includes Facilitator	Includes Participants	Includes Author	Comments
1	Aiken I-20 Bridge	Aiken	No	No	No	
1	Aiken I-20 Bridge R1	Aiken	No	No	Yes	
2	I-126	Richland	Yes	Yes	No	
3	SC 277	Richland	No	No	No	
4	US 1 BRO I-20	Lexington	Yes	Yes	No	
4	US 1 BRO I-20 R1	Lexington	Yes	Yes	No	
5	US 21	Richland	No	Yes	No	One person
6	US 301	Allendale	No	No	Yes	
6	US 301 R1	Allendale	No	No	Yes	
7	US 278	Beaufort	No	No	No	

PDR project		County	Includes Facilitator	Includes Participants	Includes Author	Comments
7	US 278 R1	Beaufort	No	Yes	Yes	One person
8	I-20-26-126	Lexington and Richland	No	No	No	
9	I-26 BRO US1	Lexington	Yes	Yes	No	
10	I-26 BRO SC 302	Lexington	No	No	No	
12	Kershaw I20	Kershaw	Yes	Yes	No	
13	256 PhI	Charleston	No	No	No	
14	256 Ph II	Charleston	No	No	No	
15	I-85 51-69	Greenville/Spartanburg	No	No	No	
15	I-85 51-69 R1	Greenville/Spartanburg	No	Yes	No	One person
16	I-26	-	-	-	-	No information
17	I-77	York	No	No	No	
17	I-77 R1	York	No	Yes	No	One person
18	I-85 40-51	Greenville	No	No	No	
19	I-26 212-217	Charleston	No	No	No	

A review of each of the Project Definition Report sections follows. The Appendix of this report includes the Project Definition Report template.

Project Description

The project description section is organized in four parts: A. General Information; B. Purpose; C. Project Attributes/Characteristics; and D. Major obstacles. The contents included in each section are comprehensive and the format used to structure the information is clear. SCDOT may consider including a cost range and any major schedule milestones as part of the project attributes. The section numbering should be reviewed to ensure homogeneity between projects. Overall, these section of the reports is comprehensive and useful.

Project Goals and Constraints

The goals and constraints sections are divided in six subsections: cost; schedule; quality; functional; right of way; and others. Clear project management goals are a key to supporting the project delivery process. In the reports that were analyzed, the goals tended to focus more on functional and quality aspects of the projects, which are design-related goals, vs. cost and schedule goals, which are more related to project management.

Functional aspects are the most commonly described project goals and constraints. Functional aspects are considered in more than 75% of the analyzed reports. They generally describe the functional challenges of each project. SCDOT may consider including some insights about the need of innovative solutions to address the functional demands.

Quality and schedule goals are included in 67%. Almost half of the quality goals refer to “minimize impact to travelling public,” which may not be strictly related to quality. Other reports include goals specifically tailored to quality aspects such as: “be an award winner for the industry, select contractors with best track history, provide high quality design/construction.” SCDOT may review the current classification of goals. For this purpose, SCDOT may consider defining a list of quality goals for design-build projects. This list will facilitate the discussion and selection appropriate quality goals.

The schedule goals are well defined and are included in 58% of the reports. Schedule goals generally emphasize the desire to minimizing time for certain parts of the project. However, there are only three cases in which specific dates or periods are provided:

- 08. I-20-26-126 project: "*Award a construction (DB or DBB) contract to a construction contractor by the end of CY 2019. This goal delivers the FEIS/ROD in 3 years, which is 4 years faster than the national average. This goal has been assigned by SCDOT executive management to quickly deliver a very needed transportation solution"*

- 10.I-26 project*: "Minimize project delivery time due to potential funding of John Hardee Expressway Phase 2. The two projects are tied together through the environmental document. It has been reported that if the John Hardee Expressway Phase 2 will be let within 18 months of securing funding."*

- 13.526 Ph1 project: *"Minimize project delivery time for this very complex project; the goal is to deliver the project within the schedule provided to the public in Consolidated Program Delivery Plan - construction in 2020."*

If they are known at the time of the Project Definition Report, SCDOT may want to include a similar level of detail regarding specific dates and periods for all the Project Definition Reports.

Cost goals were found in 58% of the report. They are generally written with phrases such as "minimize costs, change orders" or "maximize project budget, or scope and improvements". It is notable that 10 of the 24 reports do not include any cost goal or constraint. SCDOT may want to analyze if this lack of information comes from the real absence of goals and constraints, or if it is due to a lack of clarity when defining these concepts in the workshops.

Goals and constraints identified as "others" include a wide variety of topics. However, many of these topics could fit into the previous sections without much problem. SCDOT may consider eliminating this section, so that the goals and constraints could be classified in one of the other groups.

A general suggestion for the constraints section is to include any information related to third party agreements and/or any federal, state or local law that could affect the development of the project.

Project Risk and Project Summary

The SCDOT Project Definition Report includes risk analysis and a project summary sections. These sections include a project strategy and screening-level cost estimate. The research team found both of these sections to be highly beneficial and helpful in the project delivery evaluation process. For example, the *Guidebook for Selecting Project Delivery Methods and Alternative Contracting Strategies* (Molenaar et al. 2014) considers the definition of project attributes, goals, and constraints as a first step. It does not consider a risk analysis until after the initial project delivery method selection. SCDOT's approach to complete an initial risk analysis during the project definition will support the project delivery selection process. The research team will analyze this in more depth in Task 4, Design-Build Project Delivery Selection Process, portion of this study.

3.2 Benchmark on Design Management Issues

This section summarizes the current DOT practices related to the levels of design in Design-Build RFPs. The results presented in this section come from a national study developed at the University of Colorado on the risks and benefits of Alternative Contracting Methods (ACMs) for highway construction (FHWA 2018). This study collected performance data from 291 US highway projects that were completed between 2004 and 2015. These projects were collected from DOTs and the FHWA Office of Federal Lands Highway. The data collection involved 26 states who were determined to be using ACMs through a national survey of all DOTs.

Figure 1 shows the level of design in Design-Build RFPs analyzed as part of the FHWA ACM Performance Study. This national benchmark shows a high variability of the level of design in Design-Build RFPs. However, it is worth noting that 84% of the reviewed RFPs include a level of design of 30% or lower. The most frequent level of design used in the reviewed RFP was in the range of 30 - 59% design. This range was actually considered in 40% of the reviewed RFPs.

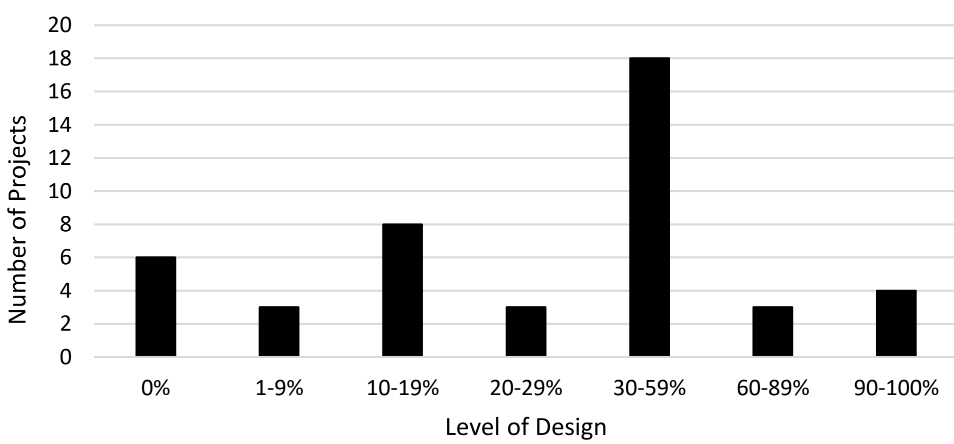

Figure 1. Level of design in DB RFP-national benchmark

The research team has analyzed the practices of other states relevant to SCDOT, including Georgia, Virginia, North Carolina, and Florida. Data on level of design was only available for Florida (Figure 2). Although Florida also uses different levels of design in their Design-Build RFPs, they tend to use higher level of design than the national average. Fifty percent (50%) of the RFPs reviewed from Florida considered levels of design of 60% or higher (while the national average for this range of design was 16%). The most frequent level of design in FDOT is the same used at the national level (30-59% design). However, this range accounts for only 18% of the RFPs reviewed from Florida.

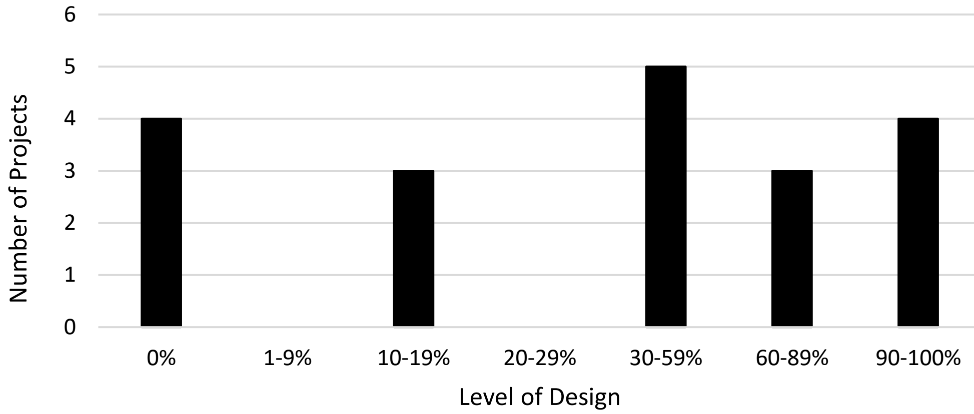

Figure 2 Level of design in DB RFP-Florida DOT

From this benchmark analysis, the research team would recommend SCDOT to consider different levels of design in their RFPs. The selection of which level of design would be appropriate would depend on the specific goals, constraints, and complexity of the project.

4. Conclusions and Recommendations

The purpose of this report was to twofold. First, to provide recommendations for improving the Project Definition Report process. Second, to explore the advantages from various levels of design in Design-Build RFPs.

SCDOT is following national best practices with its Project Definition Reports. The Project Definition Reports are extremely well structured and comprehensive. The use of project goals, risk analysis, and an initial cost estimate are at the leading edge of practice. While the Project Definition Report structure and process are excellent, SCDOT may wish to consider the following improvements.

- Consider a larger group of participants to help with completing the report. From the projects analyzed, it appeared that the reports were completed by individuals, or only a small group. The use of a larger, more inclusive group could add to a more comprehensive and innovative completion of the report.
- Consider including the budget and any relevant schedule milestone as part of the project attributes when these are known. They can be included as a range.
- Consider reviewing the criteria for section numbering to ensure homogeneity between reports.
- Consider reviewing the current classification of goals to minimize restrictions and assist in selecting the most important ones.

    - Functional goals and constrains: Consider including some insights about the need of innovative solutions to address the functional demands.
    - Quality goals: Consider only those quality goals that above and beyond the standard quality practices. Standard quality practices can be specified in the contractual obligations.
    - Other goals: Consider eliminating this section, so that the goals and constraints could be classified in one of the other groups.
- For guidance on authoring of project goals and to view other state example, please see the AASHTO Guide for Design-Build Procurement (AASHTO 2008).

SCDOT is following national practices in its use of the appropriate level of design in its Design-Build RFPs. The research team would not suggest designating a specific range of design completion. The national benchmarking shows that DOTs use a wide range of design in the RFPs. The selection of an appropriate level of design should depend on the specific goals, constraints, and complexity of the project.

5. References

AASHTO (2008). AASHTO Guide for Design-Build Procurement, *ISBN# 1-56051-384-1, American Association of Highway Transportation Officials*, Washington, DC

FHWA. (2018). "Alternative Contracting Method Performance in US Highway Construction." *FHWA Project, Publication Number FHWA-HRT-17-100*.

Molenaar, K., Harper, C., and Yugar-Arias, I. (2014). *Guidebook for Selecting Alternative Contracting Methods for Roadway Projects : Project Delivery Methods , Procurement Procedures, and Payment Provisions*.

6. Appendix

SCDOT Project Definition Report Template

Step 1: Project Description

The following items should be considered in describing the specific project. Other items can be added to the bottom of the form as needed. Relevant documents can be added as appendices to the final summary report (i.e. Structure Inventory and Appraisal, etc.).

1A: General Project Information	
Project Name:	**Project ID:**
Project Type:	**Route:**
District:	**County:**

1B.1: Existing Roadway Information	
Route:	**Limits (MP to MP):**
Functional Classification:	**Number of Lanes:**
Design Speed:	**ADT:**
Notes:	

1B.2: Existing Roadway Information	
Route:	**Limits (MP to MP):**
Functional Classification:	**Number of Lanes:**
Design Speed:	**ADT:**
Notes:	

Step 2: Project Goals

An understanding of project goals is essential to establishing the project definition. Typically, the project goals can be defined in three to five items and need to be established here. Goals are desires but not mandates on a project. Example goals are provided below, but the report should include project-specific goals. These goals should remain consistent over the life of the project. Goals should be a statement and answer "WHY" the goal is important.
Example: "Cost Goals: Eliminate R/W impacts to Tract 16 as SF costs are 10 times greater than surrounding properties." (desirable but not a mandate)

2A: Goals
Schedule Goals:
Cost Goals:
Quality Goals:
Functional Goals:
Other Goals:

General Project Goals (For Reference)

NOTE - these are generic and do not answer "WHY"

Schedule
- Minimize project delivery time to correct signficant safety deficiency
- Complete the project on schedule to honor commitment to Industry
- Accelerate start of project revenue to ensure grant funds expended within allowed timeframe

Cost

- Minimize project cost to avoid impacts to limited available funding
- Maximize project budget to effectively match the project scope
- Complete the project on budget as additional funds are not available
- Maximize the project scope and improvements within the project budget to ensure best value

Quality

- Select the best team due to critical design/construction features of the project
- Provide an aesthetically pleasing project to satisfy agreement with local municipality

Functional

• Maximize the life cycle performance of the project to match benefits attained
• Maximize capacity and mobility improvements to meet projected future volumes/operations
• Minimize inconvenience to the traveling public during construction due to large volume facility
• Account for future widening in design to avoid reconstruction in the future

Step 3: Project Constraints

These constraints can potentially eliminate certain design alternatives and may also guide the project to a specific conclusion. Constraints are mandates which must be met. Constraints should be a statement and answer "WHY" the constraint must be met.
Example: "Schedule Constraint: The interchange to serve the new Auto Plant must be open on or before June 30, 20xx or DOT will pay LD's and the company will end future expansion within SC."

3A: Constraints
Schedule Constraints:
Cost Constraints:
Quality Constraints:
Functional Constraints:
Other Constraints:

General Project Constraints

NOTE - these are generic and do not answer "WHY"

Schedule
• Utilize federal funding by a certain date prior to expiration
• Complete the project on schedule to meet commitment to industry
• Schedule work effectively to meet environmental commitments for in-water work

Cost

• Fixed project budget so consider Fixed Price procurement to maximize utilization of funds
• Minimal changes will be accepted due to budget constraints
• Some funding may only be utilized for specific type of work (bridges, drainage, etc)

Quality

• Must adhere to standards proposed by the Agency
• High quality design and construction constraints
• Adhere to local and federal codes

Functional

• Traveling public must not be disrupted during construction
• Hazardous site where safety is a concern
• Return area surrounding project to existing conditions

Step 4: Project Risks

Risk is an uncertain event or condition that, if it occurs, has an effect on achieving the goals of the project. Risk allocation is the assignment of unknown events or conditions to the party that can best manage them.

4A: Risks
ROW:
Railroad & Utilities:
Environmental/Hazardous Materials:
Construction:
Other Risks:

General Project Risks

Complicated ROW

• Outdoor advertising signs
• UST's and other hazardous materials known or suspected
• Protected Lands (US Government, environmental mitigation protected, etc.

Railroad Involvement & Utilities

• Crossings within project limits (Upgrade, replace, grade separate, eliminate, etc.)
• Design of RR facilities
• Utility relocation and prior rights

Environmental

• Critical pristine waters/wetlands
• Type & number of permits required
• Limited ability to minimize impacts to the environment

Construction

• Access constraints
• Hazardous Materials (i.e. lead, asbestos, phosphogypsum, etc.)
• Traffic control schemes elaborate/difficult

Step 5: Project Summary

Provide narrative of anticipated project strategy/approach on which the Screening Level Cost Estimate is developed. (Elements discussed may include items such as staging, road closure, top down construction, off alignment, inside/outside widening, bridge replacement, interchange improvement, etc.)

5A: Project Strategy
Approach:

1F: Major Obstacles	
Right of Way:	**Utilities:**
Environmental:	**Construction:**
Safety:	**Traffic:**
Other:	

5B: Screening Level Cost Estimate
PE:
ROW:
Construction:
TOTAL:

Appendix 2G – Tech Memo on Insurance and Bonding in Design-Build Projects

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 2. Tools, Processes and Best Practices

Task 2g. Insurance and Bonding in Design-Build Projects

Prepared by

University of Colorado Boulder

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Table of Contents

1. Executive Summary

The objective of this subtask is to explore and summarize the current practices on the level of insurance and bonding for Design-Build projects in different Departments of Transportation (DOTs). This analysis focuses on four types of insurance: Design-Builder risk, professional liability/errors and omissions, general commercial liability, and hazardous materials. Bonding analysis includes: proposal, payment, performance, and warranty bonds. This section summarizes and compares the insurance and bond amounts that are required in the Request for Proposal (RFP) issued by seven different DOTs, including South Carolina (SCDOT). Tables 1 and 2 show the most relevant results found in this analysis.

Table 1. Comparison between Types of Insurance

Type/State	**South Carolina** RFP I-85 MM 98-MM106 (2017)	**Georgia** RFP SR 21 at I-95 (2015) and Standard Spec Section 103.05	**North Carolina** RFP Buncombe (2011)	**California** RFP I-15/I-25 Interchange Improvements (Devore) (2012)	**Colorado** I-25 North (2012)	**Minnesota** Willmar Wye Roadway (2018)	**New York** Rehabilitation of I-278 Bridges (2018)
Design Build Risk	*Not mentioned (8)*	No specific indication	No specific indication (1)	Not mentioned	Probable Maximum Loss (2)	Not mentioned	Builder's Risk Policy (5)
Professional Liability/Errors and Omissions	*≥10,000,000 per claim and in the aggregate.(9)*	≥1,000,000 per claim (with a maximum of two hundred and fifty thousand dollars ($250,000) deductible per claim)	≥$1,000,000 per claim (with a maximum of two hundred and fifty thousand dollars ($250,000) deductible per claim)	>$2,000,000 per claim	>$10,000,000 per claim an aggregate of at least $10,000,000 (4)	5,000,000 per claim with an annual aggregate of $10,000,000 (4)	Deductible or self-insured retention level of no more than $250,000.00
Commercial General Liability	*$2,000,000 per occurrence $4,000,000 annual aggregate (9)*	Not specific indication about this type of insurance	$5,000,000 per occurrence and general aggregate	Varies from $1,000,000 to $2,000,000 per occurrence depending on the total bid (7)	$1,000,000 each occurrence (3)	25,000,000 each occurrence	> $1,000,000 per occurrence. > $2,000,000 aggregate
Hazardous materials	*Pollution liability ≥1,000,000 per occurrence*	Not mentioned relating to insurance	Not mentioned relating to insurance	Pollution/ Environmental Impairment Liability insurance > 5,000,000 (6)	Pollution Legal Liability Coverage ≥%5,000,000 per occurrence & ≥$10,000,000 aggregate.	Not mentioned in insurance coverage	Commercial general liability includes underground hazards

(1) The RFP indicates "*Providing and maintaining adequate insurance coverage is a material obligation of the Design-Build Team and is of the essence of this contract*."

(2) Probable Maximum Loss value at all times including any subsequent contract modifications and cost of materials supplied or installed by others, comprising a total value for the entire project at the site on a replacement cost basis without optimal deductibles.

(3) Products and Completed Operations coverage shall be continued for a minimum of five years from Project Completion

(4) The policy will have a five-year extended reporting period from the Final Acceptance Date with respect to all events that occurred but were not reported, during the term of the policy.

(5) The Design-Builder shall procure and maintain a Builder's Risk policy in a form such as ISO form CP 00 20 10 90 or a policy providing equivalent coverage, covering the perils insured under and including the special causes of loss form, including collapse, water damage, and transit and theft of building materials, with deductible not to be less than the amount of the provisions called for in DB 107-27.3 and required under Table 107-1, in non-reporting form, with limits of coverage of not less than the provisions called for in DB 107- 27.3 and required under Table 107-1, covering the total value of work performed and equipment, supplies and materials at the location of the Work as well as at any off-site storage locations (See the RFP for more detail).
(6) This insurance is not referred explicitly to the hazardous materials.
(7) See section 3.1.5of this Tech Memo
(8) SCDOT does not include references to Design-Build Risk insurance in this RFP. However, SCDOT consider specific language for this type of insurance in their agreement templates. See Appendix 4.1. for more detail.
(9) SCDOT does not include references to the extended reporting period of professional liability/Errors and Omissions insurance in this RFP. However, SCDOT consider specific language for this aspect of the insurance in their agreement templates. See Appendix 4.2. for more detail.

Table 2 Comparison between Types of bonding

Type/State	**South Carolina** RFP I-85 MM 98-MM106 (2017)	**Georgia** RFP SR 21 at I-95 (2015) and Standard specifications section 103.05	**North Carolina** RFP Ville-I-40/I-77 (2018)	**California** RFP I-15/I-25 Interchange Improvements (Devore) (2012)	**Colorado** I-25 North (2012)	**Minnesota** Willmar Wye Roadway (2018) and Mn Standard Specs for Construction	**New York** Rehabilitation of I-278 Bridges (2018)
Proposal (1)	*No required (3)*	*Not mentioned*	5%	10%	5%	5%	5%
Performance (1)	100%	100% (2)	100%	100%	100%	100%	100%
Payment (1)	100%	110% (2)	100%	100%	100%	100%	100%
Warranty	*$5,000,000 3 years from the Final Completion of the project*	Not mentioned	Not mentioned	4% contract price 2 years following Final Acceptance 2% contract price the third year following Final Acceptance	See comment (4) in insurance Table 1	4 % contract price 2 years following Substantial Completion 2% contract price the third year following Substantial Completion	Not mentioned
Amount of contract	*Contract price*	120 % of the original contract amount	Price of winning proposal	Contract price	Guaranteed Maximum Price	Contract price	Price of winning proposal

(1) % contract amount
(2) GDOT differentiates between Georgia Resident or nor Resident contractor
(3) SCDOT does not include references to proposal bonding in this RFP. However, SCDOT consider specific language for this type of bonding in their agreement templates. See Appendix 4.3. for more detail.

2. Research Methodology

To accomplish this task, the research team developed a document analysis of Design-Build Manuals, Requests for Proposals and other documentation. Other documents included the standard specifications of Georgia and the standard specifications for construction of Minnesota. The research team used the software "*atlas.ti*" for content analysis of these documents. The software allows codifying the text within the document for sorting and analysis. Table 3 summarizes the states and documents considered in this review.

Table 3. Agency Design-Build Documentation Review

	SC	GA	NC	CA	CO	MN	NY
D-B Manuals							●
RPF	●	●	●	●	●	●	
Other Docs		●				●	

3. Summary of Analysis

This summary of analysis has two sections. The first section corresponds to design-build insurance practices and the second corresponds to bonding practices.

3.1 Insurance

Four types of insurance have been examined for this study: Design-Builder Risk, professional liability/errors and omission, commercial general liability, and hazardous materials.

3.1.1 Design-Builder Risk

From the states analyzed, only two explicitly mention Design-Builder Risk, and neither of these states establish a specific amount.

CDOT indicates that the amount should be the "*Probable Maximum Loss value at all times including any subsequent contract modifications and cost of materials supplied or installed by others, comprising total value for the entire project at the site on a replacement cost basis without optimal deductibles."*

NYDOT indicates that the "*Design-Builder shall procure and maintain a Builder's Risk policy in a form such as ISO form CP 00 20 10 90 or a policy providing equivalent coverage, covering the perils insured under and including the special causes of loss form, including collapse, water damage, and transit and theft of building materials, with deductible not to be less than the amount of the provisions called for in DB 107-27.3 and required under Table 107-1, in non-reporting form, with limits of coverage of not less than the provisions called for in DB 107-27.3 and required under Table 107-1, covering the total value of work performed and equipment, supplies and materials at the location of the Work as well as at any off-site storage locations*. Please refer to the NYDOT file in SCDOT's ProjectWise for more detail (file location: University of Colorado/Task2-11-29-18 Submittal/Subtask2g Insurance and bonding/2g Reference documents).

3.1.2 Professional liability/Errors & Omissions

The professional liability is included in all the reviewed RFP. The amounts considered vary from $1,000,000 to $10,000,000 per claim. The description of the coverage for the different states can be reviewed in the RFPs within SCDOT's ProjectWise file share for more detail (file location: University of Colorado/Task2-11-29-18 Submittal/Subtask2g Insurance and bonding/2g Reference documents).

3.1.3 Commercial General Liability

The coverage per occurrence of the commercial general liability varies from $1,000,000 to $25,000,000. In some cases like Georgia, the RFP does not include specific reference to this type of insurance, considering it a type of insurance that is required elsewhere. NYDOT establishes some liability coverages that should be include in the commercial general liability insurance, one of them is related to hazardous materials and is written as follow: "*for contracts that call for the performance of excavating, underground work, and/or the use of blasting equipment* is required *Explosion, Collapse and Underground Hazards coverage ("XCU")."*

3.1.4 Hazardous Materials

Besides the information found in NYDOT related to hazardous materials within the Commercial General Liability Insurance, we did not find any specific references to this matter in the other states. Considering that SCDOT associates the concept of hazardous materials with the pollution liability coverage, the research team looked for other states consider this kind of insurance and if so, what is the amount required.

From the states analyzed, four of them (including SCDOT) mention the pollution liability coverage. Within this group, the amounts per occurrence vary from $1,000,000 to $5,000,000 (see Table 1).

3.1.5 Variation Regarding Complexity

Examining several RFPs of three states, New York, California, and Colorado, the research found some evidence related to the variation of the insurance with the contract amount. However, it was not possible to establish a general trend for the variation. For this reason, this report includes the most relevant information found and refer to the specific RFP for more detail. Table 4 is included in a Request for Proposal issued by the New York Department of Transportation

Table 4. General Insurance Coverage Variation in NYDOT Design-Build Projects [1]

TABLE 107-1 INSURANCE FOR DESIGN-BUILD CONTRACTS						
Insurance Type	Contract Value (Millions)					
	$0-$10	$10-$25	$25-$50	$50-$100	$100-$250	Over $250
Commercial General Liability Insurance (CGLI)	$1 million per occurrence; $2 million aggregate	$1.5 million per occurrence; $3 million aggregate	$2 million per occurrence; $4 million aggregate	$3 million per occurrence; $6 million aggregate	$5 million per occurrence; $10 million aggregate	$5 million per occurrence; $10 million aggregate
Commercial Auto	$1 million per accident	$1 million per accident	$1 million per accident	$1 million per accident	$1 million per accident	$1 million per accident
Umbrella / Excess Liability	None required	None required	At least $5 million when combined with the CGLI	At least $10 million when combined with the CGLI	At least $25 million when combined with the CGLI	At least $50 million when combined with the CGLI
Special Protective & Highway Liability Policy	$1 million per occurrence / aggregate	$2 million per occurrence /aggregate	$2 million per occurrence; $4 million aggregate	$3 million per occurrence; $6 million aggregate	$5 million per occurrence; $10 million aggregate	$5 million per occurrence; $10 million aggregate
Professional Liability / Errors & Omissions[1]	$1 million per occurrence; $1 million aggregate	$2 million per occurrence; $2 million aggregate	$3 million per occurrence; $3 million aggregate	$4 million per occurrence; $4 million aggregate	$5 million per occurrence; $5 million aggregate	$10 million per occurrence; $10 million aggregate
Railroad Protective[2]	$1 million per occurrence / aggregate	$1 million per occurrence; $2 million aggregate	$2 million per occurrence; $4 million aggregate	$2 million per occurrence; $5 million aggregate	$2 million per occurrence; $6 million aggregate	$2 million per occurrence; $6 million aggregate
Builders' Risks (See Note 3)	Not Required	$1 million (Deductible $25,000)	$2.5 million (Deductible $50,000)	$5 million (Deductible $100,000)	$10 million (Deductible $200,000)	$25 million (Deductible $500,000)
Marine Protective	See note 3	See note 3	See note 3	See note 3	See note 3	See note 3
Pollution Legal Liability	See note 3	See note 3	See note 3	See note 3	See note 3	See note 3

Notes:

1) Professional Liability / Errors & Omissions: The amounts set forth in Table 107-1 are for projects where there is a notable design element, i.e. a difficult bridge, etc. The actual amounts required in Part 1, DB Agreement, Article 17, may be less.

2) Railroad Protective: RR Protective insurance should only apply when there is work around railroad facilities.

3) Builders' Risks; Marine Protective; Pollution Legal Liability:

   None of these insurance types are required in standard contracts. One or more of these types may be included in Part 1, DB Agreement, Article 17, as deemed necessary by the Department in accordance with the following guidelines.

   - Builders' Risks insurance will be included if a notable structure, such as a bridge or a building, is included in the Project.
   - Marine Protective Insurance will be included if there is to be construction from vessels, or there is a risk of damage to wharfs, bridges, vessels, etc.
   - Pollution Legal Liability insurance will be included if there are considerable hazardous materials on site.

[1] NYDOT RFP Kew Gardens Interchange Infrastructure and operational improvement project Grand Central Parkway (2018)

Appendix 4.5 includes the definition of the type of insurance: Special Protective & Highway Liability Policy.

Regarding the General liability, Caltrans provides a range of variation, as it is shown in table 5, included in all the RFP analyzed for Caltrans.

Table 5. General Insurance Coverage Variation in Caltrans Design-Build Projects[2]

Total Bid	For Each Occurrence [1]	Aggregate for Products/Completed Operation	General Aggregate [2]	Umbrella or Excess Liability [3]
≤$1,000,000	$1,000,000	$2,000,000	$2,000,000	$5,000,000
>$1,000,000 ≤$10,000,000	$1,000,000	$2,000,000	$2,000,000	$10,000,000
>$10,000,000 ≤$25,000,000	$2,000,000	$2,000,000	$4,000,000	$15,000,000
>$25,000,000	$2,000,000	$2,000,000	$4,000,000	$25,000,000

1. Combined single limit for bodily injury and property damage.
2. This limit shall apply separately to the Design-Builder's work under this Contract.
3. The umbrella or excess policy shall contain a clause stating that it takes effect (drops down) in the event the primary limits are impaired or exhausted.

Regarding the umbrella or excess policy, SCDOT's standard template includes this information: "This insurance, including insurance provided under the commercial umbrella, shall apply as primary and noncontributory insurance with respect to any other insurance or self-insurance programs, including any deductibles, afforded to, or maintained by SCDOT."

With respect to CDOT, three RFPs with different project budgets were analyzed. Table 6 compares the types of insurance found within the CDOT analysis.

[2] Caltrans RFP Fresno 180 Braided Ramps Project (2012)

Table 6. Insurance Comparison between CDOT Projects of Different Budgets

Project	Budget [$ millions]	Design-Build Risks	General liability	Errors & Omissions	Hazardous materials
C-470 express lanes (2016)	276	(1)	$1,000,000 per occurrence	≥$10 million per claim and an aggregate of at least $10 million	≥$5 million and the total Project aggregate shall be at least $10 million.
I-25 North (2012)	60-66	(1)	$1,000,000 per occurrence	≥$10 million per claim and an aggregate of at least $10 million	≥$5 million and the total Project aggregate shall be at least $10 million.
Eisenhower/Johnson Memorial Tunnel (2)	25	The RFP refers to the Project Insurance Manual, which is included in the appendix of this report.			

(1) Probable Maximum Loss value at all times including any subsequent contract modifications and cost of materials supplied or installed by others, comprising total value for the entire Project at the site on a replacement cost basis without optional deductibles.
(2) The project includes a 1) water-only deluge fire suppression system, which is capable of suppressing a large fire (up to 35 megawatts) in the first two minutes of the event; 2)a system capable of providing water for 60 minutes, with two deluge sprinkler zones as well as 500 gallons per minute from the existing standpipe system;3) a new drainage system; and 4) a fiber optic linear heat detection system.

3.2 Bonding

Four types of bonds have been examined for this report: proposal bonds, performance bonds, payment bonds, and warranty bonds.

3.2.1 Proposal Bonds

Five of the states require proposal bonds. In general, the amount of the bond is 5% of the bid price, although it could be higher and up to 10%, as defined by Caltrans (see Table 2).

3.2.2 Performance and Payment Bonds

All the states analyzed require performance and payment bonds. Generally, the amount required for both is 100% of the *amount of the contract*, with the exception being GDOT who requires a payment bond of 110%.

The definition of the *amount of the contract,* which is used to calculate the percentage, differs among the states. For SCDOT, Caltrans, and MnDOT the amount of contract is the contract price. For GDOT, it is the 120% of the original contract amount, whereas for NCDOT and NYDOT it is the price of the winning proposal. CDOT considers the Guaranteed Maximum Price to calculate this bond.

A peculiarity was found in GDOT, that differentiates between Georgia Resident or Nonresident Contractors. The difference is established as follows:

"<u>Georgia Resident Contractors</u> shall furnish Performance and Payment Bonds as follows:

Performance bond in the full penal sum of the Contract and payment bond in an amount equal to 110 percent of the full amount of the Contract. The aggregate amount of the bonds shall be 210 percent of the full penal sum of the Contract."

"<u>Nonresident Contractors</u> shall furnish Contract Bonds as follows:

Performance bond in the full penal sum of the Contract, payment bond in the full penal sum of the Contract, and tax bond in the amount of 10 percent of the full penal sum of the Contract. The aggregate amount of the bonds shall be 210 percent of the full penal sum of the Contract. The tax bond shall represent the nonresident contractor bond required by the Revenue Department in accordance with Sections 48-13-30 through 48-13-38 of the Official Code of Georgia Annotated."

3.2.3 Warranty

A warranty bond is explicitly mentioned in three of the states analyzed: SCDOT, Caltrans and MnDOT. There is a difference between SCDOT and the other two, Caltrans and MnDOT, in the way in which they define the amount. SCDOT establishes a fixed value of $5,000,000 for a period of 3 years from the Final Completion of the project. Caltrans and MNDOT define the bond value as a percentage of the contract price. This percentage is 4% for the first two years and 2% for the third year in both cases. There is a difference between these states regarding the point in time from which this warranty bond starts. Caltrans establishes this point from the Project Final Acceptance and MnDOT from the Project Substantial Completion.

To evaluate if the warranty bond varies with project complexity (assessed in terms of the project budget), three Caltrans projects were examined:

- I-15/I-215 Interchange improvement (Devore) with an estimated Project cost of $208,000,000.
- I-15 Cajon Pass Rehabilitation, with an estimated Project cost of $ 140,000,000.
- Fresno 180 Braided Ramps, with an estimated Project cost of $ 51,000,000.

All of them include in their RFP the same requirement regarding the warranty bond:

"After Final Acceptance has occurred, Design-Builder may obtain a release of the Performance Bond by providing to Department and maintaining full force and effect a warranty bond which shall guarantee performance of all obligations of Design-Builder that survive Final Acceptance under the Contract Documents. <u>The warranty bond (a) shall be in an amount equal to four percent of the Contract Price during the first two years following Final Acceptance and shall be in an</u>

amount equal to two percent of the Contract Price during the third year following Final Acceptance and (b) shall be in the form set forth in Exhibit M."

3.3 Summary

As seen from the analysis in this report, insurance and bonding amounts vary widely from state to state. Tables 1 and 2 provide a benchmarking the types and amounts required. The research team hopes that this information is helpful in SCDOT's efforts to balance insurance and bonding requirements with overall project costs. The following are a brief set of recommendations for consideration.

1. Review Table 1 and example RFPs in ProjectWise to determine if any unneeded insurance is being requested or if the amounts are higher than the other states examined for this report. However, in the research team's opinion, both the types and amounts seem reasonable and prudent.
2. Revisit SCDOT's warranty bond requirements. Three of the six states did not require warranty bonds. California and Minnesota used a graduated value of 4% of the contract price 2 years following the end of the project and 2% contract price the third following the end of the project. These graduated rates may save money while still providing the desired protection.

4. Appendix.

4.1 SCDOT Design-Build Risk insurance.

SCDOT might use this language in its agreements with Design-Builders:

- CONTRACTOR is not required to purchase Builder's Risk Insurance; however, CONTRACTOR must bear all risk normally covered by Builder's Risk Insurance. If CONTRACTOR purchases Builder's Risk Insurance, it shall be at its own cost.
- CONTRACTOR shall provide Builder's Risk Insurance acceptable to the SCDOT in the amount of the Contract Price protecting the respective interests of SCDOT and CONTRACTOR and covering physical loss or damage to the work during construction of the project. The certificate of insurance shall be provided to the SCDOT at the time of execution of this Agreement. The CONTRACTOR shall also obtain ${INSERT $$} in Delay in Start Up Coverage under the Builder's Risk policy. The policy shall name the SCDOT as an additional insured and shall reference the Project by name. The certificate shall also state that the coverage will not be cancelled or reduced without 30 days prior written notice to the SCDOT.

4.2 SCDOT Professional Liability/Errors and Omissions. Period of coverage

The SCDOT'S agreement template already has the following regarding the period of coverage:

This policy is written on a claims-made basis and CONTRACTOR warrants that any retroactive date under the policy shall precede the effective date of this Contract; and that either continuous coverage will be maintained or an extended discovery period will be exercised for a period of eight (8) years beginning at the time worked under this Contract is completed.

4.3 SCDOT Proposal Bonding

The SCDOT'S agreement template already has the following regarding proposal bonding:

The Cost Proposal shall be clearly marked as "Confidential Proprietary Information" by the Proposer and shall include the completed Cost Proposal Bid Form and Bid Bond Form provided at the end of this document. The Cost Proposal Bid Form and Bid Bond Form shall be sealed in a separate envelope and delivered as part of the Cost Proposal per the Milestone Schedule.

Bid Bond

Bid Bonds must be issued by a corporate surety registered and authorized to do business in the State of South Carolina. Any person signing a bid bond as an attorney-in-fact shall include with the bid bond evidence of authority to bind the surety. An original, or a photocopy or facsimile of an original, power of attorney is sufficient evidence of such authority. Electronic, mechanically-applied and printed signatures, seals and dates on the power of attorney shall be considered original signatures, seals and dates, without regard to the order in which they were affixed. Make certain that the proposal guaranty is written by a company licensed for surety authority by the Chief Insurance Commissioner of the South Carolina Department of Insurance and has a rating of "A" or better assigned by A.M. Best Company on its most recent Best's Key Rating Guide; otherwise, the bond will not be accepted. Ensure that the proposal guaranty is fully executed and indicates the name of the Proposer, the name of the surety, the project for which the bond is issued, the penal amount of the bond, and that the bond guaranties and names the South Carolina Department of Transportation as the oblige. Proposal guarantees must be included in the Proposer's response to the RFP on the required form and submitted as part of the sealed cost proposal. Failure to furnish a bid bond in the proper form and amount with the response to the RFP may be cause for rejection of the proposal. Bid bonds shall be payable to SCDOT, shall be for at least five percent (5%) of the total amount of the proposal, and shall serve as a guarantee deposit that the offer will be carried out to the compete satisfaction of SCDOT.

Failure to execute the Contract, or failure to meet and submit insurance and bond requirements within 20 days of receipt of the contract, shall result in its bid security being forfeited, and the Notice of Award and Contract will be rescinded and awarded to another Proposer. Withdrawal or attempted withdrawal of a proposal after the receipt of the cost proposal may also result in forfeiture of bid security.

A Proposal submitted without the Bid Bond Form may be deemed non-responsive.

4.4 SCDOT General Insurance. Umbrella

SCDOT's standard template language provides:

This insurance, including insurance provided under the commercial umbrella shall apply as primary and noncontributory insurance with respect to any other insurance or self-insurance programs, including any deductibles, afforded to, or maintained by SCDOT.

4.5 NYDOT Special Protective & Highway Liability Policy

According to the NYDOT engineering instructions EI 15-003 “Revision to Standard Specifications Section 100-Insurance”

The Special Protective & Highway Liability Policy consider the following:

The Contractor shall maintain, separate and apart from its umbrella policy, a policy issued to and covering the liability of the People of the State of New York, The State of New York, the Commissioner of Transportation, all employees of the Department of Transportation, any municipality in which the work is being performed, any public benefit corporation, railroad, or public utility whose property or facilities are affected by the work, against damages that the insureds may be held legally liable to pay for property damage, personal injuries, or death that is caused by any occurrence that takes place within any location where work is to be or is being performed by Contractor, including at the location of any of the work. This should be ISO form CG 00 14 12 or a policy form providing equivalent coverage along with mandatory New York endorsements. Coverage shall be in an amount of not less than $1,000,000 per occurrence and at least $2,000,000 for each aggregate limit.

Appendix 2H – Tech Memo on Management of Alternative Technical Concepts (ATCs)

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 2. Tools, Processes and Best Practices

Task 2h. Management of Alternative Technical Concepts (ATCs)

Prepared by

University of Colorado Boulder

University of Colorado Boulder

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1. Executive Summary

The objective of this subtask is to identify and summarize best practices in managing and archiving ATCs. Since the time of proposal, the South Carolina Department of Transportation (SCDOT) has made significant progress in its goal to develop an archive of ATCs to promote innovation and lessons learned on future projects (both Design-Build and traditional). Given the lead role that the SCDOT team has taken in this section topic, the research team has provided a supporting role. The research team has provided the following support:

- Reviewed and provided input on an ATC data collection questionnaire for SCDOTs national DOT survey;
- Assisted with survey points of contact for alternative contracting managers at DOTs across the country;
- Provided input on the classification approach for ATC lessons learned; and
- Advised on an approach to publishing a Transportation Research Board paper on the overall effort and results.

With this process complete, SCDOT should continue to maintain the database and track success with implemented ATCs. Tracking of ATC approval rates on new procurements will also be beneficial. Finally, SCDOT should consider applying ATC innovations from design-build projects on future design-bid-build projects. The database will serve to be beneficial for this purpose.

Appendix 2I – Tech Memo on Construction Engineering Inspection and Project Management Functions

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 2. Tools, Processes and Best Practices

Task 2i. Construction Engineering Inspection (CEI) and Project Management (PM) Functions

Prepared by

University of Colorado Boulder

University of Colorado
Boulder

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1. Executive Summary

The objective of this subtask is to identify and summarize Construction Engineering Inspection (CEI) and Project Management (PM) definitions and functions in Design-Build projects. This Technical Memorandum benchmarks South Carolina Department of Transportation's (SCDOT) CEI practices against the data collected in the NCHRP Project 20-107 "Effective Construction Project Staffing Strategies for Transportation Agencies[1]." It also compares the current functions of the Project Manager in SCDOT projects with the functions required for these positions in other states. The summary of both analysis provides SCDOT with a framework to evaluate their current practice.

The CEI practices of SCDOT were collected by surveying two current construction projects, "I-85 Reconstruction and Widening MM 77-98" and "I-77 Widening and Rehabilitation" and comparing these data with the information included in NCHRP Project 20-107 related to Design-Build projects. The same SCDOT projects were used to identify the PM functions and compared them to the ones established in other states. The research team benchmarked these data with the information provided in Design-Build Manuals from Virginia, Florida, Colorado, North Carolina and Georgia.

Table 1 and Table 2 summarize the benchmarking between SCDOT and California, Florida, Vermont, Utah, and Virginia. Both tables classify the data according to the complexity of the project—i.e., most complex (major projects), moderately complex projects and non-complex (minor) projects. See the questionnaires in the appendix for the definition of complexity. Table 1 includes the number of professionals working as CEI or as state staff in the next different positions 1) Resident Engineer, 2) Surveyor, 3) Senior Construction Inspector, 4) Intermediate Construction Inspector, 5) Junior Construction Inspector and 6) Administrative Staff. Table 2 shows the number of professionals working as CEI or as state staff in different construction functions. These functions are divided into three main groups: 1) Construction Administration, 2) Engineering and 3) Human Resources.

Table 3 summarizes common Project Manager Functions and relate them with in-house or external personnel in the case of SCDOT projects.

[1] The project was conducted by the University of Alabama, University of Kentucky and University of Colorado Boulder. The report is in press. http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4059

Table 1. Number of professionals working in-house or as CEI consultants

Project complexity	**Most Complex**				**Most Complex**						**Moderately Complex**				**Non-Complex**	
States	**South Carolina**				**California**		**Utah**				**Vermont**		**Virginia**		**Florida**	
Project name (type)	**I-85 (Road)**		**I-77 (Road)**		**CA-072 (Road)**		**UT-011 (Road)**		**UT-002 (bridge)**		**P-06 (Bridge)**		**VA-045 (Ramps)**		**FL-007 (Ramps)**	
Positions	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**
Resident Engineer	1		1	-	1	1	1	1	1	-	-	1	1	1	-	-
Surveyor	-	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Senior Construction Inspector	-	10 to 15	1	-	1	-	3	5	3	-	1	-	3	1	-	1
Intermediate Construction Inspector	-	10 to 15	2	1	2	3	2	10	5	-	-	-	2	2	-	-
Junior Construction Inspector	-	Up to 10	1	-	-	-	-	-	5	-	-	-	-	-	-	-
Administrative Staff	-	2	1	-	2	2	1	1	1	-	-	-	1	-	-	-

Table 2. Number of professionals working in-house or as CEI consultants

	Complexity	Most Complex				Most Complex						Moderately Complex				Non-Complex	
	State	South Carolina				California		Utah				Vermont		Virginia		Florida	
	Project name (type)	I-85 (Road)		I-77 (Road)		CA-072 (Road)		UT-011 (Road)		UT-002 (bridge)		P-06 (Bridge)		VA-045 (Ramps)		FL-007 (Ramps)	
		Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI
Construction administration	Liaison		1	-	-	2	-			1	-	1	-	-	2	1	-
	Budget	1		-	-	2	-			2	-	-	-	-	2	1	-
	Meetings		1	1		1	1			2	-	-	-	-	2	1	-
	Record Prep/ Maintenance		X	5	1	2	2			4	-	-	1	-	2	1	1
	Change Orders	1		2	-	2	2	1	1	3	-	2	-	-	2	1	-
	Work orders	-	-	-	-	-	-			-	-	-	-	-	2	1	-
	Documentation		2	2	-	2	1			3	-	1	2	-	2	1	-
	Application for payment	1	1	2	-	2	1			3	-	-	1	1	2	1	1
	Post construction support	-	-	-	-	2	1			-	-	-	-	-	2	1	1
Engineering	Survey control		4	2		3	-			-	-	1	1	-	-	-	-
	Utilities		1	-	-	-	-			2	-	-	-	1	-	1	1
	Schedule	1	1	1	-	1	1			3	-	1	1	1	1	1	1
	Construction Monitoring		30	5	1	2	1	Eng*: 5 CI**: 5	Eng*:2 CI**: 12	10	-	1	1	-	3	1	1
	Geotechnical		4	-	-	-	-			-	-	1	1	-	-	-	-
	Material sampling and testing		30	5	1	1	1			6	-	1	1	1	1	-	-
	Quality management	-	-	-	-	1	1			6	-	-	-	-	-	1	1
Human resources	Personnel		1	1	-	1	-			2	-	1	-	1	-	1	1
	Project Staffing		1	1	-	1	-	-	-	1	-	1	-	-	1	-	-
	Public Relations		1	-	-	1	1			4	-	-	-	1	-	-	-

*Engineering
**Construction Inspection

NOTE: Personnel listed in this table have multiple roles. For example, CEI personnel working on construction monitoring also perform material sampling and testing.

Table 3. PM functions in agencies or CEI responsibilities

PM functions	South Carolina			
	I-85 (Road)		I-77 (Road)	
	Agency	CEI	Agency	CEI
Acting as the Department's liaison with the Design-Build Firm during the construction of the project in general and as the person in responsible charge of the project	✓	-	✓	-
Coordinating the review of the Design-Build Firm's submittals by SCDOT during design and construction	-	✓	✓	-
Working with the assigned Right of Way Project Manager to ensure right of way services are provided as specified in the contract and in compliance with applicable state and federal requirements	-	✓	✓	-
Making periodic site reviews	✓	-	✓	-
Reviewing and approving periodic progress payments	✓	-	✓	-
Monitoring MBE/DBE participation	-	✓	✓	-
Ensuring the Department receives final documents as specified in the contract	-	✓	✓	-
Ensuring that proper CEI is performed during construction	✓	-	✓	-
Ensuring Materials Acceptance Program requirements are met		✓	✓	-
Working with appropriate offices to develop supplemental agreements if applicable	✓	-	✓	-
Ensuring that the Design-Build Firm's Quality Control (QC) plan is being followed	-	✓	✓	-
Ensuring that all environmental commitments are followed	-	✓	✓	-
Ensuring that appropriate documentation takes place at each step in the process	-	✓	✓	-
Conducting performance evaluations	✓	-	✓	-
Others. Please, specify:	-	-	-	-

This research provides excellent information and benchmarking for CEI and PM functions on design-build projects. SCDOT can compare its construction administration approach to that of other states. However, the research team hesitates to make recommendations at this point. Please see the conclusions section for more discussion.

2. Research Methodology

The research team followed two different methodologies to approach the CEI and the PM questions. To identify and summarize CEI definitions and functions in Design-Build Projects, the research team developed a benchmark analysis of SCDOT projects against DB projects developed in California, Virginia, Utah, Vermont, and Florida. The research team conducted a similar survey to the one used in the NCHRP 20-107 project. This enabled the comparison between SCDOT practice and the data from other states of similar characteristics included in the NCHRP study.

The SCDOT projects surveyed were 1) "I-85 Reconstruction and Widening MM 77-98" and 2) "I-77 Widening and Rehabilitation." The projects from the NCHRP 20-107 study were selected based on their project delivery system. Design-Build project was chosen to be benchmarked. Table 4 lists these projects.

Table 4. NCHRP 20-107 projects used in the benchmarking analysis

Project name	State	Type of project	Complexity
CA-072	California	New road	Most complex
FL-007	Florida	Other*	Non-complex
P-06	Vermont	Bridge replacement	Moderately complex
UT-002	Utah	New bridge	Most complex
UT-011	Utah	New Road	Most complex
VA-045	Virginia	Other	Moderately complex

*Ramps/Curb/Shoulder/Sidewalks/Drainage/Retaining walls

The focus of the survey questions included in this tech memo is threefold. First, to recognize the drivers that agencies have to hire CEI consultants. Second, to identify the number of professionals from state and from CEI that serve in different positions. Third, to determine the number of professionals developing specific construction functions in-house or as a consultant. Table A.1 in the appendix shows the definitions of the drivers. Tables A.2-A.4 show the definitions for all the construction functions that are benchmarked in this report. The appendix also contains the completed surveys for the two SCDOT projects.

To identify and summarize PM definitions and functions in Design-Build projects, the research team reviewed the common PM functions included in Design-Build Manuals. Based on these manuals, the research team asked SCDOT to relate these functions with in-house or hired personnel. The SCDOT projects surveyed were "I-85 Reconstruction and Widening MM 77-98" and "I-77 Widening and Rehabilitation". This information was compared with the identification of CEI and PM functions that other states include in their Design-Build manuals. Table 5 summarizes the states and documents in this review.

Table 5. Design-Build manuals reviewed

	NC	GA	VA	FL	CO
Design-Build Manuals	●	●	●	●	●

3. Summary of Analysis

This summary of analysis has two sub-sections. They introduce the study related to the CEI and PM respectively.

3.1 CEI benchmarking

Following sections include the comparison between SCDOT drivers, professionals, and functions and the ones related to California, Utah, Vermont, Virginia and Florida. Table 6 shows the drivers that have motivated each state to hire an external CEI. The most common reasons for DOTs to hire a CEI are personnel shortages and need of skills. Note that Florida uses CEI consultants extensively due to state legislation.

Table 6. CEI drivers

Project Complexity	**Most complex**		**Most complex**			**Moderately complex**		**Non-complex**
State	**South Carolina**		**California**	**Utah**		**Vermont**	**Virginia**	**Florida**
Project name (type)	**I-85 (Road)**	**I-77 (Road)**	**CA-072 (Road)**	**UT-011 (Road)**	**UT-002 (Bridge)**	**P-06 (Bridge)**	**VA-045 (Ramps)**	**FL-007 (Ramps)**
Mandates			-		-			✓
Shortages	✓	✓	-		-	✓		
Skills needed			-	✓	-		✓	
Time Constrains			-		-		✓	

Tables 6, 7 and 8 summarize the benchmarking between SCDOT and California, Florida, Vermont, Utah, and Virginia. Both tables classify the data according to the complexity of the project—i.e., most complex (major projects), moderately complex projects and non-complex (minor) projects.

Table 7 includes the number of professionals working as CEI or as state staff in different positions: 1) Resident Engineer, 2) Surveyor, 3) Senior Construction Inspector, 4) Intermediate Construction Inspector, 5) Junior Construction Inspector and 6) Administrative Staff.

Table 8 shows the number of professionals working as CEI or as state staff in different construction functions. These functions are divided in three groups: 1) Construction Administration, 2) Engineering and 3) Human Resources. Tables A.1, A.2, and A.3 in the appendix provide descriptions for each of the functions.

Table 7. Number of professionals working in-house or as CEI consultants for engineering functions

Project complexity	**Most Complex**				**Most Complex**						**Moderately Complex**				**Non-Complex**	
States	**South Carolina**				**California**		**Utah**				**Vermont**		**Virginia**		**Florida**	
Project name (type)	**I-85 (Road)**		**I-77 (Road)**		**CA-072 (Road)**		**UT-011 (Road)**		**UT-002 (bridge)**		**P-06 (Bridge)**		**VA-045 (Ramps)**		**FL-007 (Ramps)**	
Positions	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**	**Agency**	**CEI**
Resident Engineer	1		1	-	1	1	1	1	1	-	-	1	1	1	-	-
Surveyor	-	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Senior Construction Inspector	-	10 to 15	1	-	1	-	3	5	3	-	1	-	3	1	-	1
Intermediate Construction Inspector	-	10 to 15	2	1	2	3	2	10	5	-	-	-	2	2	-	-
Junior Construction Inspector	-	Up to 10	1	-	-	-	-	-	5	-	-	-	-	-	-	-
Administrative Staff	-	2	1	-	2	2	1	1	1	-	-	-	1	-	-	-

Table 8. Number of professionals working in-house or as CEI consultants for various functions

	Complexity	Most Complex				Most Complex						Moderately Complex				Non-Complex	
	State	South Carolina				California		Utah				Vermont		Virginia		Florida	
	Project name (type)	I-85 (Road)		I-77 (Road)		CA-072 (Road)		UT-011 (Road)		UT-002 (bridge)		P-06 (Bridge)		VA-045 (Ramps)		FL-007 (Ramps)	
		Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI	Agency	CEI
Construction administration	Liaison		1	-	-	2	-			1	-	1	-	-	2	1	-
	Budget	1		-	-	2	-			2	-	-	-	-	2	1	-
	Meetings		1	1		1	1			2	-	-	-	-	2	1	-
	Record Prep/ Maintenance		X	5	1	2	2			4	-	-	1	-	2	1	1
	Change Orders	1		2	-	2	2	1	1	3	-	2	-	-	2	1	-
	Work orders	-	-	-	-	-	-			-	-	-	-	-	2	1	-
	Documentation		2	2	-	2	1			3	-	1	2	-	2	1	-
	Application for payment	1	1	2	-	2	1			3	-	-	1	1	2	1	1
	Post construction support	-	-	-	-	2	1			-	-	-	-	-	2	1	1
Engineering	Survey control		4	2		3	-			-	-	1	1	-	-	-	-
	Utilities		1	-	-	-	-			2	-	-	-	1	-	1	1
	Schedule	1	1	1	-	1	1			3	-	1	1	1	1	1	1
	Construction Monitoring		X	5	1	2	1	Eng*: 5 CI**: 5	Eng*:2 CI**: 12	10	-	1	1	-	3	1	1
	Geotechnical		4	-	-	-	-			-	-	1	1	-	-	-	-
	Material sampling and testing		30	5	1	1	1			6	-	1	1	1	1	-	-
	Quality management	-	-	-	-	1	1			6	-	-	-	-	-	1	1
Human resources	Personnel		1	1	-	1	-			2	-	1	-	1	-	1	1
	Project Staffing		1	1	-	1	-	-	-	1	-	1	-	-	1	-	-
	Public Relations		1	-	-	1	1			4	-	-	-	1	-	-	-

*Engineering
**Construction Inspection

3.2 PM definitions and functions

To identify and summarize PM definitions and functions in Design-Build projects, the research team reviewed the common PM functions included in Design-Build manuals. Based on these manuals, the research team created a questionnaire and asked SCDOT to relate these functions in-house or external personnel. The SCDOT projects surveyed were "I-85 Reconstruction and Widening MM 77-98" and "I-77 Widening and Rehabilitation". Table 8 shows both projects answers.

Table 8. PM functions with agency or CEI responsibilities

PM functions	South Carolina			
	I-85 (Road)		I-77 (Road)	
	Agency	CEI	Agency	CEI
Acting as the Department's liaison with the Design-Build Firm during the construction of the project in general and as the person in responsible charge of the project	✓	-	✓	-
Coordinating the review of the Design-Build Firm's submittals by SCDOT during design and construction	-	✓	✓	-
Working with the assigned Right of Way Project Manager to ensure right of way services are provided as specified in the contract and in compliance with applicable state and federal requirements	-	✓	✓	-
Making periodic site reviews	✓	-	✓	-
Reviewing and approving periodic progress payments	✓	-	✓	-
Monitoring MBE/DBE participation	-	✓	✓	-
Ensuring the Department receives final documents as specified in the contract	-	✓	✓	-
Ensuring that proper CEI is performed during construction	✓	-	✓	-
Ensuring Materials Acceptance Program requirements are met		✓	✓	-
Working with appropriate offices to develop supplemental agreements if applicable	✓	-	✓	-
Ensuring that the Design-Build Firm's Quality Control (QC) plan is being followed	-	✓	✓	-
Ensuring that all environmental commitments are followed	-	✓	✓	-
Ensuring that appropriate documentation takes place at each step in the process	-	✓	✓	-
Conducting performance evaluations	✓	-	✓	-
Others. Please, specify:	-	-	-	-

All of the PM functions show in the other states' Design-Build manuals. There is a higher use of CEI support on the I-85 Project. While the research team could not benchmark these functions against other states' projects, useful information on PM function was available. This section summarizes the key information from the Design-Build manuals.

Colorado

Colorado DOT includes a brief definition of the PM in its Design-Build Manual.

> "The Project Manager role is often provided on larger projects. The Project Manager directly supports the Project Director in leading the project and assumes specific leadership responsibilities at the direction of the Project Director. Often the Project Manager leads the development of the design and the Request for Proposal (RFP) development and is involved in more of the intimate details of the project. As the project moves into construction, the Project Manager often leads the design and construction oversight activities, and the Project Director becomes more involved in the administration of the Design-Build contract."

Florida

Florida DOT includes a more detailed description of the Project Manager functions in its Design-Build manual.

> "The Department's Project Manager will be responsible for coordinating the procurement of Design-Build services as well as overseeing the engineering/inspection/construction of the project. A team approach, with a PM from Production and a PM from Operations, is a viable solution to fulfilling the responsibilities associated with this role.
>
> The responsibilities may include, but are not limited to:
>
> - Working with Contracting Unit and other appropriate offices in establishing the pre-qualification categories and advertisement.
> - Coordinating with the Federal Highway Administration representative on oversight and exempt projects.
> - Participating in the Proposal Evaluators review of Letters of Interest submitted by responsive Design-Build Firms.
> - Participating in the development of the RFP.
> - Working with the Contracting Unit in responding to Design-Build Firm's inquiries
> - Participating in the procurement meetings.
> - Coordinating the Proposal Evaluators review of technical proposals.
> - Coordinating the submittal of technical evaluations to Selection Committee
> - Acting as the Department's liaison with the Design-Build Firm during the construction of the project in general and as person in responsible charge of the project
> - Coordinating the review of the Design-Build Firm's submittals by FDOT during design and construction.

- Working with the assigned Right of Way Project Manager to ensure right of way services are provided as specified in the contract and in compliance with applicable state and federal requirements.
- Making periodic site reviews.
- Reviewing and approving periodic progress payments.
- Monitoring MBE/DBE participation.
- Ensuring the Department receives final documents as specified in the contract
- Ensuring that proper CEI is performed during construction.
- Ensuring Materials Acceptance Program requirements are met.
- Working with appropriate offices to develop supplemental agreements if applicable.
- Ensuring that the Design-Build Firm's Quality Control (QC) plan is being followed.
- Ensuring that all environmental commitments are followed.
- Ensuring that appropriate documentation takes place at each step in the process.
- Conducting performance evaluations."

Georgia
The GDOT Design-Build Manual does not devein the PM, but it refers to CEI functions.

> "The Construction Engineering and Inspection (CEI) staff will provide monitoring and inspection of the construction in conformance with the plans, specifications and special provisions to ensure test report it is crucial that they are familiar with GDOT's practices, plans, DB Documents of the project, and proposed SOPs for the project as they will manage and track the Design-Build Team's progress and quality of the work. They will keep daily diaries, logs, and records consistent with GDOT's practice as delineated in the GDOT Construction Manual and the Design-Build Construction SOP, including Inspectors' diaries. They will inspect traffic control daily to ensure it is in compliance with the traffic control plan and GDOT's 5240-1 Work Zone Safety and Mobility Policy. They will also immediately provide regular updates to the PMC-ACM of any accident, incident, or unanticipated project conditions. The CEI staff responsibilities will be in accordance with the GDOT Construction Manual and the Design-Build Construction SOP."

North Carolina
North Carolina DOT includes a definition for both the PM and CEI functions.

> Project Manager: "The Project Manager is the Transportation Program Management Unit staff member assigned to coordinate the development of a project's RFP and the review of the Team's design submittals. The Project Manager's role is critical to the success of the project. The Project Manager has the primary responsibility for the contract development and design approval. The Project Manager works closely with the Resident Engineer during construction to provide support for contract administration items as deemed necessary by the Resident Engineer. The Project Manager and the State Contract Officer are the liaisons between the Department and prospective Design-Build Teams prior to award of a contract. This role shifts to the Resident Engineer after award of a contract."

> Construction Engineering and Inspection: "Typically, construction engineering and inspection services for Design-Build projects will be conducted by Department staff. However, the Department may also consider utilizing a third party private engineering firm or include these services in the Design-Build contract. In the event that these services are made a part of the Contract, the RFP must clearly define the construction engineering services to be provided by the Team. Services may include off-site fabrication, sampling and testing, surveying and other services as necessary for the particular project. Requirements may include the type and frequency of reports, the level of detail and type of documentation for materials used in the construction of the project, and other such requirements necessary for the particular project."

Virginia

Virginia DOT refers very briefly to the PM functions in its Design-Build Manual.

> "Project Manager - Alternate Project Delivery Office" (PM-APD) means VDOT's designee for supervising procurement of a Design-Build contract. This individual will be responsible for contract development, solicitation, and award".

4. Conclusions

This research provides excellent information and benchmarking for CEI and PM functions on Design-Build projects. SCDOT can compare its approach to construction administration with that of other states. This information may allow SCDOT to rethink its approach.

The research team hesitates to make recommendations at this point. While it would appear that SCDOT may be using more CEI consultants that other states, these data do not tell the full story. The other states may be allocating more responsibility for quality control and quality assurance to the design-builder. If this is true, these states would be paying for these functions in the design-builder's contract. If SCDOT decides to make a reduction in agency or CEI staffing, it should only be done in coordination with changes to its quality assurance approach.

5. Appendix

Table A.1. Definitions of drivers for hiring CEI

Drivers	Definition
Legal Mandates	Your agency was legally mandated by either legislative or executive branches to limit the number of staff hired
Staff Shortages	Your agency did not have enough staff to complete the project requirements within the required timeframe. Your agency was understaffed or could not handle the workload without relying on outside help.
Skill needs	Your agency did not possess a specific skill(s) and/or expertise required to perform the project.
Time constraints	Your agency would normally have had the available staff, but they were preoccupied with other projects.

Table A.2. Definitions of construction administration functions

Construction Administration	Definition
Liaison	Ensure all project parties stay informed of project status. Work with all necessary parties to meet contract and project requirements. Provide timely answers and resolutions.
Budget	Monitor, recommend and manage budget
Meetings	Set, attend, assist, or conduct preconstruction conference and other meetings
Record Prep/Maintenance	Maintain records and prepare required reports of contractor activities. Maintain accurate record of communication between parties
Change Orders	Review, estimate, prepare, and manage change orders
Work Orders	Prepare and review work orders
Documentation	Manage contractor requests for information Track and update changes to construction documents Review and track approval of plans, shop drawings, and product information Prepare project and closeout documentation Analyze and interpret contract documents Prepare and distribute correspondence Review and submit contractor construction plan
Application for payment	Review and submit contractor applications for payments Field measure quantities for payment purposes Submit final "as-built" plans Revise and submit final estimate Authorize monthly payments to contractor
Post Construction support	Monitor and document claims Prepare claim analysis support documentation Assist, analyze, or settle claims Prepare and process closeout claim documentation Assist with preparation of arbitration hearings or litigation

Table A.3. Definition of construction engineering functions

Engineering	**Definition**
Survey control	Survey preparation, control, and verification Assist in survey work Supply survey crew or licensed surveyor
Utilities	Coordinate utility work or relocation Monitor, inspect, and document work or relocation
Schedule	Verify conformance with contract documents Monitor and review or coordinate schedule Review accuracy of schedule logic
Construction Monitoring	Monitor contract activities for compliance with plans and specifications Perform final inspection and coordinate parties' attendance Report and recommend on design of field construction issues Coordinate inspection assignments Review Constructability, bid-ability, and other preconstruction issues
Geotechnical	Perform required tests and inspections Monitor progress and quality of work Review and make recommendations on contractor installation plans
Material Sampling and Testing	Perform sampling and testing of component materials and completed work Arrange and transport sample for testing to appropriate location Verify materials and applicable documents to ensure testing was performed Supervise material sampling and testing
Quality management	Provide or revise and submit quality assurance plan Perform quality assurance testing Perform quality control of contractor activities

Table A.4. Definitions of construction human resource functions

Human resources	**Definition**
Personnel	Provide, supervise, and manage personnel Review compliance with EEO, wage rates, and labor policies Provide vehicles, equipment, and supplies as required by contract
Project Staffing	Make recommendation or submit plan on project staffing Coordinate staffing needs and inspector assignments
Public Relations	Keep community aware of status and traffic impacts Provide current and accurate information through website linked to STA

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SCDOT Efficiency Study of Design-Build Program

Subtask 2i. Design-Build Construction Engineering and Inspection

Project Questionnaire

INTRODUCTION/BACKGROUND

The purpose of this questionnaire is to identify how SCDOT has implemented construction engineering and inspection (CEI) services and compare them to commonly used practices with other states nationwide. The questionnaire on the following pages is a version of the one that we used on NCHRP project 20-107 Effective Construction Project Staffing Strategies for Transportation Agencies.

I. PROJECT CHARACTERISTICS

A. PROJECT OVERVIEW

1. Please estimate the percentage of total project cost that fell into each category.

Project Description	Approximate Percentage of Total Project Cost
Facility Type	48 % Road 2 % ITS 9 % Bridges 3 % Drainage 38 % Others, please specify: 100 % Total (must total 100%) ☐ Or I do not know
Project Type	100 % New Construction/Expansion ____% Rehabilitation/Reconstruction ____% Resurfacing/Renewal ____% Others, please specify: 100 % Total (must total 100%) ☐ Or I do not know

2. Given the complexity definitions in the table below, please rate the complexity of this project.

Most Complex (Major) Projects	Moderately Complex Projects	Non-Complex (Minor) Projects
• New highways; major relocations • New interchanges • Capacity adding/major widening • Major reconstruction (4R; 3R with multiphase traffic control) • Congestion management studies are required • Environmental Impact Statement or complex Environmental Assessment required	• 3R and 4R projects which do not add capacity • Minor roadway relocations • Non-complex bridge replacements with minor roadway approach work • Categorical Exclusion or non-complex Environmental Assessment required	• Maintenance betterment projects • Overlay projects, simple widening without right-of-way (or very minimum right-of-way take) little or no utility coordination • Non-complex enhancement projects without new bridges (e.g. bike trails) • Categorical Exclusion

☒ *Most Complex (Major)* ☐ *Moderately Complex* ☐ *Non-Complex (Minor)*

B. Project Staffing

The following questions examine the extent that CEI consultants were used on the project as well as the motivation for doing so.

3. Did you use CEI consultants on the project?

☒ *Yes, continue to the next question.* ☐ *No, proceed to Question 6.*

4. What was the primary driver(s) for using CEI Consultants on this project (check all that apply)?

☐ ***Legal Mandates:*** Your agency was legally mandated by either legislative or executive branches to limit the number of staff hired.

Please describe the legal mandate that limited the number of staff hired.

☒ ***Staff Shortages:*** Your agency did not have enough staff to complete the project requirements within the required timeframe. Your agency was understaffed or could not handle the workload without relying on outside help.

☐ ***Skill Needs:*** Your agency did not possess a specific skill(s) and/or expertise required to perform the project.

☐ ***Time Constraints:*** Your agency would normally have had the available staff, but they were preoccupied with other projects.

☐ ***If Other, please describe:***

5. On this project, was there a difference in the level of authority between State Staff and CEI Consultants regarding the approval of change orders among the following positions?

	Yes	No
Senior Construction Inspector	☒	☐
Intermediate Construction Spector	☒	☐
Construction Inspector	☒	☐

6. Was the project adequately staffed? Please provide an approximate percentage.
*FTE (full-time equivalent) is a full-time employee that works a minimum of 40 hours per five-day work week.

Approximately __100__ % of the required FTEs (per DOT policy and procedure manual) were staffed on the project

7. The following table is used to understand the roles of CEI Consultants and State Staff on construction projects. Please refer to the definitions below the table for further clarification of job titles. The following job titles are generic. If they do not reflect the same classification used within your agency, please let us know the equivalent job titles in your agency. If known, please list the total number of State Staff FTEs and CEI Consultant FTEs hired on the project.

Position (Descriptions are below)	Different position name used in agency	Check if CEI Consultants were used	Number of CEI Consultants	Check if State Staff were used	Number of State Staff	State Staff are part of union.
Resident Engineer		☐		☐	1	☐
Surveyor		☐	4	☐		☐
Senior Construction Inspector		☐	10 to 15	☐		☐
Intermediate Construction Inspector		☐	10 to 15	☐		☐
Junior Construction Inspector		☐	Up to 10	☐		☐
Administrative Staff		☐	2	☐		☐

Resident Engineer
Qualifications: Bachelor's Degree – Civil Engineering and Licensed Professional Engineer
Sample Work: (1) Administers construction contracts for the assigned area. (2) Interprets construction plans, specifications and special provisions and makes corrections as required. (3) Prepares or supervises preparation of project documentation, project reports, payment estimates, change orders, final plans and contractor performance reports; reports progress of contractor payments. (4) Supervises layout and inspection personnel, including making hiring and other employment-related decisions, conducting performance management, scheduling and assigning work, and ensuring appropriate training is received. (5) Communicates with contractors and property owners to resolve construction problems; prepares department responses to contractor claims and serves as an expert witness in litigation regarding construction issues. (6) Disseminates construction information to the public, media, and local and state officials. (7) Provides technical expertise and constructability input on project core teams and scoping meetings. (8) Manages a field office including responsibility for project budgets, fleet vehicles, and acquisition and maintenance of equipment. (9) Performs field checks to evaluate work zone safety in construction areas. (10) Investigates construction problems and negotiates resolutions that may include time extensions and/or cost changes. (11) Performs supervisory responsibilities in a manner consistent with the department's Affirmative Action Program. (12) Performs other responsibilities as required or assigned.

Surveyor
Qualifications: High School Diploma or GED/HiSET or relevant experience
Sample Work: (1) Operates and maintains complex and highly technical surveying equipment. (2) Performs deed, title and map research, monument investigation, and assists in establishing control for boundary and right of way. (3) Converses with property owners to gain access to private property and answer questions concerning the progress of survey work on or near landowner's property; contacts local governments and utility companies to secure information. (4) Performs mathematical computations for field layout and land surveying calculations that require professional judgement to determine right-of-way and land corner positions. (5) Collects data and records pertinent information in survey data recorder and/or field books. (6) Provides professional land surveying services for highway design, land management, and other purposes when needed. (7) May review the preparation of plats,

maps, reports, descriptions, surveys, digital map models and data filing editing. (8) Performs lead worker responsibilities, which may include providing general instruction, assigning and reviewing work, coaching and training, providing guidance and instruction in the proper and most efficient methods of accomplishing tasks, and providing input to the direct supervisor on staffing decisions and performance management. (9) Performs other responsibilities as required or assigned.

Senior Construction Inspector
Qualifications: High School Diploma, GED/HiSET or four years of relevant highway or transportation experience
Sample Work: (1) Performs duties of inspector in responsible charge of multiple routine or complex projects; directs the overall inspection of construction projects, verifying that contractors' activities are in compliance with contracts, specifications, and engineering principles; provides clarification to contractor and department personnel regarding the contract and the interpretation of plans, specifications, and special provisions. (2) Supervises routine layout and staking; serves as party chief on staking large bridges, other critical structures, or complex interchanges; serves as inspector on large bridges or other critical structures. (3) Serves as technical expert on the project; reviews plans, specifications, and special provisions applicable to assignment; directs computations for the control of grades or alignment. (4) Prepares, or supervises the preparation of, required project documentation, change orders, estimates, final plans and correspondence; checks progress of contractors. (5) Maintains required records; prepares progress and other reports; initiates or answers correspondence. (6) Keeps supervisor fully informed of activities, progress, and changes or revisions. (7) May perform duties of resident engineer during supervisor's absence. (8) Performs lead worker responsibilities, which may include providing general instruction, assigning and reviewing work, coaching and training, providing guidance and instruction in the proper and most efficient methods of accomplishing tasks, and providing input to the direct supervisor on staffing decisions and performance management. (9) Performs other responsibilities as required or assigned.

Intermediate Construction Inspector
Qualifications: High School Diploma, GED/HiSET or two years of relevant highway or transportation experience
Sample Work: (1) Performs duties of inspector in responsible charge of routine or complex projects; may direct the overall inspection of routine projects, verifying that contractors' activities are in compliance with contracts, specifications, and engineering principles; provides clarification to contractor and department personnel regarding the contract and the interpretation of plans, specifications, and special provisions. (2) Inspects routine construction items such as asphalt or portland cement concrete plants, asphalt or concrete paving, grading and bases, large and small bridges, box and pipe culverts, incidental construction, and roadside development, including various erosion control measures. (3) Inspects general or specialty items such as utilities, signing and traffic control devices, signals and lighting, demolitions, right-of-way permit projects, enhancement projects, and county bridge projects. (4) Directs the layout and staking of routine and complex construction projects, including large and small bridges, other critical structures, or complex interchanges. (5) Prepares or supervises the preparation of final plans, bridge sheets, change orders, contractor payment estimates, engineering costs, and semi-final and final inspections. (6) Maintains required documentation, records and files; prepares progress and other reports; keeps supervisors fully informed as to activities or unusual conditions on the job. (7) Performs lead worker responsibilities, which may include providing general instruction, assigning and reviewing work, coaching and training, providing guidance and instruction in the proper and most efficient methods of accomplishing tasks, and providing input to the direct supervisor on staffing decisions and performance management. (8) Performs other responsibilities as required or assigned.

Junior Construction Inspector
Qualifications: High School Diploma or GED/HiSET or relevant experience
Sample Work: (1) Coordinates and performs construction inspections verifying that contractors' activities are in compliance with contracts, specifications, and engineering principles. (2) Performs duties of inspector in charge of routine construction items, such as asphaltic or portland cement concrete plants, asphaltic or concrete paving, including grading and base, small bridges, concrete box and pipe culverts; inspects general or special items, such as utility adjustments, signing, traffic signals and lighting. (3) Performs measurements, computations, or other work in preparing final plans, change orders, contractor payment estimates, and engineering costs. (4) Maintains required construction documentation, records and files; prepares progress and other reports, keeps supervisor fully informed as to activities or unusual conditions on the job. (5) Provides field checks for contractor surveying operations; serves as party chief on routine layout and staking; serves as instrument operator on staking of large bridges, other critical structures, or complex interchanges. (6) Performs lead worker responsibilities, which may include providing general instruction, assigning and reviewing work, coaching and training, providing guidance and instruction in the proper and most efficient methods of accomplishing tasks, and providing input to the direct supervisor on staffing decisions and performance management. (7) Performs other responsibilities as required or assigned.

8. The following table is used to understand which specific job functions were assigned to CEI Consultants versus State Staff. Please indicate whether CEI and/or State Staff were hired for the appropriate job function. If known, please list the total number of State Staff FTEs and CEI Consultant FTEs hired on the project. As a reminder, FTE (full-time equivalent) is a full-time employee that works a minimum of 40 hours per five-day work week.

Table 8a

JOB FUNCTION CATEGORY	SAMPLE CEI TASKS	Check box if CEI Consultants were hired	Number of CEI Consultants	Check box if State Staff were used	Number of State Staff
Construction Administration					
Liaison	*Ensure all project parties stay informed of project status* *Work with all necessary parties to meet contract and project requirements* *Provide timely answers and resolutions*	☒	1_	☐	_
Budget	*Monitor, recommend, and manage budget*	☐	_	☒	1_
Meetings	*Set, attend, assist, or conduct preconstruction conference and other meetings*	☒	1_	☐	_
Record Prep/ Maintenance	*Maintain records and prepare required reports of contractor activities* *Maintain accurate record of communication between parties*	☒	_	☐	_
Change Orders	*Review, estimate, prepare, and manage change orders*	☐	_	☒	_1
Work Orders	*Prepare and review work orders*	☐	_	☐	_
Documentation	*Manage contractor requests for information* *Track and update changes to construction documents* *Review and track approval of plans, shop drawings, and product information* *Prepare project and closeout documentation* *Analyze and interpret contract documents* *Prepare and distribute correspondence* *Review and submit contractor construction plan*	☒	2_	☐	_
Application for Payment	*Review and submit contractor applications for payments* *Field measure quantities for payment purposes* *Submit final "as-built" plans* *Revise and submit final estimate* *Authorize monthly payments to contractor*	☒	_1	☒	1_
Post-Construction Support	*Monitor and document claims* *Prepare claim analysis support documentation* *Assist, analyze, or settle claims* *Prepare and process closeout claim documentation* *Assist with preparation of arbitration hearings or litigation*	☐	_	☐	_
If specific numbers are unknown for each function, can you provide approximate staff estimates for overall the <u>Construction Administration</u> job functions?	Number of State Staff in Administration 1				
	Number of CEI Consultants in Administration 6				
Engineering					
Survey Control	*Survey preparation, control, and verification* *Assist in survey work* *Supply survey crew or licensed surveyor*	☒	4_	☐	_
Utilities	*Coordinate utility work or relocation* *Monitor, inspect, and document work or relocation*	☒	_1	☐	_
Schedule	*Verify conformance with contract documents* *Monitor and review or coordinate schedule* *Review accuracy of schedule logic*	☒	_1	☒	1_
If specific numbers are unknown for each function, can you provide approximate staff estimates for overall the <u>Engineering</u> job functions?	Number of State Staff in Engineering 1				
	Number of CEI Consultants in Engineering 4				

Table 8b

JOB FUNCTION CATEGORY	SAMPLE CEI TASKS	Check box if CEI Consultants were hired	Number of CEI Consultants	Check box if State Staff were hired	Number of State Staff
Inspection					
Construction Monitoring	*Monitor contract activities for compliance with plans and specifications* *Perform final inspection and coordinate parties' attendance* *Report and recommend on design of field construction issues* *Coordinate inspection assignments* *Review Constructability, bid-ability, and other preconstruction issues*	☒	_	☐	_
Geotechnical	*Perform required tests and inspections* *Monitor progress and quality of work* *Review and make recommendations on contractor installation plans*	☒	4_	☐	_
Material Sampling and Testing	*Perform sampling and testing of component materials and completed work* *Arrange and transport sample for testing to appropriate location* *Verify materials and applicable documents to ensure testing was performed* *Supervise material sampling and testing*	☒	30_	☐	_
Quality Management	*Provide or revise and submit quality assurance plan* *Perform quality assurance testing* *Perform quality control of contractor activities*	☐	_	☐	_
If specific numbers are unknown for each function, can you provide approximate staff estimates for overall the **Inspection** job functions?	Number of State Staff in Inspection 1 Number of CEI Consultants in Inspection 30				
Human Resources					
Personnel	*Provide, supervise, and manage personnel* *Review compliance with EEO, wage rates, and labor policies* *Provide vehicles, equipment, and supplies as required by contract*	☒	_1	☐	_
Project Staffing	*Make recommendation or submit plan on project staffing* *Coordinate staffing needs and inspector assignments*	☒	_1	☐	_
Public Relations	*Keep community aware of status and traffic impacts* *Provide current and accurate information through website linked to STA*	☒	_1	☐	_
If specific numbers are unknown for each function, can you provide approximate staff estimates for overall the **Human Resource** job functions?	Number of State Staff in Human Resource Number of CEI in Human Resource 3				

9. Please tell us what work types were involve in your project and rate the level of project involvement required from each of the six job categories for each work type you choose.

WORK TYPES	Check if in this Project	Importance of the Work Type to the Project Success	Approx % of Contract Value (Enter 0-100)	Please rate the required level of project field involvement for this project for each of these job categories (Please circle one of the three options): H (High) = Direct Field Involvement – Continuously; M (Medium) = Direct Field Involvement – Intermittently; L (Low) = Indirect Project Involvement					
				Resident Engineer	Surveyor	Senior Construction Inspector	Intermediate Construction Inspector	Junior Construction Inspector	Admin Staff
Excavation/ Embankment	☑	☑ High ○ Low	12 %	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L

Pipe / Drainage	☑	○ High ○ Low	3 %	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Utilities (In contract relocations)	☑	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Roadway Base	☑	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Pavement Base	☐	○ High ○ Low	4% %	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Pavement Surface	☑	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Structural Foundation	☑	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Substructure	☑	○ High ○ Low	9% %	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Superstructure	☑	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Intelligent Transportation Systems	☑	○ High ○ Low	2 %	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Strips / Signs / Signals	☑	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Roadway Lighting	☐	○ High ○ Low	8% %	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Roadside (Seeding, Landscaping, Guardrail, Fencing, etc.)_	☑	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Temporary Traffic Control	☑	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Other	☐	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L

If "Other", please specify other work types involved in this project: ____

____

Project Management Functions

Which of these options best describe the functions of the Project Manager in the project? Check all that apply.

☒SCDOT ☐CEI – Acting as the Department's liaison with the Design-Build Firm during the construction of the project in general and as the person in responsible charge of the project

☐SCDOT ☒CEI – Coordinating the review of the Design-Build Firm's submittals by SCDOT during design and construction

☐SCDOT ☒CEI – Working with the assigned Right of Way Project Manager to ensure right of way services are provided as specified in the contract and in compliance with applicable state and federal requirements

☒SCDOT ☐CEI – Making periodic site reviews

☒SCDOT ☐CEI – Reviewing and approving periodic progress payments

☐SCDOT ☒CEI – Monitoring MBE/DBE participation

☐SCDOT ☒CEI – Ensuring the Department receives final documents as specified in the contract

☒SCDOT ☐CEI – Ensuring that proper CEI is performed during construction

☐SCDOT ☒CEI – Ensuring Materials Acceptance Program requirements are met

☒SCDOT ☐CEI – Working with appropriate offices to develop supplemental agreements if applicable

☐SCDOT ☒CEI – Ensuring that the Design-Build Firm's Quality Control (QC) plan is being followed

☐SCDOT ☒CEI – Ensuring that all environmental commitments are followed

☐SCDOT ☒CEI – Ensuring that appropriate documentation takes place at each step in the process

☒SCDOT ☐CEI – Conducting performance evaluations

☐SCDOT ☐CEI – Others. Please, specify:

I-77 Survey

Construction Engineering & Management
UNIVERSITY OF COLORADO BOULDER

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SCDOT Efficiency Study of Design-Build Program

Subtask 2i. Design-Build Construction Engineering and Inspection

Project Questionnaire

INTRODUCTION/BACKGROUND

The purpose of this questionnaire is to identify how SCDOT has implemented construction engineering and inspection (CEI) services and compare them to commonly used practices with other states nationwide. The questionnaire on the following pages is a version of the one that we used on NCHRP project 20-107 Effective Construction Project Staffing Strategies for Transportation Agencies.

I. PROJECT CHARACTERISTICS

A. PROJECT OVERVIEW

1. Please estimate the percentage of total project cost that fell into each category.

Project Description	Approximate Percentage of Total Project Cost
Facility Type	66 % Road 0 % ITS 19 % Bridges 5 % Drainage 10 % Others, please specify: Erosion Contr 3, MOT 4, Barriers 2 100 % Total (must total 100%) ☐ Or I do not know
Project Type	70 % New Construction/Expansion ____% Rehabilitation/Reconstruction 30 % Resurfacing/Renewal ____% Others, please specify: 100 % Total (must total 100%) ☐ Or I do not know

2. Given the complexity definitions in the table below, please rate the complexity of this project.

Most Complex (Major) Projects	Moderately Complex Projects	Non-Complex (Minor) Projects
• New highways; major relocations • New interchanges • Capacity adding/major widening • Major reconstruction (4R; 3R with multiphase traffic control) • Congestion management studies are required • Environmental Impact Statement or complex Environmental Assessment required	• 3R and 4R projects which do not add capacity • Minor roadway relocations • Non-complex bridge replacements with minor roadway approach work • Categorical Exclusion or non-complex Environmental Assessment required	• Maintenance betterment projects • Overlay projects, simple widening without right-of-way (or very minimum right-of-way take) little or no utility coordination • Non-complex enhancement projects without new bridges (e.g. bike trails) • Categorical Exclusion

☒ *Most Complex (Major)* ☐ *Moderately Complex* ☐ *Non-Complex (Minor)*

B. Project Staffing

The following questions examine the extent that CEI consultants were used on the project as well as the motivation for doing so.

3. Did you use CEI consultants on the project?

☒ *Yes, continue to the next question.* ☐ *No, proceed to Question 6.*

4. What was the primary driver(s) for using CEI Consultants on this project (check all that apply)?

☐ ***Legal Mandates**:* Your agency was legally mandated by either legislative or executive branches to limit the number of staff hired.

Please describe the legal mandate that limited the number of staff hired.

____

____

☒ ***Staff Shortages**:* Your agency did not have enough staff to complete the project requirements within the required timeframe. Your agency was understaffed or could not handle the workload without relying on outside help.

☐ ***Skill Needs**:* Your agency did not possess a specific skill(s) and/or expertise required to perform the project.

☐ ***Time Constraints**:* Your agency would normally have had the available staff, but they were preoccupied with other projects.

☐ ***If Other, please describe:***

5. On this project, was there a difference in the level of authority between State Staff and CEI Consultants regarding the approval of change orders among the following positions?

	Yes	No
Senior Construction Inspector	☐	☒
Intermediate Construction Spector	☐	☒
Construction Inspector	☐	☒

6. Was the project adequately staffed? Please provide an approximate percentage.
*FTE (full-time equivalent) is a full-time employee that works a minimum of 40 hours per five-day work week.

Approximately 100 % of the required FTEs (per DOT policy and procedure manual) were staffed on the project

7. The following table is used to understand the roles of CEI Consultants and State Staff on construction projects. Please refer to the definitions below the table for further clarification of job titles. The following job titles are generic. If they do not reflect the same classification used within your agency, please let us know the equivalent job titles in your agency. If known, please list the total number of State Staff FTEs and CEI Consultant FTEs hired on the project.

Position (Descriptions are below)	**Different position name used in agency**	**Check if CEI Consultants were used**	**Number of CEI Consultants**	**Check if State Staff were used**	**Number of State Staff**	**State Staff are part of union.**
Resident Engineer	Resident Construction Engineer	☐	0	X	1	☐
Surveyor	Chief/Senior Geodetic Technician	☐	0	X	1	☐
Senior Construction Inspector	Chief Geodetic Technician	☐	0	X	1	☐
Intermediate Construction Inspector	Senior Geodetic Technician	X	1	X	2	☐
Junior Construction Inspector	Associate Geodetic Technician	☐	0	X	1	☐
Administrative Staff	Office Admin	☐	0	X	1	☐

Resident Engineer
Qualifications: Bachelor's Degree – Civil Engineering and Licensed Professional Engineer
Sample Work: (1) Administers construction contracts for the assigned area. (2) Interprets construction plans, specifications and special provisions and makes corrections as required. (3) Prepares or supervises preparation of project documentation, project reports, payment estimates, change orders, final plans and contractor performance reports; reports progress of contractor payments. (4) Supervises layout and inspection personnel, including making hiring and other employment-related decisions, conducting performance management, scheduling and assigning work, and ensuring appropriate training is received. (5) Communicates with contractors and property owners to resolve construction problems; prepares department responses to contractor claims and serves as an expert witness in litigation regarding construction issues. (6) Disseminates construction information to the public, media, and local and state officials. (7) Provides technical expertise and constructability input on project core teams and scoping meetings. (8) Manages a field office including responsibility for project budgets, fleet vehicles, and acquisition and maintenance of equipment. (9) Performs field checks to evaluate work zone safety in construction areas. (10) Investigates construction problems and negotiates resolutions that may include time extensions and/or cost changes. (11) Performs supervisory responsibilities in a manner consistent with the department's Affirmative Action Program. (12) Performs other responsibilities as required or assigned.

Surveyor
Qualifications: High School Diploma or GED/HiSET or relevant experience
Sample Work: (1) Operates and maintains complex and highly technical surveying equipment. (2) Performs deed, title and map research, monument investigation, and assists in establishing control for boundary and right of way. (3) Converses with property owners to gain access to private property and answer questions concerning the progress of survey work on or near landowner's property; contacts local governments and utility companies to secure information. (4) Performs mathematical computations for field layout and land surveying calculations that require professional judgement to determine right-of-way and land corner positions. (5) Collects data and records pertinent information in survey data recorder and/or field books. (6) Provides professional land surveying services for highway design, land management, and other purposes when needed. (7) May review the preparation of plats,

maps, reports, descriptions, surveys, digital map models and data filing editing. (8) Performs lead worker responsibilities, which may include providing general instruction, assigning and reviewing work, coaching and training, providing guidance and instruction in the proper and most efficient methods of accomplishing tasks, and providing input to the direct supervisor on staffing decisions and performance management. (9) Performs other responsibilities as required or assigned.

Senior Construction Inspector
Qualifications: High School Diploma, GED/HiSET or four years of relevant highway or transportation experience
Sample Work: (1) Performs duties of inspector in responsible charge of multiple routine or complex projects; directs the overall inspection of construction projects, verifying that contractors' activities are in compliance with contracts, specifications, and engineering principles; provides clarification to contractor and department personnel regarding the contract and the interpretation of plans, specifications, and special provisions. (2) Supervises routine layout and staking; serves as party chief on staking large bridges, other critical structures, or complex interchanges; serves as inspector on large bridges or other critical structures. (3) Serves as technical expert on the project; reviews plans, specifications, and special provisions applicable to assignment; directs computations for the control of grades or alignment. (4) Prepares, or supervises the preparation of, required project documentation, change orders, estimates, final plans and correspondence; checks progress of contractors. (5) Maintains required records; prepares progress and other reports; initiates or answers correspondence. (6) Keeps supervisor fully informed of activities, progress, and changes or revisions. (7) May perform duties of resident engineer during supervisor's absence. (8) Performs lead worker responsibilities, which may include providing general instruction, assigning and reviewing work, coaching and training, providing guidance and instruction in the proper and most efficient methods of accomplishing tasks, and providing input to the direct supervisor on staffing decisions and performance management. (9) Performs other responsibilities as required or assigned.

Intermediate Construction Inspector
Qualifications: High School Diploma, GED/HiSET or two years of relevant highway or transportation experience
Sample Work: (1) Performs duties of inspector in responsible charge of routine or complex projects; may direct the overall inspection of routine projects, verifying that contractors' activities are in compliance with contracts, specifications, and engineering principles; provides clarification to contractor and department personnel regarding the contract and the interpretation of plans, specifications, and special provisions. (2) Inspects routine construction items such as asphalt or portland cement concrete plants, asphalt or concrete paving, grading and bases, large and small bridges, box and pipe culverts, incidental construction, and roadside development, including various erosion control measures. (3) Inspects general or specialty items such as utilities, signing and traffic control devices, signals and lighting, demolitions, right-of-way permit projects, enhancement projects, and county bridge projects. (4) Directs the layout and staking of routine and complex construction projects, including large and small bridges, other critical structures, or complex interchanges. (5) Prepares or supervises the preparation of final plans, bridge sheets, change orders, contractor payment estimates, engineering costs, and semi-final and final inspections. (6) Maintains required documentation, records and files; prepares progress and other reports; keeps supervisors fully informed as to activities or unusual conditions on the job. (7) Performs lead worker responsibilities, which may include providing general instruction, assigning and reviewing work, coaching and training, providing guidance and instruction in the proper and most efficient methods of accomplishing tasks, and providing input to the direct supervisor on staffing decisions and performance management. (8) Performs other responsibilities as required or assigned.

Junior Construction Inspector
Qualifications: High School Diploma or GED/HiSET or relevant experience
Sample Work: (1) Coordinates and performs construction inspections verifying that contractors' activities are in compliance with contracts, specifications, and engineering principles. (2) Performs duties of inspector in charge of routine construction items, such as asphaltic or portland cement concrete plants, asphaltic or concrete paving, including grading and base, small bridges, concrete box and pipe culverts; inspects general or special items, such as utility adjustments, signing, traffic signals and lighting. (3) Performs measurements, computations, or other work in preparing final plans, change orders, contractor payment estimates, and engineering costs. (4) Maintains required construction documentation, records and files; prepares progress and other reports, keeps supervisor fully informed as to activities or unusual conditions on the job. (5) Provides field checks for contractor surveying operations; serves as party chief on routine layout and staking; serves as instrument operator on staking of large bridges, other critical structures, or complex interchanges. (6) Performs lead worker responsibilities, which may include providing general instruction, assigning and reviewing work, coaching and training, providing guidance and instruction in the proper and most efficient methods of accomplishing tasks, and providing input to the direct supervisor on staffing decisions and performance management. (7) Performs other responsibilities as required or assigned.

8. The following table is used to understand which specific job functions were assigned to CEI Consultants versus State Staff. Please indicate whether CEI and/or State Staff were hired for the appropriate job function. If known, please list the total number of State Staff FTEs and CEI Consultant FTEs hired on the project. As a reminder, FTE (full-time equivalent) is a full-time employee that works a minimum of 40 hours per five-day work week.

Table 8a

JOB FUNCTION CATEGORY	SAMPLE CEI TASKS	Check box if CEI Consultants were hired	Number of CEI Consultants	Check box if State Staff were used	Number of State Staff
Construction Administration					
Liaison	*Ensure all project parties stay informed of project status* *Work with all necessary parties to meet contract and project requirements* *Provide timely answers and resolutions*	☐	_	☐	_
Budget	*Monitor, recommend, and manage budget*	☐	_	☐	_
Meetings	*Set, attend, assist, or conduct preconstruction conference and other meetings*	☐	_	☒	1
Record Prep/ Maintenance	*Maintain records and prepare required reports of contractor activities* *Maintain accurate record of communication between parties*	☒	1	☒	5
Change Orders	*Review, estimate, prepare, and manage change orders*	☐	_	☒	2
Work Orders	*Prepare and review work orders*	☐	_	☐	_
Documentation	*Manage contractor requests for information* *Track and update changes to construction documents* *Review and track approval of plans, shop drawings, and product information* *Prepare project and closeout documentation* *Analyze and interpret contract documents* *Prepare and distribute correspondence* *Review and submit contractor construction plan*	☐	_	☒	2
Application for Payment	*Review and submit contractor applications for payments* *Field measure quantities for payment purposes* *Submit final "as-built" plans* *Revise and submit final estimate* *Authorize monthly payments to contractor*	☐	_	☒	2
Post-Construction Support	*Monitor and document claims* *Prepare claim analysis support documentation* *Assist, analyze, or settle claims* *Prepare and process closeout claim documentation* *Assist with preparation of arbitration hearings or litigation*	☐	_	☐	–
I f specific numbers are unknown for each function, can you provide approximate staff estimates for overall the **Construction Administration** job functions?	Number of State Staff in Administration	8			
	Number of CEI Consultants in Administration	1			
Engineering					
Survey Control	*Survey preparation, control, and verification* *Assist in survey work* *Supply survey crew or licensed surveyor*	☐	_	☒	2
Utilities	*Coordinate utility work or relocation* *Monitor, inspect, and document work or relocation*	☐	_	☐	_
Schedule	*Verify conformance with contract documents* *Monitor and review or coordinate schedule* *Review accuracy of schedule logic*	☐	_	☒	1
If specific numbers are unknown for each function, can you provide approximate staff estimates for overall the **Engineering** job functions?	Number of State Staff in Engineering	2			
	Number of CEI Consultants in Engineering	0			

Table 8b

JOB FUNCTION CATEGORY	SAMPLE CEI TASKS	Check box if CEI Consultants were hired	Number of CEI Consultants	Check box if State Staff were hired	Number of State Staff
Inspection					
Construction Monitoring	*Monitor contract activities for compliance with plans and specifications* *Perform final inspection and coordinate parties' attendance* *Report and recommend on design of field construction issues* *Coordinate inspection assignments* *Review Constructability, bid-ability, and other preconstruction issues*	☒	1	☒	5
Geotechnical	*Perform required tests and inspections* *Monitor progress and quality of work* *Review and make recommendations on contractor installation plans*	☐	_	☐	_
Material Sampling and Testing	*Perform sampling and testing of component materials and completed work* *Arrange and transport sample for testing to appropriate location* *Verify materials and applicable documents to ensure testing was performed* *Supervise material sampling and testing*	☒	1	☒	5
Quality Management	*Provide or revise and submit quality assurance plan* *Perform quality assurance testing* *Perform quality control of contractor activities*	☐	_	☐	_
If specific numbers are unknown for each function, can you provide approximate staff estimates for overall the **Inspection** job functions?	Number of State Staff in Inspection 5 Number of CEI Consultants in Inspection 1				
Human Resources					
Personnel	*Provide, supervise, and manage personnel* *Review compliance with EEO, wage rates, and labor policies* *Provide vehicles, equipment, and supplies as required by contract*	☐	_	☒	1
Project Staffing	*Make recommendation or submit plan on project staffing* *Coordinate staffing needs and inspector assignments*	☐	_	☒	1
Public Relations	*Keep community aware of status and traffic impacts* *Provide current and accurate information through website linked to STA*	☐	_	☐	_
If specific numbers are unknown for each function, can you provide approximate staff estimates for overall the **Human Resource** job functions?	Number of State Staff in Human Resource 1 Number of CEI in Human Resource 0				

9. Please tell us what work types were involve in your project and rate the level of project involvement required from each of the six job categories for each work type you choose.

WORK TYPES	**Check if in this Project**	**Importance of the Work Type to the Project Success**	**Approx % of Contract Value (Enter 0-100)**	**Please rate the required level of project field involvement for this project for each of these job categories (Please circle one of the three options):** **H (High) = Direct Field Involvement – Continuously** **M (Medium) = Direct Field Involvement – Intermittently** **L (Low) = Indirect Project Involvement**					
				Resident. Engineer	**Surveyor**	**Senior Construction Inspector**	**Intermediate Construction Inspector**	**Junior Construction Inspector**	**Admin Staff**
Excavation/ Embankment	X	X High ○ Low	10 %	H / $\boxed{M}$ / L	$\boxed{H}$ / M / L	$\boxed{H}$ / M / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / M / $\boxed{L}$
Pipe / Drainage	X	X High ○ Low	4 %	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	$\boxed{H}$ / M / L	$\boxed{H}$ / M / L	H / M / $\boxed{L}$
Utilities (In contract relocations)	☐	○ High ○ Low	0 %	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Roadway Base	X	○ High X Low	3 %	H / $\boxed{M}$ / L	H / M / $\boxed{L}$	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / M / $\boxed{L}$
Pavement Base	X	X High ○ Low	8 %	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / M / $\boxed{L}$	H / M / $\boxed{L}$	H / M / $\boxed{L}$
Pavement Surface	X	X High ○ Low	41 %	H / $\boxed{M}$ / L	H / M / $\boxed{L}$	$\boxed{H}$ / M / L	H / $\boxed{M}$ / L	$\boxed{H}$ / M / L	H / M / $\boxed{L}$
Structural Foundation	X	X High ○ Low	8 %	H / $\boxed{M}$ / L	H / M / $\boxed{L}$	$\boxed{H}$ / M / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / M / $\boxed{L}$
Substructure	X	X High ○ Low	8 %	H / $\boxed{M}$ / L	$\boxed{H}$ / M / L	$\boxed{H}$ / M / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / M / $\boxed{L}$
Superstructure	X	X High ○ Low	8 %	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	$\boxed{H}$ / M / L	$\boxed{H}$ / M / L	H / M / $\boxed{L}$
Intelligent Transportation Systems	☐	○ High ○ Low	0 %	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Strips / Signs / Signals	X	○ High ○ Low	3 %	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / M / $\boxed{L}$
Roadway Lighting	☐	○ High ○ Low	0 %	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L
Roadside (Seeding, Landscaping, Guardrail, Fencing, etc.)_	X	○ High X Low	3 %	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	$\boxed{H}$ / M / L	$\boxed{H}$ / M / L	H / M / $\boxed{L}$
Temporary Traffic Control	X	X High ○ Low	4 %	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	H / $\boxed{M}$ / L	$\boxed{H}$ / M / L	$\boxed{H}$ / M / L	H / M / $\boxed{L}$
Other	☐	○ High ○ Low	%	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L	H / M / L

If "Other", please specify other work types involved in this project: ____

____

Project Management Functions

Which of these options best describe the functions of the Project Manager in the project? Check all that apply.

☒SCDOT ☐CEI – Acting as the Department's liaison with the Design-Build Firm during the construction of the project in general and as the person in responsible charge of the project

☒SCDOT ☐CEI – Coordinating the review of the Design-Build Firm's submittals by SCDOT during design and construction

☒SCDOT ☐CEI – Working with the assigned Right of Way Project Manager to ensure right of way services are provided as specified in the contract and in compliance with applicable state and federal requirements

☒SCDOT ☐CEI – Making periodic site reviews

☒SCDOT ☐CEI – Reviewing and approving periodic progress payments

☒SCDOT ☐CEI – Monitoring MBE/DBE participation

☒SCDOT ☐CEI – Ensuring the Department receives final documents as specified in the contract

☒SCDOT ☐CEI – Ensuring that proper CEI is performed during construction

☒SCDOT ☐CEI – Ensuring Materials Acceptance Program requirements are met

☒SCDOT ☐CEI – Working with appropriate offices to develop supplemental agreements if applicable

☒SCDOT ☐CEI – Ensuring that the Design-Build Firm's Quality Control (QC) plan is being followed

☒SCDOT ☐CEI – Ensuring that all environmental commitments are followed

☒SCDOT ☐CEI – Ensuring that appropriate documentation takes place at each step in the process

☒SCDOT ☐CEI – Conducting performance evaluations

☐SCDOT ☐CEI – Others. Please, specify:

Appendix 3 – Tech Memo on Design-Build Cost Estimating

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 3 – Design-Build Cost Estimating

Prepared by

University of Colorado Boulder

University of Colorado
Boulder

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Table of Contents

1 Executive Summary

The objective of this task was to analyze South Carolina Department of Transportation's (SCDOT) cost estimating process for design-build procurement and suggest improvements. The research team reviewed standard national guides regarding cost estimating and benchmarked SCDOT's cost estimating practice against national practice. The research team also contacted other DOTs through surveys and follow-up interviews to assist with the benchmarking. Information on SCDOT's current cost estimating practices were gathered through cost estimating data provided by the SCDOT's estimation office and follow-up interviews with relevant agency personnel.

This research found that SCDOT's design-build cost estimating practices align with national standards and leading DOT practices. SCDOT uses standard templates for design-build estimating and a consistent process that is yielding successful results. This research also found that SCDOT's cost estimating performance is consistent with the national average. Table 1 shows the SCDOT's award growth (difference between engineering estimate and contract award) is within the range of the national average for both best-value and low bid design-build procurements. Please see Task 5 for details on these measurements.

Table 1 SCDOT design-build project award growth vs national averages (see Task 5)

	Award growth	**Mean (%)**	**Median (%)**	**St. Dev. (%)**	**Min (%)**	**Max (%)**
SCDOT	Best-value (n=22)	-9	-6	17	-44	16
	Low bid (n=16)	-21	-19	19	-53	20
National	Best-value (n=71)	-7	-7	22	-51	77
	Low bid (n=37)	-5	-6	32	-58	104

While SCDOT practices and performance are aligned with national practices and performance across the design-build program, any one project can experience estimating errors or unexpected design-builder price proposals. To mitigate against potential errors and industry pricing fluctuations, the research team identified four areas that could be considered for SCDOT cost estimating process improvement.

(1) Conceptual estimation: Due to the level of design and engineering at the time of procurement, design-build estimating relies on conceptual estimating techniques, which result in wider ranges of estimating accuracy. SCDOT should examine its practices and policies in comparing these conceptual estimates against the competitive range of design-builders during procurement. Using a 10% differential, as done in traditional

design-bid-build projects, is not a good practice for design-build projects where a greater range of accuracy is to be expected.

(2) Risk-based estimation: SCDOT's cost estimating template and risk register approach have resulted in satisfactory cost estimating results across the program. To improve the process and mitigate against inaccurate estimates on anomalous projects, the research team recommends that SCDOT develop wider range of risk-based estimating techniques. Risk-based estimating techniques can be tied to a definition of project complexity.

(3) Peer cost validation: On large and complex projects, peer reviews and validation plans for cost estimates are a best practice nationally. The research team recommends that SCDOT develop a more formal process for when and how to implement peer reviews and cost estimate validation plans. Note that peer reviews are not necessary on all projects – only the most complex.

(4) Cost estimate process and cost estimate management plan: SCDOT should consider incorporation of the high-level cost estimating and cost management processes found in the NCHRP Report 574. SCDOT is already using many of the techniques outline in this national standard. Formally incorporating these practices will help to ensure a consistent practice on design-build estimates.

2 Research Methodology

The research team reviewed SCDOT's estimating process and performed interviews with SCDOT personnel involved in the cost estimating process. SCDOT's design-build estimating template was reviewed in detail. Additionally, special attention was given on right-of-way (ROW) because SCDOT has a separate office for ROW estimation.

The SCDOT cost estimating process was compared to the national standards. The national standards include (1) AASHTO Practical Guide to Estimating (Anderson et al. 2011); (2) NCHRP Report 574 Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction (Anderson et al. 2007); and (3) NCHRP Report 658 Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs. The research team also contacted other DOTs through surveys and follow-up interviews to assist with the benchmarking.

3 Summary of Analysis

Developing cost estimates is vital for DOTs as a successful cost estimate helps in a proper translation of resource management and delivery of the DOT's project. Cost estimation involves the collection of factors relating to the scope of the project and the cost of the resources. The process is continuous and iterative; thus, it requires DOTs to anticipate cost impact that may occur due to changes in project scope, available resources, and global economic condition.

There are four methods that DOTs can use for cost estimating: (1) conceptual estimation, (2) bid-based estimation, (3) cost-based estimation, and (4) risk-based estimation. Each of the methods has its requisite conditions based on the DOT's timing of cost estimating and project characteristics. This tech memo is focused on conceptual estimation and risk-based estimation, as these are the most common methods used to estimate the cost of design-build projects once the preliminary design has been made and before the project is procured.

Conceptual estimation examines designs at an aggregate level. For example, conceptual estimates include square foot of bridge as opposed to each component of a bridge, which has yet to be fully designed. Conceptual estimate also applies contingencies that account for the uncertainties and risk events involved in the project. To estimate this contingency, the risk-based estimation is usually preferred. Thus, the analysis has focused on conceptual estimation and risk-based estimation. In addition to reviewing methods for cost estimation, the research team provides guidance on the validation of cost estimates and the use of cost estimate management plans.

This tech memo reviews five topics related to the cost estimation practice: (1) accuracy of engineering estimate, (2) conceptual estimation, (3) risk-based estimation, (4) cost validation, and (5) cost estimate management plan. For each of these topics, a synthesis of national practice and/or guidelines is first presented. The current practice of SCDOT is then briefly described. Based on national best practices, the research team derives recommendations aimed to enhance the SCDOT current approach.

3.1 Accuracy of Engineering Estimate

Prior to analyzing SCDOT practice in cost estimating, the research team performed a general review of the accuracy of engineering estimates in design-build projects. Molenaar (2007) mentions a few challenges that cause some degree of inaccuracy in the engineering estimate – risk appetite of the design-builder, design approaches, implementations of Alternative Technical Concepts (ATCs) and value-engineering techniques.

In previous research (Alleman et al., 2017), best-value design-build projects have been estimated to have a mean absolute accuracy of 18% when compared to engineers estimates, whereas low-bid design-build projects have a mean absolute accuracy of 23%. This research chose to examine absolute values (i.e., the actual magnitude of the numeric value without regard to being positive or negative in comparison to the engineering estimate). This metric represents the agencies' ability to estimate the contract value, whether it be higher than or lower than the contract award amount.

A similar study found that the minimum accuracy of best-value design-build projects is -51%, and low-bid design-build projects are -58% (FHWA, 2017). These numbers indicate design-build projects are frequently over-estimated across the country (Alleman et al., 2017). The American Association of Cost Engineering (AACE 2019), suggests that projects with 10% to 30% design development, which is a reasonable range at the time of design-build procurement, should have an estimate range of -30% to +50%. This evidence corroborates the fact that some degree of inaccuracy of engineering estimate is inevitable and DOTs should expect some degree of allowable inaccuracy in the cost estimate.

The Task 5 Performance Evaluation section of this report provides a detailed analysis of how SCDOT's estimate accuracy compares to the national averages. SCDOT follows the national trend of having a negative average award growth. This means that the engineer's estimate is higher than the award amount, implying a conservative practice in cost estimating.

3.2 Conceptual Estimation

National Practice

Conceptual cost estimation is used when the project is at its earliest development phase. According to the AASHTO Practical Guide to Estimating (Anderson et al. 2011): "*conceptual or parametric estimating techniques are primarily used to support the development of planning or early scoping phase estimates when minimal project definition is available. Statistical relationships and non-statistical ratios between historical data and other project parameters are used to calculate the cost of various items of work (e.g., center lane miles or square foot of bridge deck area)*". Conceptual estimating assists in estimating total project cost by major components like ROW, construction, preliminary engineering (design/engineering), and construction engineering.

Conceptual estimates are usually developed to support long-range plans, which can be up to 20 years ahead in the future. This estimating methodology can also be used during the scoping phase of project development to support an intermediate-range plan, which is ten (10) years ahead in the future. Lesser complex projects that tend to have standard project components can use this estimating method. However, highly complex projects need to have greater project definition before using conceptual estimating.

SCDOT Practice and Recommendations

At the planning level, SCDOT hires a design-build consultant to develop the preliminary design. A planning level estimate is then used to develop cost estimates for design-build projects. For final cost engineering estimates, SCDOT uses a more detailed template. In this process, different disciplines develop quantities. Historical unit costs from design-bid-build projects are used to determine a total cost estimate. The final estimate considers three contingencies: two applied to the construction estimate (one of approximately 7% that accounts for fluctuations in quantities and another one accounting for risk) and one (of at least 5%) applied on the design-build contract.

The current SCDOT practice has worked well but it has resulted in some conservative estimates. In addition to the contingencies described in the previous paragraph, there is likely some conservatism in the quantities and unit pricing. If SCDOT is willing to remove this conservatism in quantities and pricing, there are other techniques that can be used to add more transparent contingencies for uncertainties and risks. The next section describes these approaches.

3.3 Risk-Based Estimation

National Practice

According to the AASHTO guide on estimation (Anderson et al. 2011), a risk-based estimation combines traditional cost estimating techniques with risk analysis processes to quantify uncertain items of work, uncertain quantities, and possible risk events. The AASHTO guide recommends risk-based cost estimating for projects whose design is in the early stages of development. This estimation uses risk analysis to forecast the cost of uncertain project line items. The base estimate is developed with no conservatism, which means all contingencies applied over/involved within individual project line items are stripped away. Finally, a contingency is applied to the total of the base estimate. The contingency can be applied by different methods depending on project complexity.

With project complexity being a primary input in risk-based estimates, DOTs are encouraged to develop guidance to determine project complexity. NCHRP Report 574 (Anderson et al., 2007) includes an example of complexity classification table that provides general guidelines for classification (Table 2). Once a project is classified based on its complexity, it is recommended that the DOTs document design and estimation assumptions and concerns. The designers are required to make certain assumptions during the planning phase, and the estimators, likewise, are required to make estimation assumptions due to the low-level of design. These assumptions are crucial as they are usually the triggers for risk identification during contingency determination.

Table 2: Example of project complexity classification table. Source: Anderson et al. (2007)

Most Complex (Major)	Moderately Complex	Non-Complex (Minor)
• New highways; major relocations • New interchanges • Capacity adding/major widening • Major reconstruction (4R; 3R with multi-phase traffic control) • Require congestion management studies	• 3R and 4R projects that do not add capacity • Minor roadway relocations • Certain complex (non-trail enhancement) projects • Slides, subsidence	• Maintenance betterment projects • Overlay projects, simple widening without right-of-way (or very minimum right-of-way take) and little or no utility coordination • Non-complex enhancement projects without new bridges (e.g., bike trails)
Note: 4R is rehabilitation, restoration, resurfacing, or reconstruction.		

Contingency can be determined using three common risk-based approaches: (1) Type I — risk-based percentage contingency estimates; (2) Type II—risk-based deterministic contingency estimates; and (3) Type III—risk-based probabilistic contingency estimates.

<u>Type I — Risk-based percentage contingency estimates:</u> This technique is applicable to minor projects and some moderately complex projects. Many states apply a predetermined

contingency based on the DOTs' experience and historical data (Molenaar et al., 2010). A relevant practice for contingency setting is the use of a sliding scale, also known as the top-down percentage contingency approach. The sliding-scale contingency estimation is based on project complexity and suggests a range of contingency percentages depending on the current level of project design development. A Delphi study conducted by Olumide et al. (2010) with the help of 23 professional estimators from DOTs around the US, provides guidance on construction contingency values (low, most likely (MLE), and high value, on the basis of expert judgment) for different project complexities. An example of contingency values for non-complex projects is depicted in Figure 1. For reference purposes, contingency graphs representing the moderately complex projects and most complex projects are included in the Appendix.

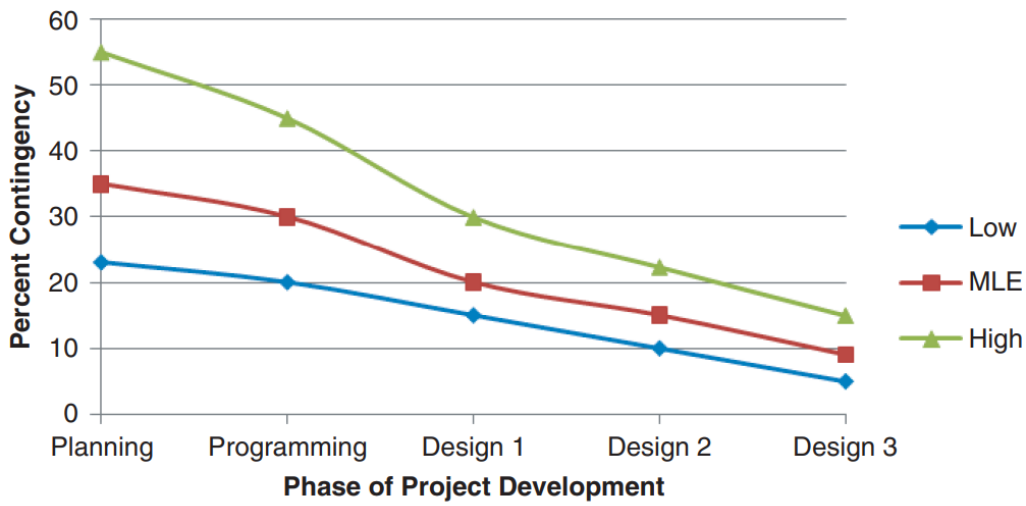

Figure 1: Sliding-scale contingency for noncomplex projects. Source: Olumide et al. (2010)

<u>Type II — Risk-based deterministic contingency estimates:</u> This approach is appropriate to estimate contingency of moderately complex project as it involves a more rigorous process for risk identification. It combines a top-down percentage contingency estimate (sliding scale described above) with a bottom-up estimation for specific project line items. The bottom-up approach considers the probability of the occurrence of an event and the impact on cost if the event occurs. A deterministic value of contingency on that item is calculated by multiplying the probability and cost impact of the particular event. See NCHRP Report 658 for more details on this approach (Molenaar, et al. 2010).

<u>Type III — Risk-based probabilistic contingency estimates:</u> These estimates are often based on Monte Carlo simulation. This tool helps develop a range of cost estimate using computerized probabilistic calculations. The project management team can explicitly incorporate the possible risk events and uncertainties for both project cost and schedule. Further, the sensitivity analysis helps the team understand the impact of a specific risk on the value of interest. See NCHRP Report 658 for more details on this approach (Molenaar, et al. 2010).

SCDOT Practice and Recommendations

SCDOT rigorously peer reviews both the quantities and the unit prices to ensure all fluctuations and potential changes are considered. In other words, SCDOT takes into account the relevant contingencies by conducting multiple reviews of quantity and unit prices of every individual project line items. The appropriate changes to the quantities and unit prices are made during these reviews to account for their contingencies. This technique has worked for the department and they have been using it for a long time. However, the agency has been conservative, on average in their estimates. The research team believes SCDOT could consider incorporating some practices to enhance its risk-based estimation. Specifically, SCDOT could consider the following recommendations:

- Develop a project complexity identification process. This process will allow SCDOT to classify projects based on complexity. This classification could then be used to determine the most appropriate method to estimate contingency, with Types I, II, and III recommended for non-complex, moderately complex, and highly complex projects, respectively.
- Use of risk-based approaches to estimate contingency. The research team suggests SCDOT use the three types of risk-based estimation methods Type I, II, and III described above) in conjunction with risk-analysis tools and methods. These risk-analysis tools and methods are depicted in the NCHRP Report 658 – Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs. This guidebook recommends using certain tools and methods during risk identification, assessment analysis, mitigation and allocation. These approaches could potentially remove conservatism in the current SCDOT approach while also minimizing cost escalation due to foreseeable risks. For additional reference, the research team suggests SCDOT review the SHRP2 Report S2 - Guide for the Process of Managing Risk on Rapid Renewal Projects (Roberts et al., 2014). This SHRP2 report provides information on risk management practices on rapid renewal projects and in-depth tips on risk identification and mitigation strategies.
- Sliding scale approach for contingency estimation. The research team would suggest SCDOT incorporate a risk-based percentage for contingency estimates (among the approaches described in this tech memo, this approach corresponds to Type I). SCDOT may consider using a sliding scale for contingency estimation based on project complexity. This method is comprised of two primary steps. First, a base estimate is developed with no contingency. Second, an appropriate percentage of contingency is applied based on project complexity and the level of design development.

3.4 Cost Validation

National Practice

The cost validation process ensures the accurate development of cost estimate. Within the national benchmarking, the research team finds of interest the Cost Estimating Validation Process (CEVP) used by the Washington State Department of Transportation (WSDOT). This process is a workshop including rigorous peer review and uncertainty analysis process resembling the value engineering analysis. The process requires participation of multidisciplinary teams consisting of experts from public and private sector. The disciplines include but are not limited to engineering, construction, risk management, and planning. These efforts are made to improve the end-of-project cost and schedule results.

The CEVP process involves multiple phases (Table 3) where experts of planning, design, construction contracting, program delivery strategy, cost-estimating, environmental programs, and economics participate in identifying the risks and alternative strategies (Molenaar, 2005). This process also results in an enhanced ability to identify high-risk items and mitigation measures to reduce uncertainty. This example shows that having an in-house rigorous risk-based estimation plan or adopting one such program could help improve the accuracy of engineering estimate.

Table 3: Summary of the Cost Estimating Validation Process (CEVP). Source: Molenaar (2005)

CEVP process phase	Summary description
Phase I—Project identification and preparation	Project data compilation.
	CEVP training and education.
Phase II—Workshop initiation	Establishment of workshop goals, workshop scope, and project alternatives being explored.
	Project team presentation of scope and assumptions for each decision alternative, cost and schedule estimate, and major issues and concerns.
	Development of project flow chart or schedule (the basis for the cost and schedule risk and uncertainty mode).
Phase III—Cost validation and risk identification	Cost validation team breakout activities.
	Risk team breakout activities.
	Environmental costing team breakout activities.
	Modeling team breakout activities.
Phase IV—Integration and model construction	Breakout team reports.
	Reconciliation of breakout assumptions.
	Construction of cost and schedule risk and uncertainty model.
Phase V—Presentation of results	Oral presentation of workshop results.
	Written presentation of workshop results.
Phase VI—Validation of results and generation of alternatives	Project and CEVP teams validate workshop results.
	Alternative project scenarios are explored and evaluated.
Phase VII—Implementation and auditing	Development of risk mitigation planning and integration into project management.
	Reviewing and updating of workshop results and predictions as compared to actual project results.

SCDOT Practice and Recommendations

Currently, SCDOT uses a State Transportation Improvement Program (STIP) amendment process to communicate all the potential changes concerning project scope and project risks that can potentially change the cost and schedule of the project. Once SCDOT identifies the changes, they incorporate these changes in a financial software (called P2S), where they handle the approvals and the estimate updates. P2S is the internal financial system used by SCDOT, whereas ESTIP is used for external communication with stakeholders such as FHWA and local authorities. Although this approach has worked for the department for a long time, the research team would suggest:

- Adopting a validation plan for cost estimates. SCDOT could benefit from a process for validating cost estimates similar to the one used by WSDOT. This process would allow SCDOT to incorporate discussions over the updates, approvals, and estimate adjustments. Although the CEVP has two primary tasks: (1) peer review of the base project cost estimate, and (2) modeling uncertainties and assessing contingencies accordingly; the research team would suggest SCDOT to adopt this validation plan partially by focusing on the peer review of the base estimate. SCDOT can consider adopting a similar process than the one used in the CEVP (Table 3) and focus on the peer review process by excluding the steps related to risk management. The process needs the participation of multiple teams of experts and professionals from relevant fields (e.g., construction administration, construction planning, procurement, economics, and environmental).

3.5 Cost Estimate Management Plan

National Practice

A formal cost estimate management plan helps monitor and control the project cost estimate during the preliminary design phase. One of the main challenges of DOTs is to account for cost escalation due to unforeseen issues in constructability and low level of design, which ultimately affect knowledge about ROW, traffic control, or environmental mitigation. The cost estimate management plan assists with controlling cost escalation by providing strategies to tackle possible cost escalation factors.

NCHRP Report 574 (Anderson et al. 2007) is helpful to address this issue as it presents a holistic approach towards cost estimation and cost management that improves the process at an organizational, program, and project level. NCHRP Report 574 delineates cost estimation practices to develop baseline estimates during the programming phase (Table 4). Separately, it delineates the cost management process (Table 5). These practices are recommended to follow during the preliminary stage, where the adjustments to the STIP are made as the project scope develops. These practices help manage the project scope, cost, and time during the programming as well as the preliminary design phase. The practices proposed in the report are iterative and inclusive of all the elements involved in the development of the cost estimation.

Table 4: Cost Estimating Process. Source NCHRP Report 574.

Cost Estimating Step	Description
Determine Estimate Basis	Document project type and scope, including: • scope documents; • drawings that are available (defining percent engineering and design completion); • project design parameters; • project complexity; • unique project location characteristics; and • disciplines required to prepare the cost estimate.
Prepare Base Estimate	Prepare estimate, including: • documentation of estimate assumptions, types of cost data, and adjustments to cost data; • application of appropriate estimate techniques, parameters, and cost data consistent with level of scope definition; • coverage of all known project elements; • reflecting known project conditions; and • checking key ratios to ensure that estimates are consistent with past experience.
Determine Risk and Set Contingency	Identify and quantity areas of uncertainty related to: • project knowns and unknowns; • potential risks elements associated with these uncertainties; and • appropriate level of contingency congruent with project risks.
Review Total Estimate	Review estimate basis and assumptions; including: • methods used to develop estimate parameters (e.g., quantities) and associated costs; • verify estimate completeness relative to the project scope; • check application of cost data including project specific adjustments; • reconcile current estimates to the baseline estimate and explaining differences; and • prepare an estimate file that compiles information and data used to prepare the project estimate

Table 5: Cost Estimating Management Process. Source NCHRP Report 574.

Cost Estimating Management Step	Description
Obtain Appropriate Approvals	Obtain management authorization to proceed by: • review of current project scope and estimate basis; • ensure approvals from appropriate management levels; • approve current estimates including any changes from previous estimates; and • release estimate for its intended purpose and use..
Determine Estimate Communication Approach	Communication is dependent upon the stakeholder who is receiving the information, but all communication should include: • determine the mechanism for communicating the cost estimate for its intended purpose; • determine the uncertainty that should be communicated in the estimate given the information upon which it is based; and • determine mechanism to communicate estimate to external parties.
Monitor Project Scope/Project Conditions	Identify any potential deviation from the existing estimate basis, including: • changes in project scope; • changes due to design development; • changes due to external conditions; • document the nature and description of the potential deviation; and • decide if the deviation impacts the project budget and/or schedule (potential increase or decrease).
Evaluate Potential Impact of Change	Assess potential impact of change, including: • cost and time impact of the deviation; • document the impact; and • recommend whether or not to modify the project scope, budget and/or schedule due to change.
Adjust Cost Estimate	Changes to the baseline estimate; including: • appropriate approval of the deviation; • change the project scope, budget and/or schedule; and • notify project personnel of the change.

NCHRP report 574 (Anderson et al. 2007) also presents a table (Table 6) that signifies the link between cost escalation factors and strategies that DOTs could implement to control the cost escalation phenomenon. The cost escalation factors have been classified into internal and external factors depending on the level of control that the DOTs have on them. For more information, the NCHRP report provides guidance on the specific methods and tools to be considered in each strategy. These comprehensive methods and tools are helpful to the DOTs to continually monitor and control cost-escalation factors such as project schedule changes, scope creep, contract conflicts, faulty execution, and unforeseen conditions. Irrespective of the complexity of the project, this technique ensures that the DOTs accurately update the baseline budget as changes in project requirements occur.

Table 6: Link between strategies and cost escalation factors during a project programming and preliminary design phase. Source: NCHRP Report 574 (Anderson et al. 2007)

Cost Escalation Factors		Strategies							
		Management	Scope and Schedule	Off-Prism Issues	Risk	Delivery and Procurement	Document Quality	Estimate Quality	Integrity
	Section	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8
Internal	Bias	√							√
Internal	Delivery and Procurement Approach	√	√		√	√			
Internal	Project Schedule Changes	√	√		√			√	
Internal	Engineering and Construction Complexities	√	√		√		√	√	
Internal	Scope Changes	√	√		√		√		
Internal	Scope Creep	√	√				√		
Internal	Poor Estimation	√	√		√		√	√	
Internal	Inconsistent Application of Contingencies				√			√	
Internal	Faulty Execution	√	√				√		
Internal	Ambiguous Contract Provisions						√		
Internal	Contract Document Conflicts								
External	Local Concerns and Requirements	√	√	√	√				√
External	Effects of Inflation		√	√				√	√
External	Scope Changes	√	√		√				
External	Scope Creep		√	√					
External	Market Conditions	√		√	√	√		√	
External	Unforeseen Events				√				
External	Unforeseen Conditions				√				

The eight strategies are listed below for reference. More details are provided about the cost escalation strategies in the NCHRP 574 Guidebook.

1. Management Strategy – Manage the estimate process and cost through all stages of project development;

2. Scope/Schedule Strategy – Formulate definitive processes for controlling project scope and schedule changes;

3. Off-prism Strategy – Use proactive methods for engaging those external participants and conditions that can influence project costs;

4. Risk Strategy – Identify risks, quantify their impact on cost, and take actions to mitigate the impact of risks as the project scope is developed;

5. Delivery and Procurement Method Strategy – Apply appropriate delivery methods to better manage cost, as project delivery influences both project risk and cost;

6. Document Quality Strategy – Promote cost estimates accuracy and consistency through improved project documents;

7. Estimate Quality Strategy – Use qualified personnel and uniform approaches to achieve improved estimate accuracy; and
8. Integrity Strategy – Ensure checks and balances are in place to maintain estimate accuracy and minimize the impact of outside pressures that can cause optimistic biases in estimates.

SCDOT Practice and Recommendations

SCDOT uses the STIP amendment process to communicate changes in the project cost estimate. Later, an internal financial software (i.e., P2S) helps in relaying information regarding estimation details, updates, and approvals. This process provides structured communications of estimate cost changes with SCDOT planners and engineers, the FHWA and local authorities. This software and its usage have helped SCDOT achieve the goal of communicating the development of a cost estimate. The research team would suggest that SCDOT:

- <u>Incorporate the high-level cost estimating and cost management processes found in the NCHRP Report 574.</u> Table 4 and 5 summarizes the cost estimate and cost management processes. Table 6 describes the between strategies and cost escalation factors. These processes and strategies are generally in alignment with current SCDOT practices. Adopting such cost estimation practices and the management plan delineated in the NCHRP report 574 can help SCDOT enhance their ability to communicate cost estimates effectively and to update the base estimates when changes in the project requirements occur. Detailed guidance on specific strategies can be found in the NCHRP Report 574 by Anderson et al. (2007).

4 Recommendations

Overall, SCDOT's design-build cost estimating practices and performance align well with national standards and leading DOT estimating practices. As shown in Task 5, SCDOT's cost estimating practices have similar results to other DOTs across the country. While this study has found no need for significant improvements, the analysis identified four areas from national practice standards that from which SCDOT could benefit: (1) conceptual estimation, (2) risk-based estimation, (3) peer cost validation, and (4) cost estimate management plan.

Due to the level of design and engineering at the time of procurement, design-build estimates must use conceptual estimating techniques. Engineering estimates will result in a wider range of accuracy when compared to the design-builder proposal prices than will engineering estimates when compared to design-bid-build contractor bids. This does not imply that engineering estimates are inaccurate or that design-builder price proposals are inflated. SCDOT should examine its practices and policies in comparing these conceptual estimates against the competitive range of design-builders during procurement.

SCDOT's cost estimating template and risk register approach have resulted in satisfactory cost estimating results across the program. To improve the process and mitigate against inaccurate estimates on anomalous projects, the research team recommends that SCDOT develop wider range of risk-based estimating techniques. Based on national practice, SCDOT could consider the use of a project complexity categorization process to select from a variety of risk-based approaches to estimate contingency. Smaller, less complex projects warrant a sliding scale risk-based contingency whereas larger complex project warrant a probabilistic, simulation-based approach to cost estimating.

On large and complex projects, peer reviews and validation plans for cost estimates are a best practices nationally. The research team recommends that SCDOT develop a more formal process for when and how to implement peer reviews and cost estimate validation plans. Note that these are not necessary on all projects. For this effort, SCDOT can use the WSDOT CEVP approach as a guiding model. However, the research team would suggest SCDOT employ this model partially and focus on the peer-review process of the base estimate with the participation of experts and professionals from relevant fields (e.g., construction administration, construction planning, procurement, economics, and environmental).

Finally, the research team would suggest SCDOT incorporate the high-level cost estimating and cost management processes found in the NCHRP Report 574. SCDOT is already using many of the techniques outline in this national standard. Incorporating these practices will formalize the processes and help to ensure consistency on design-build estimates. Adopting such cost estimation practices and the management plan delineated in the guide can help SCDOT enhance their ability to communicate cost estimates effectively and to update the base estimates when changes in the project requirements occur.

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6. Appendix

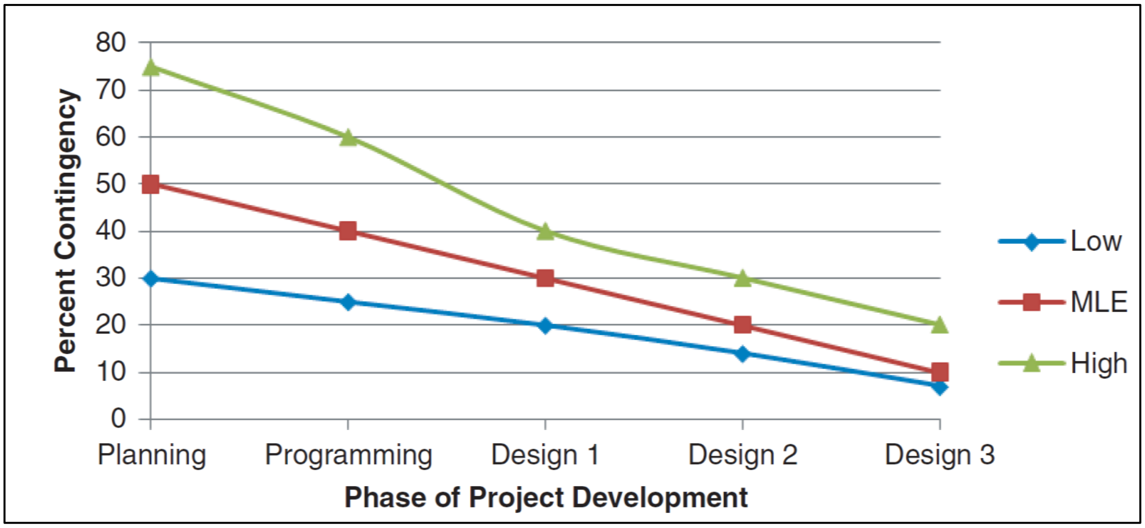

Figure2: Sliding-scale contingency for moderately complex projects. Source: Olumide et al. (2010)

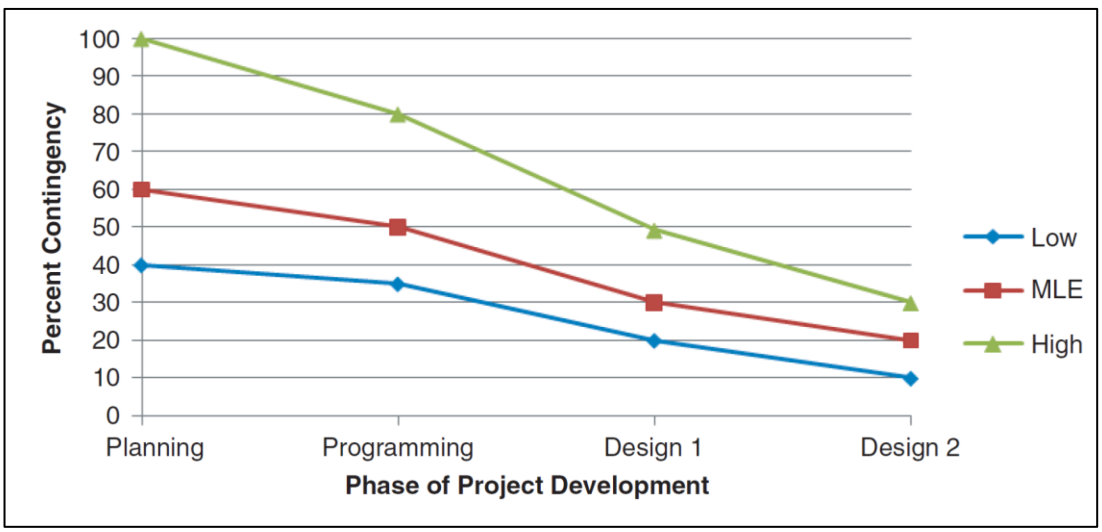

Figure3: Sliding-scale contingency for most complex projects. Source: Olumide et al. (2010)

Appendix 4 – Tech Memo on Project Delivery Selection

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 4. Project Delivery Selection

Prepared by

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Boulder

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Table of Contents

1. Executive Summary

The objective of this task is to review and make recommendations for improvement to the current project delivery selection process used by the South Carolina Department of Transportation (SCDOT). This analysis of project delivery selection methods focused on analyzing SCDOT's current project delivery selection process. It should be noted that SCDOT is taking part in the Federal Highway Administration (FHWA) Alternative Contracting Method (ACM) Toolkit development project. This Toolkit will change the SCDOT process in the future, but it is not covered in detail in this report due to the timing and scope of the research study.

The research team conducted a document analysis to compare design-build project delivery selection practices across different states. Secondly, the research team supported SCDOT participation in the FHWA ACM Toolkit project delivery selection tool for which SCDOT is currently in a pilot state. This tech memo focuses primarily on the cross-state comparison

This document reviews current methods used by SCDOT and five other Departments of Transportation (DOTs) to choose the project delivery methods and makes recommendations to improve SCDOT current practice. These recommendations are based on the benchmark analysis of current practice and on the Guidebook for Selecting Alternative Contracting Methods for Road Projects Delivery Selection (Molenaar et al. 2014).

The research team conducted a document analysis of design-build manuals from six states (SC, CO, MN, NY, WA, GA); and of reports from project delivery selection workshops available from three states (SC, CO, MN). The research team used three questions to assess the decision process included in the design-build manuals:

1. Who performs the evaluation?
2. What factors are considered to assess the options?
3. How are these factors evaluated?

The analysis shows that three of the DOTs (SCDOT, CDOT, and MnDOT) use a Project Delivery Selection Matrix (PDSM), while the other three (NYSDOT, WSDOT, GDOT) follow different approaches for the selection of project delivery method. Tables 1 and 2 compare the answers to the three questions among the states.

Table 1. PDSM state comparison

<table>
<tr><th>Aspects analyzed</th><th>SCDOT</th><th>CDOT</th><th>MnDOT</th></tr>
<tr><td>1. Who evaluates?</td><td>PM, DM, Director of Construction (DOC) representative, and any other necessary technical resources and/or subject matter experts.</td><td>Not specified</td><td>Not specified</td></tr>
<tr><td rowspan="2">2. What factors are considered?</td><td colspan="3">Primary factors
Delivery schedule
Project complexity and innovation
Level of design
Cost</td></tr>
<tr><td colspan="3">Secondary factors
Staff experience
Level of oversight
Competition and contractor experience</td></tr>
<tr><td>3. How are the factors evaluated</td><td colspan="3">Following a flow chart with qualitative comparisons (++, +, -)</td></tr>
</table>

The approaches followed by NYDOT, WSDOT, and GDOT are not based on a project delivery selection matrix. The aim of these approaches is not to decide among different project delivery systems but to assess the suitability that any given project might have to be delivered using design-build.

Table 2. Other approach state comparison

	NYSDOT	WSDOT	GDOT
1. Who evaluates?	There is no specific indication on the manual	Project Engineer with the assistance of Project Development staff for weighting the identified benefit against the risks assessed by the Project Team	The Innovative Project Manager will prepare the DB suitability report and Risk Matrix Template to determine the project's delivery goals and the likelihood that DB will achieve these goals
2. What factors are considered?	• Time • Clarity and consistency of scope • Flexibility • Innovation/creativity and complexity • Current status of design • Approval requirements • Cost/funding • Miscellaneous requirements • Environmental Risk • Potential Proposal cost and stipends	• Savings • Higher quality • WSDOT staff • Impact on public • Completion schedule • Project Complexity • Traffic Management • Project size • Workload leveling • Benchmark projects	**Pass/Fail process** • Legal and statutory requirements • Agency resources and experience • Project funded • Leadership support • DB Marketplace conditions **SWOT analysis** • Project delivery schedule • Innovation • Level of design • Quality • Staff experience • Marketplace conditions, completion, and DB team experience
3. How are the factors evaluated	Through discussion of the previous factors	1) Benefit analysis 2) Risks analysis	1) Pass/fail 2) SWOT analysis 3) Risks analysis

SCDOT's approach to the selection of project delivery systems is aligned with surrounding states and others across the country. While SCDOT's project delivery selection represents national best practice, the research team would encourage SCDOT to implement the new FHWA ACM Toolkit when it is ultimately released by FHWA. The primary advantage to this new approach is that FHWA will be able to create a national standard for project delivery selection. It will also be able to create a database of projects that have used this tool, which should allow for better project delivery selection and correlate to long-term project performance.

2. Research Methodology

To accomplish this task, the research team developed a document analysis of design-build manuals from six different DOTs (Table 2).

Table 3. Agency design-build documentation review

	SCDOT	CDOT	MnDOT	NYSDOT	WSDOT	GDOT
DB Manuals	●	●	●	●	●	●
PDS workshops reports	●	●	●			

The research team used three questions to assess the decision process included in the DB Manuals: (1) who performs the evaluation? (2) What factors are considered to assess the options? (3) How are these factors evaluated? These questions enable the comparison of the key elements of the evaluation developed by the different states.

3. Summary of Analysis

Out of the six DOTs analyzed, three of them (SCDOT, CDOT, MnDOT) used the PDSM, whereas the other three (NYSDOT, WSDOT, GDOT) used a different approach. To account for this difference, the summary of analysis has two sub-sections. The first one summarizes the general guidelines and current practice of the DOTs using the PDSM. The second one includes other approaches to the project delivery selection used by New York, Washington, and Georgia.

3.1 PROJECT DELIVERY SELECTION MATRIX (PDSM)

3.1.1 General guidelines

According to Molenaar et al. (2014), the PDSM is a decision support tool that enables highway agencies to select from three common project delivery methods—namely, design-bid-build, design-build and, construction management/general contractor. This approach is based on projects risks analysis and objective selection. To perform the assessment, the method uses project attributes, goals, and constraints to compare a set of primary and secondary evaluation factors. These factors are evaluated using a non-numerical rating system. The PDSM constitute a structured approach, in the form of workshop, to assist DOT in making project delivery decisions.

3.1.1.1 Workshop participants

Molenaar et al. (2014) make recommendations regarding the roles and the number of participant of the project delivery selection matrix workshop:

- The selection team should include the project manager, the project engineer, a representative of the procurement/contracting office, and any other highway agency staff that might be crucial to the project. Additionally, the selection team might want to include representatives from specialty units and from local jurisdictions where the project is located.

- The selection team should consider a minimum amount of participants in order to not extend the process more than necessary. Usually, “3-7 people represent a selection team, but this number should be based on the specific project being analyzed.” (Molenaar et al. 2014).

3.1.1.2 Factors considered for the selection

The PDSM considers the evaluation of five primary factors (Table 4) and three secondary factors (Table 5).

Table 4. PDSM primary factors (Molenaar et al. 2014)

Primary evaluation factors	**Description**
Delivery Schedule	The effect the overall project schedule (from scoping through design, construction, and completion) has on selecting an optimal delivery method
Project complexity and Innovation	The use of a project delivery method that addresses the overall project needs for applications of new designs or processes to resolve complex & technical issues
Level of Design	The amount of design completed at the time of selection of a delivery method.
Cost	The financial process related to meeting budget restrictions, the accuracy of cost estimates, and the control of project costs
Risk Assessment	The process of quantifying uncertainties to ensure the selection of a method that addresses these uncertainties appropriately. Project

Table 5. PDSM secondary factors (Molenaar et al. 2014)

Secondary evaluation factors	**Description**
Staff Experience and Availability	The highway agency staff experience and availability to execute a selected method
Level of Oversight and Control	The level of and manner in which the highway agency exercises control over the design and construction process
Competition and Contractor Experience	The amount of competition to expect and the experience that contractors possess in the market of the project location

3.1.1.3 The process to evaluate the factors

The selection approach follows three stages (Fig 1).

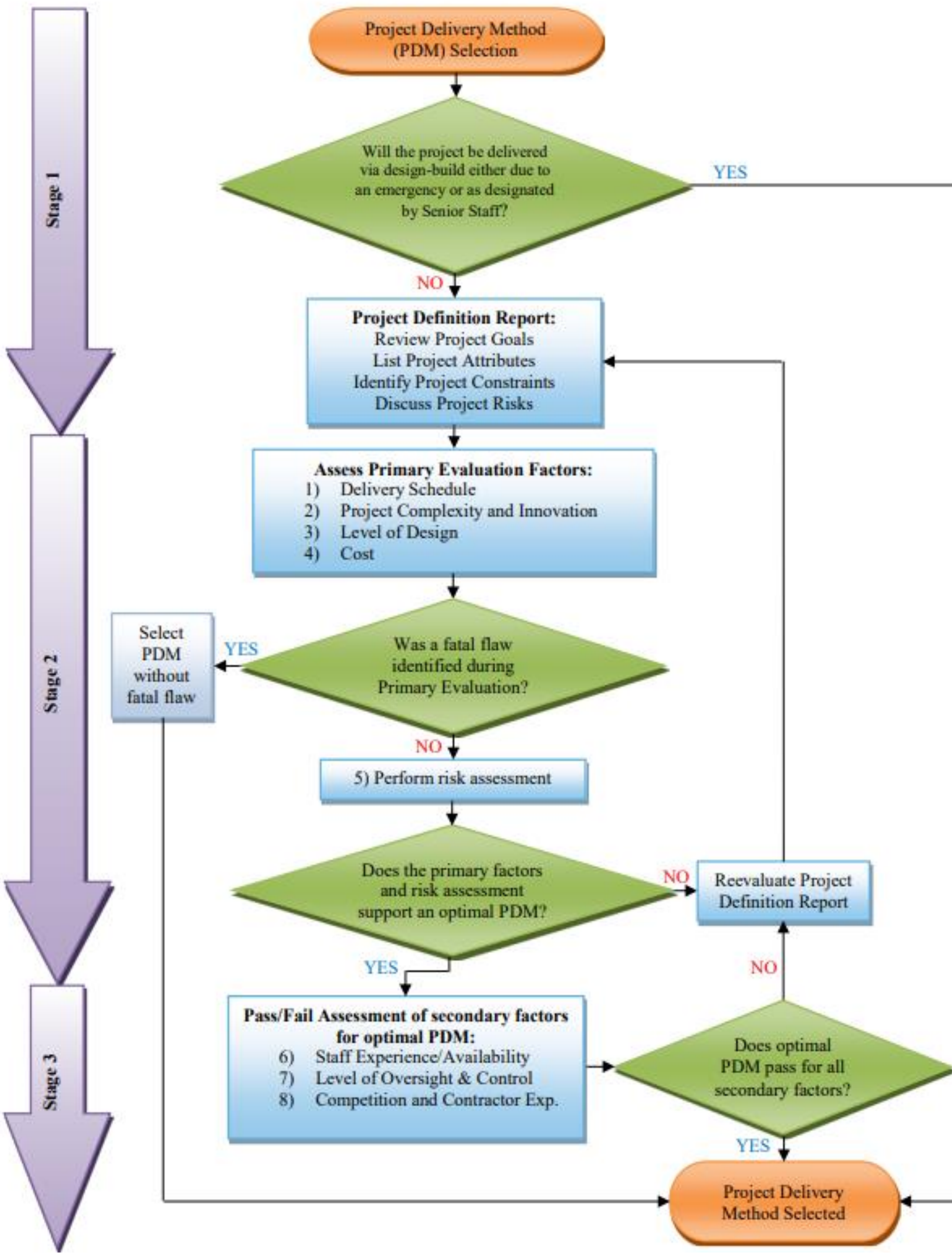

Figure 1. PDSM flow chart

In Stage 1, the selection team lists the project attributes, reviews project goals and identify project constrains. A clear understanding of project goals is a key factor in the selectin process and these goals should remain consistent throughout the procurement, design and construction phases of the design-build project.

In Stage 2, the selection team assesses opportunities and challenges for the primary factors, based on the project characteristics, goals and constraints. The rating is given using a qualitative scale, ranging from most appropriate (++), to appropriate (+), least appropriate (-), fatal flaw (X), and not applicable (NA). The selection team should document their discussion throughout the evaluation process (Molenaar et al. 2014). The second stage frequently results in a clear project delivery choice.

In Stage 3, the selection team evaluates the secondary factors for the optimal method. The team will discuss each factor in detail and provide a rating for each delivery method for that factor. If there is a clear choice from Stage 2, then Stage three is performed only on the selected method to ensure that there are no fatal flaws to selecting the project delivery method.

3.1.2 Review of Current Practice Using the PDSM

South Carolina

SCDOT refers to the project delivery selection process in Chapter 2 of the Design-Build Manual. SCDOT follows the three-stage methodology described in the PDSM approach. Their selection team review project's goals, attributes, and constraints and they assess the project development status and risks.

The Manual establishes the following step previously to develop the PDSM:

- Screen the project based on cost. The PDSM will be used for those projects which have an estimated total cost exceeding $30 million.
- Elaborate on the project definition report. This report includes the goals and outcomes of the project. This report is developed at the direction of the Director of Preconstruction with the assistance of the Design-Build Engineer, Regional Production Engineer, Office of Planning representative, Director of Maintenance representative and Office of Materials and Research representative.

After having these requirements completed, the project PDSM is ideally completed in a project delivery selection workshop. This workshop is organized by the Design-Build Engineer. The Project Manager, Design Manager, and District Construction Representative should be among the participants.

The research team had access to 20 SCDOT PDSM back up documents. All of them follow the PDSM template (https://www.colorado.edu/tcm/project-delivery-selection-matrix). Generally they include a summary table of the factors' assessment as well as a summary of the discussion and decision taken.

Colorado

The CDOT refers to the project delivery selection process in Chapter 2 of their Design-Build Manual. CDOT follows the three stage methodology described in the PDSM approach. The PDSM used by CDOT is available on their Innovative Contracting website at:

https://www.codot.gov/business/designsupport/adp-db-cmgc/pdsm

CDOT website includes PDSM reports of past projects and workshop summaries. Making these documents public is considered to be a best practice as it communcates the project goals and reasons for design-build selection to the industry.

Minnesota

The MnDOT refers to the project delivery selection process in Chapter 1 of their Design-Build Manual. MnDOT follows the three stage methodology described in the PDSM approach. The PDSM used by MnDOT is available on their Innovative Contracting website at www.dot.state.mn.us/pm/deliverymethod.html.

MnDOT website specifies the characteristics of the workshop, which consists of a half-day workshop and involves a guided discussion between project staff, delivery method experts, and management.

3.1.3 Summary

Overall, the three DOTs currently using the PDSM process follow the same process, which is described in the general guidance section. They present, however, slight differences regarding the participants involved in the decision-making workshop.

SCDOT specifies in the Design-Build Manual the roles of workshop participant. However, the review of 20 SCDOT workshop's memos indicates a limited participation in the meetings. CDOT and MnDOT do not refer in their Design-Build Manuals to specific participant roles, although it is clear from their websites that they considered a wide range of participants in past PDSM's reports.

Recommendations derived from the state of practice and Molenaar et al. (2014) suggest that the selection team should include the project manager, the project engineer, a representative of the procurement/contracting office, and any other highway agency staff that might be crucial to the project. Additionally, the selection team might want to include representatives from specialty units and from local jurisdictions where the project is located.

Therefore, SCDOT might wish to evaluate the PDSM workshops' participant involvement given that "using the project delivery selection matrix is only as good as the people who are involved in the selection workshop." (Molenaar et al. 2014).

3.2 OTHER APPROACHES FOR PROJECT DELIVERY SELECTION

The previous section focused on those states that use the PDSM. This section focuses in the other three states (NYSDOT, WSDOT, GDOT) that follow a different approach for the selection of project delivery method.

3.2.1 Review of Current Practice Using Other Approaches

New York

The NYSDOT refers to the project delivery selection process in Chapter 2 of their Design-Build Manual[1]. NYDOT does not provide specific guidelines to develop the project delivery selection process. This highway agency only provides a brief discussion of ten factors that should be taken into account when considering the use of design-build:

- **Time.** If timely completion is critical and/or the available or desired time of project delivery is short, the Project may be an excellent candidate for DB. Even if time is not an overriding consideration, the Project may still be a good DB project.

- **Clarity and Consistency of Scope**. A successful DB project needs a well-defined, consistent scope of work. The Department must be able to spell out the needs and objectives and define the criteria and constraints.

- **Flexibility.** DB thrives in situations where designers and design-builders have a fair degree of latitude in determining the solution to a given problem or situation. If the design solution and construction means and methods are generally tightly controlled by the Department or other Stakeholders, the Project may not be a good candidate for DB.

- **Innovation/Creativity and Complexity.** If the Project offers opportunities for innovation and creativity relating to design and engineering solutions and/or construction scheduling, phasing, or techniques, the synergistic relationship of designer and constructor inherent in DB can work strongly to the benefit of the Project and the Department.

- **Current Status of Design**. It is best to determine whether or not to use the DB method of project delivery early in the project planning phases before significant design work is done. The scope of the pre-design-build contract work can then be tailored to meet the specific needs and conditions associated with the DB project.

[1] Available at: https://www.dot.ny.gov/divisions/engineering/design/dqab/dqab-repository/2011%20Design%20Build%20Manual%20%20Volume1%20of%205.pdf

- **Approval Requirements**. If third party approvals requirements of the project require the design to be progressed to a high level of completion, the primary time benefits associated with DB will be reduced. Potential problems can be minimized by giving the third parties the opportunity to participate with the Department in formulating project requirements, evaluating Proposals, and executing the Project.

- **Cost/Funding.** DB projects typically see less cost escalation during the course of the project, primarily because one of the primary reasons for Orders-on-Contract (i.e., change orders) and claims on design-bid-build projects (design errors and omissions or design/construction interface issues), is removed from the Department's realm of responsibility. In addition to design risk issues, public owners have also been successful in shifting a greater degree of other project risks to the Design-Builder, thereby reducing Order-on-Contract potential and increasing certainty of first cost.

- **Miscellaneous Requirements:** DB has proven to be particularly adaptable to and able to handle miscellaneous project requirements, such as erosion and sediment control, public information, community relations, environmental mitigation, MOT, and maintenance of access. If such issues are a significant element of a project, DB may provide an opportunity for the Department to review and evaluate a number of alternative solutions during the selection process and to benefit from all the good solutions offered by Proposers (including ideas submitted by unsuccessful Proposers) during execution of the Project.

- **Environmental Risks/Issues**: The project delivery method does not have a direct relationship with the environmental documentation for a project. However, the environmental issues and required mitigation measures on some projects may require design to be taken to a high level of completion, thereby reducing the benefits of DB. Environmentally sensitive projects have been delivered successfully using DB, and DB can handle the moving target associated with such projects. The overall contract provides flexibility and the means to mitigate or minimize the uncertainties and risks in an equitable manner.

- **Potential Proposal Costs and Stipends**. The cost of preparing Proposals is a major concern to Design-Builders and designers. Preparation costs for DB Proposals are usually significantly higher than traditional design-bid-build bids. Recognizing that the cost of proposal preparation is one of the factors examined by the industry in making the decision to participate in DB procurements, the Department will need to evaluate the potential costs. To the extent legally permissible, stipend payments can help offset some of the costs incurred in responding to RFPs and are becoming a frequent tool for public owners to engender interest and high-quality Proposals.

Washington

WSDOT refers to the project delivery selection process in Chapter 2 of their Design-Build Manual[2]. They consider two primary requirements for design-build projects: (1) funding must be available for the entire project from the outset and, (2) public endorsement of the project should be considered early on.

The selection of the project delivery method comprises two steps:

1. Benefit-oriented criteria are used to determine which projects appear to be likely candidates for design-build contracting.
2. Project evaluation for fatal flaws by assessing project risks. Fatal flaws that might make design-build contracting too risky for the DOT or the design-builder.

Step 1. Assessing project benefits
WSDOT consider the use of "benefit-oriented project evaluation guidelines" to assess if design-build is appropriate. Within these guidelines, they suggest consideration of the following primary questions:

- Can significant time savings be realized through concurrent activities?
- Will higher quality products be realized from designs tailored to contractor capability?
- Do WSDOT staff resource constraints impact project schedule?
- Will there be less impact on the public with the use of expedited construction processes?

WSDOT does not establish a specific procedure for selecting the project delivery method. They indicate that project goals, potential benefits, and probable risks should be weighted in order to determine if design-build project delivery method is appropriate for a candidate project. Additionally, WSDOT discusses six criteria that they consider when screening a project to determine the suitability of design-build. These criteria are:

- **Completion schedule.** The overall project delivery schedule is generally the overriding reason for using DB contracting. Questions to ask include:
  - Must the work begin or end by a specific time?
  - Is the available time unusually short?
  - Are work windows a significant issue?
  - Are certain seasons or dates critical?
  - Are traffic detour and/or closure periods limited?

- **Project complexity.** Projects that are complicated present more challenges and therefore, more potential benefits from a DB approach. Questions to ask include:
  - Does the project include a number of primary features (road, bridge, traffic control system)?
  - Are the features tightly interrelated and/or closely located?
  - Will construction staging be a major issue?

[2] Available at: https://wsdot.wa.gov/publications/manuals/m3126

- Does the site present unique or unusual conditions?
  - Are specialty skills needed for design or construction?
  - Does the project include emerging technology (IT projects)
  - Will extensive temporary facilities be required?

- **Traffic management.** Construction staging that minimizes impacts to the traveling public is one of the most significant issues for any transportation project. The contractor may submit a “value engineering” or “cost reduction” proposal, which would allow for a change in the contract requirements. This proposal requires preparation by the contractor, and review and acceptance by the Department, subtracting from the total benefit of a customized approach. Using the DB contract to set the performance standard, and allowing the contractor to combine his expertise with the designer, maximizes the potential benefits.

- **Project size.** Current Washington State Law requires a minimum project size of $10 million. There is no maximum project size limit. Larger projects, measured in dollar value, usually offer the greatest overall potential benefits (and greatest risks). Smaller projects may present opportunities for specific benefits, such as specialty work.

- **Workload leveling**. DB contracting may be useful to shift workload to Design-Builders. Be aware that scope definition and proposer selection requires a more considerable effort and impact project success more in DB delivery than in design-bid-build delivery. Except in extreme cases, the decision to utilize DB should not rest solely upon Workload Leveling

- **Benchmark projects.** Continued tracking of the realized benefits is a long-term goal of the Department. When a candidate project is identified, screen the current projects to determine if another similar project is also in development. Direct comparisons can then be made between the projects using criteria identified in the evaluation program. While benchmarking is important, be sure to choose projects that will yield the most significant benefit from DB (i.e. schedule compression, innovation, etc.). Benchmarking is NOT a selection criterion.

Step 2. Assessing project risks

According to WSDOT Design-Build Manual, the design-build process is formulated upon a risk assessment and allocation. Allocation of the risks also defines ownership and responsibility for each task of the project delivery process. In design-build, the guiding principle should lead to assign the risk to the party that most economically can handle the risk. A question that should be asked is “how much is the Department willing to pay a Design-Builder to assume risk that WSDOT typically owns?”

Within the risk assessment, the lack of complete funding may be a fatal flaw for projects attempting to be switched from design-bid-build to design-build. Other issues that should be reviewed and considered in the decision of using design-build include those listed in Table 6.

Table 6. RFQ Past Performance Comparison

Construction administration	Third-party claims	Performance schedule
Permit requirement	Schedule	Ability to compete
Utility relocation	Incremental acceptance of work	Ownership of ideas
Funding	Performance guarantees/warranties	Cost of proposing
QC/QA responsibilities	Force majeure	Contract terms
Labor disputes	Design reviews/approvals	Payment methodology
Weather conditions	Liability for design	Incentives/disincentives
Inflation	Site conditions/differing site conditions	Assignment of risk
Hazardous materials	Contract changes	Bonding requirements
Third-party involvement	Liquidated damages	Errors and Omissions Insurance requirements

Overall, the process used by WSDOT helps to decide the suitability of a project to be delivered using design-build. WSDOT assess the suitability considering first, the potential benefits of using design-build. The benefits are analyzed taking into account projects "schedule," "complexity," "traffic management," "size," "workload leveling" and "benchmarking." WSDOT also assess the suitability based on risk evaluation. The risks evaluation should include a review of the items listed in Table 6.

Georgia

GDOT refers to the project delivery selection process in Chapter 1 of their Design-Build Manual[3]. The selection process is developed by the Innovative Delivery Project Manager (ID-PM). The ID-PM prepares the design-build suitability report and risk matrix for the candidate project. The purpose of the report and risk matrix is to determine the project's delivery goals and the likelihood that design-build will achieve those goals based on an assessment of such items as opportunities for innovation, constructability, safety, environmental permitting, right-of-way acquisition, utilities, traffic management, public/business perception, and any third-party constraints.

As part of developing the design-build suitability report, the ID-PM:

- Consult with the assigned GDOT Project Manager and other GDOT Subject Matter Experts (SMEs) to collect information as to the Project's history and current status, available information, and potential risks.
- Ensure that adequate funding for design, right-of-way, and construction is programmed (or can be programmed).
- Take into consideration Section 32-2-81 (e), O.C.G.A., which states, "In contracting for DB projects, GDOT shall be limited to contracting for no more than 50 percent of the total amount of construction projects awarded in the previous fiscal year." If it is determined

[3] Available at: http://www.dot.ga.gov/PS/DesignManuals/DesignGuides

a project is suitable for DB, but the estimated overall total project costs may exceed 50 percent for a given fiscal year as compared to the previous fiscal year's total construction contract award value, then the OID-OA will consult with the Chief Engineer.

The design-build suitability assessment considers three steps:

1. Pass/fail analysis
2. SWOT analysis
3. Risks analysis

Step 1. Pass/Fail analysis

The pass/fail analysis is based on the evaluation of "Deal-Breaker" issues consisting of a set of requirements that the project needs to satisfy in order to be suitable for design-build. These requirements are:

- **Legal & Statutory Requirements:** Considering the project characteristics (type and size), does Georgia's current regulation allow for the use of design-build contracting?
- **Agency Resources and Experience**: Considering available GDOT resources and/or GDOT's access to DB consultants, can this project be effectively managed as a design-build contract?
- **Project Funding**: Considering GDOT's funding resources, can this project receive funding in foreseeable future, in order to be delivered using a design-build contract?
- **Leadership Support:** Does GDOT's leadership support the utilization of design-build contracting for this project?
- **DB Marketplace Conditions**: Considering available design-build expertise in Georgia, and GDOT's potential access to qualified design-build Teams, can this project be delivered using a design-build contract?

Step 2. SWOT analysis

The second steps comprise a SWOT (Strengths, Weaknesses, Opportunities and, Threats) analysis. This analysis serves to determine the appropriateness of DB regarding specific factors:

- **Project delivery schedule:** overall project schedule from planning through design phase, construction phase and open to traffic.
- **Innovation**: application of [new] methods, techniques, and technologies in order to overcome project complexities, expedite the project delivery, reduce project costs and/or enhance quality.
- **Level of design:** the percentage of design completion at the time of delivery procurement.
- **Project delivery cost:** overall project cost from planning through the design phase, construction phase and open to traffic.
- **Quality:** ability of the delivered project to meet or exceed GDOT's requirements and performance expectations
- **Staff experience:** GDOT personnel capacity in managing design-build.

- **Marketplace conditions, competition, and DB team experience:** refer to how market conditions might influence project price and, how the design-build team experience might influence project development.

Step 3. Risk analysis

Finally, if the previous steps have identified the project as a good candidate for DB project delivery, a risk allocation matrix is fulfilled as a preliminary assignment of generic risks of the project. The main groups of risks considered are "scope issues," "environmental issues," "design issues," "right of way issues," "local agency, utility, railroad, other stakeholders issues," "contracting and procurement issues" and "construction." For more details, the reader is referred to the GDOT template for design-build suitability assessment[4], which includes a list of potential risks.

3.2.2 Summary

The approaches followed by NYDOT, WSDOT, and GDOT are not based on the project delivery selection matrix. The aim of these approaches is not to decide among different project delivery systems, but to assess the suitability that any given project might be delivered using design-build.

These approaches suggest the use of different factors when assessing the suitability of a project to be delivered using design-build. The factors used in these evaluations are often similar to the primary factors used in the PDSM[5]. The three states analyzed in this section consider "project schedule," "project complexity and innovation" and "cost." GDOT is the only one that also considers "level of design."

Regarding the process used to evaluate the factors, the three DOTs follow different processes, which also differ from the one used in the PDSM. According to the Design-Build Manuals, NYDOT uses discussions about the factors, WSDOT follows a benefit and risk analysis, and GDOT considers three steps: pass/fail, SWOT analysis, and risks analysis.

Comparing the SCDOT's project delivery selection practice with the methods used by the states analyzed in this section, the research team confirms that SCDOT is using the adequate tool for the objective of selecting a project delivery method. The PDSM tool assists in determining if there is a dominant or optimal choice of a delivery methods while the other approaches are only focused on the suitability of design-build.

[4] Available at: http://www.dot.ga.gov/PartnerSmart/DesignManuals/DesignBuild/4-Design-Build%20Suitability%20Report%20and%20Risk%20Matrix%20Template.pdf

[5] Primary factors: schedule, project complexity and innovation, level of design and cost. Secondary factors: staff experience, level of oversight and competition and contractor experience.

4. Suggestions

SCDOT's approach to the selection of project delivery systems is aligned with surrounding states and others across the country. While SCDOT's project delivery selection does represent national best practice, the research team would encourage SCDOT to implement the new FHWA ACM Toolkit when it is ultimately released by FHWA. The primary advantage to this new approach is that FHWA will be able to create a national standard for project delivery selection. It will also be able to create a database of projects that have used this tool, which should allow for better project delivery selection and correlation to long-term project performance.

Whether SCDOT continues with its current selection process or fully changes over to the new FHWA process, experience has shown that careful crafting of the participants in a selection workshop is key to success. The research team recommends that SCDOT continues to focus on aligning the number and expertise of workshop participants with the scope and complexity of each new project delivery selection. In order to follow best practices (Molenaar et al. 2014), the selection team should include, at a minimum, the project manager, the project engineer, a representative of the procurement/contracting office, and any other highway agency staff that might be crucial to the project. To add an unbaised perspective, SCDOT should consider the inclusion of a participant with no experiene in design-build or alternative delivery methods. Further, the selection team may need to include representatives from specialty units and from local jurisdictions where the project is located.

5. References

Molenaar, K., Harper, C., and Yugar-Arias, I. (2014). *Guidebook for Selecting Alternative Contracting Methods for Roadway Projects : Project Delivery Methods , Procurement Procedures , and Payment Provisions*.

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Appendix 5 – Tech Memo on Effectiveness Evaluation

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South Carolina Department of Transportation

Efficiency Study of Design-Build Program

Task 5. Effectiveness Evaluation

Prepared by

University of Colorado Boulder

Table of Contents

1 Executive summary

The objective of this task is to evaluate the effectiveness of the SCDOT design-build highway projects program. To this end, the research team benchmarked the performance of 39 design-build and 22 design-bid-build projects of similar size at SCDOT. The research team also benchmarked the performance against a national database from the recent FHWA study on the Quantification of Cost, Benefits and Risk Associated with Alternative Contracting Methods and Accelerated Performance Specifications. This national FHWA study collected a dataset from 291 completed highway projects and quantified the performance of design-build, construction manager/general contractor, and design-bid-build highway project delivery.

The analysis included five primary metrics that align with the FHWA national study: award growth (i.e., variation of cost from engineer's estimate to award), cost growth (i.e., variation of cost from award to completion), estimate to final cost growth (i.e., engineer's estimate to final), schedule growth (i.e., variation of schedule from the planned schedule at the beginning of the contract) and intensity (i.e., final cost/actual project duration).

Overall, SCDOT average design-build project performance outperforms SCDOT design-bid-build project performance and national design-build project performance in four of the five metrics. Schedule growth is the one metric where SCDOT underperforms and this appears to be true for both design-build and design-bid-build.

The following bullets provide a high-level summary of this analysis. The detailed statistical analysis can be found in the body of this tech memo and in the "Design-Build Project Effectiveness Calculator," which is being provided to SCDOT as an Excel tool for use as new projects are finished.

- **Award Growth (estimate to award)** – On average, SCDOT design-build projects outperformed SCDOT design-bid-build projects in the average award growth. SCDOT follows the national trend of having a negative average award growth for design-bid-build projects. This means that the engineer's estimate is higher than the award amount, implying a conservative practice in cost estimating.
- **Cost Growth (award to final)** – SCDOT design-build projects experience lower cost growth from award to project completion when compared to both SCDOT design-bid-build projects and national design-build projects.
- **Estimate to Final Cost Growth (estimate to final)** – SCDOT design-build projects outperform both their design-bid-build counterparts and the national design-build projects.
- **Schedule Growth** – SCDOT schedule growth is higher than desirable. Schedule growth is the one metric where SCDOT design-build projects are not performing as well as the national average. Average schedule growth for SCDOT design-build projects is high for both best-value (33%) and low-bid (17%). This is at least double the national average for design-build projects. However, SCDOT design-build projects are performing better than

their design-bid-build counterparts. The average schedule growth for the design-bid-build sample is 29% and the average of best-value and low bid design-build projects is 24%. Design-bid-build projects are performing better than design-build best-value projects but not design-build low bid projects.

- **Intensity** – SCDOT project intensity performance is relatively similar to national design-build projects and SCDOT design-bid-build projects. On average, SCDOT's project intensity is lower than national practice for design-build/best-value and higher for design-build/low bid. Conversely, when compared to SCDOT's design-bid-build average project intensity, it is higher for design-build/best-value and lower for design-build/low bid.

2 Introduction

The objective of this task is to evaluate the effectiveness of the SCDOT design-build highway program through a historic project analysis and benchmarking. To this end, this tech memo summarizes the research team effort on analyzing SCDOT design-build and design-bid-build projects as well as benchmarking the information of these projects against the national practice. The document is structured in the following sections: research methodology, summary of analysis (including data characterization, design-build performance analysis, and design-build vs. design-bid-build performance comparison) and conclusions and recommendations.

3 Research Methodology

To accomplish this task, the research team conducted a descriptive statistical analysis on four types of data samples categorized in two groups, SCDOT projects, and national projects. In each of these groups, the analysis was conducted on design-build and design-bid-build highway projects.

SCDOT project data were provided by the design-build group, while national data was obtained from the database of the FHWA research project "Quantification of Cost, Benefits and Risk Associated with Alternative Contracting Methods and Accelerated Performance Specifications" (FHWA 2017). In total, the analysis examined 61 SCDOT projects and benchmarked them against 240 national projects. Information about the procurement method used in SCDOT projects was obtained from a review of RFP.

The research team followed a three-steps methodology. First, the analysis characterized the project samples. Second, the research team compared the performance of SCDOT design-build projects and national practice. Third, the study examined the difference in performance between SCDOT design-build and design-bid-build projects (Figure 1).

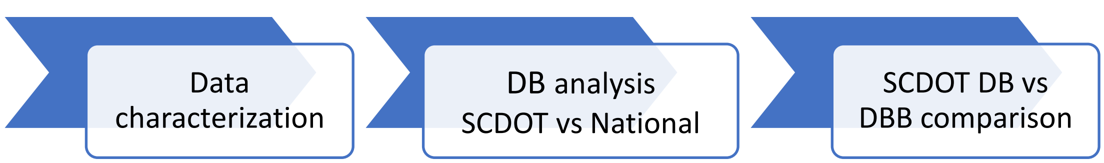

Figure 1 Three steps approach methodology

The study used five metrics to measure project performance: award growth, cost growth, difference between engineering estimate and final cost, schedule growth, and intensity.

Award growth (i.e., engineer's estimate to award), is the percent change from the original contract amount for the project contract and the engineer's estimate prior to bid. The calculation of project awarded growth is based on equation (1).

$$Award\ Growth = \frac{Original\ Contract\ Amount - Engineer's\ Estimate}{Engineer's\ Estimate}\ x\ 100 \qquad (1)$$

Cost growth (i.e., award to final), is the percent change from the original contract amount to the successful bidder to the final cost to deliver the project (i.e., revised contract amount). It is important to note that, for design-bid-build projects, this value is for construction only; but for design-build projects, this value is inclusive of both construction and design performed by the design-builder. The calculation of contract cost growth is based on equation (2).

$$Cost\ Growth = \frac{Revised\ Contract\ Amount - Original\ Contract\ Amount}{Original\ Contract\ Amount}\ x\ 100 \qquad (2)$$

Estimate to final cost growth, is the percent change from the revised contract amount (i.e., final cost to deliver the project) and the engineer's estimate prior to bid. This metric is calculated based on this equation (3)

$$Estimate\ to\ Final\ Cost\ Growth = \frac{Revised\ Contract\ Amount - Engineer's\ Estimate}{Engineer's\ Estimate}\ x\ 100 \qquad (3)$$

Schedule growth is the percent change from the awarded contract duration of the project to the actual construction duration of the project using the documented date that construction is allowed to commence. Construction duration spans from notice to proceed to substantial completion. Again, it is important to note that, for design-bid-build projects, this value is for construction only; but for design-build projects, this value is inclusive of both construction and design performed by the design-builder. The calculation of contract cost growth is based on equation (4).

$$Schedule\ Growth = \frac{Actual\ Construction\ Duration\ - Planned\ Construction\ Duration}{Planned\ Construction\ Duration} x\ 100 \qquad (4)$$

Project intensity is a hybrid performance metric of cost and schedule. Intensity provides a high-level indication of the pace of delivery of a project in terms of how resources were expended during the entire project. The overall project duration is the time from the start of the project design through the substantial completion of the project. Note that the final cost is inclusive of all project costs, except for agency design in design-bid-build or agency design/RFP preparation in design-build. Project Intensity is calculated based on equation 5, in which actual project duration comprises both design and construction and is estimated as the days between substantial completion and PE authorization.

$$Project\ Intensity = \frac{Revised\ Contract\ Amount\ (\$)}{Actual\ Project\ Duration\ (days)} \quad (5)$$

4 Summary of Analysis

This section includes three sub-sections. The first part includes a brief description of the data samples that were used for the analysis. The second section comprises the comparative analysis between design-build projects from SCDOT and national practice. The third part consists of the comparative analysis of SCDOT design-build and design-bid-build projects.

4.1 Data sample

SCDOT provided information from 39 design-build and 22 design-bid-build projects to conduct the analysis. The design-build sample has an average revised contract amount of $64,713,268 and a median value of $24,989,809. This means that half of the design-build projects have a revised contract amount larger than $24,989,809 and the other half is below this value. The design-bid-build sample has an average revised contract amount of $50,987,595 and a median value of $46,027,630.

The national samples used to benchmark SCDOT projects come from the FHWA study “Quantification of Cost, Benefits, and Risk Associated with Alternate Contracting Methods and Accelerated Performance Specification” (FHWA 2017), a study that was conducted by Keith Molenaar, the principal investigator on the SCDOT design-build research project. These data relate to 240 design-build and design-bid-build projects with comparable information to calculate award growth, cost growth, schedule growth and intensity. Table 1 shows the number of projects with information available to calculate each of the metrics for both the national and SCDOT data. For example, the national database includes information of award cost and final cost for 74 DB/BV projects, but it only contains information of engineering estimates for 71 DB/BV projects. Therefore, cost growth is estimated from 74 projects and award growth from 71 projects.

It is important to note that in the calculation of these metrics, some projects (both from the national database and the SCDOT database) showed unreasonable extreme values. These datapoints are considered outliers, identified as such in the detailed spreadsheet provided and not included in the analysis.

Table 1 Number of design-build projects considered in metrics calculations

Contract Method	Award growth		Cost growth		Estimate to final cost		Schedule growth		Intensity	
	National	SCDOT	National	SCDOT	National	SCDOT	National	SCDOT	National	SCDOT
DB/BV	71	22	74	12	71	12	33	11	21	10
DB/LB	37	16	36	14	36	14	11	14	17	14

4.2 Design-build performance analysis SCDOT vs. National

The study compared design-build performance on the basis of award, cost, estimate to final, and schedule growth and intensity statistics.

Award Growth (estimate to award)

SCDOT design-build projects have a negative average award growth, which is in line with the national practice (Table 2). This means that engineers estimates are conservative and result in average cost estimates higher than the award cost. However, the difference between engineering estimates and award cost is larger in SCDOT projects than the national practice, meaning that SCDOT engineer's estimates are generally more conservative than the national practice.

Table 2 SCDOT design-build project award growth vs national averages

	Award growth	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
SCDOT	Best-value (n=22)	-9	-6	17	-44	16
	Low bid (n=16)	-21	-19	19	-53	20
National	Best-value (n=71)	-7	-7	22	-51	77
	Low bid (n=37)	-5	-6	32	-58	104

The average award growth of SCDOT design-build/best-value projects is similar to national values (-9% SCDOT compared to -7% national, Table 2). In SCDOT design-build/best-value projects, the engineers' estimate is conservative and in-line with national ranges.

SCDOT design-build projects procured with low bid are significantly more conservative than national average (-21% SCDOT compared to -5% national, Table 2). These projects mainly consist of emergency projects that had engineer's estimates that were, on average, 21% larger than the awarded cost. This value is four times larger than the national average, which demonstrate conservatism in these engineer's estimate.

For further discussion of possible reasons for this conservatism, please see Tech Memo 3 relating to cost estimating. Tech Memo 3 discusses conceptual estimating, risk-based estimating, peer cost evaluation, and estimate management plans.

Cost Growth (award to final)

SCDOT projects experience a lower cost growth than national practice (Table 3). This difference is particularly significant in best-value procurement, where SCDOT projects have a cost growth 2.1 times lower than national average (1.8% SCDOT compared to 3.8% in national average, Table 3). SCDOT projects also have a lower standard deviation than national practice, which means that the cost growth is better controlled.

Table 3 SCDOT design-build project cost growth vs national averages

	Cost growth	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
SCDOT	Best-value (n=14)	1.8	1.0	2.0	-0.7	4.9
	Low bid (n=14)	1.4	0.1	3.4	0.0	12.7
National	Best-value (n=74)	3.8	1.6	5.4	-4.5	19.6
	Low bid (n=36)	2.6	0.2	5.6	-5.6	19.0

Estimate to Final Cost Growth (estimate to final)

When comparing the difference between estimated and final costs, both SCDOT and national projects show conservative trends in engineering estimates. As shown in Table 4, both average and median values of this metric in SCDOT and national projects are negative, meaning that engineering estimates are larger than final costs. SCDOT engineering estimates, however, seem to be more conservative than national projects, with low bid projects being particularly conservative.

Table 4 SCDOT design-build difference between engineering estimate and final cost vs national averages

	Estimate to final cost	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
SCDOT	Best-value (n=12)	-10	-11	21	-43	22
	Low bid (n=14)	-21	-19	16	-53	2

	Estimate to final cost	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
National	Best-value (n=71)	-3	-4	22	-49	77
	Low bid (n=36)	-1	-6	33	-58	107

Schedule Growth

SCDOT projects experience a higher schedule growth in both low-bid and best-value procurement than national practice (Table 5). This means that the original completion date is frequently being extended. Schedule growth is particularly important in SCDOT projects procured using best-value, as their duration is on average 33% larger than initially planned.

Table 5 SCDOT design-build project schedule growth vs national averages

	Schedule Growth	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
SCDOT	Best-value (n=11)	33	23	31	5	93
	Low bid (n=14)	17	7	34	-29	92
National	Best-value (n=33)	17	1	34	-38	81
	Low bid (n=11)	-10	-2	21	-44	19

Both in SCDOT and national projects, design-build/best-value projects have a schedule growth significantly higher than design-build/low-bid projects. A closer look at the differences between projects procured using best-value and low-bid (Table 6) reveals that best-value projects are larger projects, with significantly larger costs and durations than projects procured using low-bid. Best-value projects seem thus to be more complex than low-bid projects. Many of the SCDOT design-build/low bid projects are emergency projects, which can also help explain why there is less schedule growth. Schedule is a preeminent factor in emergency projects and extensions are avoided. It is therefore reasonable that best-value projects would have higher schedule growth than low-bid projects.

Given the variation between schedule growth statistics in SCDOT design-build/low-bid and design-build/best-value projects, SCDOT might wish to explore differences between design-build/low-bid and design-build/best-value projects using a project-by-project analysis . This project-by-project analysis is outside the scope of this study.

Table 6 Mean final cost and planned duration of SCDOT and national projects used to estimate schedule growth

	Schedule growth	Mean final cost ($)	Mean planned construction duration (days)
SCDOT	Best-value (n=11)	47,174,840	846
	Low bid (n=14)	6,273,282	212
National	Best-value (n=33)	44,442,704	731
	Low bid (n=11)	8,279,855	514

Intensity

This section compares the intensity values between SCDOT design-build projects and national practice. On average, SCDOT projects' intensity is lower than national practice for design-build/best-value and higher for design-build/low bid (Table 7). SCDOT design-build/best-value projects have 1.17 times lower intensity and design-build/low bid projects have 1.34 times higher than the national averages. It should be noted that intensity is calculated on the actual project duration, which includes schedule growth. The lower intensity for design-build/best-value could be caused by a multitude of factors, but the two most likely are extensive time from PE to procurement (i.e., in the calculation of intensity, project duration is estimated as the actual duration from PE authorization to substantial completion) and the overall schedule growth that the projects are experiencing (see previous section on schedule growth).

Table 7 SCDOT design-build project intensity vs national averages

	Contract Method	Mean Final Cost ($)	Mean Project Intensity ($/Days)	Min Project Intensity ($/Days)	Max Project Intensity ($/Days)
SCDOT	Best-value (n=10)	47,118,990	26,002	4,124	54,678
	Low bid (n=14)	6,273,282	17,303	6,287	28,044
National	Best-value (n=21)	50,853,159	30,416	1,881	239,890
	Low bid (n=17)	12,890,231	12,901	852	58,571

4.3 SCDOT design-build vs design-bid-build comparison

In this section, the research team analyzed the difference in the performance of SCDOT design-build and design-bid-build projects. The study compared design-build and design-bid-build performance on the basis of the five metrics described in the previous section: award growth, cost growth, estimate to final cost growth, schedule growth, and intensity.

As explained in the methodology section, SCDOT provided 22 design-bid-build projects. These projects, selected by SCDOT, provide a sample that was roughly equivalent in contract value and scope. Like the national comparison, not all projects had data available for all metrics. Additionally, extreme outliers were removed from the analysis for both design-bid-build and design-build projects. Table 8 provides a summary of the projects for this analysis.

Table 8 Number of SCDOT projects for design-build vs design-bid-build comparison[1]

Contract Method	Award Growth	Cost Growth	Estimate to Final Cost Growth	Schedule Growth	Project Intensity
D-B-B	22	16	16	15	13
D-B	38	27	26	26	25

Award Growth (estimate to award)

Design-build projects have a substantially lower award growth than design-bid-build projects (Table 9). On average, design-build projects have an award cost 14% lower than the engineering estimate, resulting thus in a negative value of award growth. On the contrary, design-bid-build projects have average awarded costs 6% higher than engineering estimates.

Table 9 also shows median values, which may represent better the distribution of the data than average values because there is a maximum value of 125% for design-bid-build award growth. The median of a dataset represents the value for which half of the sample is larger than the median and the other half is smaller. In design-bid-build projects, the median award growth is 1%, whereas in D-B is -14%.

Table 9 Award growth for SCDOT design-bid-build vs design-build projects

Award Growth	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
D-B-B (n=22)	6	1	32	-30	125
D-B (n=38)	-14	-14	19	-53	20

[1] Note: One SCDOT design-build project was not classified as best-value or low-bid. This project is included in the overall design-build analysis, but not the individual D-B/best-value or D-B/low bid analysis.

Cost Growth (award to final)

On average, design-build projects have a similar cost growth than design-bid-build projects. However, the median and the standard deviation of design-build projects are lower than design-bid-build. This suggests that design-build projects are better at controlling cost growth than design-bid-build projects (Table 10). This is likely due to the design-builder having responsibility for both design and construction, but there are many factors that could influence cost growth. Overall, the cost growth is similar for both delivery methods.

Table 10 Cost growth for SCDOT design-bid-build vs design -build projects

Cost Growth	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
D-B-B (n=16)	1.8	4.0	7.2	-14.2	12.3
D-B (n=27)	2.0	0.5	3.7	-0.7	14.6

Estimate to Final Cost Growth (estimate to final)

Table 11 shows results that are similar to Tables 9 and 10. Engineer's estimates for design-build projects are more conservative than design-bid-build and the cost growth for both project delivery methods is similar. On average, design-build projects have a final cost that is 16% lower than the initial estimate, whereas design-bid-build projects have final costs 2% larger than the estimates.

Table 11 Difference between estimate and final cost for SCDOT design-bid-build vs design -build projects

Estimate to Final Cost Growth	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
D-B-B (n=16)	2	-1	15	-19	44
D-B (n=26)	-16	-16	19	-53	22

Schedule Growth

As discussed in the comparison of SCDOT design-build projects against the national benchmarks, SCDOT design-build schedule growth is high. Table 12 shows a consistent trend with design-bid-build projects. In fact, SCDOT design-build projects have lower schedule growth than design-bid-build project sample. This is evident from both average and median values (Table 12). SCDOT design-build projects show a generally better schedule performance than design-bid-build.

Table 12 Schedule growth for SCDOT design-bid-build vs design -build projects

Schedule growth	Mean (%)	Median (%)	St. Dev. (%)	Min (%)	Max (%)
D-B-B (n=15)	29	25	26	-8	73
D-B (n=26)	24	16	33	-29	93

Project Intensity

Table 13 summarizes the project intensity analysis between design-bid-build and design-build projects. The project intensity is relatively similar between delivery methods. When comparing the overall samples, design-bid-build is delivering projects at a 10% higher level of intensity than design-build. However, the overall design-build intensity is tempered by lower mean final cost of the design-build/low bid projects. A low mean final cost will result in a lower intensity regardless of project delivery method (see SCDOT-national comparison in Table 7). When comparing design-bid-build to design-build/best value, which have more comparable mean final costs ($54M vs $47M respectively), design-build/best value has an 8% higher level of intensity. When looking at results in Table 13 it is important to note that one design-build project in the SCDOT database was not classified as either best-value or low-bid. Therefore, this project is only included in the overall metrics for design-build and the total in this category (n = 25) does not match the sum of projects in best-value (n = 10) and low-bid (n = 14).

Table 13 Project intensity for SCDOT design-bid-build vs design -build projects

Intensity	Mean Final Cost ($)	Intensity		
		Mean ($/day)	Min ($/day)	Max ($/day)
D-B-B (n=13)	54,019,686	23,863	8,354	47,630
D-B (n=25)	24,904,546	21,500	4,124	54,678
D-B/BV (n=10)	47,118,990	26,002	4,124	54,678
D-B/LB (n=14)	6,273,282	17,303	6,287	28,044

5 Conclusions and recommendations

This tech memo focused on evaluating the effectiveness of the SCDOT design-build highway program. The effectiveness was assessed by (1) comparing current SCDOT design-build projects against the national practice; and (2) comparing SCDOT design-build and design-bid-build practices against five standard performance metrics. Overall, SCDOT average project performance compares favorably with national project performance in four of the five metrics. The key findings and recommendations in each of these areas follows.

Award Growth (estimate to award)

On average, SCDOT design-build projects outperformed SCDOT design-bid-build projects in the samples analyzed in this study. The design-build project estimates were more conservative than the design-bid-build projects with the mean award growth metrics of -14% and 6%, respectively. SCDOT's conservative trend in engineer's estimates followed the national trend. In fact, SCDOT's mean award growth (D-B/BV = -9% and D-B/LB = -21%) was more conservative than the national trends (D-B/BV = -7% and D-B/LB = -5%). Tech Memo 3 provides some recommendations for addressing this conservatism, which include conceptual estimating refinement, risk-based estimating techniques, select peer cost validation, and formalized cost estimate management plan.

Cost Growth (award to final)

The analysis of projects in this research found that SCDOT design-build projects experience lower cost growth from award to project completion when compared to both SCDOT design-bid-build projects and national design-build projects. SCDOT design-build projects also have more certainty in cost growth performance when compare to SCDOT design-bid-build projects as seen through the narrower standard deviation of the samples. SCDOT design-build projects have lower cost growth than the national projects in both the best-value and low bid delivery methods.

Estimate to Final Cost Growth (estimate to final)

When comparing engineering estimates to final costs, SCDOT design-build projects outperform both their design-bid-build counterparts and the national design-build projects. The estimate to final cost growth metric is a summation of the award growth and cost growth metrics. Therefore, the comments in the previous two sections hold true for this metric as well.

Schedule Growth

Schedule growth is the one metric where SCDOT design-build projects are not performing as well as the national average. Average schedule growth for SCDOT design-build projects is high for both best-value (33%) and low-bid (17%). This is at least double the national average for design-build projects. However, SCDOT design-build projects are performing better than their design-bid-build counterparts. The average schedule growth for the design-bid-build sample is 29% and the average of best-value and low bid design-build projects is 24%. Design-bid-build projects are performing better than design-build best-value projects but not design-build low bid projects. In any case, SCDOT design-build schedule growth is much higher than desirable. While it is beyond the scope of this research, the research team would recommend that SCDOT examine the design-build projects with the highest schedule growth to see if there are common causes for this escalation.

Intensity

Project intensity provides a relative measure of work put in place over time. This measurement includes the entire duration for engineering and construction from the point of project approval. The project intensity is relatively similar between delivery methods. On average, SCDOT's project intensity is lower than national practice for design-build/best-value and higher for design-build/low bid. Conversely, when compared to SCDOT's average project intensity for design-bid-build, it is higher for design-build/best-value and lower for design-build/low bid. If SCDOT would like to improve its intensity, it could look at ways to shorten the time from project approval to project award or decrease overall schedule growth.

6 References

FHWA (2017) "Alternative Contracting Method Performance in US Highway Construction." (DTFH61-13-R-00019)