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# Evaluation of Highway Agency Approaches to Consultant Oversight for Construction Engineering and Inspection Services

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**EVALUATION OF HIGHWAY AGENCY APPROACHES TO CONSULTANT  
OVERSIGHT FOR CONSTRUCTION ENGINEERING AND INSPECTION SERVICES**

by

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B.S.C.E., Polytechnic University of Puerto Rico, 2001

A thesis submitted to the Faculty of the Graduate School of the University of Colorado in  
partial fulfillment of the requirement for the degree of Master of Civil Engineering

Department of Civil, Environment and Architectural Engineering

2014

## **SIGNATURE PAGE**

This thesis entitled:  
Evaluation of Highway Agency Approaches to Consultant Oversight for Construction  
Engineering and Inspection Services  
Written by Valerie Carrasco Torres  
has been approved by the Department of Civil, Environmental, and Architectural  
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May 23, 2014

The signatories have examined the final copy of this thesis, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

## **ABSTRACT**

Valerie Carrasco Torres (M.S. Civil Engineering)

Evaluation of Highway Agency Approaches to Consultant Oversight for Construction Engineering and Inspection Services

Thesis directed by Professor Paul M. Goodrum

Transportation is a dynamic environment with large fluctuations in workloads, reductions in workforce, hiring restrictions, among other constraints. Construction engineering and inspection (CEI) services offer a flexible strategy to reduce workloads, and to add private industry knowledge. It is beneficial for State DOTs to use their field engineering and project management areas to supervise CEI consultants. Thus, program oversight should be a major consideration in the management of CEI consultants. For this reason, the collection of processes, and procedures used to oversee CEI consultants through a literature review and an online survey was essential. The literature review of past reports and present agencies documents (request for proposals, scope of services, scope of works, etc.) uncovered the common activities used under CEI services. In addition, it allowed the organization of this information into a CEI table. This table served as a guide in the preparation of the online survey. The data obtained from the survey revealed the tools most often used and their frequency usage. The results indicate that some tools are highly used among most of the participants. In other instances, the same tools were the most selected but differed by their frequency usage. In few occurrences, the use and the frequency usage of tools was divided between always using it and never using it. The CEI function table and the results will serve as a guide in the oversight of CEI consultants, and as roadmap to implement CEI. Finally, this thesis presents a mapping of the activities of CEI services, the tools being used, the level of use and frequency usage of the tools, the user level of states (including District of Columbia), the number of CEI contracts issued, and that no relationship exists between the CEI user level of participating agencies with the tool frequency usage level. This information will allow readers to review their own procedures, tools, and policies for adequate tools to use in their own oversight programs.

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# 1 Introduction

## 1.1 History

The use of outsourcing is a viable alternative for many States Department of Transportation (DOTs) that deal with an increased workload and a lack of sufficient in-house personnel. According to Warne (2003), the need to outsource is guided by the enactment of the Transportation Equity Act (TEA) for the 21<sup>st</sup> Century and the status of the in-house resources of States DOTs.

The purpose of the Transportation Equity Act for the 21<sup>st</sup> Century (TEA-21) is to “authorize funds for Federal-aid highways, highway safety programs, and transit programs and for other purposes” (Govtrack.us 2013). Warne (2003) indicated that a consequence of this extra funding was an increased in outsourcing created by the anticipation of a reduction in the delivery time of projects by government employees. Furthermore, Warne (2003) added that state DOTs have not increased their staff at the same rate that funding has increased. Moreover, Weatherby (2001) mentions “increased funding, expected faster project deliveries, political and policy decisions” are some of the factors that influence the staffing of a project with private sector resources.

According to Taylor and Maloney (2013), the appropriate selection of in-house staff has become a difficult task for States DOTs. In their research, Taylor and Mahoney (2013) indicated that the most mentioned factors affecting the staffing requirements of in-house staff are “poor quality plans, specifications, and cost estimates and an accelerated construction schedule”.

The enactment of TEA-21 brought additional funding not anticipated by State DOTs. Consequently, State DOTs tried to staff their agencies to keep up with workload demand but found that their unique staffing requirements make it a rather difficult task. Thus, outsourcing provided the needed help to decrease workload while providing private sector knowledge.

### 1.1.1 Construction Staffing of Transportation Projects

Transportation is a dynamic environment that requires the support of an adequate supply of

work forces. Hancher and Weikmeister (2001) indicate in their research that State DOTs utilized their in-house staff to perform a majority of their functions but understood that new approaches were necessary to deal with changes happening in the Transportation industry. According to Hancher and Werkmeister (2001), State DOTs have guided their decision to outsource by some of the following factors:

- “U.S. Population Growth and the subsequent increase in travel demands;
- Increased magnitude of the construction/reconstruction projects required;
- User demand for better and quicker service, and minimal delays;
- Reduction in workforce in DOTs and/or loss of in-house specialty capabilities;
- Ability to handle peaks in demand for services; and
- State legislators favor outsourcing”.

A report titled “Forecasting Construction Staffing Requirements for Future Projects” indicates that staff turnover of experienced managers, lack of available in-house staff with proper qualifications, and replacement of less experienced personnel with increased responsibilities has influenced the construction staffing capabilities of many State DOTs (Taylor and Maloney 2013).

Warne (2003) mentioned the two major reasons to outsource include the lack of sufficient staff, and the insufficient combination of skills among the existing staff. Likewise, Warne (2003) indicates that the most common reason to outsource work for construction engineering and material-testing activities was staff constraints. Numerous writings present reasons for outsourcing. Wilmot et al. (2013) present many of these reasons as follows:

- “Improved efficiency, and costs savings cited by writings such as Boyne (1998), Domberger and Jensen (1997), and Sheldon and Gordan (2007);
- Smaller government cited by works from Buchanan and Tullock (1965), Ostrom and Ostrom (1977), Niskanen (1971), Mueller (1989), and Tullock (1971);
- Qualifications cited by Osborne and Gaebler (1992), Savas (1987), and Thompson and

Elling (2000);

- Political Mandate cited by Ugboro et al (2001);
- Better service and bureaucratic hindrances cited by Kakabadse and Kakabadse (2001) and Schimdt (2003);
- Innovation cited by Pattenau and Landis (1979), Baty et al (1971), and Gray (1989); and
- Core functions cited by Brown and Potoski (2003), Van Slyke and Hammonds (2003), and Kakabadse and Kakabadse (2001)”.

However, a study by Taylor and Mahoney (2013) identified other strategies used by State DOTs such as “placing staff on overtime, assigning non-construction personnel to construction duties, transferring staff among districts, hiring additional staff, reducing inspection requirements, and reducing work volume” to avoid or reduce the need for human resources.

Outsourcing as a staffing alternative brings the added benefit of aiding State DOTs in adapting to changes in the Transportation industry. The use of private sector resources can provide up to date expertise, and can reduce the addition and maintenance of numerous in-house staff. Nevertheless, the use of other strategies can avoid the added work that comes from the procurement, and management of consultants.

### **1.1.2 Limitations and Weaknesses to Outsourcing**

The economy and efficiency review of the Construction Engineering and Inspection (CEI) services of the Mississippi Department of Transportation found that outsourcing faces several limitations and weaknesses that affect the emergence of savings (Joint Committee on Performance Evaluation and Expenditure Review 1999). The limitations and weaknesses included in this Performance Evaluation and Expenditure Review (1999) are:

- “The restriction (Federal law, and State law and regulations) to use competitive bidding on CEI contracts;



- Limitation to using competitive negotiation;
- Weak selection process that uses inconsistent applied evaluation criteria with inconsistently rated firms; and
- If no federal funding is awarded, there are professional regulations that restrict its use”.

The research by the Transportation Policy and Analysis Center (2003) supports the findings related to lack of savings in outsourcing by the indication that costs are comparable to those of traditional methods. Likewise, it supplements this statement by indicating that outsourcing “may require a more experienced contract and program management State DOT staff”, which could be more costly than their current staff (Transportation Policy and Analysis Center 2003).

Another weakness is presented in a report on the Impact of Privatizing Civil Engineering Operations in the Louisiana DOTD, which states that private firms may not be working with the best interest of the public (Wilmot et al 2013).

The Joint Committee on Performance Evaluation and Expenditure Review (1999) identified a possible countermeasure to the limitations and weaknesses of outsourcing related to Mississippi DOT. The committee suggested using the cost of performing the work internally as a benchmark to which proposals from all firms should be compared. The purpose of this comparison is to find the best price, which is achieved by requesting proposals from all participants in the list of qualified consultants and comparing them against this benchmark (Joint Committee on Performance Evaluation and Expenditure Review 1999).

### **1.1.3 Factors to consider before Outsourcing**

In the report titled “Outsourcing of State DOT Capital Program Delivery Functions”, the Transportation Policy and Analysis Center (2003) found from Louisiana DOTD that the following items should be considered before making the decision to outsource:

- “Costs;
- Need to expedite;

- Peak work volumes;
- Unique skills;
- Training and re-training;
- Human resource aspects;
- Retention of strategic core competencies with the public agency; and
- The infrastructure needs of the state, financial, political and legislative”.

Subsequently, the Transportation Policy and Analysis Center (2003) indicates that the following five factors must be contemplated for the attainment of desirable results:

- “Economic impact;
- Vendor service reliability and service quality;
- Legal ramifications;
- Impact on strategic core competencies; and
- Sociological factors”.

Moreover, the 1972 Brooks Act directs government agencies to follow a qualifications-based selection (QBS) process in the selection of architecture and engineering companies. This process is centered on the qualifications of the firms instead of price (Rogge et al. 2013). According to the American Council of Engineering Companies (ACEC 2012), the steps to use QBS for “federal design work” are:

- “Public solicitation for architectural and engineering services;
- Submission of annual statement of qualifications and supplemental statements of ability to design specific projects for which public announcements were made;
- Evaluation of both the annual and project-specific statements;
- Development of short-list of at least three submitting firms in order to conduct interviews with them;
- Interviews with the firms;

- Ranking of at least three of the most qualified firms; and
- Negotiation with the top ranked firm.” (Rogge et al. 2013)

Furthermore, a revision to the 2005 Transportation, Treasury, Housing, and Urban Development, the Judiciary, the District of Columbia, and Independent Agencies Appropriations Act instructs to grant contracts of “engineering and design services” of federally funded construction projects as architectural and engineering contracts “under the Brooks Act provisions in chapter 11 of 40 United States Code” (FHWA 2005).

Since the use of QBS must be followed for services directly related to construction projects using Federal–aid highway funding, their applicability to Construction Engineering and Inspection (CEI) services depends on use of federal funding and the definition of engineering and design, and architectural and engineering services under the U.S.C. and Brooks Act, respectively. According to 23 U.S.C. 112 (b)(2)(A) and 23 CFR, “engineering and design related services are defined as:

- Program management;
- Construction management;
- Feasibility studies;
- Preliminary engineering;
- Design;
- Engineering;
- Surveying;
- Mapping; or
- Architectural related services.”

According to 40 U.S.C. 1102(2), the Brooks Act “defines architectural and engineering services as professional services of an architectural or engineering nature, as defined by State law, if applicable, that are required to performed, approved, or logically justifiably performed by a person licensed, registered, or certified as an engineer or architect to provide the services” (FHWA 2005).

The use of QBS in the selection of CEI consultants depends not only on the type of funding, but also on the correspondence of these services to the appointed definition. In addition, state DOTs face the challenge of determining the balance of in-house and/or private human resources that would be more beneficial to their specific needs. The items mentioned above provide guidance in the decision to outsource.

#### **1.1.4 Types of Outsourcing**

##### **1.1.4.1 *Design-Build***

In Design-Build, State DOTs can enter into contract with a private sector company to design and concurrently start constructing a project. Transportation Policy and Analysis Center (2003) found that the Maryland Department of Transportation (MDOT) is utilizing Design-Build to complete more projects in less time, and within cost. Their research found that MDOT divides the risk with its contractors. According to their research, the use of Design-Build has reduced project duration time, and change orders. In addition, their research determined that Design-Build is preferable for projects that reward innovation.

The Transportation Policy and Analysis Center (2003) mentioned that some advantages to Design-build are the significant savings in time, and fewer change orders, and some disadvantages are the closely comparable values between attained costs, and the costs provided by traditional methods.

Some of the recommendations provided by their research regarding Design-build are to have an outside service provider to verify how efficient the contractor is executing its work, to use State DOT management staff that is versed in the intricacies of this delivery method, and to utilize a contract appropriate for its complexity.

##### **1.1.4.2 *Build-Operate-Maintain***

Build-Operate-Maintain is a project delivery method that could be considered a type of outsourcing as it utilizes private sector companies to complete the life cycle of a project. According to the Transportation Policy and Analysis Center (2003), the Virginia Department of Transportation

(VDOT) utilizes public/private partnerships (P3) to deliver Build/Operate/Maintain (DBO) projects. The legislation allowing P3 does so to enhance the public safety and welfare while delivering services and projects in a timely and economical way (Transportation Policy and Analysis Center 2003).

## **1.2 Literature Review**

There are two syntheses used in this literature review to present the consultant management practices of State DOTs. One is synthesis 277 titled “Consultants for DOT Preconstruction Engineering Work” where Witheford (1999) presents practices that State DOTs use to oversee preconstruction engineering consultants. This synthesis discusses the appointment of administrative and technical responsibilities to agency staff, and the functions executed by project managers, which can vary among State DOTs. Although, this synthesis is about pre-construction engineering, the approaches utilize can be adapted as oversight practices for construction engineering and inspection (CEI) services.

The second is synthesis 146 titled “Use of Consultants for Construction Engineering and Inspection” where Newman (1989) presents approaches utilized by State DOTs to manage CEI contracts.

For this literature review, there are instances when the reports supplement and complement each other and instances when differences and similarities are found between them. Still, there is enough support for the premise that approaches identified by Witheford (1999) for preconstruction engineering can be adapted to oversee CEI contracts.

### **1.2.1 CEI Functions**

To understand the approaches utilized to oversee CEI contracts or consultants, it is important to first identify the functions performed under CEI services.

Newman (1989) mentions in his research that CEI consultants may perform the following functions:

- “Staking or checking contractor staking;
- Conducting or attending preconstruction conference;
- Performing field sampling and testing of material;
- Inspection;
- Documentation;
- Preparation of progress and final estimates for payment;
- Computing final quantities and costs;
- Preparing change orders;
- Investigating claims;
- Making recommendations;
- Liaison with agency; and
- Monitor contractor’s performance”.

Newman (1989) indicates that the functions above can vary by agency due to differences in the “availability of in-house personnel, and past experience with consultants”. It is interesting to note that Newman found that in most cases, agencies prefer to manage consultants in large projects rather than in smaller projects. He also suggested that consultants might find the idea of clustering projects appealing because it simplifies the effort required to manage CEI consultants.

### **1.2.2 CEI Function Table**

The Construction Engineering and Inspection (CEI) Table was prepared to understand the functions and tasks that different states Department of Transportation (DOT) consider to be Construction Engineering and Inspection Services (see table 1).

The Construction Engineering and Inspection table was developed through a web search of the acronym CEI or its complete name. Search locations such as Transportation Research Information Service and Google were employed. Most of the results included draft scope of works from different state Departments of Transportation. Other information was found in Request for Proposals and

Pamphlets describing their understanding of the scope for this type of work. One exception was a review report by the Joint Committee Performance Evaluation and Expenditure Review for the Mississippi Legislature regarding the use of private firms to perform CEI work, which organized CEI functions under headings. These headings and functions found under the review report from Mississippi were used as guidelines to establish the headlines in the CEI function table. All similar tasks found in the documents mentioned above were grouped under the most suitable function and given a representative abridged description. In addition, references were placed on all tasks to orient the reader to the corresponding DOT where the information was found.

**Table 1 CEI Function Table**

CONSTRUCTION SUPERVISION			
Contract Administration			
Liaison	Meetings	Documentation	Record Preparation & Maintenance
Facilitate communication between all parties <sup>1</sup>	Set, attend, assist or conduct pre-construction conference, and other meetings <sup>1, 2, 4, 5, 6, 7, 11</sup>	Manage contractor's RFIs <sup>6</sup>	Maintain record-keeping & prepare required reports of contractor's activities <sup>1, 2, 4, 5, 6, 7, 8, 9, 11</sup>
Ensure all project parties stay informed of project status <sup>1, 4, 11</sup>		Track & update changes to construction documents <sup>1, 5, 6</sup>	Prepare & submit field reports and records <sup>3, 4, 6, 9</sup>
Work with all necessary parties to meet contract & project requirements <sup>2</sup>		Review & submit and/or be responsible for approval of plans, shop drawings, drawings, and product information <sup>5, 6, 7, 8</sup>	Maintain accurate record of communications between parties <sup>1</sup>
Provide answers & resolutions in a timely manner <sup>1, 3, 11</sup>		Prepare project and/or closeout documentation <sup>3, 4, 6, 7, 8, 11</sup>	Review project records for compliance with Department's criteria <sup>4</sup>
Report to and be directly accountable to DOT <sup>4</sup>		Analyze & interpret contract documents <sup>1, 2, 6</sup>	
		Prepare & distribute correspondence <sup>2, 5, 8</sup>	
		Review & submit contractor's construction plan <sup>2, 8</sup>	
		Submit contractor evaluation form <sup>4</sup>	

CONSTRUCTION SUPERVISION				
Contract Administration				
Change Orders	Work Orders	Budget	Applications for Payment	Post Construction Support
Review, estimate, prepare, & manage change orders <sup>7, 8, 11</sup>	Prepare work orders <sup>2, 8</sup>	Monitor & recommend <sup>2</sup>	Review & submit contractor's applications for payments <sup>1, 2, 4, 5, 6, 7, 8, 10, 11</sup>	Monitor & document claims <sup>6</sup>
	Review work orders <sup>2</sup>	Manage budget <sup>11</sup>	Field measure quantities for payment purposes <sup>1, 2, 4, 7, 8</sup>	Prepare claim analysis support documentation <sup>5, 8</sup>
			Submit final "as-built" plans <sup>1, 3, 4, 6, 7, 10</sup>	Assist or analyze and/or settle claims <sup>1, 2, 5, 6</sup>
			Revise & submit final estimate <sup>1, 4, 6</sup>	Prepare & process close out claim documentation <sup>1</sup>
			Submit offer of final estimate to contractor <sup>1</sup>	Assist in preparation of arbitration hearings or litigations <sup>1</sup>
			Authorize monthly payments to contractor <sup>11</sup>	Provide qualified staff witnesses <sup>1, 9</sup>

CONSTRUCTION SUPERVISION			
Inspection			
Construction Work	Geotechnical	Material Sampling & Testing	Quality Management
Daily or occasionally monitor contractor's activities <sup>1, 3, 4, 5, 6, 7, 8, 9, 11</sup>	Monitor progress & quality of work <sup>1</sup>	Perform sampling, and testing of component materials & completed work <sup>1, 2, 4, 6, 7, 8, 11</sup>	Provide or revise and submit QA Plan <sup>1, 4, 8</sup>
Monitor contractor's compliance with plans & specs. <sup>4, 11</sup>	Attend geo meetings <sup>1</sup>	Arrange & transport sample to be tested to appropriate location <sup>1, 7</sup>	Perform testing quality assurance <sup>5, 6</sup>
Perform final inspection and/or coordinate parties attendance <sup>7, 10</sup>	Review & make recommendations on contractor's installation plans <sup>1</sup>	Verify materials and/or applicable documents to ensure testing was performed <sup>1, 3, 4, 7, 11</sup>	Perform quality control of contractor's activities <sup>1, 2, 3</sup>
Report & recommend or direct on design or field construction issues <sup>2, 8, 11</sup>	Performed required tests & inspections <sup>1</sup>	Submit all sampled materials or certify material testing <sup>4, 6, 10</sup>	Determine if work conforms to contract documents <sup>7</sup>
Coordinate inspection assignments <sup>2, 11</sup>	Observe & report on adequacy of work <sup>1, 5</sup>	Supervise material sampling & testing <sup>2, 9, 11</sup>	Observe contractor's work to determine quality of work <sup>4</sup>
Identify, report & instruct contractor to correct discrepancies <sup>1, 4</sup>	Prepare & submit pile driving data & piling record <sup>4</sup>		
Review constructability or bidability or other issues <sup>2, 8</sup>			
Act as inspector <sup>4</sup>			

CONSTRUCTION ADMINISTRATION			
Human Resources		Project Staffing	Public Relations
Personnel	Training		
Provide &/or, supervise &/or manage personnel <sup>2, 4, 9, 11</sup>	Consultant to provide training to their staff <sup>2, 5, 6, 11</sup>	Make recommendations or submit plan on project staffing <sup>2, 8</sup>	Keep community aware of status & traffic impacts <sup>1</sup>
Review compliance with EEO, wage rates, & labor policies <sup>1, 3, 4, 5, 7, 8</sup>		Coordinate staffing needs and inspector assignments <sup>4, 11</sup>	Provide current & accurate info through website linked to DOT <sup>1</sup>
Provide vehicles, equipment, & supplies as required by contract <sup>4, 9</sup>			
Responsible for performance & actions of staff <sup>2</sup>			

- 1 Florida Department of Transportation
- 2 Virginia Department of Transportation
- 3 Colorado Department of Transportation
- 4 Georgia Department of Transportation
- 5 Tennessee Department of Transportation
- 6 Louisiana Department of Transportation
- 7 Missouri Department of Transportation (Platte County)
- 8 Connecticut Department of Transportation
- 9 Mississippi Department of Transportation
- 10 Georgia Department of Transportation
- 11 Washington State Department of Transportation

The literature review is organized under the headings of the CEI function table. Additional headings such as pre-construction, closeout, advantages and disadvantages were added. The purpose is to enable a seamless reading from literature review to research findings.

### 1.2.3 Pre-Construction

For this report, pre-construction can be described as the stage before construction where the notice to proceed is issued, contract documents are distributed, pre-construction submittals (insurance, bonds, construction schedule, submittal schedule, etc.) are collected from contractor, permits are attained, and mobilization occurs, among others (CSI 2005).



When CEI consultants have Commercial General Liability (CGL) insurance, they are protecting themselves against claims by third parties who declare that they have undergone losses because the consultant has acted negligently according to tort law. Unlike CGL insurance, professional liability insurance covers claims against losses that are “directly traceable” to the negligence attributed to the consultant for failing to follow “legal standards” (Sweet et al. 2013).

According to Sweet et al. (2013), professional liability insurance protects main activities such as “preparing drawings, and specifications” in design. However, it also includes “site services such as monitoring the work as it proceeds for issuing payments and completion certificates” (Sweet et al. 2013). Moreover, it might cover the following tasks:

- “Improper documentation;
- Improper fact verification;
- Missed deadlines;
- Misrepresentation of facts;
- Breach of nondisclosure;
- Loss of data, improper procedures or negligent handling of data;
- Failure to prevent electronic theft of records and confidential information;
- Employee theft and sale of client’s trade secrets;
- Deliberate dissemination of false information; and
- Violations of state and federal law, such as violation of right to privacy” (Lemieux 2010).

It is important to clarify that professional liability insurance, and errors and omissions insurance are the same.

Witheyford (1999) presented in his research a citation from Harp (1996) where it indicates that it is common obligation for consultants to acquire insurance for general liability, and for errors and omissions. At the time of his research, Witheyford (1999) found that states differ in the requirements demanded from consultants in the attainment of insurance for general liability, for errors and

omissions, and the use of hold harmless agreement. The research identified the alternatives used by participating agencies to manage risk, like:

- “Inclusion of a hold harmless clause;
- A probable request for insurance in the RFP;
- Certificate of insurance; and
- Not utilizing anything”.

Newman (1989) found that the majority of the agencies that participated in his research make consultants liable for their mistakes, and few assumed accountability for their consultant’s errors.

The preparation of the scope of work occurs in the stages before construction starts. Agencies may use different methods to outline their scope of work. Newman (1989) found from his research the following methods used to do so:

- “Statement of work in the contract agreement;
- Advertisement or RFP;
- Scoping meeting; and
- Written scope statement”.

The main idea is that every agency should establish their own scope statement based on the project’s requirements, and the particular use of consultants (Newman 1989).

## **1.2.4 Construction Supervision**

### **1.2.4.1 Contract Administration**

#### 1.2.4.1.1 Liaison

The Merriam-Webster (2013) dictionary defines liaison as “a relationship that allows different organizations or groups to work together and provide information to each other”.

Newman (1989) mentions that the role of a liaison, known to some agencies as the liaison officer, is generally given to the State DOT employee managing the CEI contract, and facilitating the flow of communication among the participating parties. As discovered by his research, the

approaches used by some of the State DOTs to manage the flow of communication, and to maintain the pecking order are:

- “By way of normal agency channels;
- Directly to head office;
- To the district; and
- By way of consultant”.

According to Newman (1989), the approach most used is the first on the list above, and establishes the following path:

- “Consultants report to liaison officer; and
- Liaison officer reports to district and central office using normal agency channels”.

The other methods allow the consultant to directly communicate with the “head of construction in the central office”, consider the consultant part of the agency, and employ a consultant to manage the CEI consultant (preferable for large projects with limited staff), correspondingly. The last approach requires the agency to have control of the main consultant, and to inspect with regularity all consultants. (Newman 1989)

In contrast, Witheford (1999) does not indicate how parties communicate, but does present the mediums used to maintain relationships with consultants, which are:

- “Meet regularly with consultant groups;
- Participate in joint working committees;
- Conduct joint workshops;
- Communicate through web pages and the Internet;
- Project meetings;
- Posting information on electronic bulletin boards;
- Use of prequalification mailing lists;

- Invitations for letters of interest; and
- Training opportunities”.

Under the topic of liaison, Newman indicates how parties communicate, and Witheford complements these findings by presenting the mediums to maintain established relationships.

#### 1.2.4.1.2 Meetings

Meetings are a form of communication in projects. The uniqueness of projects can make meetings a changeable tool. Their duration, topics, frequency, participants, and types can vary by project. For example, Witheford (1999) found that many State DOTs differ in the frequency with which they maintain contact with consultants as follows:

- “Meetings between major milestones;
- Conducting scheduled and unexpected visits to consultants;
- Performing monthly meetings; and
- Performing bi-weekly meetings.

#### 1.2.4.1.3 Contract Clarifications and Modifications

As the project progresses, changes can occur, states of minds can change, and parties may need clarification of the contract documents to continue their work. These changes depending on their magnitude and contract interpretation may require a modification to the contract.

Witheford (1999) indicates that according to federal regulations there are certain conditions that can cause a change in contract cost, including:

- “Character;
- Scope;
- Complexity;
- Duration; or
- Work conditions change”.

According to Witheford (1999), some State DOTs utilize a contract service department or “central office” to modify the contract, and it is common for “project managers or district offices to negotiate the technical details” of the contract during that time. His research adds that the approach and time required in verifying these changes can vary by state.

Witheford (1999) found in other studies that some State DOTs employing a cost plus fixed fee contract adjust the fixed fee portion to reflect changes made to the total amount. He also notes that federal regulations indicate that no adjustments should be made to the “fixed fee” portion of the contract for excessive costs, but modifications should be made for “significant changes to the scope of work in a cost plus fixed fee contract or in a lump sum contract”.

There are occasions in the progression of a contract or project when events and/or the consultant’s performance drive the owner to end a contract. According to Witheford (1999), there are two reasons for terminating a consultant contract in pre-construction engineering work, which are:

- “Change in a state program; and
- Unsatisfactory performance from consultant”.

In addition, the report from Witheford (1999) mentions several reasons why an agency starts the termination process for its benefit:

- “Unexpected shortage or delay in program funding; and
- Delay caused by lack of clearances of an environmental or similar nature”.

Witheford (1999) indicates that whether the termination is executed for the benefit of an agency or for unsatisfactory performance, a clause for both conditions is included in the consultant contract, which includes:

- Time of notice before termination; and
- Management of:

- “Project deliverables;
- Adjustments in payments; and
- Resolution of disputes”.

At the time of the report, Witheford (1999) found no written procedures to execute a termination due to unsatisfactory performance but collected examples from three states, which are:

- “Connecticut advises orally, follows with written notification, and advises in meetings;
- Nebraska informs upper management who later provides a decision; and
- Several states required approval from some or the director, state highway engineer, deputy secretary, or other executive management level”.

From the information above, it is inferred that contracts should be comprehensive in the inclusion of subjects that are known to commonly arise in the progression of a project. However, consideration should be taken in the inclusion of some subjects that can occur in extreme situations, like the termination of a consultant, to have guidelines for the actions to follow in such a situation.

#### 1.2.4.1.4 Payments

Consultants expect to be paid as established in their contracts while work progresses. The payment process of DOTs can vary by state.

Witheford (1999) indicated that some State DOTs “receive an invoice from consultants on a monthly basis, generally in conjunction with a progress report”, which is then either verified by the State DOT employee managing the contract or by other agency staff. His research also uncover that only one state stop paying consultants when the project was delayed.

The research from Newman (1989) presents the different approaches that State DOTs utilize to pay applications for payment, such as reviewing “monthly documentation (time sheets, expense reports”, etc.), using a representative “percentage” as for each completed “stage or phase”, and allotting a “ratio” equivalent to the “contractor’s earning”.

Retainage can be described as a “security system” established in the contract that allows the owner to retain an amount of money from progress payments to safeguard against certain risks (Sweet et al. 2013). Thus, a retained amount can be understood as the money withheld from the establishment of retainage in the construction contract. Furthermore, Newman (1989) found that some State DOTs retained part of the contract amount for a certain amount of time. He identified information on some agencies using different retainage such as 5% from the total contract amount, and 3% from “salary related and fixed fee earnings”. Similarly, Witheford (1999) discovered that the amount and time retained varies by State DOT. However, his report also mentions that State DOTs are departing from this practice. One example is the removal of this practice by the State Legislature of Texas, and another example comes from the results obtained from 1990 AASHTO survey, which shows a decrease in the use of retainage (Witheford 1999).

As shown by these two syntheses, the payment process can include review, retention of an amount, and disbursement of application for payments.

#### 1.2.4.1.5 Monitoring and Inspection

This section of the literature review discusses the project management requirements from federal regulations, progress reports, and evaluations.

Witheford (1999) mentions in his research the project management requirements established by federal regulations, which are:

- The appointment of a State DOT employee to manage the contract or project with his/her delineated functions;
- The execution of “final performance evaluations”; and
- The inclusion of a “contract clause” that allows execution of rework as needed later in the project.

The last requirement in the list above extends further and can have repercussions that make it a necessity for State DOTs to employ project managers to monitor consultants (Witheford 1999).

When progress reports are discussed, Witheford (1999) states that most participating State DOTs favored the delivery of progress reports on a monthly basis. Although this coincides with more invoice submissions, it does not mean that a joint verification is performed by many DOTs (Witheford 1999).

Witheford (1999) communicates in his report that an integral part of managing a project involves verification of its performance through intermediate and final evaluations, which can be presented either in a standard form or in summary form that could include a narrative or not depending on the State DOT. He adds that agencies perform intermediate evaluations to improve the quality of their current work, and the frequency of these evaluations varies by state, as shown below:

- “Every six months;
- Every year;
- At every milestone;
- When changes in performance occur;
- At completion of work;
- Twice in the duration of contract; and
- Frequently as necessary”.

In addition, Newman (1989) indicates that evaluation practices of State DOTs can vary as shown below:

- “Florida
  - Reviews daily both the consultant and the progress of the project.
- Alaska
  - Performs a closeout performance evaluation at the completion of contracts;
  - and
  - In the event of major issues, interim evaluations are performed monthly”.



For final evaluations, Newman (1989) identified three types of evaluations performed at the end of the contract, which are:

- Verification that all contract conditions were met includes:
  - “Reviews of material tests and certifications;
  - As-built plans;
  - Documentation submittals; and
  - Final quantity calculations”.
- Review of CEI consultants final costs includes:
  - “Billings;
  - Additive rates only if actual rates are adjusted during an active contract; and
  - Overhead and fringe benefits”.
- Consultant efficiency could include the following criteria used by South Dakota DOT:
  - “Demonstration of knowledge of agency’s administration and procedures;
  - Ability to meet contract requirements with minimum direction;
  - Adequate staff assigned to project;
  - Competent staff assigned to the project;
  - General spirit of cooperation;
  - Quality of work; and
  - Completion of work within the terms of the contract”.

In the same manner, Witheford (1999) found that State DOTs assess the following items in the pre-construction engineering final evaluation:

- “Timeliness;
- Technical performance;
- Administrative performance;
- Quality of work;

- Cooperation/human relations;
- Budget conformity;
- Professionalism;
- DBE considerations; and
- Report quality”.

Some participating State DOTs indicated the different uses for pre-construction engineering final evaluations such as to discuss the results with consultants, to request a written response on results from consultants, to keep a record of responses from consultants, to require consultants to sign a delivery receipt, and to use as a reference in the shortlisting process (Witheford 1999).

The number of CEI contracts that a State DOT employee manages can have an effect on the resulting quality of the work. This is supported by the information found by Newman (1989), which identified several factors that can alter the number of contracts managed by the assigned State DOT employee such as:

- “Size and complexity of the project;
- Agency work load; and
- Available staff”.

Lastly, State DOTs make consultants accountable for the quality of their work, and can request the dismissal of any consultant employee for poor execution (Newman 1989).

Thus, the number of CEI contracts, the performance of the consultant’s employee, the execution of intermediate and final evaluations, the items assessed in these evaluations, the frequency of these evaluations, the demand for CEI consultants’ progress reports, and the appointment of a State DOT project manager can have an effect on the resulting quality of the project.

## **1.2.5 Construction Administration**

### **1.2.5.1 Human Resources**

The manner in which human resources are used in a project is integral in the efficient management and completion of a contract. For that, human resources should be given appropriate assignment of duties based on their knowledge, and abilities.

In his research, Witheford (1999) found that State DOTs differ in the assignment of technical and administrative responsibilities to their project managers, which can be divided or joined as follows:

- “Both administrative and technical aspects; or
- Administrative aspects with technical support from other units; or
- Technical aspects with administrative support from other units; or
- Both in-house and consultant projects”.

The research by Newman (1989) is more detailed in the presentation of the common tasks perform by several State DOT project managers, which are:

- “Reviewing and monitoring the work of consultant staff;
- Reviewing and approving such as:
  - Progress payments from contractor;
  - Change orders from consultants;
- Auditing and authorizing final estimate payments;
- Interpreting plans and specifications in the event of disagreements; and
- Making decisions involving additional work or plan revisions”.

According to Witheford (1999), State DOTs need to train their staff, and adds a statement from an AASHTO guide that infers that training leads to the generation of higher quality products. Still, not all State DOTs have or are incorporating training to develop their staff or are including consultants in their training programs (Witheford 1999).

### **1.2.5.2 Project Staffing**

The selection of human resources for a project can be contingent on many factors or requirements, which is topic discuss by Taylor and Mahoney (2013). As presented by Newman (1989) in his report, public transportation projects financed by federal funds and managed by CEI consultants are required by the Federal Highway Administration (FHWA) to be administered by a capable State DOT employee that ensures work is performed in accordance with the “terms, conditions, and specifications” of the contract. Newman (1989) mentions the functions of this employee as follows:

- “Be part of the decisions that generate change orders or supplemental agreements;
- Be acquainted with the qualifications and performance of the consultant’s staff;
- Check the relationship between cost billed and contract progress;
- Be attentive to the daily operations of the project;
- Visit the project in a frequency comparable to the magnitude and complexity of the work; and
- Perform final performance evaluation”.

Just as some of the functions of project manager were mentioned above, Newman (1989) listed the functions of a CEI consultant project engineer as follows:

- “Directly handle the contractor supervisors to inspect the work;
- Understand the plans and specifications;
- Test materials;
- Enforce contract provisions;
- Review and approve:
  - Progress payments;
  - Change orders;
  - Major changes to quantities and claims;
  - Time extensions;

- Final payments”.

It was noted by Newman (1989) that State DOTs alleviate their workload by employing CEI consultant staff to perform their work under the eye of DOT staff. In addition, State DOTs authorize who and the number of CEI consultant employees per project with that number varying throughout the duration of the project. Lastly, agencies can easily request the discharge of “any unsatisfactory employee” from a CEI project (Newman 1989).

As mentioned above, project staffing for State DOTs includes establishing the corresponding functions for the DOT project manager and the CEI consultant project engineer, and having the authority to discharge CEI consultant employees for poor performance.

#### **1.2.6 Closeout**

Witthford (1999) identified the following steps as requirements for completion of a contract:

- The project manager confirms required work is completed and deliverables were submitted;
- Disbursement of final payments is started;
- Deliverables are transferred to the owner;
- Final audits are started;
- If applicable, funds held by agency are freed; and
- Project documentation is completed.

In addition, Witthford (1999) mentioned in his report that project managers are usually required to communicate the “acceptance and approval of the consultant’s work to contract administrators closing out the project”. His report also mentions that some states utilize their technical staff to assess the project, while others involved their staff in the closeout process.

As the final process of a contract, the closeout process should be as organized as possible to include the steps necessary to ensure the proper completion of the contract.

### **1.2.7 Advantages and Disadvantages**

Newman (1989) collected the advantages and disadvantages of employing CEI consultants by State DOTs, which are shown below. The advantages found were:

- “Improves ability to handle peak work loads;
- Makes it easier to control in-house staff size;
- Provides flexibility to add or reduce staff more quickly;
- Provides special expertise not available in-house;
- Makes it easier to obtain equipment, office, etc.;
- Is more competitive; and
- Is in keeping with state’s goal of increasing privatization”.

Similarly, Newman (1999) found the following disadvantages:

- “Costs are higher;
- Familiarity with procedures is lacking;
- Monitoring requires a duplication of effort/increased paperwork;
- Consultant forces may be poorly qualified;
- Training opportunities for in-house employees are lost;
- Training of consultant personnel must be continual;
- Salary disparities cause in-house morale problems;
- Control and responsiveness are lost;
- Consultant recruit agency employees; and
- Consultants are more concerned with protecting themselves than the agency”.

### **1.2.8 States employing Leading Consultant Management Practices**

The study titled “A Summary Report of Consultant Management Best Practices” investigates the many approaches employed by various State DOTs to better their administration and utilization of consultants (Cochran et al. 2003). These approaches can be adapted as oversight practices of

consultants in construction engineering and inspection contracts. As perceived from the study, below is a short description of the purpose of each consultant management practice with the states that implemented it. It is recommended to directly refer to the report to further learn about these practices. Copying the following link and pasting it into the address bar of the web browser of your preference will guide you to the report with detailed examples of state practices in the areas presented below.

<http://www.dot.ga.gov/doingbusiness/research/Documents/reports/final-task3.pdf>

**Table 2 Examples of state practices in different areas**

<b>Consultant Management Practices</b>	<b>State DOT</b>	<b>Description</b>
<b>Strategic Planning and Management</b>	Pennsylvania Department of Transportation (DOT), Florida DOT	To successfully manage consultants, agencies must align their resources and actions with their strategy, vision, mission, and values. This brings a sense of direction that enables the organization to effectively select, and manage staff.
<b>Automation and Information Systems</b>	Pennsylvania DOT, Florida DOT	Enables agencies to efficiently receive, store, process, and transfer information internally and with consultants.
<b>Portfolio Managers</b>	Pennsylvania DOT	Their purpose is the timely selection of projects based on the Agency's strategic goals. They ensure that funds and resources go to the right projects.
<b>Training and Project Management</b>	Pennsylvania DOT, Florida DOT, Ohio DOT	Training staff and consultants increases the likelihood of successfully completing a project. Training prepares and increases the capability of consultants. This ensures that consultants understand how to perform and deliver the work. In addition, training aids the development of staff to be able to take more responsibilities.
<b>Consultant Audits</b>	Pennsylvania DOT, Florida DOT	Since consultants will be running operations on behalf of agencies, audits are used to verify that their contract documents are free from misstatements, and can be relied upon. Likewise, pre-award audits can provide agencies with the performance status of the consultant.
<b>Consultant Negotiations and Contract Development</b>	Pennsylvania DOT, Florida DOT, Ohio DOT, Wisconsin DOT	The flexibility to modify a contract and to centralize key processes can increase the control and effectiveness to manage consultants. Some agencies have centralized their negotiation process with the intention of simplifying it. Others have modified their contracts to terminate them with ease, to fit the behavior of project phases, and to reflect the intricacies of the project as best as possible.
<b>Consultant Evaluations</b>	Florida DOT, Ohio DOT	These evaluations are performed: <ul style="list-style-type: none"> <li>• To know the extent to which the consultant met the goals;</li> <li>• To know the quality of the consultant's work;</li> <li>• To know if more, fewer, or the same resources are needed; and</li> <li>• To exchange feedback between Agency and consultant.</li> </ul>
<b>Resource Allocation</b>	Florida DOT, Ohio DOT, Kentucky DOT	Resource allocation enables agencies to decide the best use of their resources in completing projects. Agencies employ consultants as resources to assist in the achievement of their goals. Beforehand,



		agencies must know what internal and external resources are available, and how can these be effective in the accomplishment of their goals. Internal resources can be used to oversee external resources. For that reason, some agencies have programs to continually replenish the pool of resources.
<b>Performance Measurement</b>	Florida DOT, Arizona DOT	Agencies measure their performance: <ul style="list-style-type: none"> <li>• To verify how well they and their consultants are achieving their work;</li> <li>• To demonstrate overseeing authorities that they are doing a good job;</li> <li>• To confer on concerns; and</li> <li>• To identify areas for betterment, among others.</li> </ul>
<b>Connecting with Consultants</b>	Pennsylvania DOT, Florida DOT, Ohio DOT	Agencies established relationships with consultants: <ul style="list-style-type: none"> <li>• To share information;</li> <li>• To confer on prevailing issues;</li> <li>• To find solutions; and</li> <li>• To observe, and impart ethics.</li> </ul>
<b>Quality Initiatives</b>	Florida DOT, Delaware DOT	Agencies safeguard the quality of their consultant management process by: <ul style="list-style-type: none"> <li>• Inspecting consultants on quality assurance; and</li> <li>• By using surveys to gather feedback on the quality of their consultant management process.</li> </ul>
<b>Role of Project and Contract Managers</b>	Ohio DOT	Some agencies understand that dividing the administrative and technical tasks between a contract manager and project manager encompasses and focuses the oversight of consultant activities.
<b>Consultant Selection Process</b>	Ohio DOT	To ensure that there is an ample pool of consultants where to choose from, some agencies habitually advertised projects and permit participation of the same consultant in several concurrent bids.
<b>Electronic Bidding System</b>	Pennsylvania DOT	Developed to expedite, and control the bidding process between agencies and consultants.

## 2 Overview and Methods

State Department of Transportations (DOT) face the challenge of dealing with dynamic construction programs that have large fluctuations in workload. The use of consultants for Construction Engineering and Inspection (CEI) services is a flexible workforce strategy to respond to this challenge. This thesis aims to find how DOTs provide oversight for CEI services.

### 2.1 Objective and Methods

The objective of this thesis is to identify the current state of practices in utilizing consultants for CEI services, and to discover the services included under CEI services.

This thesis was prepared through a combination of a literature review, and online survey. The preparation of the literature review and online survey used the following two reports as guides, Consultants for DOT Preconstruction Engineering Work, and Use of Consultants for Construction Engineering and Inspection. Other publications used were state request of proposals, state scopes of work, and state scope of services, which mentioned the services to be provided under CEI. Additional publications used complement the literature review.

The survey collected information on topics such as State DOT contact information, CEI inspection program characteristics, tools in the selection, administration and closeout process, payment procedures, insurance, routine contact with CEI consultant, and importance of advantages and disadvantages. The survey was organized based on the CEI function table. It includes the following:

- CEI Categories (Activities) Usage;
- General Demographic Questions;
- Estimated Annual Dollar Volume of CEI Consultant Work;
- Frequency of CEI Services per Project Size;
- Practices or Tools used in Administration of CEI Consultants:

- Define Scope of Work;
  - Selection Process;
  - Pre-construction;
  - Contract Clarification and Modification;
  - Work Execution;
  - Payment Administration;
  - Monitoring and Inspection; and
  - Human Resources.
- Closeout Process
  - Frequency of Meetings
  - Importance of Advantages & Disadvantages

The survey was sent to all 50 states, District of Columbia, two provinces of Canada (British Columbia and Ontario), and several transportation authorities.

### 3 Results

The survey provided information on the composition of state departments of transportation, a Canadian ministry of transportation agency, and transportation authorities. This information is presented under the demographics heading. Furthermore, the survey provided information on the current tools used to oversee CEI consultants. The data was analyzed to determine the order of use of the tools on the areas identified by the literature review. These results are presented under analysis heading.

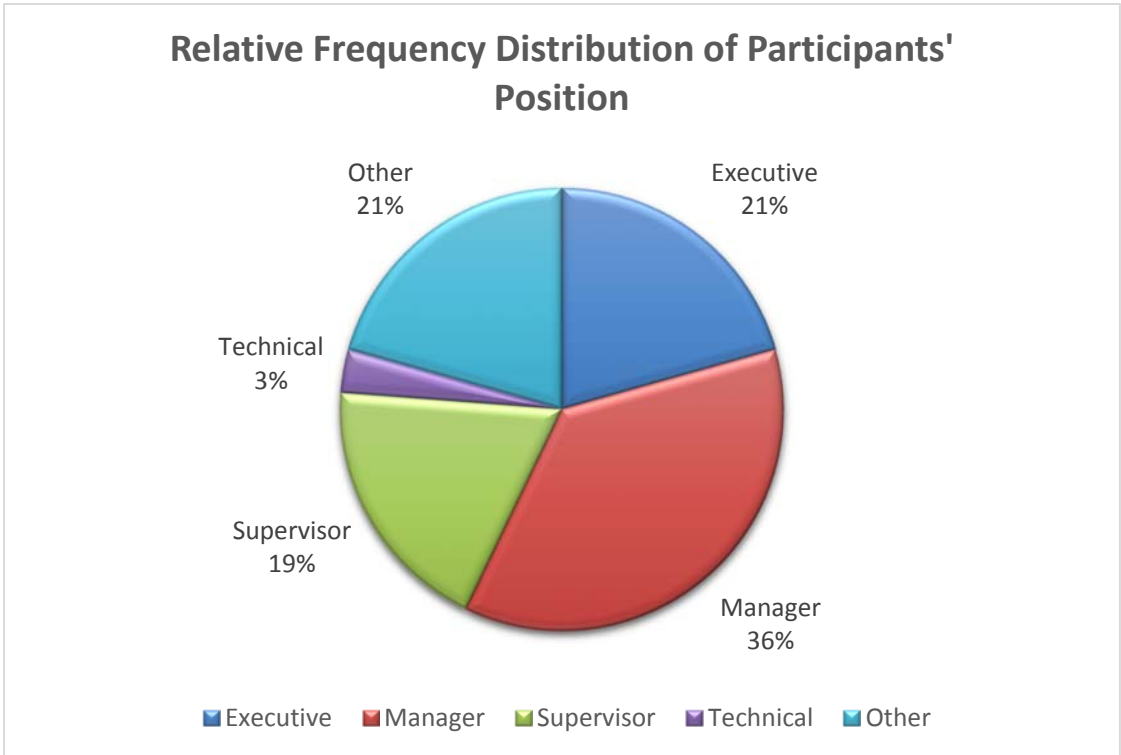
#### 3.1 Demographics

Surveys were sent to all 50 states Departments of Transportation, District of Columbia Department of Transportation, Ontario Ministry of Transportation, British Columbia Ministry of Transportation and Infrastructure, and several transportation authorities. A total of 63 responses were received. Those responses included 51 completed and 12 partially completed surveys.

The participants represent a combination of executives, managers, supervisors, technical, and others (see table 2). A chi-square analysis indicates that responses are significantly different ( $p$ -value = 0.002\* in appendix). Hence, the majority of participants were managers (see figure 1).

**Table 3 Classification of participants**

Management Classification		Frequency	Relative Frequency (%)
Executive	E	13	20.6%
Manager	M	23	36.5%
Supervisor	S	12	19.0%
Technical	T	2	3.2%
Other	O	13	20.6%
		63	100.0%

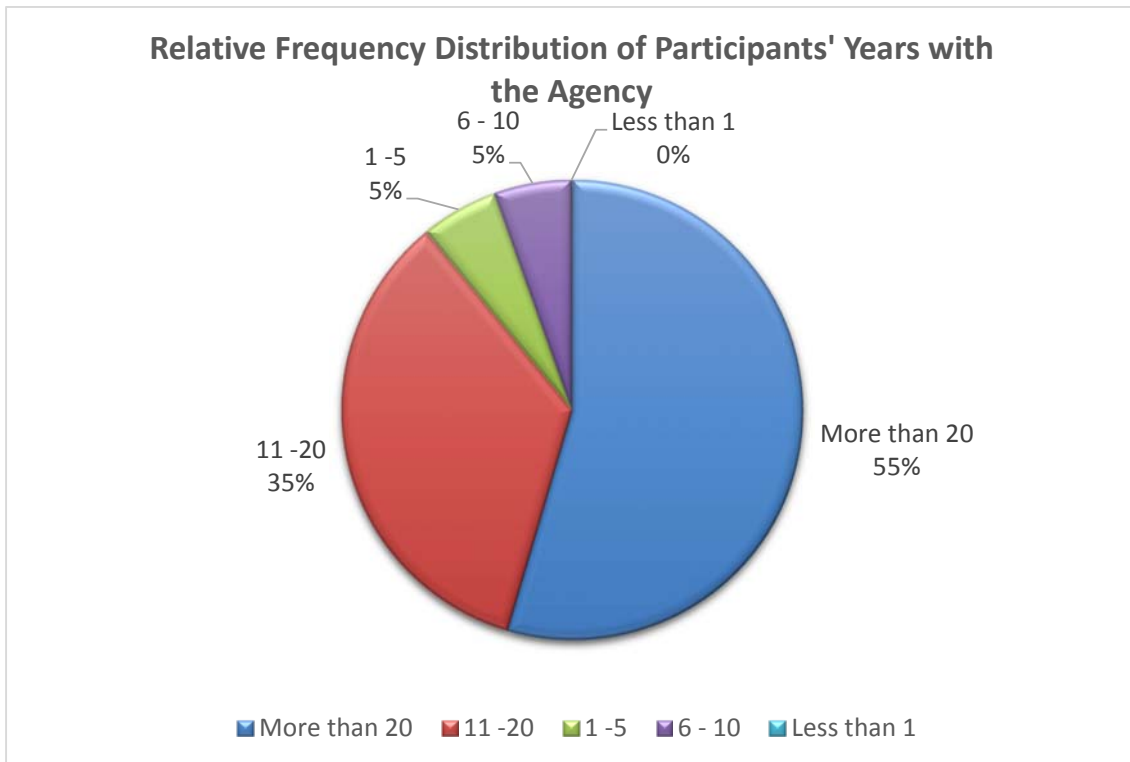


**Figure 1** Pie chart of relative frequency distribution of participants' constitution

The number of responses about the quantity of years that participants have been with their agencies is statistically different (p-value = 0.000\* in appendix). Hence, the relative frequency shows that the majority of participants (54.5%) have been with their agencies for more than 20 years (see table 4 and figure 2).

**Table 4** Frequency and relative frequency of participants' years with agency

Item No.	Years with Agency	Frequency	Relative Frequency [%]
5	More than 20	30	54.5%
4	11 -20	19	34.5%
2	1 -5	3	5.5%
3	6 - 10	3	5.5%
1	Less than 1	0	0.0%
<b>Total # of Responses</b>		55	100.0%

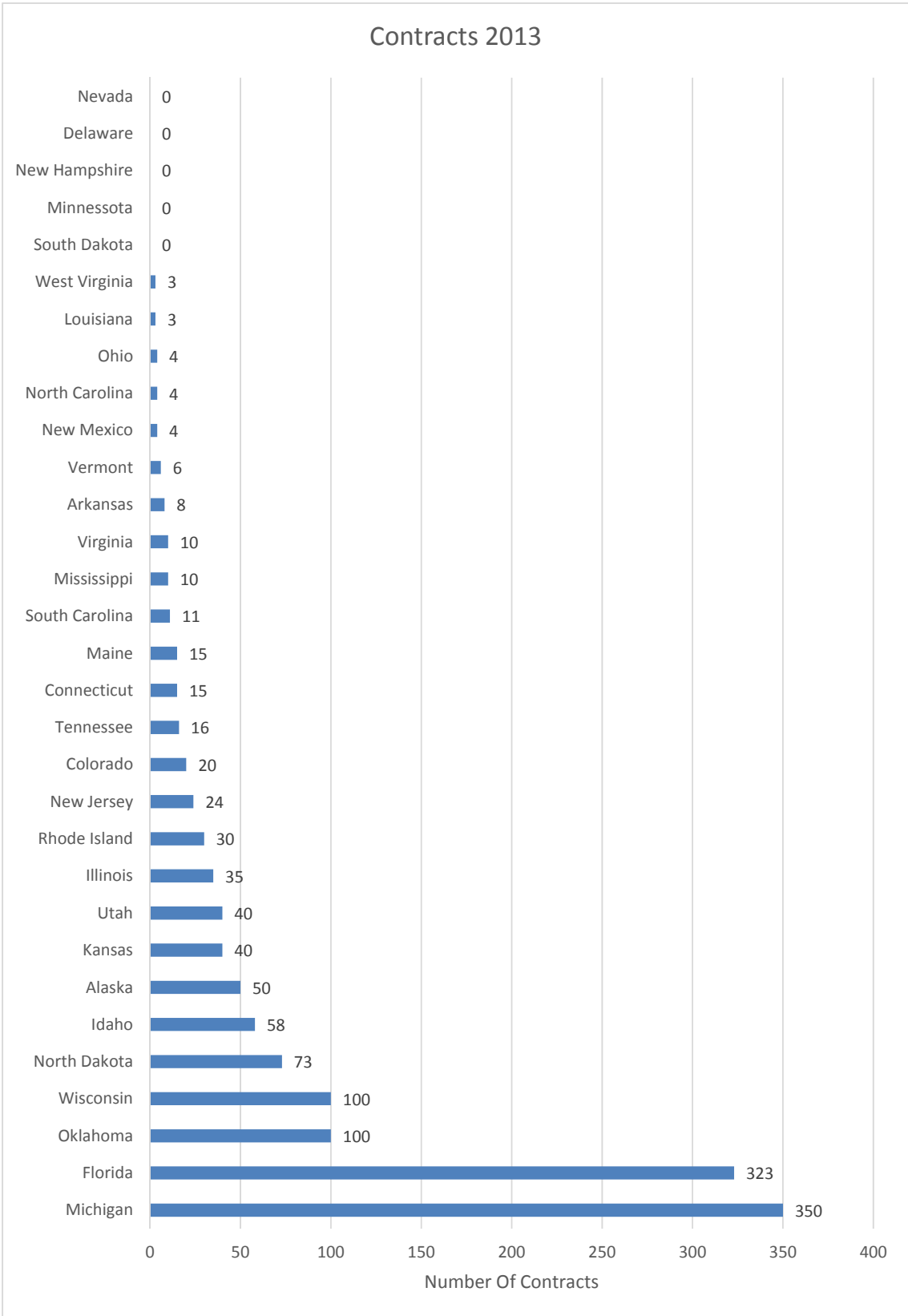


**Figure 2 Relative frequency pie chart of participants' years with agency**

As part of understanding how CEI services work, inquiries or investigation were performed to learn the number of CEI contracts in 2013, the estimated annual dollar volume of CEI consultant work, and the annual state funding for highways.

States provided an estimate of the number of CEI contracts issued in 2013. As shown in figure 3, the range of contracts issued is from 3 to 100. However, two exceptions to this range are Florida and Michigan with 323 and 350 contracts, respectively. Both states have a large number of contracts issued under 2013.

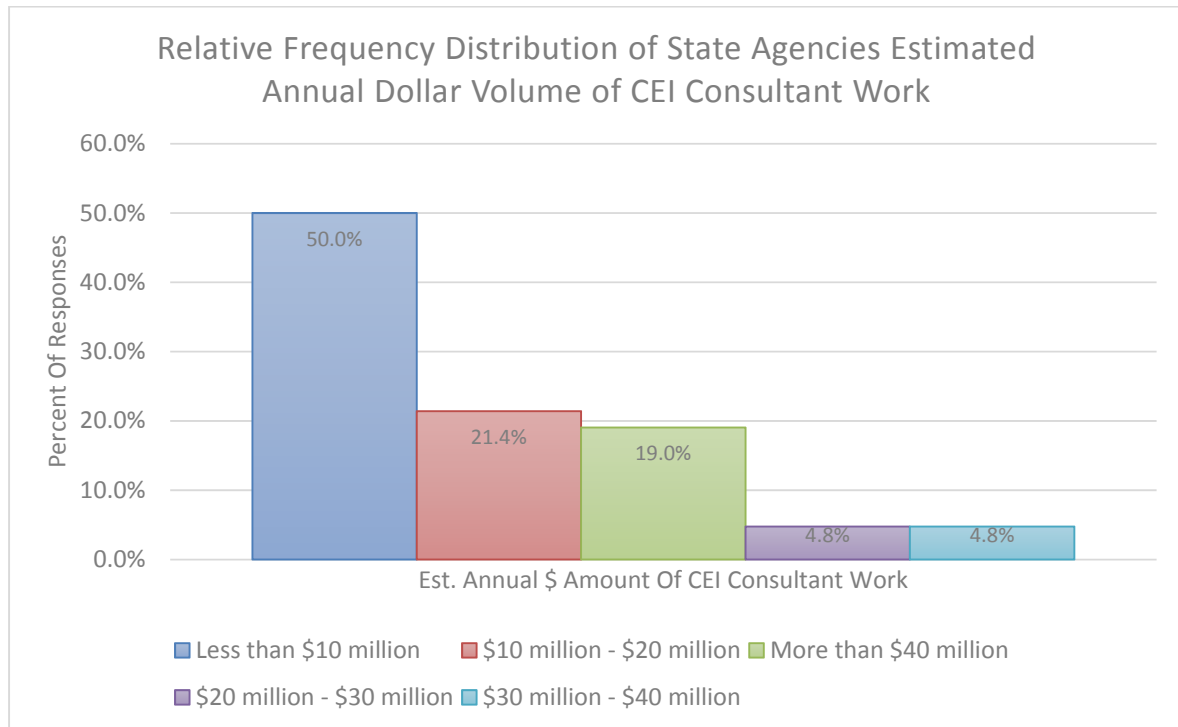
A chi-square analysis of the estimated annual dollar amount of CEI consultant work indicates that responses are significantly different (p-value = 0.000\* in appendix). Hence, it can be stated that the majority of CEI consultant work falls under \$10 million dollar volume (see table 5 and figure 4).



**Figure 3 Estimated quantity of CEI contracts issued on 2013 among State DOTs**

**Table 5 Estimated annual dollar volume of CEI consultant work**

Item No.	Estimated Annual Dollar Amount of CEI Consultant Work	Frequency	Relative Frequency [%]
1	Less than \$10 million	21	50.0%
2	\$10 million - \$20 million	9	21.4%
3	More than \$40 million	8	19.0%
4	\$20 million - \$30 million	2	4.8%
5	\$30 million - \$40 million	2	4.8%
<b>Total</b>		<b>42</b>	<b>100.0%</b>

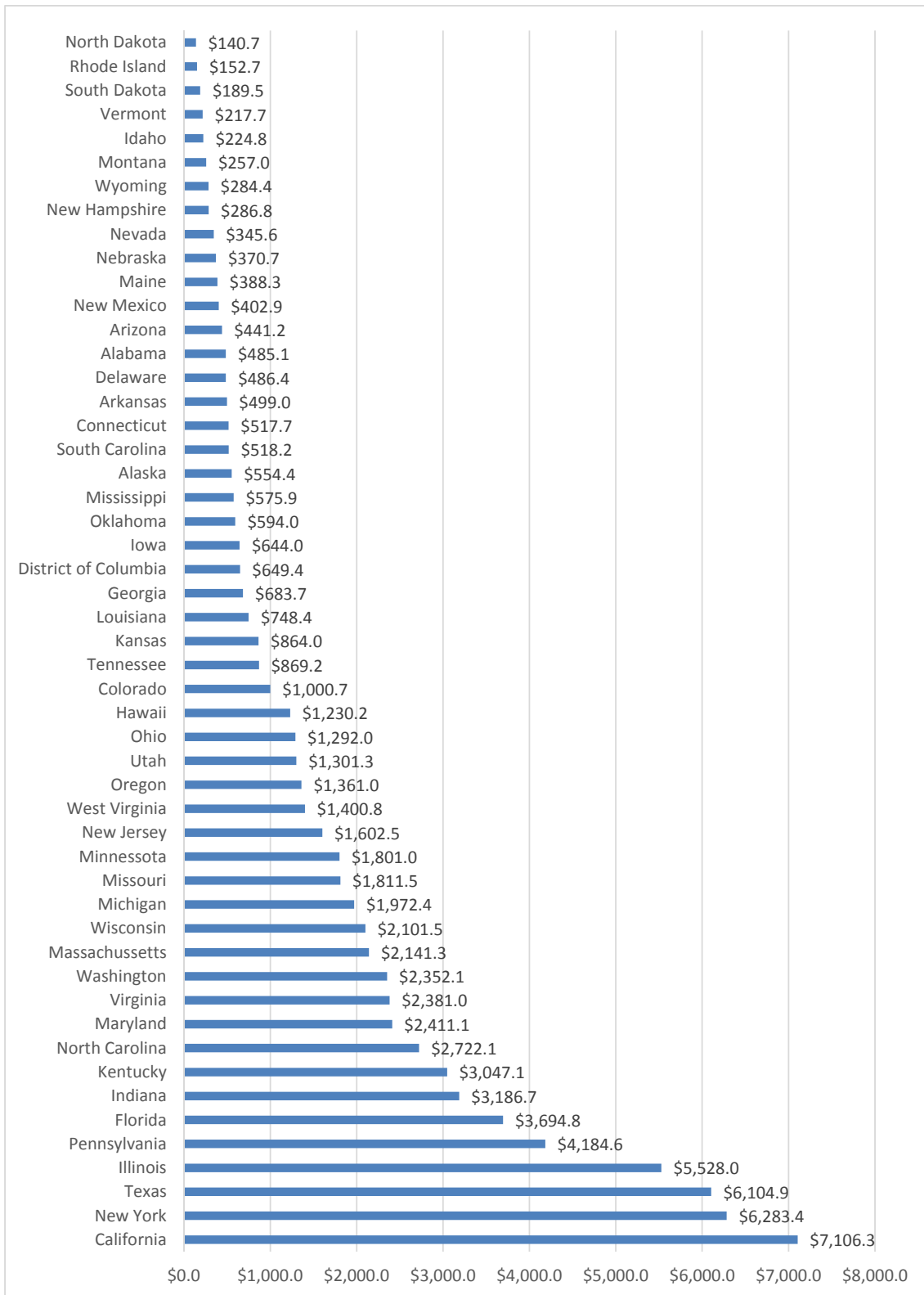


**Figure 4 Estimated annual dollar volume of CEI consultant work relative frequency graph**

The State DOTs Budgets State Funding plus Federal Aid data (see figure 5) shows the total budgets for each state. The graph provides a glimpse into the funding size of each state. As shown in the figure, California has the highest budget and North Dakota has the lowest budget.

This information also aided in the determining a percent estimate of CEI services used based on the total state budget.





**Figure 5 Graph of federal and state funding per state (FHWA - State funding for highways - Summary - 2010 1/ Table SF-21)**

The estimated percentage of CEI consultant work was calculated by dividing the estimated annual dollar volume of CEI consultant work by the total state funding for highways per state (see figure 5). The results were classified among high, medium, and low user (see figure 5). The classification was attained by calculating the 33<sup>th</sup> and 66<sup>th</sup> percentiles of the percentages. It can be observed that North Dakota is an outlier due to its high percentage of 35.5% in comparison with other states.

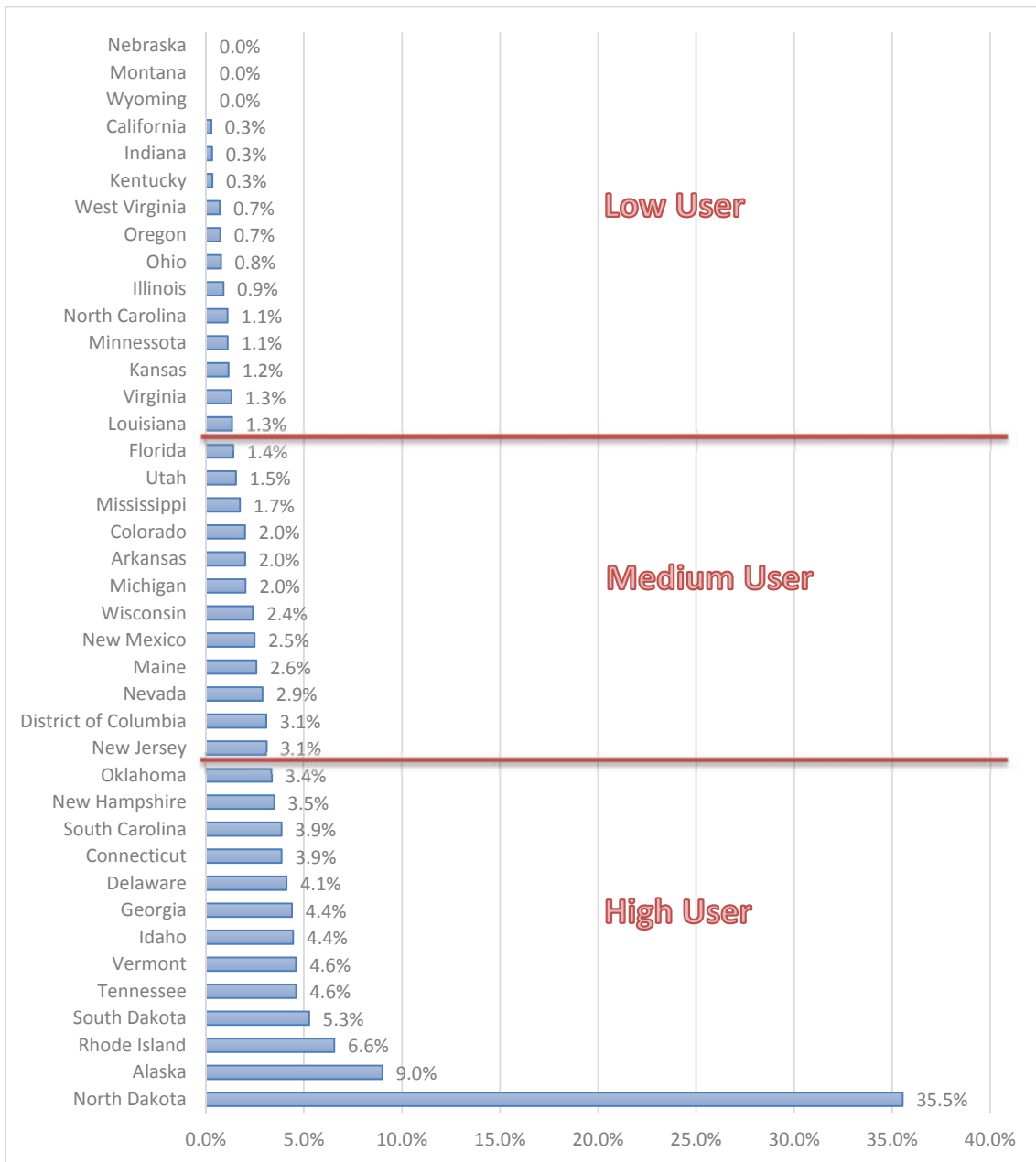
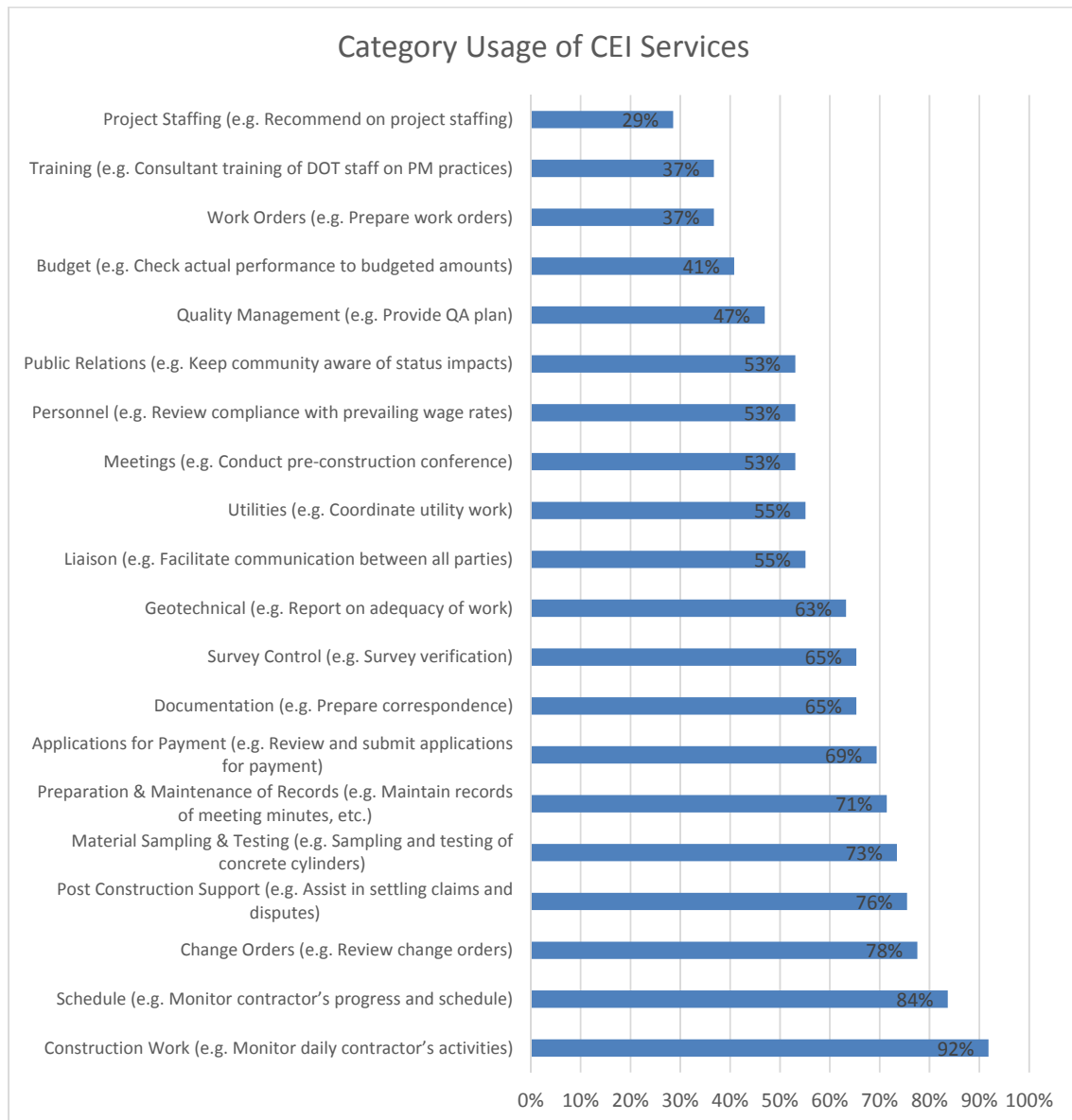


Figure 6 Graph of CEI consultant work estimated percentage of total highway funding per state

### 3.2 Use of CEI Categories

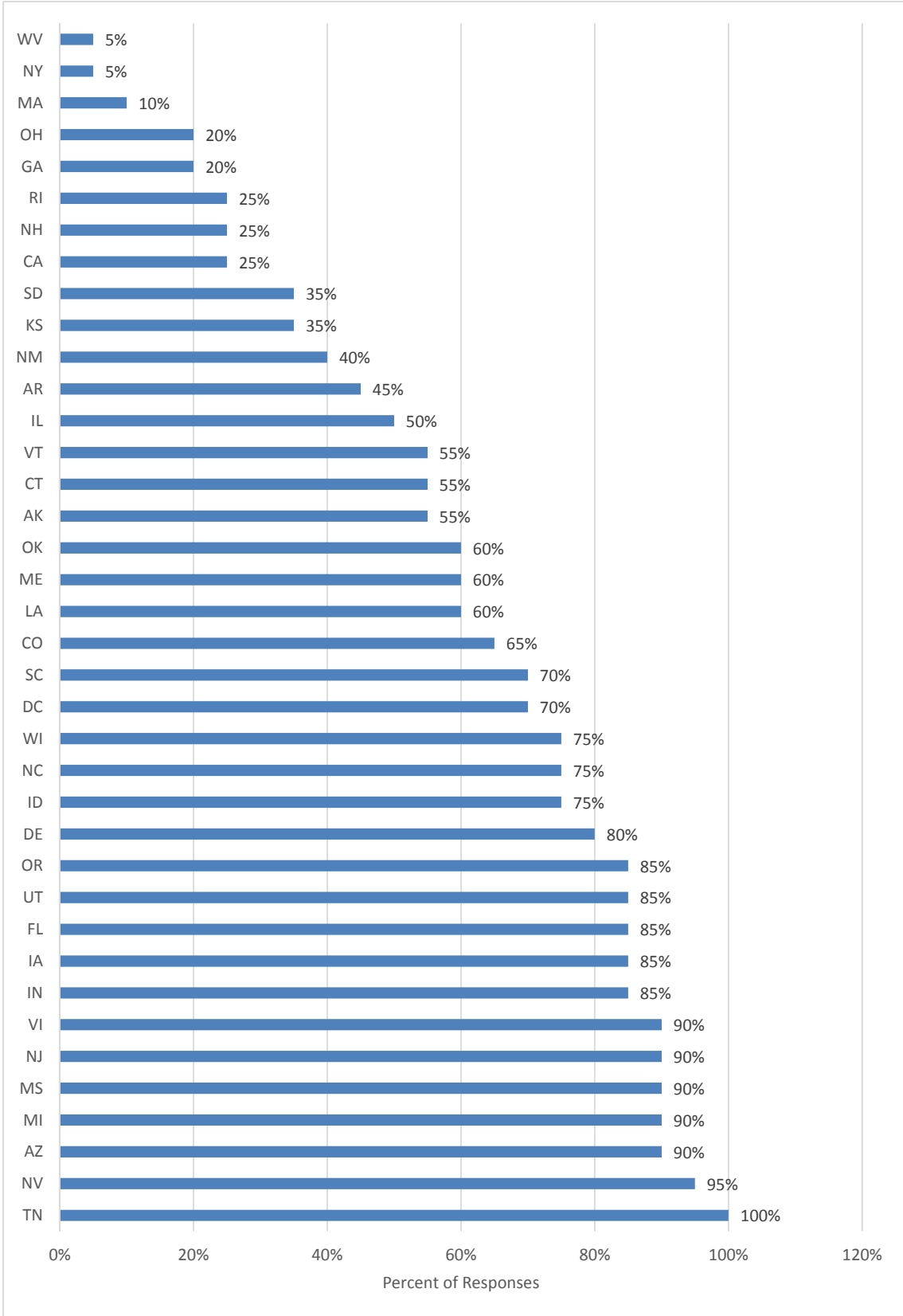
To understand the extent that states use CEI services, the functions found to be included under these services were presented in the survey as CEI categories.

The level of CEI usage of the categories discovered through the literature review is shown in the graph below. Figure 7 shows that the categories most often used in order of selection are construction work, schedule, and change orders among others.

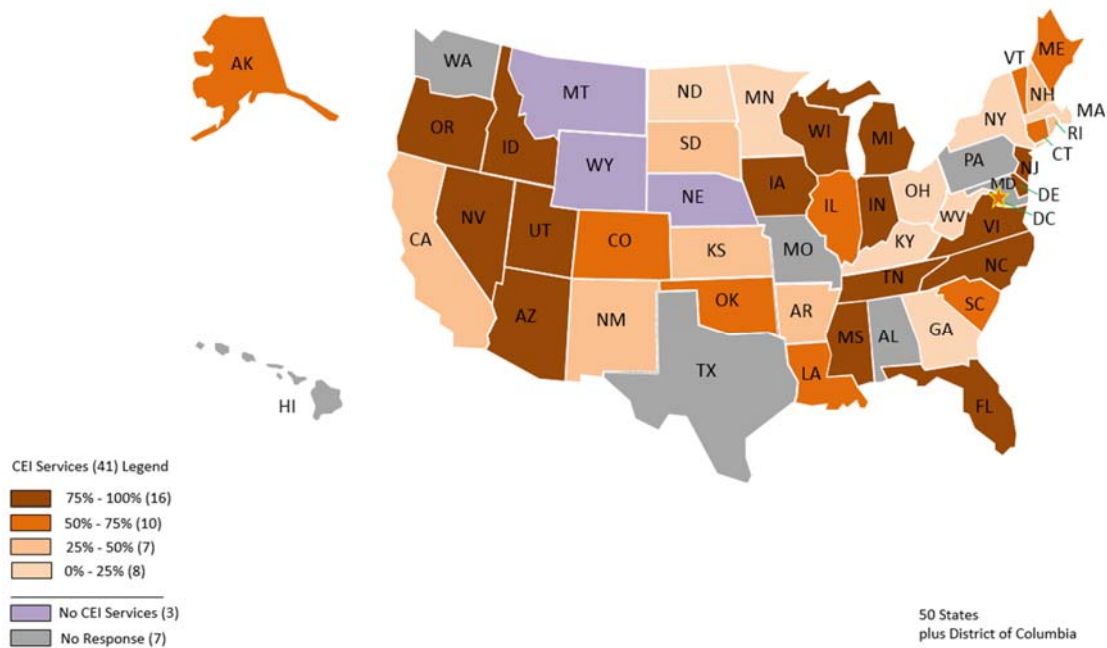


**Figure 7 Graph of usage percentage of CEI categories**

A heat map (see figure 9) is presented to show the use of CEI categories (see figure 8) by state. The heat map is a graphical representation of data activity with colors. Colors indicate the level of activity. For example, the dark colors represent high activity level, and the lighter colors represent low activity. The heat map shows not only the states that participated but also the ones that did not participate in the survey. Of the states that participated, three states do not use CEI services. States such as Oregon, Indiana, Nevada, Utah, Arizona, Wisconsin, Iowa, Michigan, Idaho, Tennessee, Virginia, North Carolina, Mississippi, Florida, and New Jersey use most if not all of the CEI categories as shown with the darkest color in the heat map.



**Figure 8 Graph depicting the use of CEI categories by participating state**



**Figure 9 Usage heat map of CEI categories**

### 3.3 Analysis

A relationship between the level of CEI usage per state and the level of CEI practice or tool usage per state was proposed. An example of this type relationship is as follows, Colorado is classified as a medium user of CEI services (Estimated annual dollar amount of CEI consultant work / Total construction funding) that indicated it uses the “Statement of Work” CEI tool “All 100%” of the time as the practice to define the scope of work for a CEI consultant. Is there a relationship between Colorado (medium CEI user) with its 100% use of the Statement of Work CEI tool to define the CEI scope of work? A chi-square analysis was performed to confirm the existence of this relationship. The results as shown in the table 6 and 7 are all above 0.05, which indicates that there is no difference between the level of CEI usage (high, medium, and low) and the level of CEI tool or practice usage. A high, medium, or low user is not different within any of the six categories depicting the level of CEI tool or practice usage. Whether you are a low user, you are still using the tools the same way as a medium or high user.

**Table 6 Results of Chi-Square analysis of CEI user level and CEI tool frequency usage level part 1**

<b>Q</b>	<b>Items</b>	<b>p-value Chi Square</b>
<b>How frequent are CEI services used in projects among the following size?</b>	1 Very large (Above \$40M)	0.138
	2 Large (\$10M to \$40M)	0.256
	3 Medium (\$2M to \$10M)	0.398
	4 Small (\$1M to \$2M)	0.829
	5 Very small (\$0 to \$1M)	0.463
<b>How often is each practice used to define the scope of the work for consultant CEI Services?</b>	1 Statement of work in contract agreement	0.795
	2 Advertisement or RFP	0.563
	3 Scoping meeting	0.912
	4 Written scope statement	0.583
<b>Which tools does your agency use in the selection process of CEI consultants?</b>	1 Select CEI consultant from a prequalification list of CEI consultants	0.738
	2 Advertise to bid for CEI consultant services through media outlets & ask for proposal	0.779
	3 Develop a shortlist of CEI consultants based on response to advertisements & ask for proposal	0.323
	4 Require CEI consultant to have professional liability insurance	0.402
<b>Which tools does your agency use in the pre-construction part of the administration of a CEI consultant?</b>	1 Prepare a list of the documentation that CEI consultant will manage to be later used as closeout checklist	0.798
	2 Require CEI consultant to submit hold harmless agreement	0.882
<b>Which tools does your agency use in the contract clarification and modification part of the administration of a CEI consultant contract?</b>	1 Verification that CEI consultant is appropriately managing modifications to the contract	0.945
	2 Verify that CEI consultant is responding to construction contractor's request for assistance	0.557
	3 Maintain a record of all changes to CEI consultant's scope of work	0.908
	4 Internally review and approve changes to CEI consultant's scope of work	0.583
	5 Adjust fixed fee of CEI consultant's contract when the total contract amount is revised due to a change in the scope of work	0.750
<b>Which tools does your agency use in the work execution part of the administration of a CEI consultant contract?</b>	1 Verify that CEI consultant complies with terms and conditions of its contract	0.611
<b>Which tools does your agency use in the payment part of an administration of a CEI contract?</b>	1 Require monthly applications for payment from CEI consultant	0.616
	2 Hold payment from CEI consultant if project is behind schedule	0.378
	3 Retain amount (Retainage) from CEI consultant's applications for payment	0.728
<b>Which tools does your agency use in the monitoring and inspection part of the administration of a CEI consultant contract?</b>	1 Verification that CEI consultant adequately reviews construction contractor's application for payment	0.613
	2 Require CEI consultants to submit progress reports	0.085
	3 Perform intermediate evaluations of CEI consultant's performance	0.930

**Table 7 Results of Chi-Square analysis of CEI user level and CEI tool frequency usage level part 2**

<b>Q</b>	<b>Items</b>	<b>p-value Chi Square</b>
<b>Which tools does your agency use in the human resource area of the administration of a CEI consultant contract?</b>	1 Provide training to DOT staff in CEI consultant management	0.354
	2 Provide CEI consultant access to DOT's internal information system	0.798
	3 Provide training to CEI consultant on DOT's processes and procedures	0.587
	4 Require DOT project manager to get acquainted with the roles and skills of selected CEI consultant	0.676
<b>Which tools does your agency use in the closeout process of the CEI consultant contract?</b>	1 Verify that all work assigned to CEI consultant is complete	0.271
	2 Perform final performance evaluation of CEI consultant	0.414
	3 Share final evaluation with CEI consultant	0.737
	4 Verify that CEI consultant delivered all project documentation and records	0.154
	5 Verify consistency of CEI consultant's contract costs	0.761
	6 Verify CEI consultant used proper accounting methods to record costs	0.285
	7 Release retained amount from CEI consultant's contract	0.190
<b>How frequently does your agency perform meetings with CEI consultants?</b>	1 Between major milestones	0.703
	2 Monthly meetings	0.630
	3 Bi-weekly meetings	0.526
	4 Weekly meetings	0.218
<b>Importance of Advantages</b>	1 Improves ability to handle peak work loads	0.371
	2 Makes it easier to control in-house staff size	0.495
	3 Provides flexibility to add or reduce staff more quickly	0.970
	4 Provides special expertise not available in-house	0.513
	5 Makes it easier to obtain equipment, office, etc.	0.619
	6 Is more competitive	0.562
	7 Is in keeping with state's goal of increasing privatization	0.763
<b>Importance of Disadvantages</b>	1 Costs are higher compared to in-house staff	0.130
	2 Lack of familiarity with procedures	0.718
	3 Monitoring requires a duplication of effort, and increased paperwork	0.640
	4 CEI consultant forces may be poorly qualified	0.708
	5 Training opportunities for in-house employees are lost	0.837
	6 Training of CEI consultant personnel must be continual	0.174
	7 Salary disparities between CEI consultants and in-house staff cause morale problems	0.244
	8 Control and responsiveness from construction contractors is lost	0.520
	9 CEI consultants recruit DOT employees	0.759
	10 CEI consultants are more concerned with protecting themselves than the agency	0.112

As there is no difference in how all level of users are using each tool, the question then is rewritten to find the difference in the overall usage of each tool. Subsequently, a second analysis that



considers the marginal values from all types of users under each of the CEI tool frequency usage categories was performed. The results are shown under each applicable question.

As shown in figure 11, CEI services are used more on smaller projects. The results of the analysis about the frequency of use of CEI services in projects of different size is as follows:

- The CEI usage level of the “Very large (Above \$40M)” project size (item 1) is not statistically significantly different (see table 8).
- The CEI usage level values of the remaining project sizes (items 2 to 5) are statistically different (see table 8).
- The overall values per CEI tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 8.
- As shown below (see table 9, and figure 10 and 11), project sizes from most to less used were selected in the following order:
  - Project size “Very small (\$0 to \$1M)” was selected 61% under frequency category “To some degree <25%”.
  - Project size “Small (\$1M to \$2M)” was selected 58% under frequency category “To some degree <25%”.
  - Project size “Medium (\$2M to \$10M)” was selected 43% under frequency category “To some degree <25%”.
  - Project size “Large (\$10M to \$40M)” was selected 33% under frequency category “To some degree <25%”.
  - Project size “Very large (Above \$40M)” was selected 29% under frequency category “Almost completely 75 to less than 100%”, but this selection is not different than selecting across all the other CEI tool frequency usage categories shown in table 8.

There were states such as South Carolina that complemented their responses by indicating that the use of CEI consultants depends on staff availability at the time of project award. In contrast,

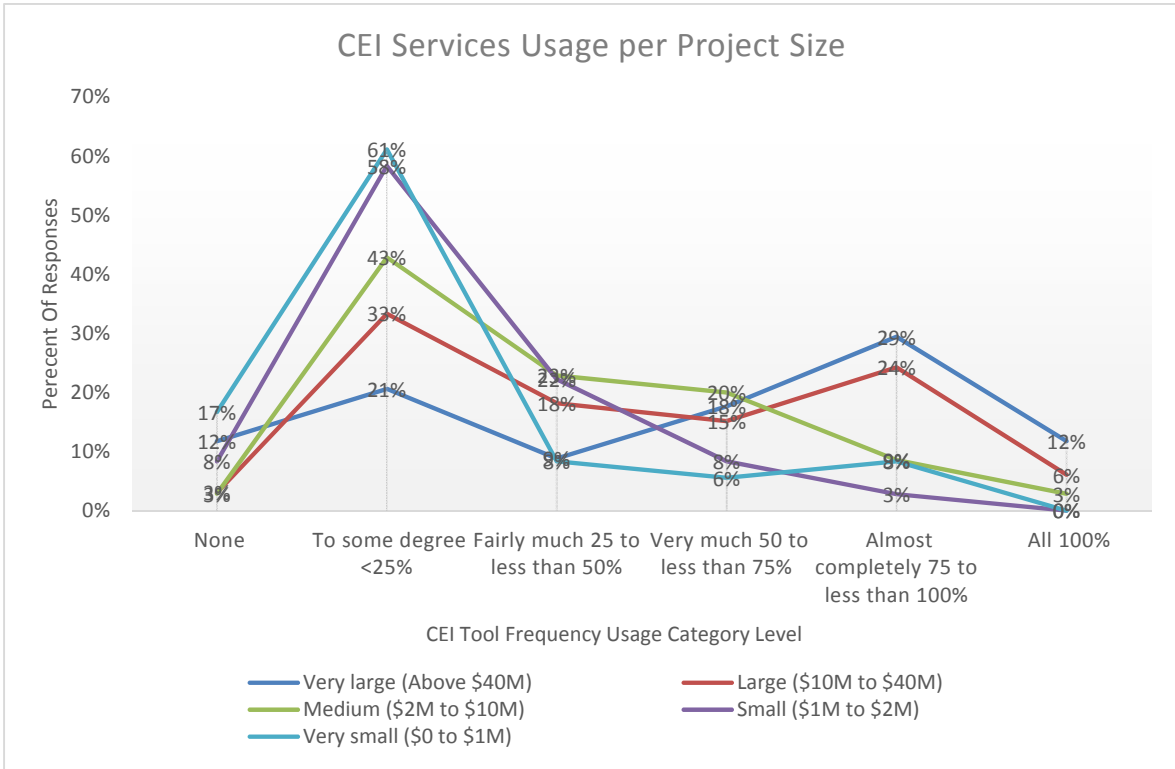
Indiana solely responded by indicating that it uses CEI consultants based on where their employees are geographically located in relation to the project.

**Table 8 Frequency use of CEI services under different size projects - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

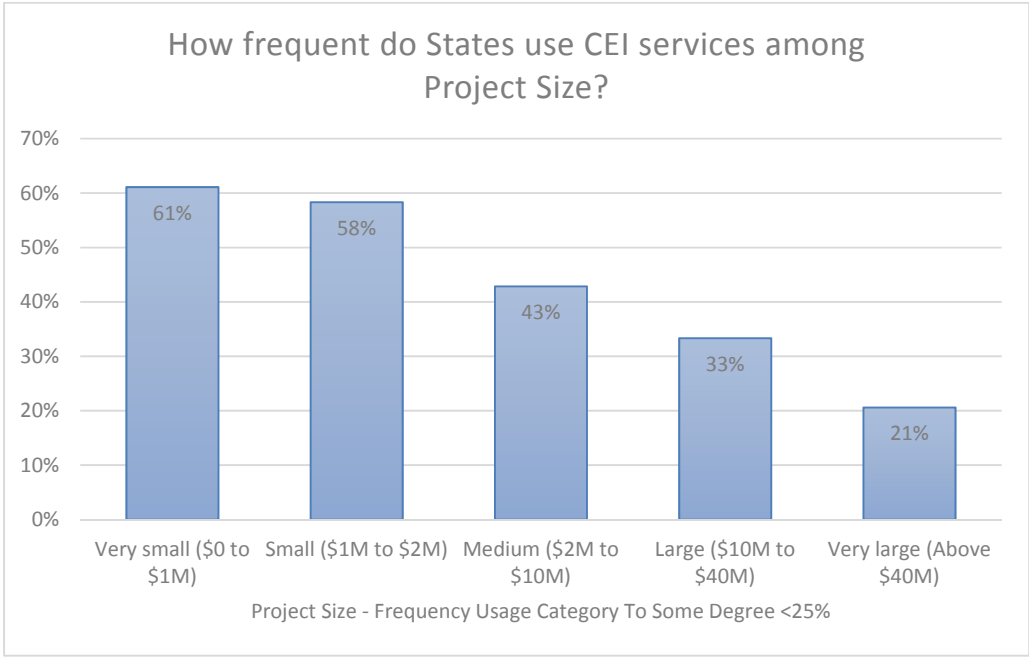
Question	Project Size	CEI Tool Frequency Usage Data						Chi Square	p-value Chi Sq
		None	To some degree <25%	Fairly much 25 to less than 50%	Very much 50 to less than 75%	Almost completely 75 to less than 100%	All 100%		
How frequent are CEI services used in projects among the following size?	Very large (Above \$40M)	4	7	3	6	10	4	5.882	0.3178
	Large (\$10M to \$40M)	1	11	6	5	8	2	12.636	0.0270
	Medium (\$2M to \$10M)	1	15	8	7	3	1	24.829	0.0002
	Small (\$1M to \$2M)	3	21	8	3	1		51.333	0.0000
	Very small (\$0 to \$1M)	6	22	3	2	3		54.333	0.0000
	<b>Total</b>	<b>15</b>	<b>76</b>	<b>28</b>	<b>23</b>	<b>25</b>	<b>7</b>	<b>101.448</b>	<b>0.0000</b>

**Table 9 Frequency use of CEI services under different size projects - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Project Size	CEI Tool Frequency Usage Categories						Sum
		None	To some degree <25%	Fairly much 25 to less than 50%	Very much 50 to less than 75%	Almost completely 75 to less than 100%	All 100%	
How frequent are CEI services used in projects among the following size?	Very large (Above \$40M)	12%	21%	9%	18%	29%	12%	100%
	Large (\$10M to \$40M)	3%	33%	18%	15%	24%	6%	100%
	Medium (\$2M to \$10M)	3%	43%	23%	20%	9%	3%	100%
	Small (\$1M to \$2M)	8%	58%	22%	8%	3%	0%	100%
	Very small (\$0 to \$1M)	17%	61%	8%	6%	8%	0%	100%



**Figure 10** Frequency use of CEI services under different size projects - Graph of all percentages from all users under each of the CEI tool frequency usage categories



**Figure 11** Frequency use of CEI services under different size projects graph- Percentages under CEI tool frequency usage category (To some degree <25%) from all users

As shown in figure 13, the statement of work is the most used tool all the time in defining the scope of work for a CEI contract. The results of the analysis about the tools used to define the CEI consultant scope of work are as follows:

- All CEI usage level values (rows) are statistically different in all the practices (items 1 to 4) included in this question (see table 10).
- The overall values per CEI tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 10.
- As shown below (see table 10, and figure 12 and 13), the tools to define the scope of work were selected in the following order:
  - The practice of “Statement of Work” was selected 71% under the frequency category “All 100%”.
  - The practice of “Advertisement or RFP” was selected 57% under the frequency category “All 100%”.
  - The practice of “Written Scope Statement” was selected 53% under the frequency category “All 100%”.
  - The practice of “Scoping Meeting” was selected 39% under the frequency category “All 100%”.

As the tool most selected, the statement of work is a “narrative description of the products, services, or results to be supplied” (PMI 2008). In contrast, the written scope statement can be defined as a “narrative description of the project scope, including major deliverables, project assumptions, project constraints, and a description of the work” (PMI 2008).

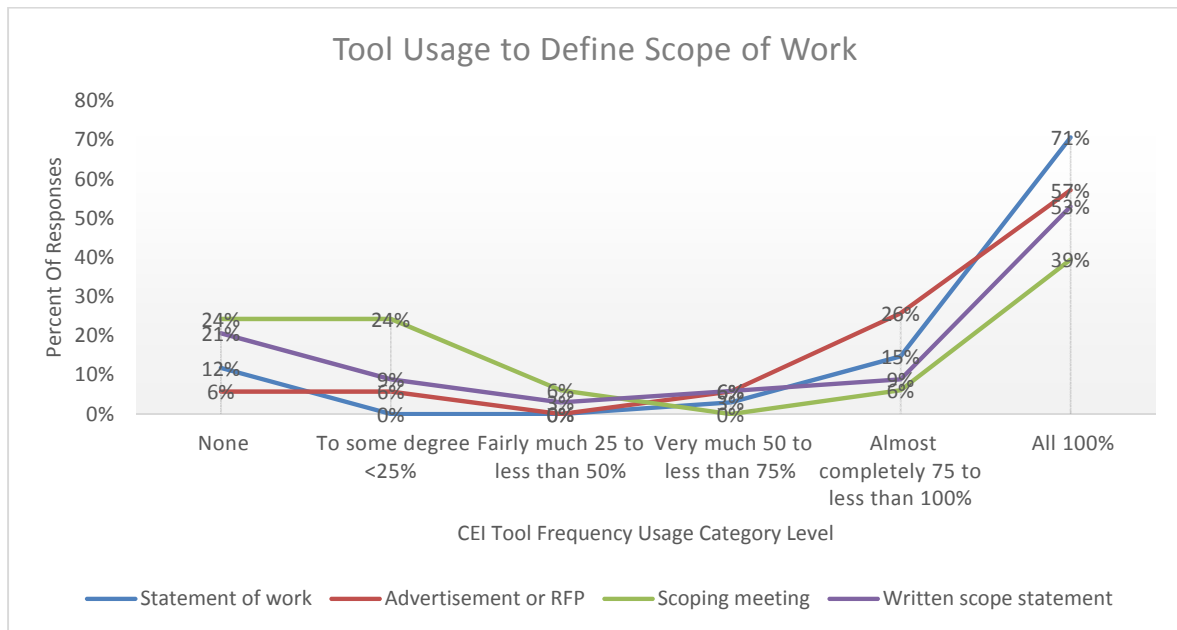
In addition to the practices included in this question, Oklahoma indicated that they select several engineering firms, and through an RFP award a two-year contract. During the contract period, Oklahoma provides them with project specific task orders that have a defined scope.

**Table 10 Tools to define CEI consultant scope of work - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

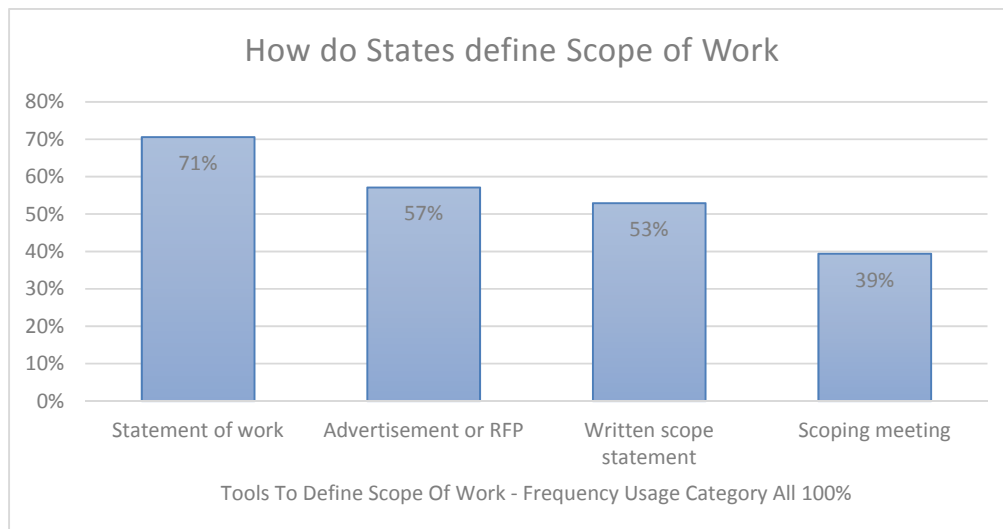
Question	Tool	CEI Tool Frequency Usage Data						Chi Square	p-value Chi Sq
		None	To some degree <25%	Fairly much 25 to less than 50%	Very much 50 to less than 75%	Almost completely 75 to less than 100%	All 100%		
How often is each practice used to define the scope of the work for consultant CEI Services?	Statement of work in contract agreement	4			1	5	24	38.706	0.0000
	Advertisement or RFP	2	2		2	9	20	35.429	0.0000
	Scoping meeting	8	8	2		2	13	13.212	0.0100
	Written scope statement	7	3	1	2	3	18	35.882	0.0000
<b>Total</b>		<b>21</b>	<b>13</b>	<b>3</b>	<b>5</b>	<b>19</b>	<b>75</b>	<b>156.500</b>	<b>0.0000</b>

**Table 11 Tools to define CEI consultant scope of work - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tool	CEI Tool Frequency Usage Categories						Sum
		None	To some degree <25%	Fairly much 25 to less than 50%	Very much 50 to less than 75%	Almost completely 75 to less than 100%	All 100%	
How often is each practice used to define the scope of the work for consultant CEI Services?	Statement of work	12%	0%	0%	3%	15%	71%	100%
	Advertisement or RFP	6%	6%	0%	6%	26%	57%	100%
	Scoping meeting	24%	24%	6%	0%	6%	39%	100%
	Written scope statement	21%	9%	3%	6%	9%	53%	100%



**Figure 12 Tools to define CEI consultant scope of work - Graph of all percentages from all users under each of the CEI tool frequency usage categories**



**Figure 13 Tools to define CEI consultant scope of work graph - Percentages under CEI tool frequency usage category (All 100%) from all users**

As shown in figure 15, the requirement of professional liability insurance is the most used tool all the time in the selection of a CEI consultant. The results of the analysis about the tools used to select CEI consultants are as follows:

- All CEI usage level values are statistically different in all the tools (items 1 to 4) included in this question (see table 12).
- The overall values per tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 12.
- As shown below (see table 13, and figure 14 and 15), the tools for the selection process were selected in the following order:
  - The tool of “Require CEI consultant to have professional liability” was selected 94% under category “Always”.
  - The tool of “Select CEI consultant from a prequalification list of CEI consultants” was selected 49% under category “Always”.
  - The tool of “Advertise to bid for CEI consultant services through media outlets & ask proposal” was selected 47% under category “Always”.

- The tool of “Develop a shortlist of CEI consultants based on response to advertisements & ask for proposal” was selected 41% under category “Always”.

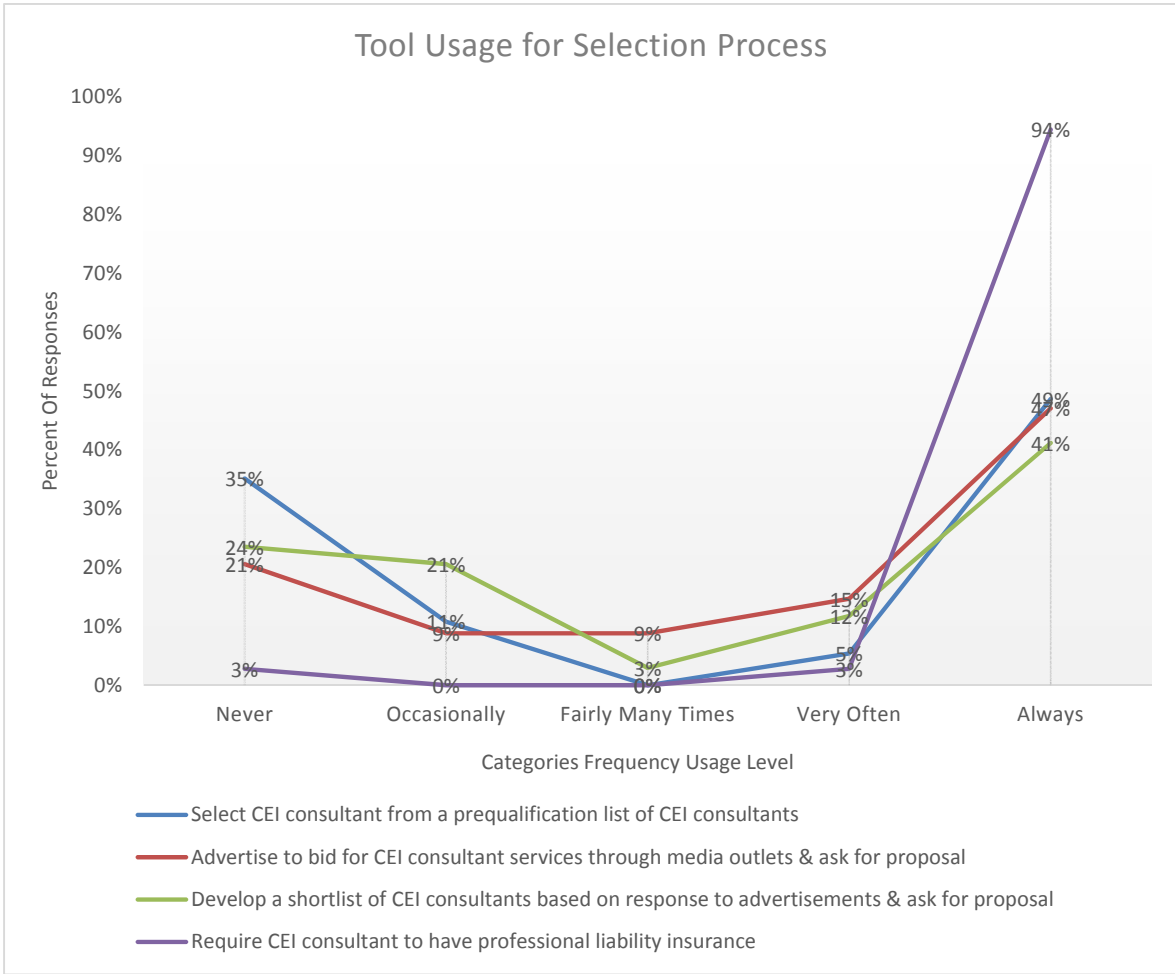
Additionally, Mississippi informed that they issue work orders to the CEI consultants within an On-Call Master Contract List.

**Table 12 Tools use in the selection of CEI consultants - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tool	CEI Tool Frequency Usage Categories					Chi Square	p-value Chi Sq
		Never	Occasionally	Fairly Many Times	Very Often	Always		
Which tools does your agency use in the selection process of CEI consultants?	Select CEI consultant from a prequalification list of CEI consultants	13	4		2	18	18.459	0.0000
	Advertise to bid for CEI consultant services through media outlets & ask for proposal	7	3	3	5	16	17.176	0.0018
	Develop a shortlist of CEI consultants based on response to advertisements & ask for proposal	8	7	1	4	14	13.941	0.0075
	Require CEI consultant to have professional liability insurance	1			1	34	151.000	0.0000
<b>Total</b>		<b>29</b>	<b>14</b>	<b>4</b>	<b>12</b>	<b>82</b>	<b>172.564</b>	<b>0.0000</b>

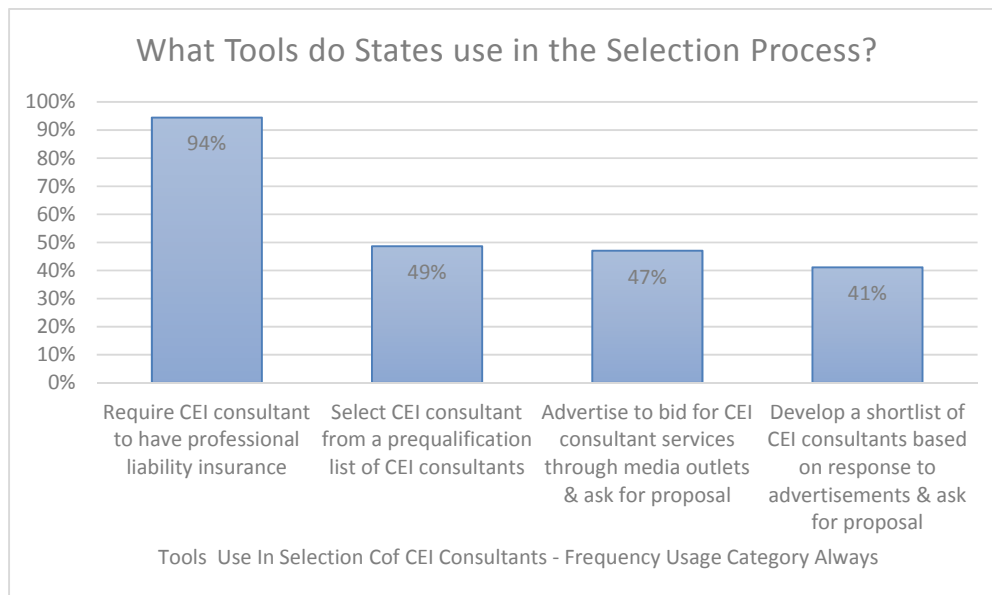
**Table 13 Tools use in the selection of CEI consultants - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tools	CEI Tool Frequency Usage Categories					Sum
		Never	Occasionally	Fairly Many Times	Very Often	Always	
Which tools does your agency use in the selection process of CEI consultants?	Select CEI consultant from a prequalification list of CEI consultants	35%	11%	0%	5%	49%	100%
	Advertise to bid for CEI consultant services through media outlets & ask for proposal	21%	9%	9%	15%	47%	100%
	Develop a shortlist of CEI consultants based on response to advertisements & ask for proposal	24%	21%	3%	12%	41%	100%
	Require CEI consultant to have professional liability insurance	3%	0%	0%	3%	94%	100%



**Figure 14 Tools use in the selection of CEI consultants - Graph of all percentages from all users under each of the CEI tool frequency usage categories**





**Figure 15 Tools use in the selection of CEI consultants - Percentages under CEI tool frequency usage category (Always) from all users**

As shown in figure 17, the tools most used all the time is the preparation of a list of the documentation that the CEI consultant will manage to administer the pre-construction part. The results of the analysis about the tools used to administer the pre-construction part of CEI contracts are as follows:

- All CEI usage level values are statistically different in all the tools (items 1 to 2) included in this question (see table 14).
- The overall values per tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 14.
- As shown below (see table 15, and figures 16 and 17), the tools for the pre-construction part were selected in the following order:
  - The tool of “Require CEI consultant to submit hold harmless agreement” was selected 48% under category 1 “Never”. However, it was selected by 42% under category “Always”.
  - The tools of “Prepare a list of the documentation that the CEI consultant will manage, which will be later used as a closeout checklist” was selected 35%

under category “Never”. However, it was selected by 27% under category “Always”.

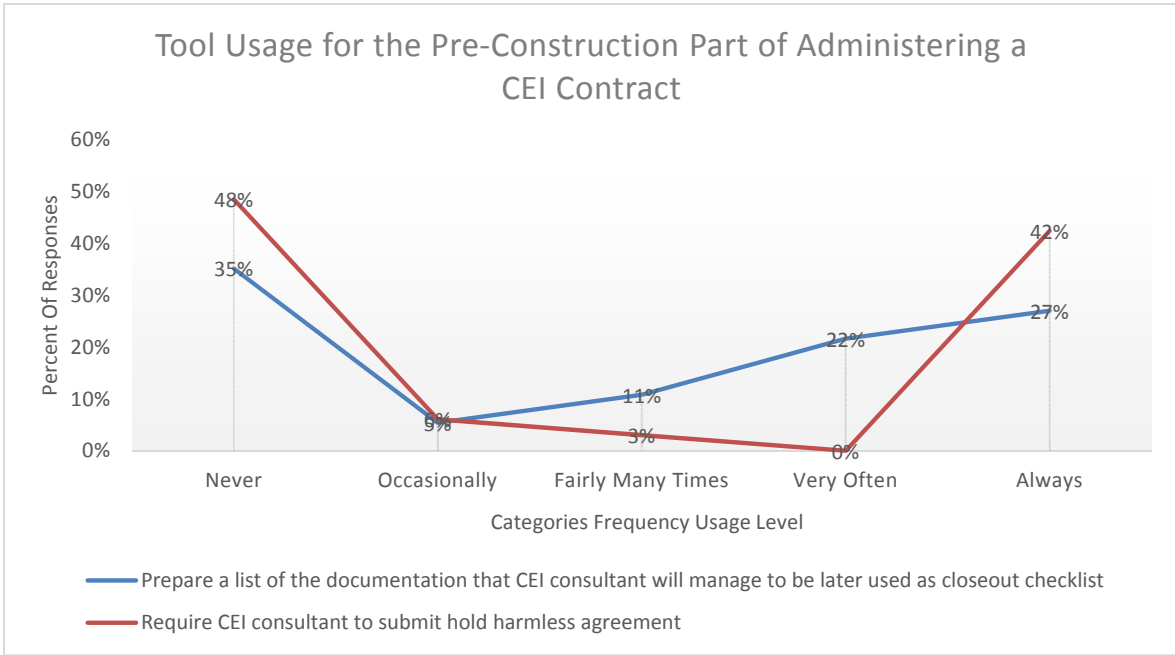
In reference to these tools, Ontario added that the selected CEI consultant would prepare the documentation list. Others like Georgia use tools such as consultant certification, drug-free workplace certification, primary consultant certification, certification of lower-tier (the lowest level participants and all subcontractors resulting from an initial contract), certification regarding debarment, suspension, ineligibility, and voluntary exclusion, among others.

**Table 14 Tools use in the administration of pre-construction - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

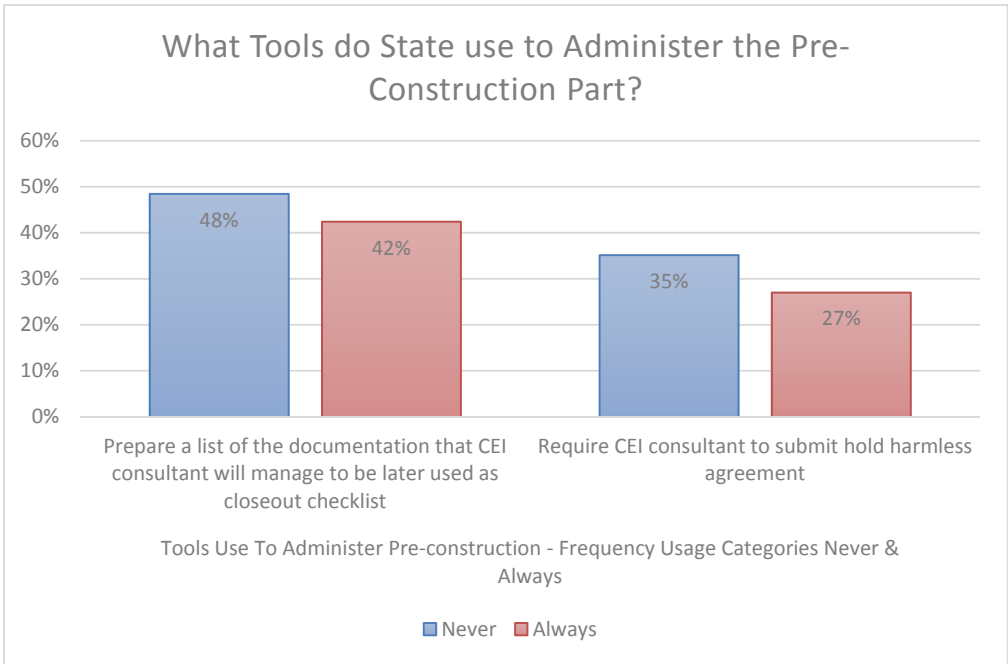
Question	Tool	CEI Tool Frequency Usage Categories					Chi Square	p-value Chi Sq
		Never	Occasionally	Fairly Many Times	Very Often	Always		
Which tools does your agency use in the pre-construction part of the administration of a CEI consultant?	Prepare a list of the documentation that CEI consultant will manage to be later used as closeout checklist	13	2	4	8	10	10.703	0.0301
	Require CEI consultant to submit hold harmless agreement	16	2	1		14	22.394	0.0002
<b>Total</b>		<b>29</b>	<b>4</b>	<b>5</b>	<b>8</b>	<b>24</b>	<b>22.394</b>	<b>0.0002</b>

**Table 15 Tools use in the administration of pre-construction - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tools	CEI Tool Frequency Usage Categories					Sum
		Never	Occasionally	Fairly Many Times	Very Often	Always	
Which tools does your agency use in the pre-construction part of the administration of a CEI consultant?	Prepare a list of the documentation that CEI consultant will manage to be later used as closeout checklist	35%	5%	11%	22%	27%	100%
	Require CEI consultant to submit hold harmless agreement	48%	6%	3%	0%	42%	100%



**Figure 16 Tools use in the administration of pre-construction - Graph of all percentages from all users under each of the CEI tool frequency usage categories**



**Figure 17 Tools use in the administration of pre-construction graph - Percentages under CEI tool frequency usage categories (Never) and (Always) from all users**

As shown in figure 19, the tool most used all the time is to internally review and approve changes to the CEI consultant’s scope of work in the administration of the contract clarification and

modification part. The results of the analysis about the tools used to administer the contract clarification and modification part of CEI contracts are as follows:

- The CEI usage level of the “Verification that CEI consultant is appropriately managing modifications to the contract” tool, and the “Adjust fixed fee of CEI consultant’s contract” tool are not statistically significantly different (see table 16).
- The CEI usage level values of the remaining tools (items 1, 3, and 4) are statistically different (see table 16).
- The overall values per tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 16.
- As shown below (see table 17, and figures 18 and 19), the tools for the contract clarification part were selected in the following order:
  - The tool of “Internally review and approve changes to CEI consultant’s scope of work” was selected 61% under category “Always”.
  - The tool of “Maintain a record of all changes to CEI consultant’s scope of work” was selected 55% under category “Always”.
  - The tool of “Verify that CEI consultant is responding to construction contractor’s request for assistance” was selected 41% under category “Very Often”.
  - The tool of “Adjust fixed fee of CEI consultant’s contract” was selected 31% under category “Never” and category “Always. However, the level of usage of this tool is not statistically different. Thus, the responses from participants do not allow the determination of the level of usage for this tool.
  - The tool of “Verification that CEI consultant is appropriately managing modifications to the contract” was selected 24% under categories “Fairly Many Times” and “Always”. However, the level of usage of this tool is not

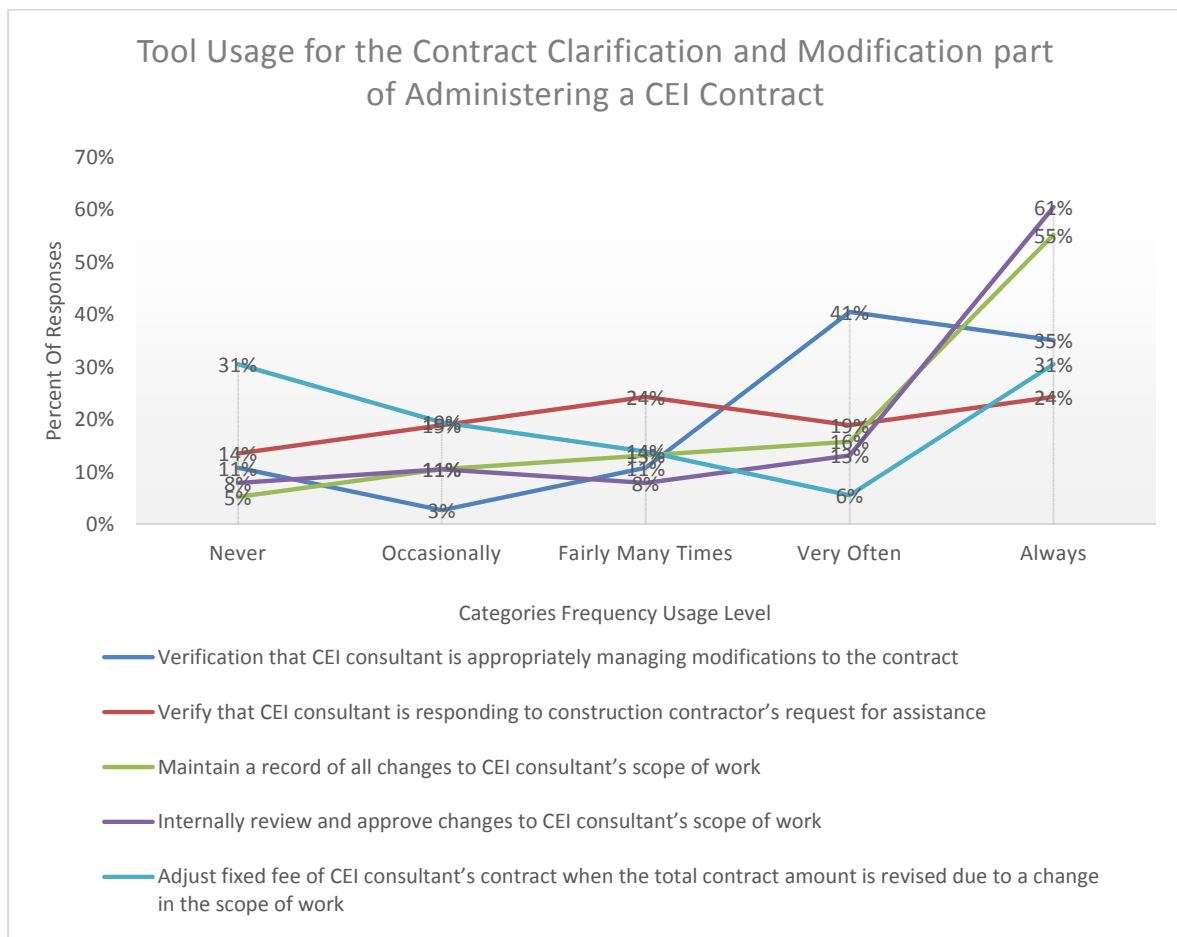
statistically different. Thus, the responses from participants do not allow the determination of the level of usage for this tool.

**Table 16 Tools use in the administration of contract clarification and modification - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

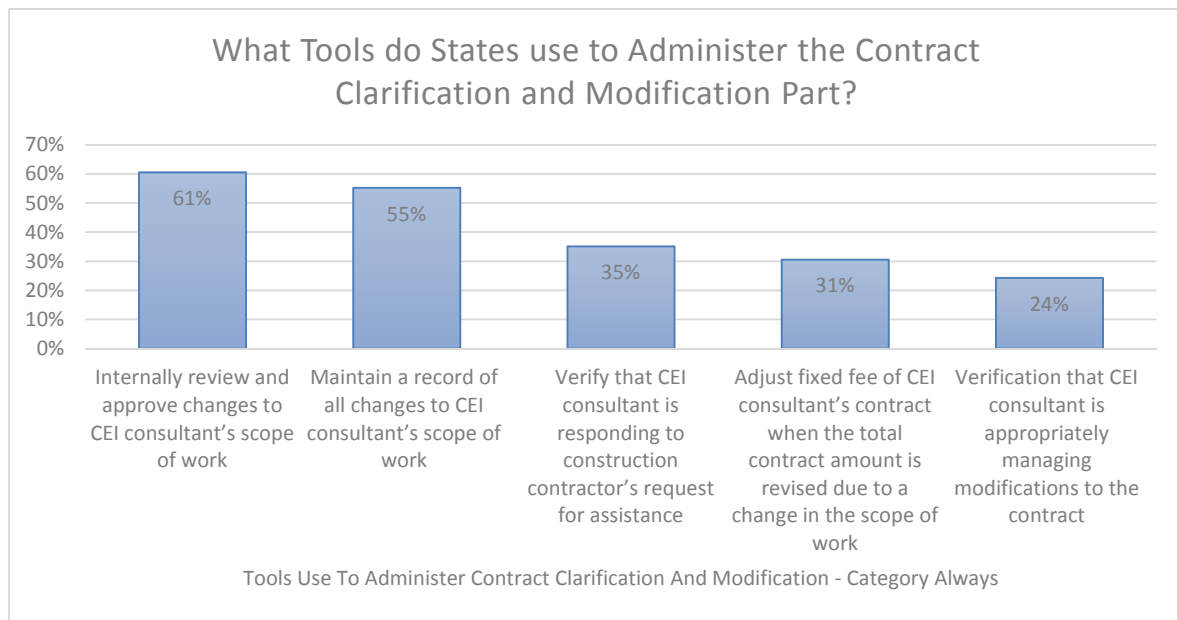
Question	Tool	CEI Tool Frequency Usage Categories					Chi Square	p-value Chi Sq
		Never	Occasionally	Fairly Many Times	Very Often	Always		
Which tools does your agency use in the contract clarification and modification part of the administration of a CEI consultant contract?	Verification that CEI consultant is appropriately managing modifications to the contract	4	1	4	15	13	20.703	0.0004
	Verify that CEI consultant is responding to construction contractor's request for assistance	5	7	9	7	9	1.514	0.8242
	Maintain a record of all changes to CEI consultant's scope of work	2	4	5	6	21	30.684	0.0000
	Internally review and approve changes to CEI consultant's scope of work	3	4	3	5	23	39.368	0.0000
	Adjust fixed fee of CEI consultant's contract when the total contract amount is revised due to a change in the scope of work	11	7	5	2	11	8.444	0.0766
<b>Total</b>		<b>25</b>	<b>23</b>	<b>26</b>	<b>35</b>	<b>77</b>	<b>55.505</b>	<b>0.0000</b>

**Table 17 Tools use in the administration of contract clarification and modification - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tools	CEI Tool Frequency Usage Categories					Sum
		Never	Occasionally	Fairly Many Times	Very Often	Always	
Which tools does your agency use in the contract clarification and modification part of the administration of a CEI consultant contract?	Verification that CEI consultant is appropriately managing modifications to the contract	11%	3%	11%	41%	35%	100%
	Verify that CEI consultant is responding to construction contractor's request for assistance	14%	19%	24%	19%	24%	100%
	Maintain a record of all changes to CEI consultant's scope of work	5%	11%	13%	16%	55%	100%
	Internally review and approve changes to CEI consultant's scope of work	8%	11%	8%	13%	61%	100%
	Adjust fixed fee of CEI consultant's contract when the total contract amount is revised due to a change in the scope of work	31%	19%	14%	6%	31%	100%



**Figure 18 Tools use in the administration of contract clarification and modification - Graph of all percentages from all users under each of the CEI tool frequency usage categories**



**Figure 19 Tools use in the administration of contract clarification and modification - Percentages under CEI tool frequency usage category (Always) from all users**

As shown in the figure 21, the tools most used always in the administration of the work execution part is to verify that CEI consultants complies with the terms and conditions of its contract. The results of the analysis about the tools used to administer the work execution part of CEI contracts are as follows:

- The CEI usage level value is statistically different under this question (see table 18).
- As shown below (see table 19, and figures 20 and 21), the tools for the work execution part was selected as follows:
  - The tools of “Verify that CEI consultant complies with terms and conditions of its contract” was selected 62% under category “Always”.

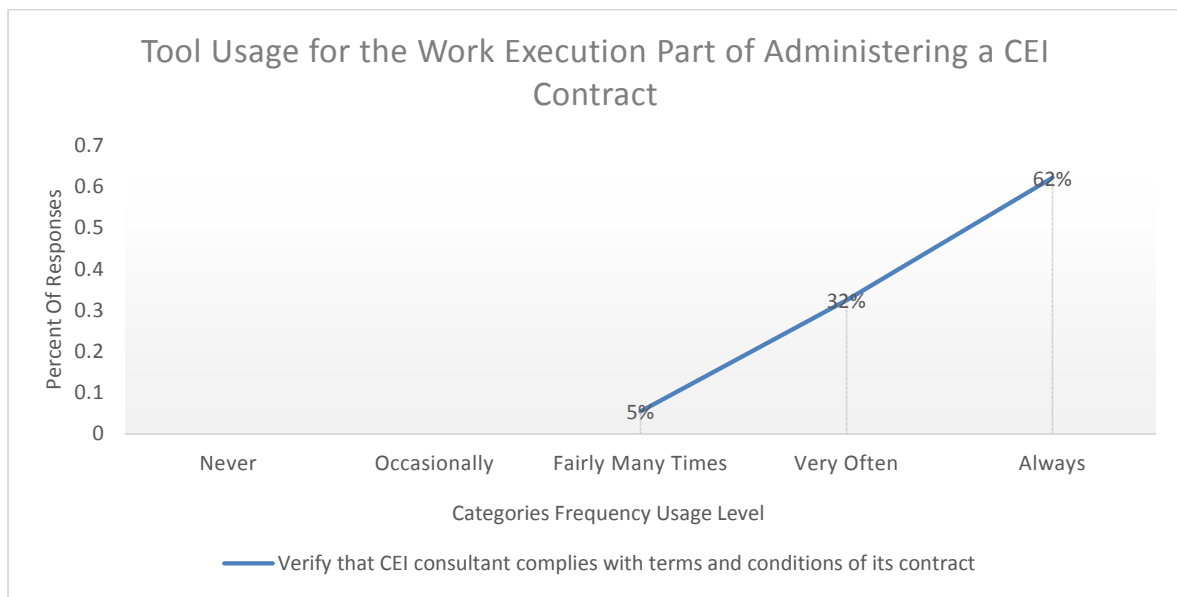
In addition to using the tool under this question, Ontario indicated that monthly audit reports are used to administer the work execution part of the CEI contract.

**Table 18 Tools use to administer the work execution - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tool	CEI Tool Frequency Usage Categories					Chi Square	p-value Chi Sq
		Never	Occasionally	Fairly Many Times	Very Often	Always		
Which tools does your agency use in the work execution part of the administration of a CEI consultant contract?	Verify that CEI consultant complies with terms and conditions of its contract			2	12	23	17.892	0.0000

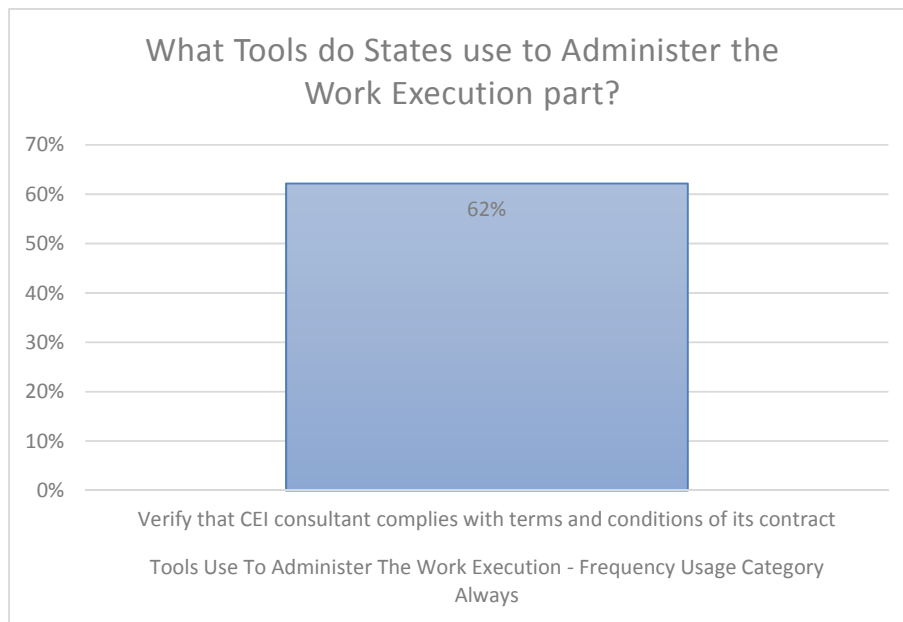
**Table 19 Tools use to administer the work execution -Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tools	CEI Tool Frequency Usage Categories				
		Never	Occasionally	Fairly Many Times	Very Often	Always
Which tools does your agency use in the work execution part of the administration of a CEI consultant contract?	Verify that CEI consultant complies with terms and conditions of its contract			5%	32%	62%



**Figure 20 Tools use to administer the work execution - Graph of all percentages from all users under each of the CEI tool frequency usage categories**





**Figure 21 Tools use to administer the work execution - Percentages under CEI tool frequency usage category (Always) from all users**

As shown in figure 23, the tool most used always in the administration of payment part is to require monthly applications for payment. The results of the analysis about the tools used to administer the payment part of CEI contracts are as follows:

- All CEI usage level values are statistically different among all tools (items 1 to 3) under this question (see table 20).
- The overall values per tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 20.
- As shown below (see table 21, and figures 22 and 23), the tools for the payment part were selected in the following order:
  - The tools of “Require monthly applications for payment from CEI consultant” was selected 76% under category “Always”.
  - The tool of “Hold payment from CEI consultant if project is behind schedule” was selected 81% under category “Never”.
  - The tool of “Retain amount (retainage) from CEI consultant’s applications for payment” was selected 77% under category “Never”.

In addition to these tools, Mississippi indicated that they use a Labor Rate Schedule for payment. Georgia added that consultants are paid based on a monthly invoice for hourly services rendered.

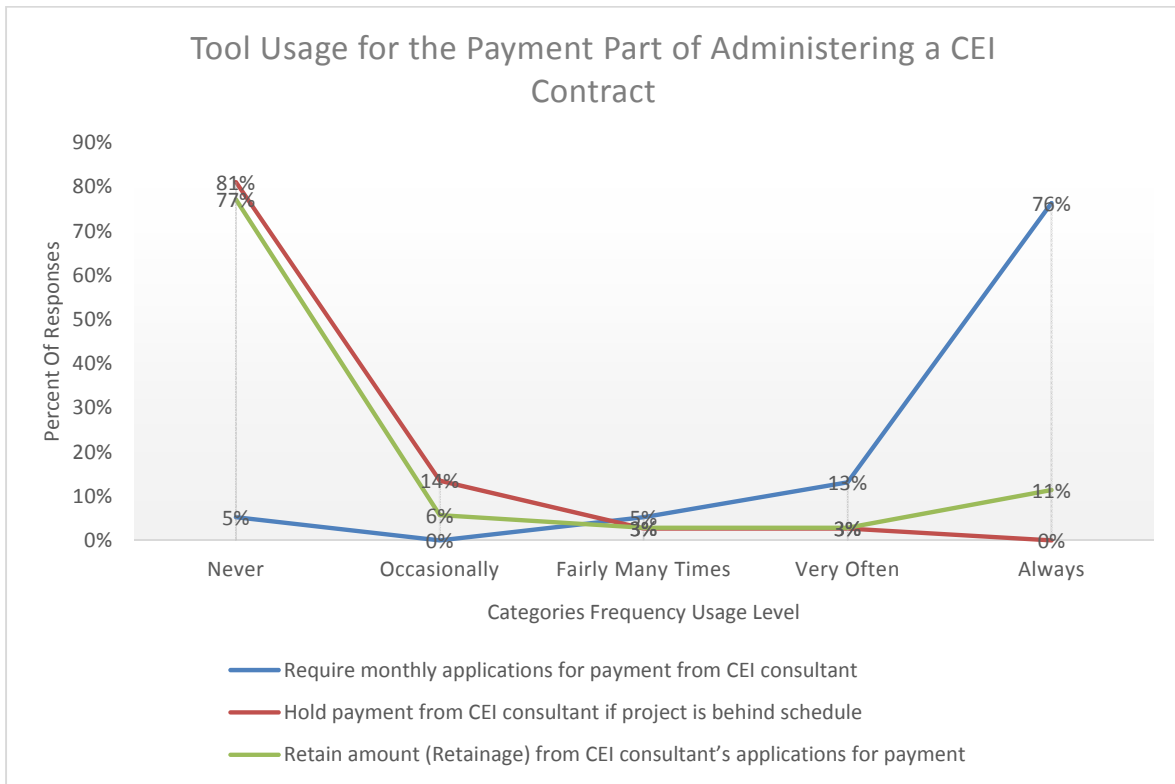
Furthermore, Witheford (1999) had reported that the use of retainage was declining. In his research, Witheford (1999) presented the results on the use of retainage to be 80% (1990s AASHTO survey) and 67% in his survey. On this research, the use of retainage has declined to 11%. Hence, the use of retainage as tool to administer the payment part of a CEI contract is keeping with the declining trend stated by Witheford (1999).

**Table 20 Tools use to administer the payment part - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

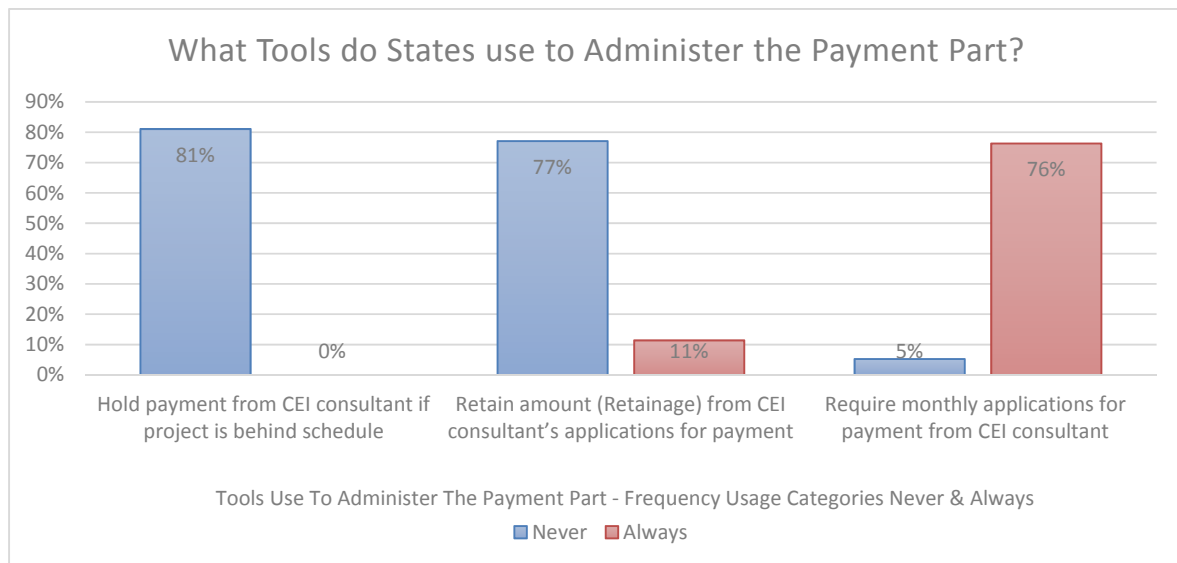
Question	Tool	CEI Tool Frequency Usage Categories					Chi Square	p-value Chi Sq
		Never	Occasionally	Fairly Many Times	Very Often	Always		
Which tools does your agency use in the payment part of a administration of a CEI contract?	Require monthly applications for payment from CEI consultant	2		2	5	29	54.000	0.0000
	Hold payment from CEI consultant if project is behind schedule	30	5	1	1		88.270	0.0000
	Retain amount (Retainage) from CEI consultant's applications for payment	27	2	1	1	4	72.286	0.0000
<b>Total</b>		<b>59</b>	<b>7</b>	<b>4</b>	<b>7</b>	<b>33</b>	<b>102.909</b>	<b>0.0000</b>

**Table 21 Tools use to administer the payment part - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tools	CEI Tool Frequency Usage Categories					Sum
		Never	Occasionally	Fairly Many Times	Very Often	Always	
Which tools does your agency use in the payment part of a administration of a CEI contract?	Require monthly applications for payment from CEI consultant	5%	0%	5%	13%	76%	100%
	Hold payment from CEI consultant if project is behind schedule	81%	14%	3%	3%	0%	100%
	Retain amount (Retainage) from CEI consultant's applications for payment	77%	6%	3%	3%	11%	100%



**Figure 22 Tools use to administer the payment part - Graph of all percentages from all users under each of the CEI tool frequency usage categories**



**Figure 23 Tools use to administer the payment part - Percentages under CEI tool frequency usage categories (Never & Always) from all users**

As shown in figure 25, the tool most and always used in the administration of the monitoring and inspecting part is to verify that the CEI consultant adequately reviews construction contractor’s applications for payment. The results of the analysis about the tools used to administer the monitoring and inspection part of CEI contracts are as follows:

- The CEI usage level of the “Perform intermediate evaluations of CEI consultant’s performance” tool is not statistically significantly different (see table 22).
- All CEI usage level values of the remaining tools (items 1 to 2) are statistically different (see table 22).
- The overall values per tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 22.
- As shown below (see table 23, and figures 24 and 25), the tools for the monitoring and inspection part were selected in the following order:
  - The tools of “Verification that CEI consultant adequately reviews construction contractor’s applications for payment” was selected 46% under category “Always”.

- The tool of “Require CEI consultants to submit progress report” was selected 43% “Always”.
- The tool of “Perform intermediate evaluations of CEI consultant’s performance” was selected 32% under category “Fairly Many Times”. However, the level of usage of this tool is not statistically different. Thus, the responses from participants do not allow the determination of the level of usage for this tool.

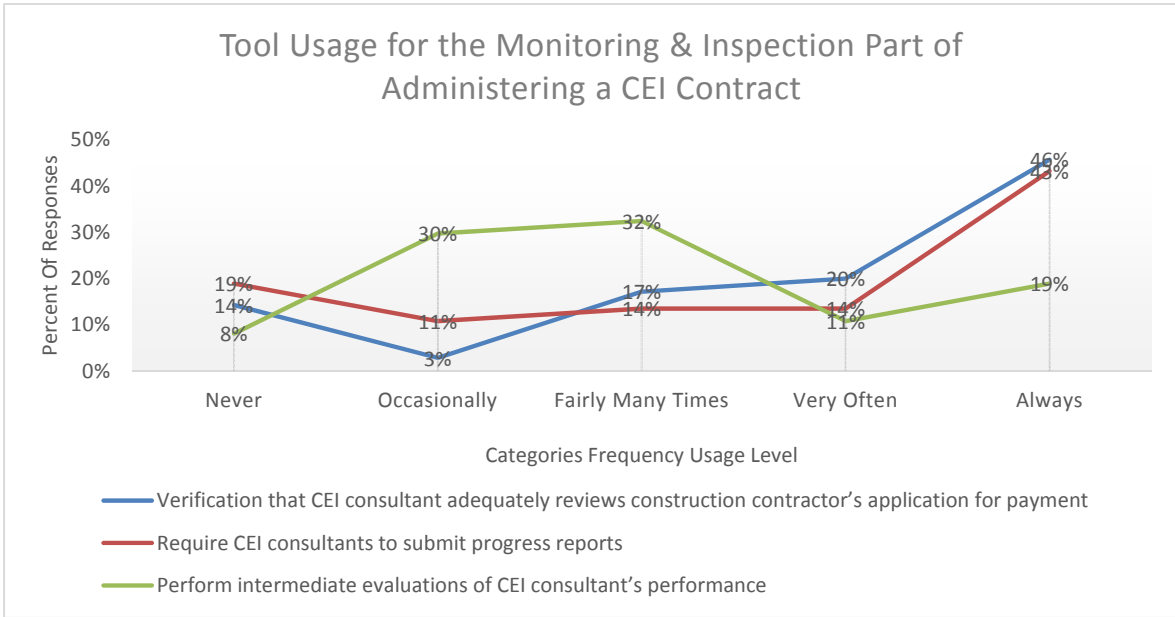
Other states such as Rhode Island indicated that their CEI consultants never fully manage projects and always work with the State Resident Engineer. Mississippi requires a final performance evaluation of the CEI consultant. Similarly, Indiana stated that they review their CEI consultants at the end of the contract.

**Table 22 Tools use to administer the monitoring and inspection part - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

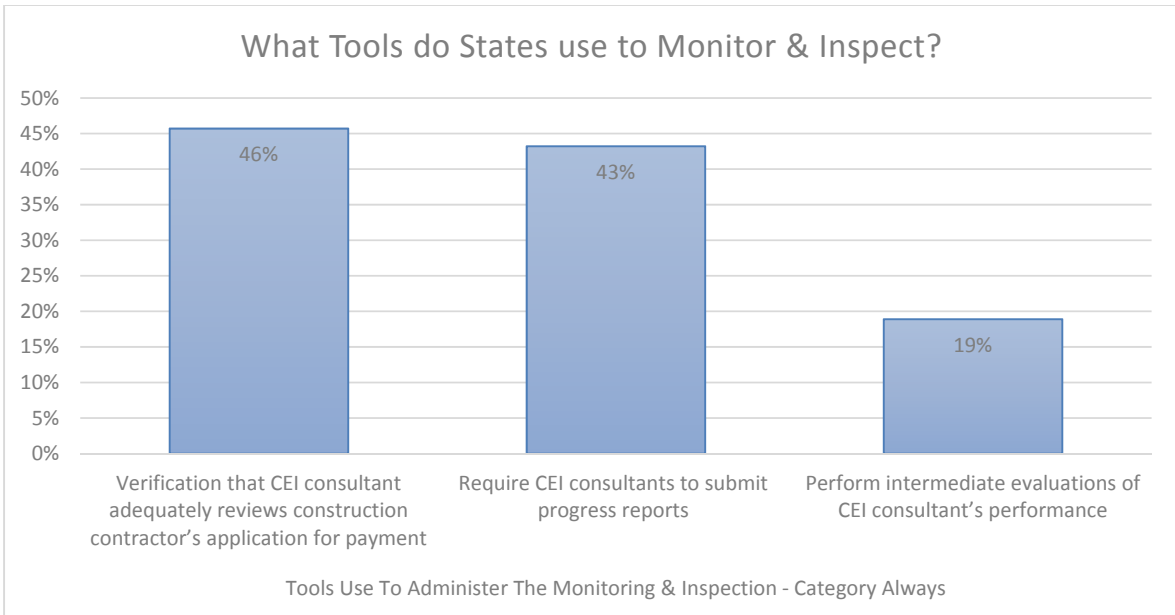
Question	Tool	CEI Tool Frequency Usage Categories					Chi Square	p-value Chi Sq
		Never	Occasionally	Fairly Many Times	Very Often	Always		
Which tools does your agency use in the monitoring and inspection part of the administration of a CEI consultant contract?	Verification that CEI consultant adequately reviews construction contractor’s application for payment	5	1	6	7	16	17.429	0.0016
	Require CEI consultants to submit progress reports	7	4	5	5	16	13.135	0.0106
	Perform intermediate evaluations of CEI consultant’s performance	3	11	12	4	7	8.811	0.0660
<b>Total</b>		<b>15</b>	<b>16</b>	<b>23</b>	<b>16</b>	<b>39</b>	<b>18.844</b>	<b>0.0008</b>

**Table 23 Tools use to administer the monitoring and inspection part - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tools	CEI Tool Frequency Usage Categories					Sum
		Never	Occasionally	Fairly Many Times	Very Often	Always	
Which tools does your agency use in the monitoring and inspection part of the administration of a CEI consultant contract?	Verification that CEI consultant adequately reviews construction contractor’s application for payment	14%	3%	17%	20%	46%	100%
	Require CEI consultants to submit progress reports	19%	11%	14%	14%	43%	100%
	Perform intermediate evaluations of CEI consultant’s performance	8%	30%	32%	11%	19%	100%



**Figure 24 Tools use to administer the monitoring and inspection part - Graph of all percentages from all users under each of the CEI tool frequency usage categories**



**Figure 25 Tools use to administer the monitoring and inspection part - Percentages under CEI tool frequency usage category (Always) from all users**

As shown in figure 27, the tool most used in the administration of the human resource area is to provide training to DOT staff in CEI consultant management occasionally. The results of the analysis about the tools used to administer the human resources area of CEI contracts are as follows:

- The CEI usage level of the “Provide CEI consultant access to DOT’s internal information system” tool, and “Require DOT project manager to get acquainted with the roles and skills of selected CEI consultant” are not statistically significantly different (see table 24).
- All CEI usage level values of the remaining tools (items 1 and 3) are statistically different (see table 24).
- The overall values per tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 24.
- As shown below (see table 25, and figures 26 and 27), the tools for the human resource area were selected in the following order:
  - The tools of “Provide training to DOT staff in CEI consultant management” was selected 55% under category “Occasionally”.
  - The tool of “Provide training to CEI consultant on DOT’s processes and procedures” was selected 34% under category “Very Often”.
  - The tool of “Provide CEI consultant access to DOT’s internal information system” was selected 29% under category “Very Often”. However, the level of usage of this tool is not statistically different. Thus, the responses from participants do not allow the determination of the level of usage for this tool.
  - The tool of “Require DOT project manager to get acquainted with the roles and skills of selected CEI consultant” was selected 26% under category “Very Often”. However, the level of usage of this tool is not statistically different. Thus, the responses from participants do not allow the determination of the level of usage for this tool.

Additionally, Georgia informed that they communicate with the Consultant Liaison concerning the performance of inspectors.

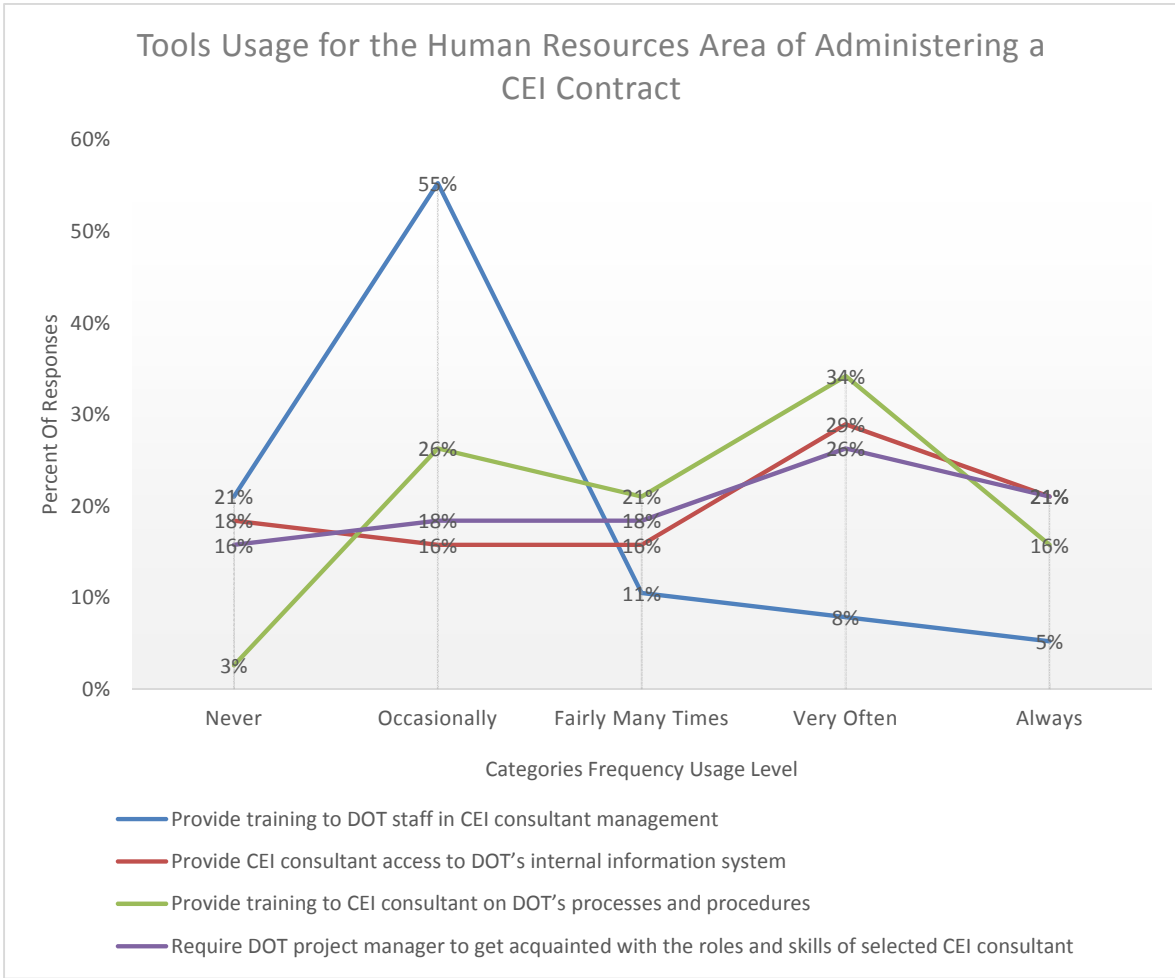
**Table 24 Tools use to administer the human resource area - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tool	CEI Tool Frequency Usage Categories					Chi Square	p-value Chi Sq
		Never	Occasionally	Fairly Many Times	Very Often	Always		
Which tools does your agency use in the human resource area of the administration of a CEI consultant contract?	Provide training to DOT staff in CEI consultant management	8	21	4	3	2	32.263	0.0000
	Provide CEI consultant access to DOT's internal information system	7	6	6	11	8	2.263	0.6875
	Provide training to CEI consultant on DOT's processes and procedures	1	10	8	13	6	10.684	0.0304
	Require DOT project manager to get acquainted with the roles and skills of selected CEI consultant	6	7	7	10	8	1.211	0.8764
<b>Total</b>		<b>22</b>	<b>44</b>	<b>25</b>	<b>37</b>	<b>24</b>	<b>12.145</b>	<b>0.0163</b>

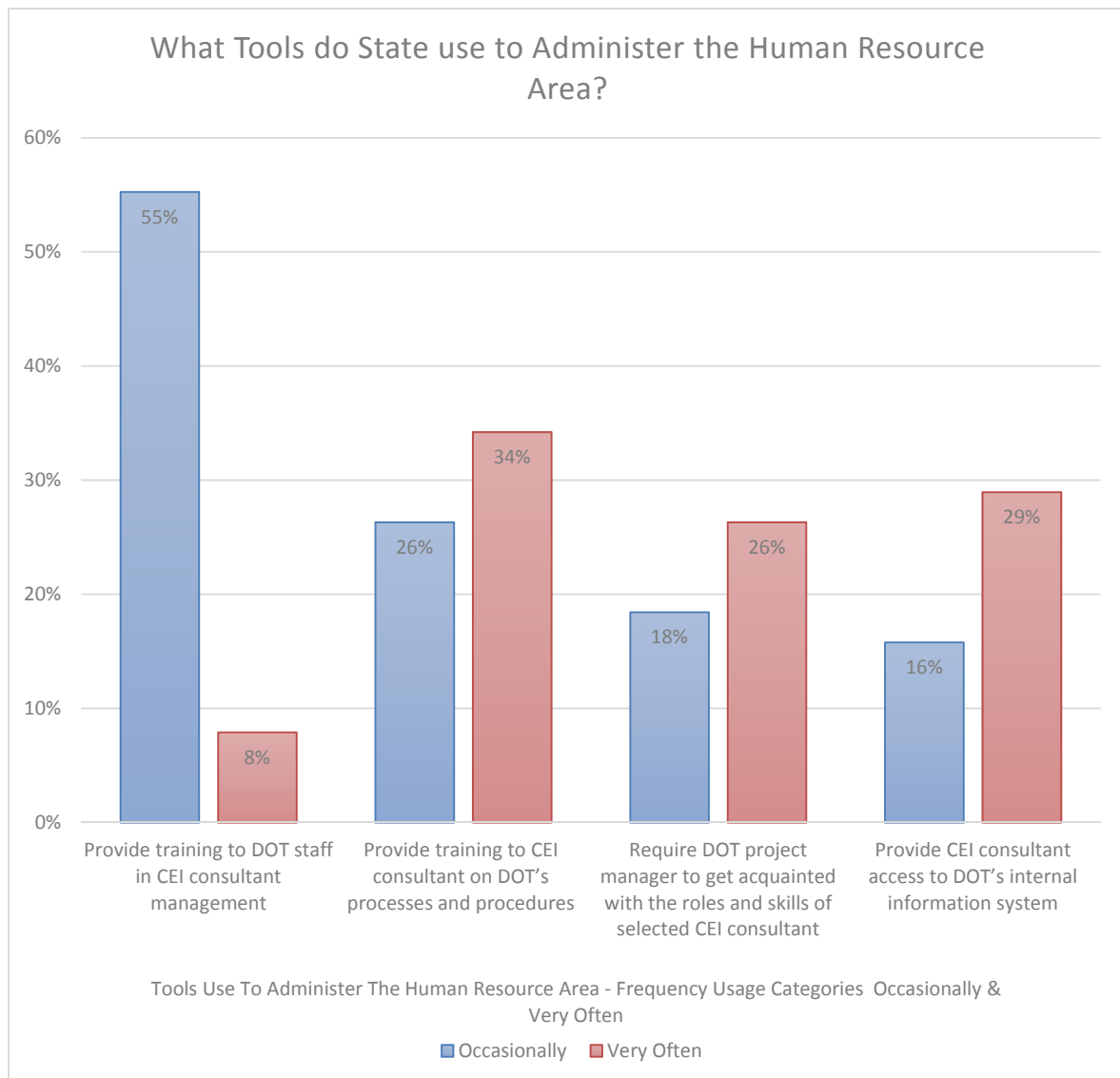
**Table 25 Tools use to administer the human resource area - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tool	CEI Tool Frequency Usage Categories					Sum
		Never	Occasionally	Fairly Many Times	Very Often	Always	
Which tools does your agency use in the human resource area of the administration of a CEI consultant contract?	Provide training to DOT staff in CEI consultant management	21%	55%	11%	8%	5%	100%
	Provide CEI consultant access to DOT's internal information system	18%	16%	16%	29%	21%	100%
	Provide training to CEI consultant on DOT's processes and procedures	3%	26%	21%	34%	16%	100%
	Require DOT project manager to get acquainted with the roles and skills of selected CEI consultant	16%	18%	18%	26%	21%	100%





**Figure 26 Tools use to administer the human resource area - Graph of all percentages from all users under each of the CEI tool frequency usage categories**



**Figure 27 Tools use to administer the human resource area - Percentages under CEI tool frequency usage categories (Occasionally & Very often) from all users**

As shown in figure 29, the tool most and always used in the administration of the closeout process is to verify that CEI consultant delivered all project documentation and records. The results of the analysis about the tools used to administer the closeout process of CEI contracts are as follows:

- All CEI usage level values are statistically different among all tools (items 1 to 7) included in this question (see table 26).
- The overall values per tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 26.

- As shown below (see table 27, and figures 28 and 29), the tools for the closeout process were selected in the following order:
  - The tool of “Verify that CEI consultant delivered all project documentation and records” was selected 78% under category “Always”.
  - The tools of “Verify that all work assigned to CEI consultant is complete” was selected 70% under category “Always”.
  - The tool of “Share final evaluation with CEI consultant” was selected 57% under category “Always”. In addition, it was selected 19% under category “Very Often”.
  - The tool of “Perform final performance evaluation of CEI consultant” was selected 57% under category “Always”. In addition, it was selected 14% under category “Very Often”.
  - The tool of “Verify CEI consultant used proper accounting methods to record costs” was selected 53% under category “Always”.
  - The tool of “Verify consistency of CEI consultant’s contract costs” was selected 43% under category “Always”.
  - The tool of “Release retained amount from CEI consultant’s contract” was selected 53% under category “Never”.

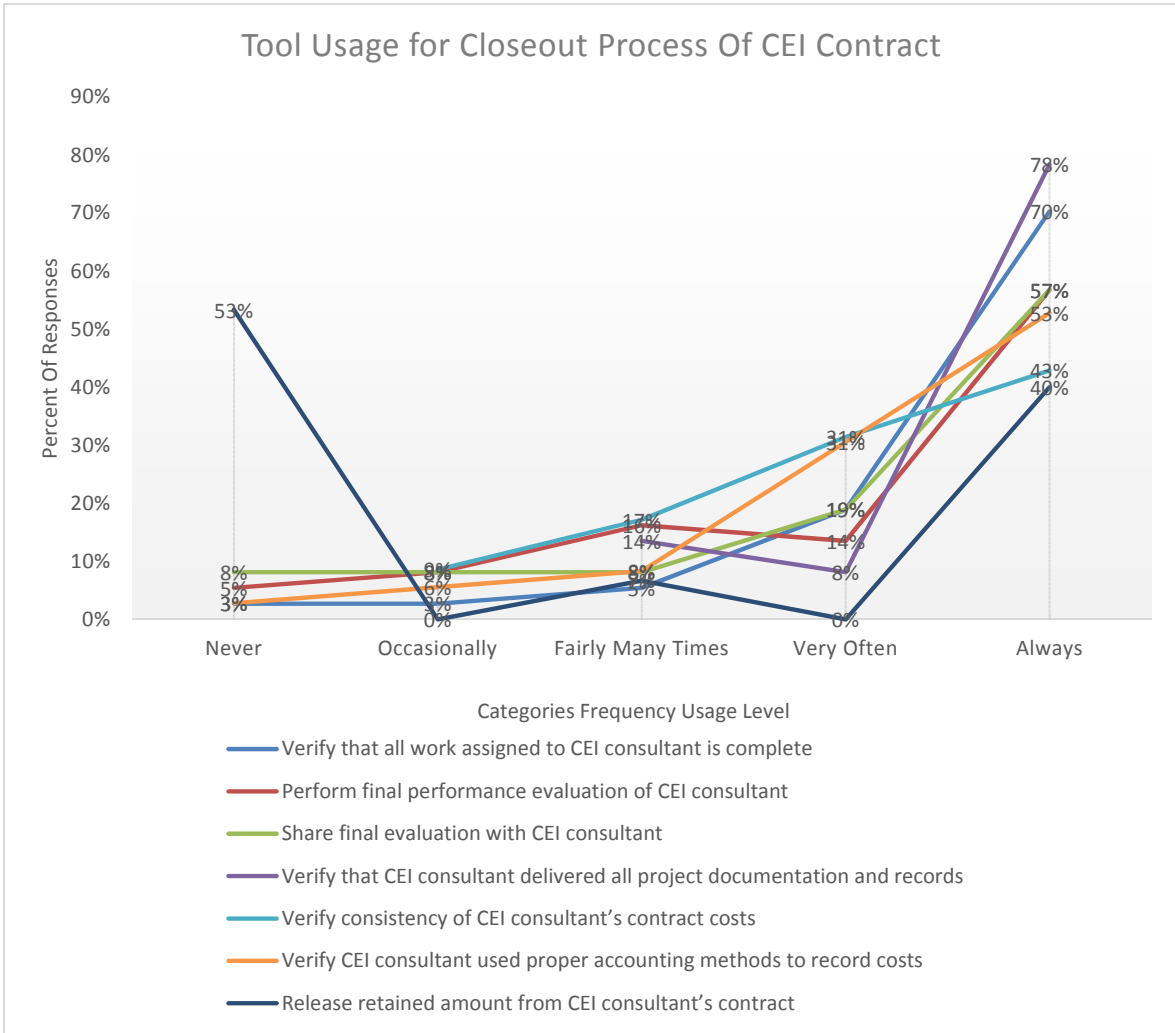
Also, Ontario indicated that contract payment and record assessment reviews are performed on 10% of assignments.

**Table 26 Tools used to administer the closeout process - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

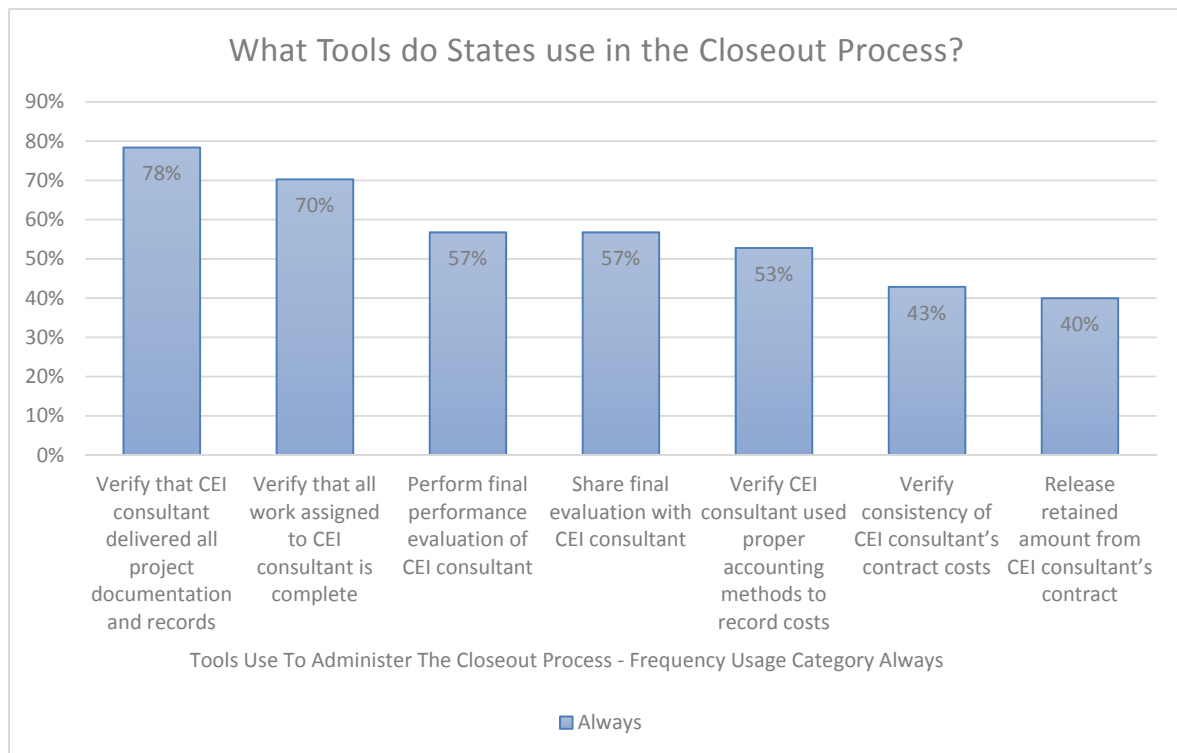
Question	Tool	CEI Tool Frequency Usage Categories					Chi Square	p-value Chi Sq
		Never	Occasionally	Fairly Many Times	Very Often	Always		
Which tools does your agency use in the closeout process of the CEI consultant contract?	Verify that all work assigned to CEI consultant is complete	1	1	2	7	26	61.784	0.0000
	Perform final performance evaluation of CEI consultant	2	3	6	5	21	32.595	0.0000
	Share final evaluation with CEI consultant	3	3	3	7	21	32.865	0.0000
	Verify that CEI consultant delivered all project documentation and records			5	3	29	33.946	0.0000
	Verify consistency of CEI consultant's contract costs		3	6	11	15	9.686	0.0210
	Verify CEI consultant used proper accounting methods to record costs	1	2	3	11	19	32.889	0.0000
	Release retained amount from CEI consultant's contract	16		2		12	37.333	0.0000
<b>Total</b>		<b>23</b>	<b>12</b>	<b>27</b>	<b>44</b>	<b>143</b>	<b>228.651</b>	<b>0.0000</b>

**Table 27 Tools used to administer the closeout process - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tool	CEI Tool Frequency Usage Categories					Sum
		Never	Occasionally	Fairly Many Times	Very Often	Always	
Which tools does your agency use in the closeout process of the CEI consultant contract?	Verify that all work assigned to CEI consultant is complete	3%	3%	5%	19%	70%	100%
	Perform final performance evaluation of CEI consultant	5%	8%	16%	14%	57%	100%
	Share final evaluation with CEI consultant	8%	8%	8%	19%	57%	100%
	Verify that CEI consultant delivered all project documentation and records			14%	8%	78%	100%
	Verify consistency of CEI consultant's contract costs		9%	17%	31%	43%	100%
	Verify CEI consultant used proper accounting methods to record costs	3%	6%	8%	31%	53%	100%
	Release retained amount from CEI consultant's contract	53%	0%	7%	0%	40%	100%



**Figure 28 Tools used to administer the closeout process - Graph of all percentages from all users under each of the CEI tool frequency usage categories**



**Figure 29 Tools used to administer the closeout process - Percentages under CEI tool frequency usage category (Always) from all users**

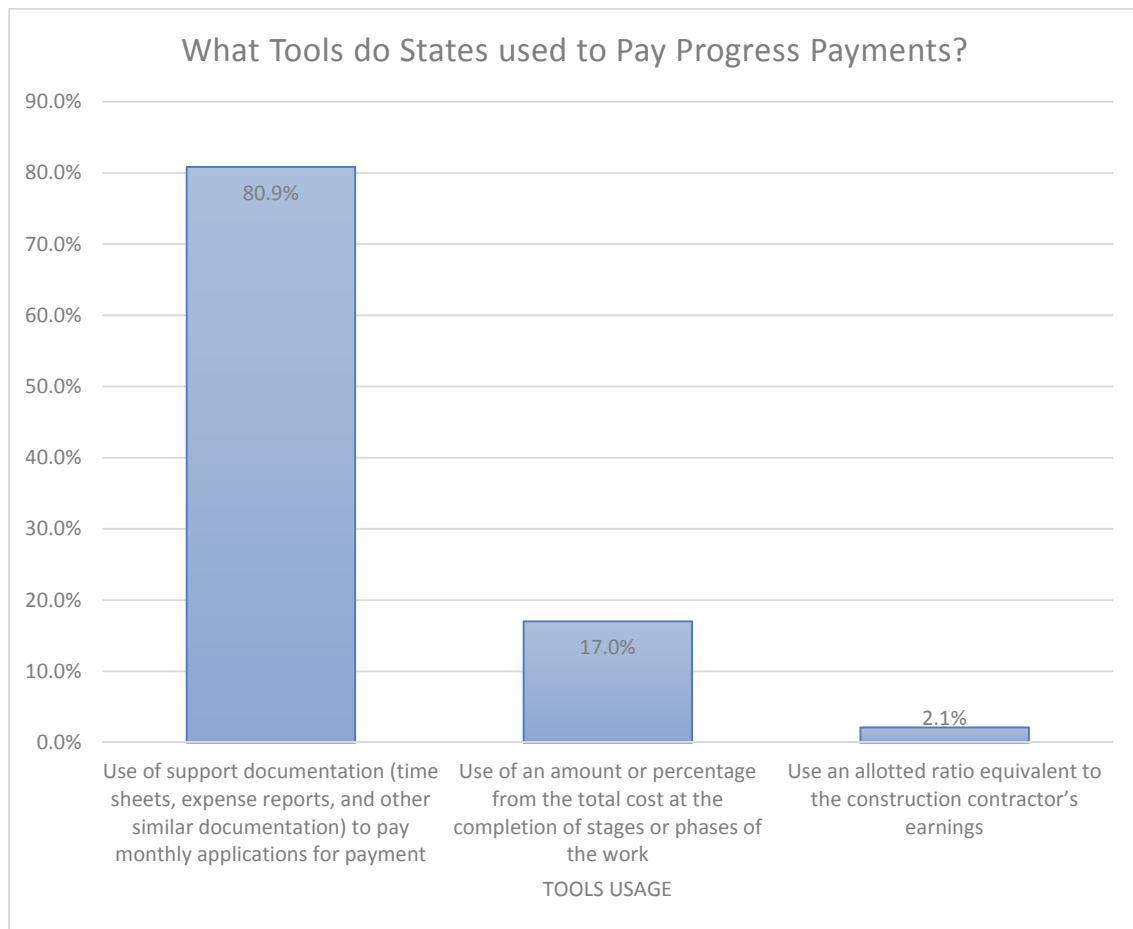
As shown in figure 30, the tool most used to pay progress payments is support documentation. The results of the analysis about the tools used to pay progress payments to CEI consultants indicate that the CEI usage values under the frequency columns are statistically different (p-value = 0.000\* in appendix). As shown (see table 28, and figure 30), the tools were selected in the following order:

- The “Use of support documentation (time sheets, expense reports, and other similar documentation) to pay monthly applications for payment” tool was selected 80.9%;
- The “Use of an amount or percentage from the total cost at the completion of stages or phases of the work” tool was selected 17%; and
- The “Use an allotted ratio equivalent to the construction contractor’s earnings” was selected 2.1%.

Additionally, Ontario indicated that another method to pay progress payment is to divide the lump sum price over the months of the contract.

**Table 28 Tools used to pay progress payments - Frequency and relative frequency values**

Item No.	Method to Pay Progress Payments	Frequency	Relative Frequency [%]
1	Use of support documentation (time sheets, expense reports, and other similar documentation) to pay monthly applications for payment	38	80.9%
2	Use of an amount or percentage from the total cost at the completion of stages or phases of the work	8	17.0%
3	Use an allotted ratio equivalent to the construction contractor's earnings	1	2.1%
<b>Total</b>		47	100.0%



**Figure 30 Tools used to pay progress payments - Relative frequency distribution graph**

As shown in figure 31, the type of insurance most required for CEI consultants is general liability. The results of the analysis about the types of insurance required from CEI consultants indicate that the CEI usage values under the frequency columns are not statistically different (p-value = 0.218

in appendix). This means that agencies are requiring “Errors and omissions insurance” much in the same way as they are requiring “General liability insurance” for CEI consultants. The responses reflect that “General liability insurance” might be used a bit more. As shown (see table 29, and figure 31), the tools were selected in the following order:

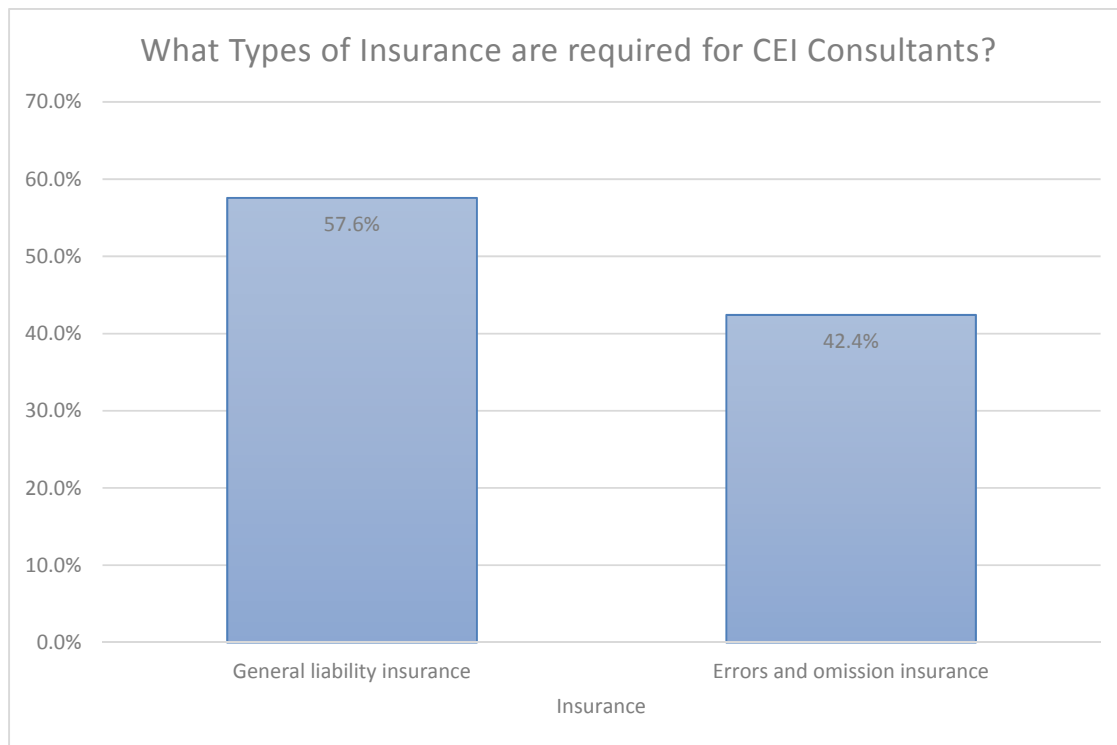
- The “General liability insurance” tool was selected 57.6%; and
- The “Errors and omission insurance” tool was selected 42.4%.

In addition, other states such as Ontario required automobile insurance. New York State Bridge Authority also requires owner’s protective insurance. New Jersey requires automobile insurance too. Lastly, Idaho also requires worker’s compensation insurance.

**Table 29 Types of insurance required from CEI consultants - Frequency and relative frequency values**

<b>Item No.</b>	<b>Types of Insurance required of CEI consultants</b>	<b>Frequency</b>	<b>Relative Frequency [%]</b>
1	General liability insurance	38	57.6%
2	Errors and omission insurance	28	42.4%
<b>Total</b>		66	100.0%





**Figure 31 Types of insurance required from CEI consultants - Relative frequency distribution graph**

As shown in figure 33, bi-weekly meetings are the meetings most executed on an occasional basis. The results of the analysis about the frequency of performing meetings with CEI consultants are as follows:

- The CEI usage level value of the “Monthly meetings” is not statistically significantly different (see table 30).
- All CEI usage level values (items 1, 3, and 4) are statistically different among all the tools under this question (see table 30).
- The overall values per tool frequency usage category (refer to columns) are statistically different as shown in the total row of table 30.
- As shown below (see table 31, and figures 32 and 33), the frequency for execution of meetings was selected in the following order:
  - The frequency of “Bi-weekly meetings” was selected 55% under category “Occasionally”.
  - The frequency of “Weekly meetings” was selected 45% under category “Occasionally”.

- The frequency of “Between major milestones” was selected 38% under category “Very Often”.
- The frequency of “Monthly meetings” was selected 34% under category “Occasionally”.

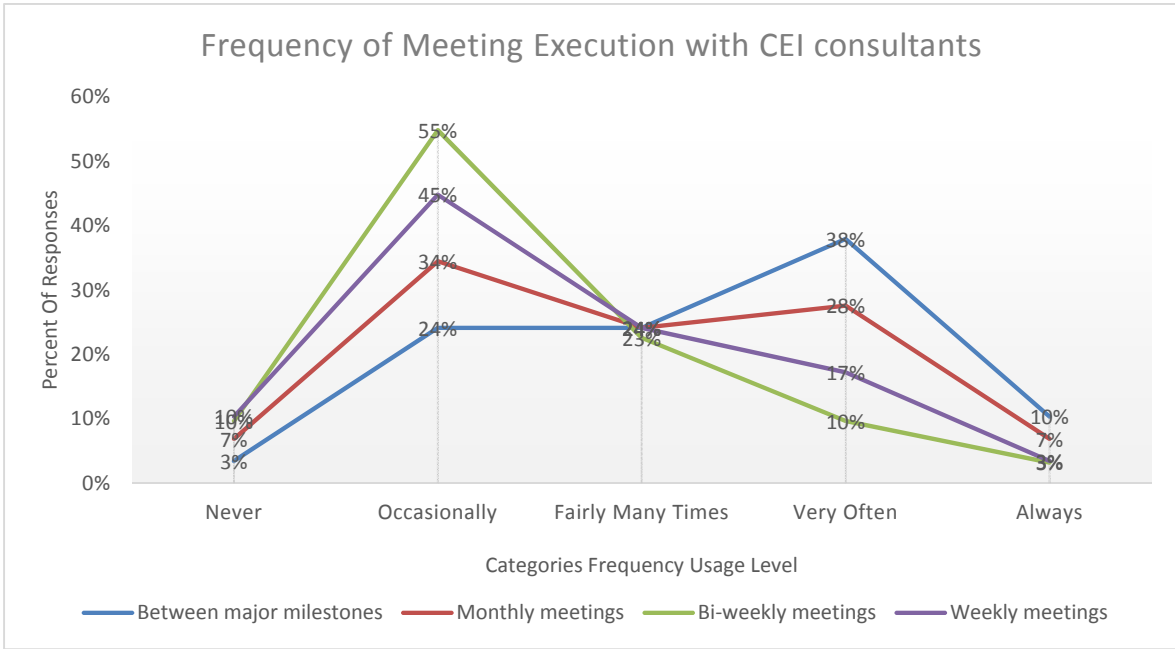
Other states such as South Carolina indicated that daily contact is maintained with CEI consultants, and meet when needed. Oklahoma informed that there is no standard frequency, is more on a needed basis depending on the project.

**Table 30 Frequency execution of meetings - Chi-Square analysis results of all count values from all users under each of the CEI tool frequency usage categories**

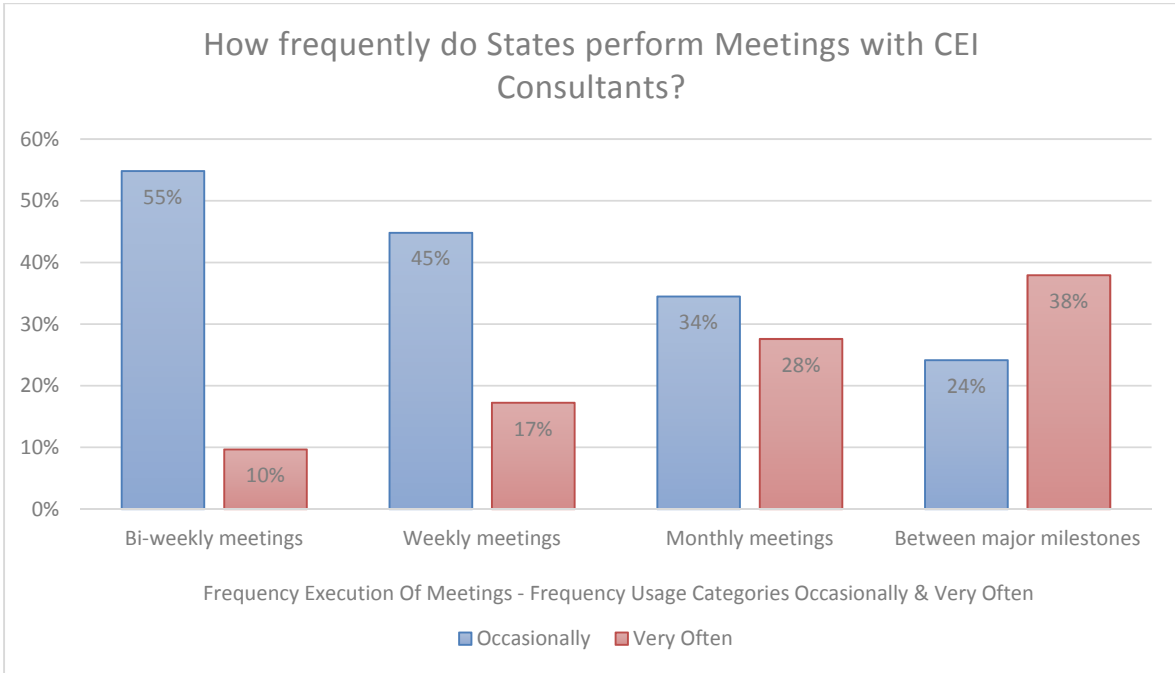
Question	Tool	CEI Tool Frequency Usage Categories					Chi Square	p-value Chi Sq
		Never	Occasionally	Fairly Many Times	Very Often	Always		
How frequently does your agency perform meetings with CEI consultants?	Between major milestones	1	7	7	11	3	10.483	0.0330
	Monthly meetings	2	10	7	8	2	9.103	0.0586
	Bi-weekly meetings	3	17	7	3	1	26.581	0.0000
	Weekly meetings	3	13	7	5	1	14.621	0.0056
<b>Total</b>		<b>9</b>	<b>47</b>	<b>28</b>	<b>27</b>	<b>7</b>	<b>45.220</b>	<b>0.0000</b>

**Table 31 Frequency execution of meetings - Percentages of all count values from all users under each of the CEI tool frequency usage categories**

Question	Tools	CEI Tool Frequency Usage Categories					Sum
		Never	Occasionally	Fairly Many Times	Very Often	Always	
How frequently does your agency perform meetings with CEI consultants?	Between major milestones	3%	24%	24%	38%	10%	100%
	Monthly meetings	7%	34%	24%	28%	7%	100%
	Bi-weekly meetings	10%	55%	23%	10%	3%	100%
	Weekly meetings	10%	45%	24%	17%	3%	100%



**Figure 32 Frequency execution of meetings - Graph of all percentages from all users under each of the CEI tool frequency usage categories**



**Figure 33 Frequency execution of meetings - Percentages under CEI tool frequency usage categories (Occasionally and Very Often) from all users**

As shown in figure 34, the factor that most determines the number of meetings is the complexity of the project. The results of the analysis about the determining the frequency of performing meetings with CEI consultants indicate that the CEI usage values under the frequency

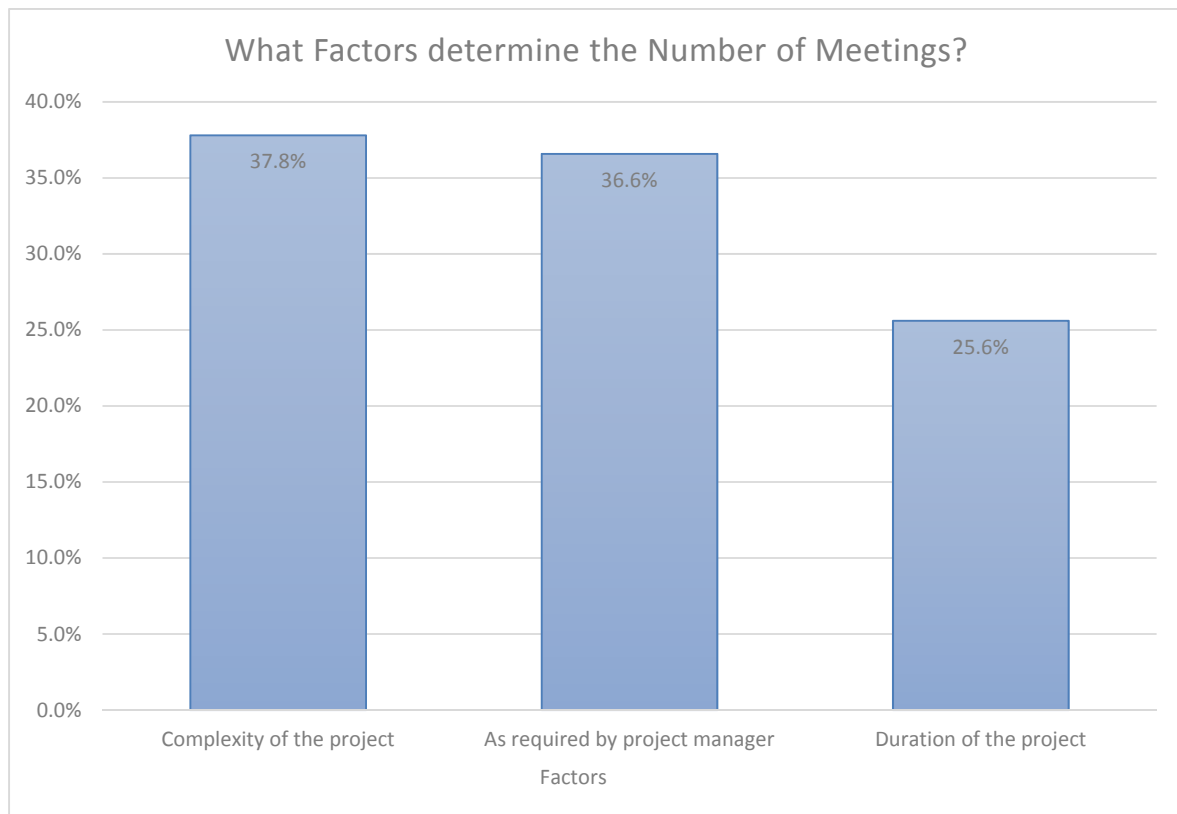
columns are not statistically different ( $p$ -value = 0.330 in appendix). This means that the frequency of the meetings is determined as much by all three tools. As shown (see table 32, and figure 34), the tools were selected in the following order:

- The “Complexity of the Project” tool was selected 37.8%; and
- The “As Required by Project Manager” tool was selected 36.6%.
- The “Duration of the Project” tool was selected 25.6%.

In addition, states such as Tennessee also included high profile projects in their response. Indiana added that generally the Area Engineer in charge of the project decides the frequency. In contrast, New Mexico indicated that the Construction Engineer decides the frequency of the meetings.

**Table 32 Determination of the number of meetings – Frequency and relative frequency Values**

Item No.	Determination of the Number of Meetings	Frequency	Relative Frequency [%]
1	Duration of the project	21	25.6%
2	As required by project manager	30	36.6%
3	Complexity of the project	31	37.8%
<b>Total</b>		82	100.0%



**Figure 34 Relative frequency distribution graph of determination of the number of meetings**

As shown in figure 36, the most important advantage is the improvement in the ability to handle peak workloads. The results of the analysis about the importance of the advantages of using CEI consultants are as follows:

- All importance level values are statistically different among all advantages included in this question (see table 33).
- The overall values per importance category (refer to columns) are statistically different as shown in the total row of table 33.
- As shown below (see table 34, and figures 35 and 36), the importance level of the advantages was selected as follows:
  - The advantage of “Improves ability to handle peak workloads” was selected 72% under category “Very Important”.

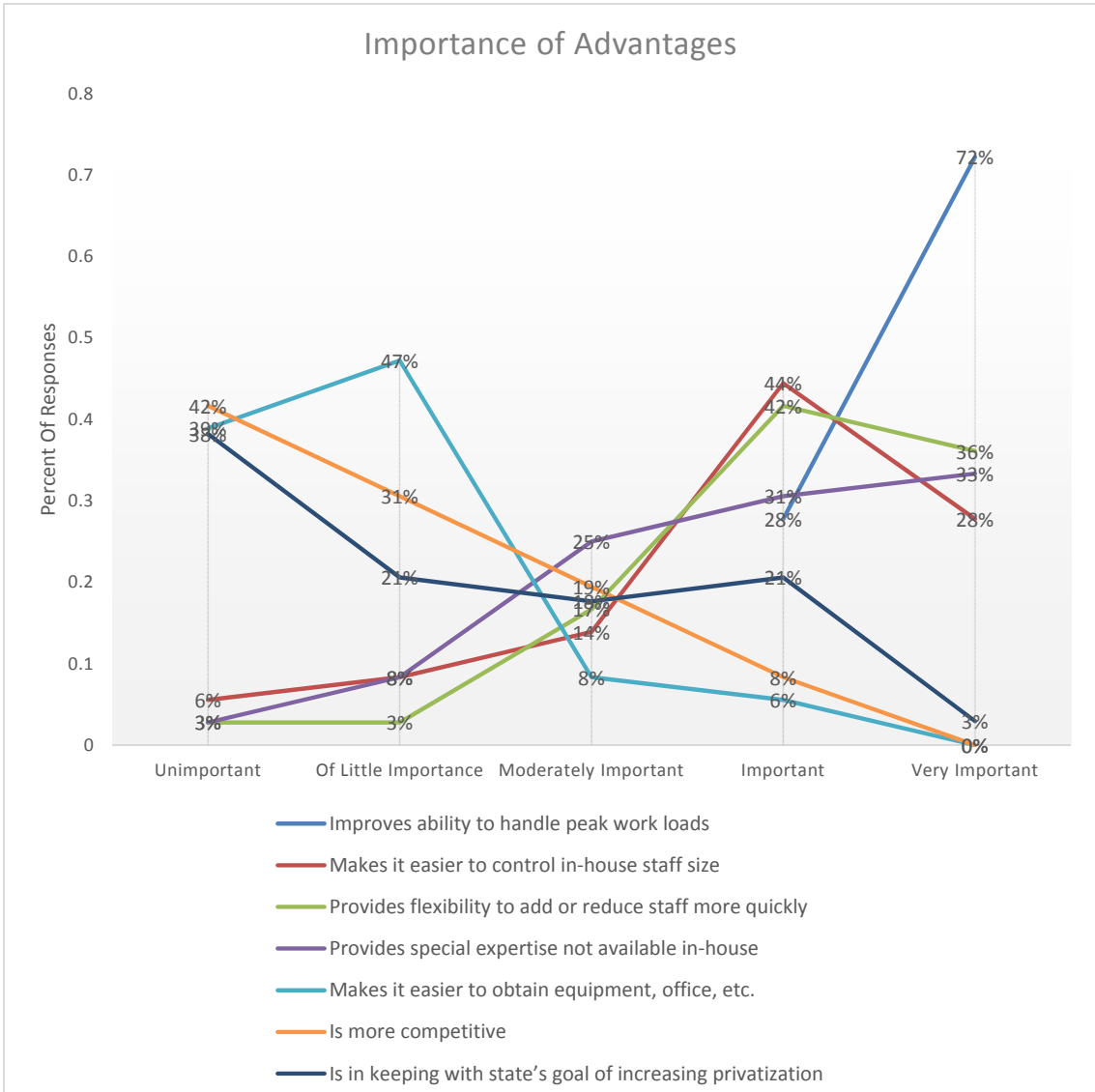
- The advantage of “Provides flexibility to add or reduce staff more quickly” was selected 42% under category “Important”. In addition, it was selected 36% under category “Very Important”.
- The advantage of “Makes it easier to control in-house staff size” was selected 44% under category “Important”. In addition, it was selected 28% under category “Very Important”.
- The advantage of “Provides special expertise not available in-house” was selected 33% under category “Very Important”.
- The advantage of “Makes it easier to obtain equipment, office, etc.” was selected 47% under category “Of Little Importance”.
- The advantage of “Is more competitive” was selected 42% under category “Unimportant”.
- The advantage of “Is in keeping with state’s goal or increasing privatization” was selected 38% under category “Unimportant”.

**Table 33 Importance of advantages - Chi-Square analysis results of all count values from all users under each of the importance categories**

Question	Advantages	Importance					Chi Square	p-value Chi Sq
		Unimportant	Of Little Importance	Moderately Important	Important	Very Important		
Importance of Advantages	Improves ability to handle peak work loads				10	26	7.111	0.0080
	Makes it easier to control in-house staff size	2	3	5	16	10	18.722	0.0009
	Provides flexibility to add or reduce staff more quickly	1	1	6	15	13	24.000	0.0001
	Provides special expertise not available in-house	1	3	9	11	12	13.444	0.0093
	Makes it easier to obtain equipment, office, etc.	14	17	3	2		19.333	0.0007
	Is more competitive	15	11	7	3		8.889	0.0310
	Is in keeping with state’s goal of increasing privatization	13	7	6	7	1	10.706	0.0301
	<b>Total</b>	<b>46</b>	<b>42</b>	<b>36</b>	<b>64</b>	<b>62</b>	<b>12.320</b>	<b>0.0151</b>

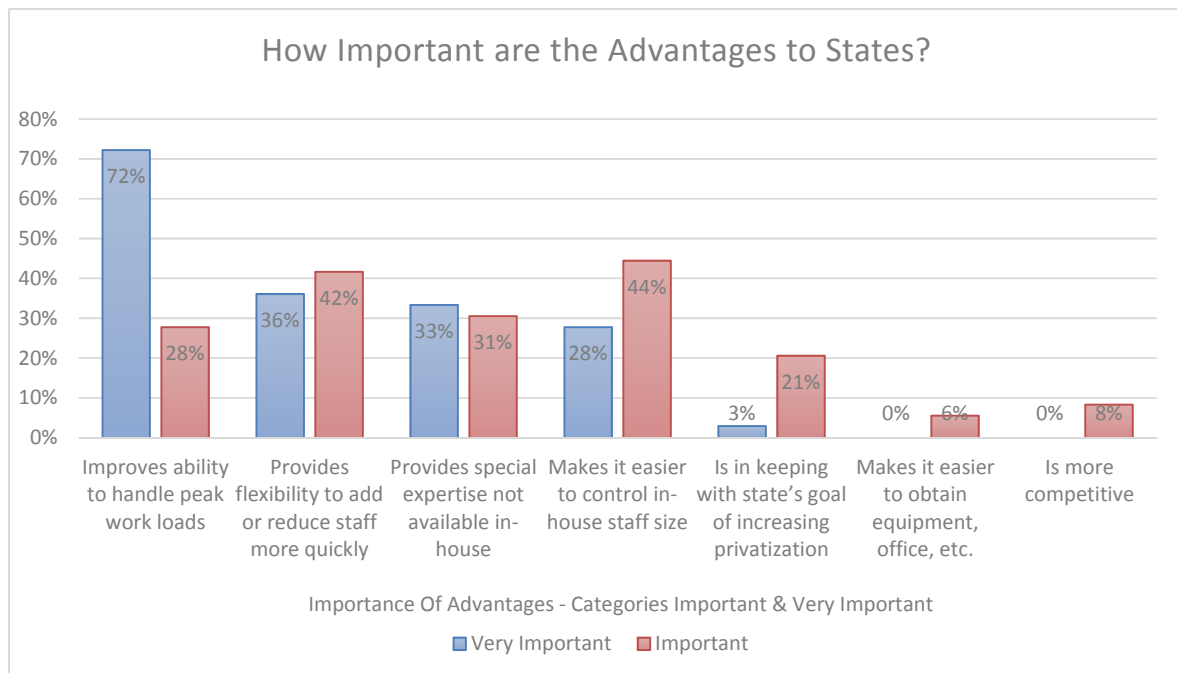
**Table 34 Importance of advantages - Percentages of all count values from all users under each of the importance categories**

Question	Advantages	Importance					Sum
		Unimportant	Of Little Importance	Moderately Important	Important	Very Important	
Importance of Advantages	Improves ability to handle peak work loads				28%	72%	100%
	Makes it easier to control in-house staff size	6%	8%	14%	44%	28%	100%
	Provides flexibility to add or reduce staff more quickly	3%	3%	17%	42%	36%	100%
	Provides special expertise not available in-house	3%	8%	25%	31%	33%	100%
	Makes it easier to obtain equipment, office, etc.	39%	47%	8%	6%	0%	100%
	Is more competitive	42%	31%	19%	8%	0%	100%
	Is in keeping with state's goal of increasing privatization	38%	21%	18%	21%	3%	100%



**Figure 35 Importance of advantages - Graph of all percentages from all users under each of the importance categories**





**Figure 36 Importance of advantages - Percentages under important categories (Very important and Important) from all users**

As shown in figure 38, the most important disadvantage is the lack of familiarity with procedures. The results of the analysis about the importance of the disadvantages of using CEI consultants are as follows:

- The importance level values of the “Costs are higher compared to in-house staff”, “Training opportunities for in-house employees are lost”, and “Salary disparities between CEI consultants and in-house staff cause morale problems” are not statistically significantly different (see table 35).
- All importance level values (items 2 to 4, 6, 8 to 10) are statistically different among all the disadvantages under this question (see table 35).
- The overall values per importance category (refer to column) are statistically different as shown in the total row of table 35.
- As shown below (see table 36, and figures 37 and 38), the importance of the disadvantages was selected as follows:

- The disadvantage of “Lack of familiarity with procedures” was selected 53% under category “Important”.
- The disadvantage of “Control and responsiveness from construction contractors is lost” was selected 42% under category “Moderately Important”.
- The disadvantage of “CEI consultants are more concerned with protecting themselves than the agency” was selected 39% under category “Important”.
- The disadvantage of “CEI consultant forces may be poorly qualified” was selected 35% under category “Important”.
- The disadvantage of “Monitoring requires a duplication of effort, and increased paperwork” was selected 35% under category “Moderately Important”.
- The disadvantage of “CEI consultants recruit DOT employees” was selected 38% under category 2 “Of Little Importance”.
- The disadvantage of “Training opportunities for in-house employees are lost” was selected 33% under category “Important”. However, the level of usage of this tool is not statistically different. Thus, the responses from participants do not allow the determination of the level of usage for this tool.
- The disadvantage of “Training of CEI consultant personnel must be continual” was selected 32% under category “Important”.
- The disadvantage of “Salary disparities between CEI consultants and in-house staff cause morale problems” was selected 30% under category “Important”. However, the level of usage of this tool is not statistically different. Thus, the responses from participants do not allow the determination of the level of usage for this tool.

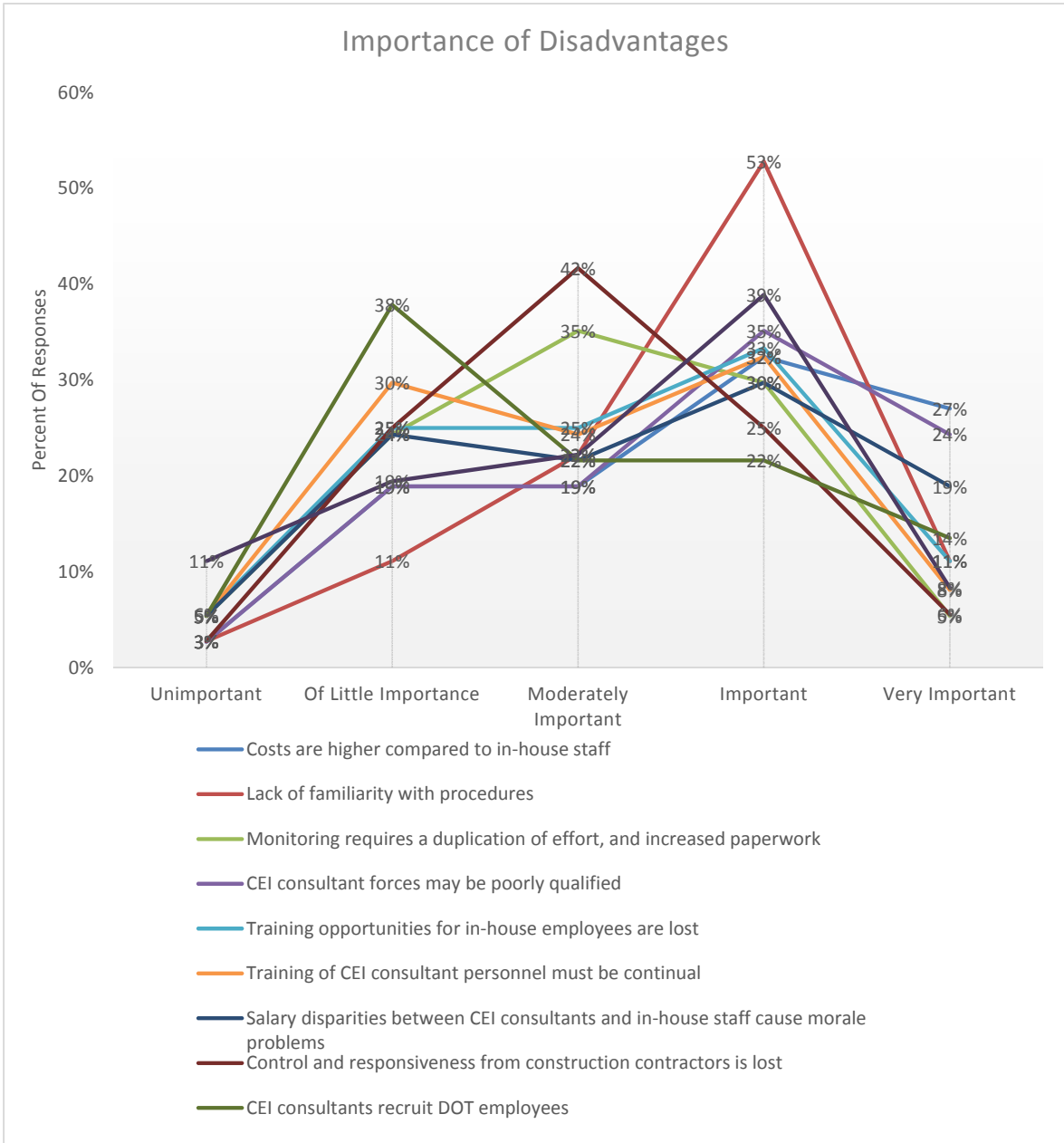
- The disadvantage of “Costs are higher compared to in-house staff” was selected 27% under category “Very Important”. However, the level of usage of this tool is not statistically different. Thus, the responses from participants do not allow the determination of the level of usage for this tool.

**Table 35 Importance of disadvantages - Chi-Square analysis results of all count values from all users under each of the importance categories**

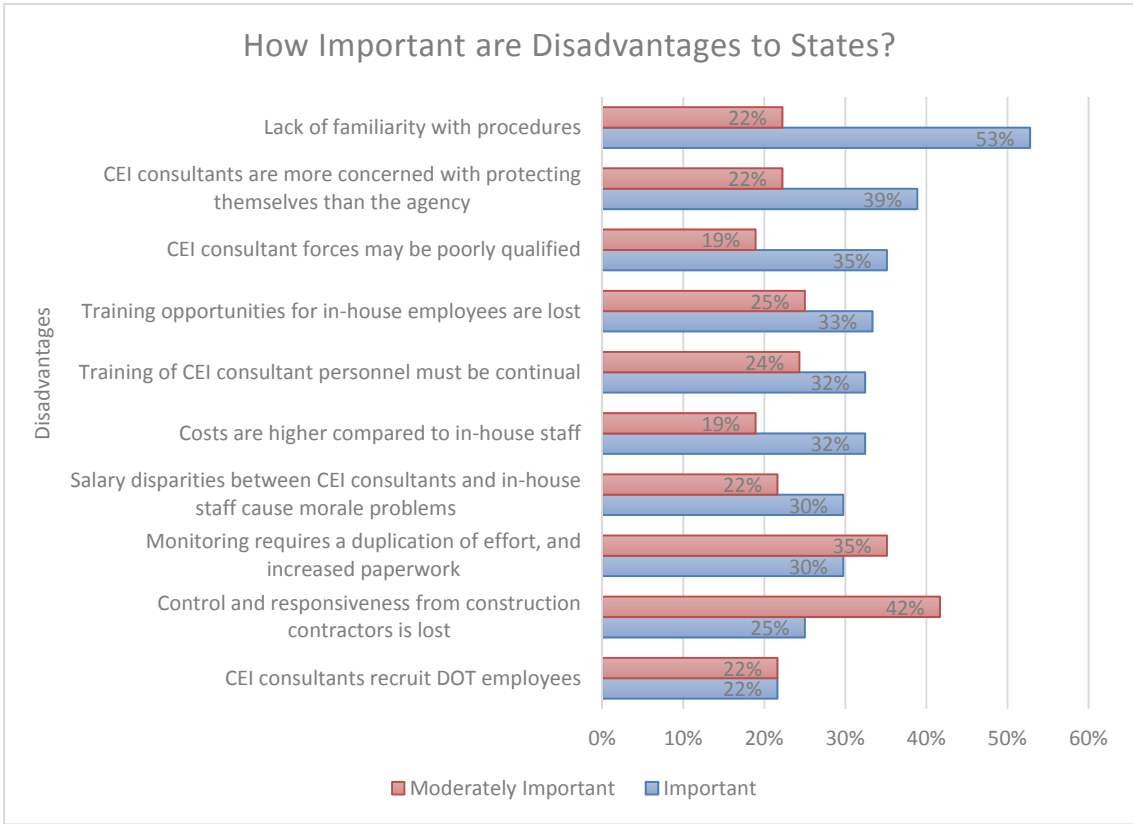
Question	Disadvantages	Importance					Chi Square	p-value Chi Sq
		Unimportant	Of Little Importance	Moderately Important	Important	Very Important		
Importance of Disadvantages	Costs are higher compared to in-house staff	1	7	7	12	10	9.351	0.0529
	Lack of familiarity with procedures	1	4	8	19	4	27.611	0.0000
	Monitoring requires a duplication of effort, and increased paperwork	2	9	13	11	2	14.216	0.0066
	CEI consultant forces may be poorly qualified	1	7	7	13	9	10.162	0.0378
	Training opportunities for in-house employees are lost	2	9	9	12	4	9.278	0.0545
	Training of CEI consultant personnel must be continual	2	11	9	12	3	11.514	0.0214
	Salary disparities between CEI consultants and in-house staff cause morale problems	2	9	8	11	7	6.108	0.1912
	Control and responsiveness from construction contractors is lost	1	9	15	9	2	18.444	0.0010
	CEI consultants recruit DOT employees	2	14	8	8	5	10.703	0.0301
	CEI consultants are more concerned with protecting themselves than the agency	4	7	8	14	3	10.389	0.0344
<b>Total</b>		<b>18</b>	<b>86</b>	<b>92</b>	<b>121</b>	<b>49</b>	<b>87.907</b>	<b>0.0000</b>

**Table 36 Importance of disadvantages - Percentages of all count values from all users under each of the importance categories**

Question	Disadvantages	Importance					Sum
		Unimportant	Of Little Importance	Moderately Important	Important	Very Important	
Importance of Disadvantages	Costs are higher compared to in-house staff	3%	19%	19%	32%	27%	100%
	Lack of familiarity with procedures	3%	11%	22%	53%	11%	100%
	Monitoring requires a duplication of effort, and increased paperwork	5%	24%	35%	30%	5%	100%
	CEI consultant forces may be poorly qualified	3%	19%	19%	35%	24%	100%
	Training opportunities for in-house employees are lost	6%	25%	25%	33%	11%	100%
	Training of CEI consultant personnel must be continual	5%	30%	24%	32%	8%	100%
	Salary disparities between CEI consultants and in-house staff cause morale problems	5%	24%	22%	30%	19%	100%
	Control and responsiveness from construction contractors is lost	3%	25%	42%	25%	6%	100%
	CEI consultants recruit DOT employees	5%	38%	22%	22%	14%	100%
	CEI consultants are more concerned with protecting themselves than the agency	11%	19%	22%	39%	8%	100%



**Figure 37 Importance of disadvantages - Graph of all percentages from all users under each of the importance categories**



**Figure 38 Importance of disadvantages - Percentages under categories (important and moderately important) from all users**

### 3.4 Discussion of Results

Based on the presented statistical analysis, these project sizes use CEI services to some degree of frequency. In order of selection, these project sizes are:

1. Very small (\$0 to \$1M);
2. Small (\$1M to \$2M);
3. Medium (\$2M to \$10M); and
4. Large (\$10M to \$40M).

Based on the presented statistical analysis, this project size uses CEI services approximately at an all-time frequency. However, it is not statistically different from the other project sizes. Thus, its frequency of use and selection order are inconclusive.

1. Very large (Above \$40M)

Based on the presented statistical analysis, these tools have high frequency of usage when it comes to defining the scope of work of CEI consultants. In order of selection, these tools are:

1. Statement of work;
2. Advertisement or RFP;
3. Written scope statement; and
4. Scoping meeting.

Based on the presented statistical analysis, these tools have high frequency of usage when it comes to selecting the CEI consultants. In order of selection, these tools are:

1. Require CEI consultant to have professional liability insurance; and
2. Select CEI consultant from a prequalification list of CEI consultants.

Based on the presented statistical analysis, these tools have high frequency of usage when it comes to administering the pre-construction part of a CEI contract. In order of selection, these tools are:

1. Require CEI consultant to submit hold harmless agreement; and

2. Prepare a list of the documentation that CEI consultant will manage, to be later used as a closeout checklist.

Based on the presented statistical analysis, these tools have high frequency of usage when it comes to administering the contract clarification and modification part of a CEI contract. In order of selection, these tools are:

1. Internally review and approve changes to CEI consultant's scope of work;
2. Maintain a record of all changes to CEI consultant's scope of work; and
3. Adjust fixed fee of CEI consultant's contract when the total contract amount is revised due to a change in the scope of work.

Based on the presented statistical analysis, these tools are used frequently very often when it comes to administering the contract clarification and modification part of a CEI contract. In order of selection, these tools are:

1. Verify that CEI consultant is responding to construction contractor's request for assistance. However, this tool is not statistically different from the other tool. Thus, its frequency of use and selection order are inconclusive.; and
2. Verification that CEI consultant is appropriately managing modifications to the contract.

Based on the presented statistical analysis, this tool has a high frequency of usage when it comes to administering the work execution part of a CEI contract.

1. Verify that CEI consultant complies with terms and conditions of its contract.

Based on the presented statistical analysis, this tool has a high frequency of usage when it comes to administering the payment part of a CEI contract.

1. Require monthly applications for payment from CEI consultant.

Based on the presented statistical analysis, this tool has a high frequency of usage when it comes to administering the monitoring and inspection part of a CEI contract.



1. Verification that CEI consultant adequately reviews construction contractor's application for payment.

Based on the presented statistical analysis, this tool is used with a frequency of fairly many times when it comes to administering the monitoring and inspection part of a CEI contract.

1. Perform intermediate evaluations of CEI consultant's performance. However, this tool is not statistically different from the other tools. Thus, its frequency of use and selection order are inconclusive.

Based on the presented statistical analysis, these tools are used frequently very often when it comes to administering the human resource part of a CEI contract. In order of selection, these tools are:

1. Provide training to DOT staff on CEI consultant management;
2. Provide training to CEI consultant on DOT's processes and procedures; and
3. Require DOT project manager to get acquainted with the roles and skills of selected CEI consultant. However, this tool is not statistically different from the other tools.

Thus, its frequency of use and selection order are inconclusive.

At the time of the research from Witheford (1999), most states were recognizing the importance of staff competence in consultant management. The results of this survey show that providing training to DOT staff on CEI consultant management is the most selected tool, which confirms the findings from Witheford (1999). Although, the frequency of using this tool is occasional, an assumption can be made that training is provided at the start of projects.

Based on the presented statistical analysis, this tool is used with occasional frequency when it comes to administering the human resource part of a CEI contract.

1. Provide training to DOT staff in CEI consultant management.

Based on the presented statistical analysis, these tools have high frequency of usage when it comes to closeout process of a CEI contract. In order of selection, these tools are:

1. Verify that CEI consultant delivered all project documentation and records;

2. Verify that all work assigned to CEI consultant is complete;
3. Share final evaluation with CEI consultant;
4. Perform final performance evaluation of CEI consultant;
5. Verify CEI consultant used proper accounting methods to record costs; and
6. Verify consistency of CEI consultant's contract costs.

Witthford (1999) indicated in his research that 33 states responded to part 1 of the survey, and most responded that they share evaluations with consultants. In the current survey, 28 states indicated that they always and very often share evaluations with CEI consultants. Thus, the number of states sharing evaluations has remained more or less the same.

Based on the presented statistical analysis, a meeting is executed frequently very often when it comes to meeting with CEI consultants.

1. Between major milestones.

Based on the presented statistical analysis, these meetings are executed with occasional frequency when it comes to meeting with CEI consultants. In order of selection, these meetings are:

1. Bi-weekly meetings;
2. Weekly meetings; and
3. Monthly meetings. However, this tool is not statistically different from the other tool. Thus, its frequency of use and selection order are inconclusive.

Based on the presented statistical analysis, these advantages are very important when it comes to CEI consultants. In order of importance, these advantages are:

1. Improves ability to handle peak workloads; and
2. Provides special expertise not available in-house.

Based on the presented statistical analysis, these advantages are important when it comes to CEI consultants. In order of importance, these advantages are:

1. Makes it easier to control in-house staff size; and
2. Provides flexibility to add or reduce staff more quickly.

Based on the presented statistical analysis, these advantages are of little importance when it comes to CEI consultants.

1. Makes it easier to obtain equipment, office, etc.

Based on the presented statistical analysis, these disadvantages are important when it comes to CEI consultants. In order of importance, these disadvantages are:

1. Lack of familiarity with procedures;
2. CEI consultants are more concerned with protecting themselves than the agency;
3. CEI consultant forces may be poorly qualified;
4. Training of CEI consultant personnel must be continual;
5. Training opportunities for in-house employees are lost. However, this advantage is not statistically different from the other advantages. Thus, its level of importance and selection order are inconclusive;
6. Salary disparities between CEI consultants and in-house staff cause morale problems. However, this advantage is not statistically different from the other advantages. Thus, its level of importance and selection order are inconclusive; and
7. Costs are higher compared to in-house staff. However, this advantage is not statistically different from the other advantages. Thus, its level of importance and selection order are inconclusive.

Based on the presented statistical analysis, the usage proportion of these tools when it comes to paying progress payments to CEI consultants is as follows:

1. Use of support documentation (time sheets, expense reports, and other similar documentation) to pay monthly applications for payment;
2. Use of an amount or percentage from the total cost at the completion of stages or phases of the work; and
3. Use an allotted ratio equivalent to the construction contractor's earnings.

Based on the presented statistical analysis, the usage proportion of the types of insurance required from CEI consultants was selected in this order:

1. General liability insurance; and
2. Errors and omission insurance.

Based on the presented statistical analysis, the proportion of what determines the number of meetings with CEI consultants is as follows:

1. As required by project manager;
2. Complexity of the project; and
3. Duration of the project.

## 4 Conclusions & Recommendations

As part of the research, an understanding of the services included under CEI was necessary. The current literature review on request for proposals, scope of services, scope of work, and pamphlets from different agencies found terms with similar meanings but different wording. These terms were organized under the appropriate headings in the CEI function table to provide a clearer concept of CEI. The process of organizing these services brought the perception that no standard CEI language exists among state agencies.

The selection process, whether qualification-based or price-based, can be determine by the type of funding (state or federal) and the services (architectural & engineering or design & engineering) to be provided under CEI.

Participants shared some tools or practices specific to their agencies. Some of these tools or practices are similar or variations of the practices or tools, as we know it to be today.

A relationship between the overall level of usage (high, medium, or low) and the frequency use of specific CEI tools was proposed. After an analysis, there has been no observed statistical differences across the use of CEI tools based on the overall level of usage (High, Medium, or Low). In contrast, an analysis of the use of specific CEI tools indicates that there are statistical significant differences in the overall frequency of how those tools are used. A summary of those results is as follows:

- The selection of CEI services decrease as the project size increase, but as the project size increase so did the frequency use of CEI services;
- The tool most often used to define the scope of work is the statement of work, and its use 100% of the time;
- The tool most often used to select CEI consultants is to require CEI consultant to have professional liability insurance, and its use always;

- The tool most often used to administer the pre-construction part of the CEI contract is to require the CEI consultant to submit a hold harmless agreement, and its use always. However, it was also the tool most chosen to never be use;
- The tool most often used to administer the contract clarification and modification part of the CEI contract is to internally review and approve changes to CEI's consultant scope of work, and is use always;
- The tool most often used to administer the work execution part of the CEI contract is to verify that CEI consultant complies with terms and conditions of its contract, and its use always;
- The tool most often used to administer the monitoring and inspection part of the CEI contract is to verify that CEI consultant adequately review the construction contractor's applications for payment, and its use always;
- The tool most often used to administer the human resource area of the CEI contract is to provide training to DOT staff in CEI consultant management, and its use occasionally;
- The tool most often used closeout process of the CEI contract is to verify that CEI consultant delivered all project documentation and records, and its use always;
- The method most often used to pay progress payments to CEI consultants is to use support documentation to pay monthly applications for payments;
- The types of insurance most often required for a CEI consultant can be either the errors and omissions, or general liability. This result may indicate that selection depends on the unique needs of an agency;
- The frequency most often followed in performing meetings with CEI consultants is to execute them bi-weekly on an occasional rate;
- The advantage considered as the most important is that CEI consultants improve the ability to handle peak workloads; and

- The disadvantage considered as the most important is that CEI consultants lack familiarity with procedures.

Moreover, the use of retainage as tool has been declining over the years as compare with past surveys and the discovery in this research that only 11% use this tool. Another finding has been the number of states sharing evaluations has remained more or less the same. Finally, a past research discovered that most states recognized the importance of staff competence in consultant management. The importance of this finding was confirmed by its selection as the most used tool to administer the human resource area of a CEI contract.

The research shows several tools that can be used within each stage or part of a project. Yet, the selection of the most consequential tool was based on finding an overall area that could encompass all the other tools once it is learned. To start, it is important to understand that the success of a project depends not only on the goals of each DOT but also on the quality of the team managing the project. To achieve this, the assembly and training of a team is essential. Thus, the most significant tool falls under the human resource administration area.

Every project should be adequately planned, and effectively managed by the assigned leader and the team. For this reason, training is extremely important to both sides. For DOTs, training should be acquired in management of CEI consultants. For CEI consultants, training should be acquired in the processes and procedures of DOTs. In addition, both sides should clearly understand each other roles and responsibilities. Finally, DOTs should make efforts to upgrade document control to an electronic system for the efficient management of not only time, but for the reduction of errors in the handling of documents. All of these tools contribute to the oversight of CEI consultants. Nevertheless, it is the training of the DOT team in CEI consultant management, which can encompass all the tools. Thus, a DOT team instructed in the management of CEI consultants can better understand the intricacies of managing CEI consultants.

Finally, some of the contributions of this thesis are:

- The mapping of the functions and/or activities performed under CEI services;

- The tools and/or functions being used;
- The level of use and frequency usage of the tools;
- The user level of states (including District of Columbia);
- The states issued the most CEI contracts;
- The states that most use CEI categories;
- The CEI categories most used by states; and
- No relationship exists between the CEI user levels of participating agencies with the tool frequency usage levels.

The recommended next steps for this research are to investigate the impact of using CEI consultants in project performance, to search for the specific tools or processes that hurt performance, and to discover the impact of outsourcing on state DOTs.



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## 6 Appendix A – Summary of Results

In this section, the results of each question are summarized in table format for easier understanding.

**Table 37 Summary of results of the frequency use of CEI by project size**

Frequency use of CEI Services by Project Size				
Item No.	Project Size	Selection [%]	Frequency Usage	Comment
1	Very small (\$0 to \$1M)	61%	To some degree <25%	
2	Small (\$1M to \$2M)	58%	To some degree <25%	
3	Medium (\$2M to \$10M)	43%	To some degree <25%	
4	Large (\$10M to \$40M)	33%	To some degree <25%	
5	Very large (Above \$40M)	29%	Almost completely 75 to less than 100%	Not statistically different

**Table 38 Summary results of the tools to define the scope of work**

Define Scope of Work				
Item No.	Tools	Selection [%]	Frequency Usage	Comment
1	Statement of work	71%	All 100%	
2	Advertisement or RFP	57%	All 100%	
3	Written scope statement	53%	All 100%	
4	Scoping meeting	39%	All 100%	

**Table 39 Summary of results of tools to select CEI consultants**

Selection of CEI Consultants				
Item No.	Tools	Selection [%]	Frequency Usage	Comment
1	Require CEI consultant to have professional liability insurance	94%	Always	
2	Select CEI consultant from a prequalification list of CEI consultants	49%	Always	
3	Advertise to bid for CEI consultant services through media outlets & ask for proposal	47%	Always	
4	Develop a shortlist of CEI consultants based on response to advertisements & ask for proposal	41%	Always	

**Table 40 Summary of results of tools to administering the pre-construction part**

Pre-Construction Part of Administering a CEI Contract				
Item No.	Tools	Selection [%]	Frequency Usage	Comment
1	Require CEI consultant to submit hold harmless agreement	42%	Always	Selected as never used by 48% of participants
2	Prepare a list of the documentation that CEI consultant will manage to be later used as closeout checklist	27%	Always	Selected as never used by 35% of participants

**Table 41 Summary of results of tools to administering the pre-construction part**

<b>Contract Clarification and Modification Part of Administering a CEI Contract</b>				
<b>Item No.</b>	<b>Tools</b>	<b>Selection [%]</b>	<b>Frequency Usage</b>	<b>Comment</b>
1	Internally review and approve changes to CEI consultant's scope of work	61%	Always	
2	Maintain a record of all changes to CEI consultant's scope of work	55%	Always	
3	Verify that CEI consultant is responding to construction contractor's request for assistance	41%	Very often	
4	Adjust fixed fee of CEI consultant's contract when the total contract amount is revised due to a change in the scope of work	31%	Always	Selected as never used by 31% of participants
5	Verification that CEI consultant is appropriately managing modifications to the contract	24%	Very Often	Selected as used fairly many times by 24% of participants

**Table 42 Summary of results of tools to administering the work execution part**

<b>Work Execution Part of Administering a CEI Contract</b>				
<b>Item No.</b>	<b>Tools</b>	<b>Selection [%]</b>	<b>Frequency Usage</b>	<b>Comment</b>
1	Verify that CEI consultant complies with terms and conditions of its contract	62%	Always	

**Table 43 Summary of results of tools to administering the payment part**

<b>Payment Part of Administering a CEI Contract</b>				
<b>Item No.</b>	<b>Tools</b>	<b>Selection [%]</b>	<b>Frequency Usage</b>	<b>Comment</b>
1	Require monthly applications for payment from CEI consultant	76%	Always	
2	Hold payment from CEI consultant if project is behind schedule	81%	Never	
3	Retain amount (Retainage) from CEI consultant's applications for payment	77%	Never	

**Table 44 Summary of results of tools to administering the monitoring and inspection part**

<b>Monitoring and Inspection of Administering a CEI Contract</b>				
<b>Item No.</b>	<b>Tools</b>	<b>Selection [%]</b>	<b>Frequency Usage</b>	<b>Comment</b>
1	Verification that CEI consultant adequately reviews construction contractor's application for payment	46%	Always	
2	Require CEI consultants to submit progress reports	43%	Never	
3	Perform intermediate evaluations of CEI consultant's performance	32%	Fairly many times	Not statistically different

**Table 45 Summary of results of tools to administering the human resource part**

Human Resource of Administering a CEI Contract				
Item No.	Tools	Selection [%]	Frequency Usage	Comment
1	Provide training to DOT staff in CEI consultant management	55%	Occasionally	
2	Provide training to CEI consultant on DOT's processes and procedures	34%	Very often	
3	Provide CEI consultant access to DOT's internal information system	29%	Very often	Not statistically different
4	Require DOT project manager to get acquainted with the roles and skills of selected CEI consultant	26%	Very often	Not statistically different

**Table 46 Summary of results of tools to administering the closeout process**

Closeout Process of Administering a CEI Contract				
Item No.	Tools	Selection [%]	Frequency Usage	Comment
1	Verify that CEI consultant delivered all project documentation and records	78%	Always	
2	Verify that all work assigned to CEI consultant is complete	70%	Always	
3	Share final evaluation with CEI consultant	57%	Always	Selected as used very often by 19 % of participants
4	Perform final performance evaluation of CEI consultant	57%	Always	Selected as used very often by 14% of participants
5	Verify CEI consultant used proper accounting methods to record costs	53%	Always	
6	Release retained amount from CEI consultant's contract	53%	Never	
7	Verify consistency of CEI consultant's contract costs	43%	Always	

**Table 47 Summary of results of tools used in the Payment of Progress Payments**

Tools used in the Payment of Progress Payments				
Item No.	Tools	Selection [%]	Frequency Usage	Comment
1	Use of support documentation (time sheets, expense reports, and other similar documentation) to pay monthly applications for payment	81%	N/A	
2	Use of an amount or percentage from the total cost at the completion of stages or phases of the work	17%	N/A	
3	Use an allotted ratio equivalent to the construction contractor's earnings	2%	N/A	

**Table 48 Summary of results of types of insurance required from CEI consultants**

Types of Insurance required from CEI Consultants				
Item No.	Tools	Selection [%]	Frequency Usage	Comment
1	General liability insurance	58%	N/A	
2	Errors and omission insurance	42%	N/A	

**Table 49 Summary of results of the frequency execution of meeting with CEI consultants**

Frequency Execution of Meetings with CEI Consultants				
Item No.	Meetings	Selection [%]	Frequency Usage	Comment
1	Between major milestones	38%	Very often	Selected as occasionally used by 24 % of participants
2	Bi-weekly meetings	55%	Occasionally	
3	Weekly meetings	45%	Occasionally	
4	Monthly meetings	34%	Occasionally	Not statistically different

**Table 50 Summary of results for the determination of number of meetings with CEI consultants**

Determination of Number of Meetings with CEI Consultants				
Item No.	Tools	Selection [%]	Frequency Usage	Comment
1	As required by project manager	37%	N/A	
2	Complexity of the project	31%	N/A	
3	Duration of the project	26%	N/A	

**Table 51 Summary of results of importance of advantages**

Importance of Advantages				
Item No.	Tools	Selection [%]	Importance Level	Comment
1	Improves ability to handle peak work loads	72%	Very important	
2	Makes it easier to control in-house staff size	44%	Important	
3	Provides flexibility to add or reduce staff more quickly	42%	Important	
4	Provides special expertise not available in-house	33%	Very important	
5	Makes it easier to obtain equipment, office, etc.	47%	Of little importance	
6	Is more competitive	42%	Unimportant	
7	Is in keeping with state's goal of increasing privatization	38%	Unimportant	

**Table 52 Summary of results of importance of disadvantages**

Importance of Disadvantages				
Item No.	Tools	Selection [%]	Importance Level	Comment
1	Lack of familiarity with procedures	53%	Important	
2	Control and responsiveness from construction contractors is lost	42%	Moderately important	
3	CEI consultants are more concerned with protecting themselves than the agency	39%	Important	
4	CEI consultant forces may be poorly qualified	35%	Important	
5	Monitoring requires a duplication of effort, and increased paperwork	35%	Moderately important	
6	CEI consultants recruit DOT employees	38%	Of little importance	
7	Training of CEI consultant personnel must be continual	32%	Important	
8	Training opportunities for in-house employees are lost	33%	Important	Not statistically different
9	Salary disparities between CEI consultants and in-house staff cause morale problems	30%	Important	Not statistically different
10	Costs are higher compared to in-house staff	27%	Important	Not statistically different



## 7 Appendix B – Online Survey

### Survey of States Department of Transportation on Oversight Approaches for CEI Consultants

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#### Survey Questionnaire

The primary purpose of this questionnaire is to acquire information on the approaches used to oversee Construction Engineering and Inspection (CEI) consultants. Your input is important to create an improved and comprehensive guidebook. The oversight of CEI consultants requires the involvement of the agency. For those states Department of Transportation (DOTs) that do manage CEI consultants, we believe that your approaches are unique to your particular situation. It is for this reason that a survey is required. A survey will allow the collection of the different approaches used by state DOTs for the benefit of all agencies. The goal is that all state DOTs partake in the improvement of CEI oversight management practices.

Your participation is voluntary and your responses are confidential. Your responses will not be reported in any manner which can be associated with any specific individual, organization, agency, program, or project.

If you have questions about this study, you can contact Paul Goodrum by phone or email at 303-492-0475 or at paul.goodrum@colorado.edu. This research is sponsored by Federal Highway Administration (FHWA) - Transportation Management Pooled Funds research fund. The results will be publically accessible upon completion.

#### **7.1 Section 1 – Introduction**

The following questions are to determine the extent of your participation in the survey.

- A. Does your agency employ CEI services? Yes or No. If yes, please continue.
- B. Does your agency employ CEI services for the following categories? (Mark all that apply)
  - 1. Liaison (e.g. Facilitate communication between all parties)
  - 2. Meetings (e.g. Conduct pre-construction conference)
  - 3. Documentation (e.g. Prepare correspondence)

4. Preparation & Maintenance of Records (e.g. Maintain records of meeting minutes, shop drawings, etc.)
5. Change Orders (e.g. Review, estimate, prepare, and submit change orders)
6. Work Orders (e.g. Prepare work orders)
7. Budget (e.g. Check actual performance to budgeted amounts)
8. Applications for Payment (e.g. Review and submit contractor's request for payment to DOT)
9. Post Construction Support (e.g. Assist in settling claims and disputes)
10. Survey Control (e.g. Survey verification)
11. Utilities (e.g. Coordinate utility work)
12. Schedule (e.g. Monitor contractor's progress and schedule)
13. Construction Work (e.g. Monitor daily contractor's activities)
14. Geotechnical (e.g. Report on adequacy of work)
15. Material Sampling & Testing (e.g. Sampling and testing of concrete cylinders)
16. Quality Management (e.g. Provide QA plan)
17. Personnel (e.g. Review compliance with prevailing wage rates)
18. Training (e.g. Consultant training of DOT staff on project management practices)
19. Project Staffing (e.g. Recommend on project staffing)
20. Public Relations (e.g. Keep community aware of status impacts)
21. Other: \_\_\_\_\_

## **7.2 Section 2 – Background Information**

The following questions identify your state agency, and permit the classification of responses based on your years of employment. In addition, it will allow comparisons among DOTs across the United States. Your responses are strictly confidential, and will only be viewed by the research team. We appreciate your help in providing this important information.

1. Agency state:
2. Agency address:
3. Agency division, department:
4. Your name:
5. Your phone number:
6. Your e-mail address:
7. Your position:
8. How many years have you been with your agency?
  - a. Less than 1

- b. 1 - 5
- c. 6 – 10
- d. 11 – 20
- e. More than 20

**7.3 Section 3 – Construction Engineering and Inspection Program**

The following questions will provide a scenario of your agency’s utilization of CEI services. To the best of your ability, please choose or provide the most appropriate response based on your experience.

- 9. Does your agency use consultants for CEI? If yes, please continue
  - a. Yes
  - b. No
- 10. What is the estimated annual dollar volume of Construction Engineering and Inspection (CEI) consultant work for your agency?
  - a. Less than \$10M
  - b. \$10M – \$20M
  - c. \$20M – \$30M
  - d. \$30M – \$40M
  - e. More than \$40M
  - f. Other: \_\_\_\_\_
- 11. How many CEI consultant contracts did your agency award in 2013?
- 12. How frequent are CEI services used in projects among the following size?

	Size	None	To Some Degree <25%	Fairly Much 25 to less than 50%	Very Much 50 to less than 75%	Almost Completely 75 to less than 100%	All 100%
a.	Very large (above \$40M)	0	1	2	3	4	5
b.	Large (\$10M to \$40M)	0	1	2	3	4	5
c.	Medium (\$2M to \$10M)	0	1	2	3	4	5
d.	Small (\$1M to \$2M)	0	1	2	3	4	5
e.	Very small (\$0k to \$1M)	0	1	2	3	4	5
f.	Other: _____	0	1	2	3	4	5

- 13. How often is each practice used to define the scope of work for CEI Consultant Services?

	Methods	None	To Some Degree <25%	Fairly Much 25 to less than 50%	Very Much 50 to less than 75%	Almost Completely 75 to less than 100%	All 100%
a.	Statement of work in the contract agreement	0	1	2	3	4	5
b.	Advertisement or RFP	0	1	2	3	4	5
c.	Scoping meeting	0	1	2	3	4	5
d.	Written scope statement	0	1	2	3	4	5
e.	Other: _____	0	1	2	3	4	5

#### 7.4 Section 4 - CEI Management Practices

The following questions are to understand the practices utilize by your agency in managing CEI consultants at different stages of the CEI contract.

14. Which tools does your agency use in managing CEI consultants during different phases of their involvement?

a. Selection Process of Identifying CEI Consultant:

	Tools	Never	Occasionally	Fairly Many Times	Very Often	Always
i.	Select CEI consultant from a prequalification list of CEI consultants	0	1	2	3	4
ii.	Advertise to bid for CEI consultant services through media outlets & ask for proposal	0	1	2	3	4
iii.	Develop a shortlist of CEI consultants based on response to advertisements & ask for proposal	0	1	2	3	4
iv.	Require CEI consultant to have professional liability insurance	0	1	2	3	4
v.	Other: _____	0	1	2	3	4

b. Administration of CEI Consultant Contract:

i. Pre-Construction

	<b>Tools</b>	<b>Never</b>	<b>Occasionally</b>	<b>Fairly Many Times</b>	<b>Very Often</b>	<b>Always</b>
1)	Prepare a list of the documentation (contract documents and amendments, correspondence, shop drawings, change orders, etc.) that the CEI consultant will manage, which will be later used as a closeout checklist.	0	1	2	3	4
2)	Require CEI consultant to submit hold harmless agreement	0	1	2	3	4
3)	Other: _____	0	1	2	3	4

ii. Contract Clarification and Modification

	<b>Tools</b>	<b>Never</b>	<b>Occasionally</b>	<b>Fairly Many Times</b>	<b>Very Often</b>	<b>Always</b>
1)	Verify that CEI consultant is responding to construction contractor's request for assistance	0	1	2	3	4
2)	Verification that CEI consultant is appropriately managing modifications to the contract	0	1	2	3	4
3)	Maintain a record of all changes to CEI consultant's scope of work	0	1	2	3	4
4)	Internally review and approve changes to CEI consultant's scope of work	0	1	2	3	4
5)	Adjust fixed fee of CEI consultant's contract when the total contract amount is revised due to a change in the scope of work.	0	1	2	3	4
6)	Other: _____	0	1	2	3	4

iii. Work Execution

	<b>Tools</b>	<b>Never</b>	<b>Occasionally</b>	<b>Fairly Many Times</b>	<b>Very Often</b>	<b>Always</b>
1)	Verify that CEI consultant complies with terms and conditions of its contract	0	1	2	3	4
2)	Other: _____	0	1	2	3	4

iv. Payment

	<b>Tools</b>	<b>Never</b>	<b>Occasionally</b>	<b>Fairly Many Times</b>	<b>Very Often</b>	<b>Always</b>
1)	Require monthly applications for payment from CEI consultant	0	1	2	3	4
2)	Hold payment from CEI consultant if project is behind schedule	0	1	2	3	4
3)	Retain amount (Retainage) from CEI consultant's applications for payment	0	1	2	3	4
4)	Other: _____	0	1	2	3	4

v. Monitoring and Inspection

	<b>Tools</b>	<b>Never</b>	<b>Occasionally</b>	<b>Fairly Many Times</b>	<b>Very Often</b>	<b>Always</b>
1)	Verification that CEI consultant adequately reviews construction contractor's application for payment	0	1	2	3	4
2)	Require CEI consultants to submit progress reports	0	1	2	3	4
3)	Perform intermediate evaluations of CEI consultant's performance	0	1	2	3	4
4)	Other: _____	0	1	2	3	4

vi. Human Resources

	<b>Tools</b>	<b>Never</b>	<b>Occasionally</b>	<b>Fairly Many Times</b>	<b>Very Often</b>	<b>Always</b>
1)	Provide training to DOT staff in CEI consultant management	0	1	2	3	4
2)	Provide CEI consultant access to DOT's internal information system	0	1	2	3	4
3)	Provide training to CEI consultant on DOT's processes and procedures	0	1	2	3	4
4)	Require DOT project manager to get acquainted with the roles and skills of selected CEI consultant	0	1	2	3	4
5)	Other: _____	0	1	2	3	4

c. Closeout Process of CEI Consultant Contract:

	<b>Tools</b>	<b>Never</b>	<b>Occasionally</b>	<b>Fairly Many Times</b>	<b>Very Often</b>	<b>Always</b>
i.	Verify that all work assigned to CEI consultant is complete	0	1	2	3	4
ii.	Perform final performance evaluation of CEI consultant	0	1	2	3	4
iii.	Share final evaluation with CEI consultant	0	1	2	3	4
iv.	Verify that CEI consultant delivered all project documentation and records.	0	1	2	3	4
v.	Verify consistency of CEI consultant's contract costs	0	1	2	3	4
vi.	Verify CEI consultant used proper accounting methods to record costs	0	1	2	3	4
vii.	Release retained amount from CEI consultant's contract	0	1	2	3	4
ix.	Other: _____	0	1	2	3	4

- d. What method does your agency follow to pay applications for payment to CEI consultants? (Mark all that apply)
- i. Use of support documentation (time sheets, expense reports, and other similar documentation) to pay monthly applications for payment
  - ii. Use of an amount or percentage from the total cost at the completion of stages or phases of the work
  - iii. Use an allotted ratio equivalent to the construction contractor's earnings
  - iv. Other: \_\_\_\_\_
- e. What types of insurance are consultants required to carry? (Mark all that apply)
- i. General liability insurance
  - ii. Errors and omission insurance
  - iii. Other: \_\_\_\_\_
- f. How frequently does your agency perform meetings with consultants?

	<b>Meeting Occurrence</b>	<b>Never</b>	<b>Occasionally</b>	<b>Fairly Many Times</b>	<b>Very Often</b>	<b>Always</b>
i.	Between major milestones	0	1	2	3	4
ii.	Monthly meetings	0	1	2	3	4
iii.	Bi-weekly meetings	0	1	2	3	4
iv.	Weekly meetings	0	1	2	3	4
v.	Other: _____	0	1	2	3	4

- g. What decides the frequency of meetings in your agency? (Mark all that apply)

- i. Duration of the project
- ii. Complexity of the project
- iii. As required by project manager
- iv. Other: \_\_\_\_\_

**7.5 Section 5 - Advantages and Disadvantages**

Please classify by importance the following advantages and disadvantages identified by agencies in the use of CEI consultants in the management of CEI work. Your responses will allow the research team to rank the reasons why agencies utilize CEI consultants.

15. Below is a list of typical advantages identified in the use of consultants for CEI work. Please indicate how important each advantage is to your agency.

	<b>Advantages</b>	<b>Unimportant</b>	<b>Of Little Importance</b>	<b>Moderately Important</b>	<b>Important</b>	<b>Very Important</b>
a.	Improves ability to handle peak work loads	1	2	3	4	5
b.	Makes it easier to control in-house staff size	1	2	3	4	5
c.	Provides flexibility to add or reduce staff more quickly	1	2	3	4	5
d.	Provides special expertise not available in-house	1	2	3	4	5
e.	Makes it easier to obtain equipment, office, etc.	1	2	3	4	5
f.	Is more competitive	1	2	3	4	5
g.	Is in keeping with state's goal of increasing privatization	1	2	3	4	5
h.	Other: _____	1	2	3	4	5

16. Below is a list of typical disadvantages identified in the use of consultants for CEI work. Please indicate how important each disadvantage is to your agency.



	<b>Disadvantages</b>	<b>Unimportant</b>	<b>Of Little Importance</b>	<b>Moderately Important</b>	<b>Important</b>	<b>Very Important</b>
a.	Costs are higher compared to in-house staff.	1	2	3	4	5
b.	Lack of familiarity with procedures	1	2	3	4	5
c.	Monitoring requires a duplication of effort, and increased paperwork	1	2	3	4	5
d.	CEI consultant forces may be poorly qualified	1	2	3	4	5
e.	Training opportunities for in-house employees are lost	1	2	3	4	5
f.	Training of CEI consultant personnel must be continual	1	2	3	4	5
g.	Salary disparities between CEI consultants and in-house staff cause morale problems	1	2	3	4	5
h.	Control and responsiveness from construction contractors is lost	1	2	3	4	5
i.	CEI consultants recruit DOT employees	1	2	3	4	5
j.	CEI consultants are more concerned with protecting themselves than the agency	1	2	3	4	5
k.	Other: _____	1	2	3	4	5

17. Please suggest a CEI Consultant (Provide Company Name, Contact Name, Email, Phone Number) to participate in this research. \_\_\_\_\_

Thank you for completing the survey! Your input is invaluable and will benefit other state DOTs.

May we contact you for additional information?

Yes       No

Would you like to receive a copy of the summary report?

Yes       No

If you have any questions, please contact:

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## 8 Appendix C – Other Chi Square Analyses

### 8.1 Chi-Square Analysis for Table 3 Management Classification

	C=1	C=2	C=3	C=	C=5	Total
R=1	13	23	12	2	13	63
Total	13	23	12	2	13	63

#### CROSSTABS: C by R

##### Chi-Square

$\chi^2 = 17.556$  df = 4 p-value = 0.002\*

### 8.2 Chi-Square Analysis for Table 4 Participants' Years with the Agency

	C=1	C=2	C=3	C=4	C=5	Total
R=1	0	3	3	19	30	55
Total	0	3	3	19	30	55

#### CROSSTABS: C by R

##### Chi-Square

$\chi^2 = 61.273$  df = 4 p-value = 0.000\*

### 8.3 Chi-Square Analysis for Table 5 Estimated Annual Dollar Volume of CEI Work

	C=1	C=2	C=3	C=4	C=5	Total
R=1	21	9	2	2	8	42
Total	21	9	2	2	8	42

#### CROSSTABS: C by R

##### Chi-Square

$\chi^2 = 28.714$  df = 4 p-value = 0.000\*

### 8.4 Chi-Square Analysis for Table 28 Methods to Pay Progress Payments

	C=1	C=2	C=3	Total
R=1	1	8	38	47
Total	1	8	38	47

#### CROSSTABS: C by R

##### Chi-Square

$\chi^2 = 49.319$  df = 2 p-value = 0.000\*

### 8.5 Chi-Square Analysis for Table 29 Types of Insurance Required

	C=1	C=2	Total
R=1	28	38	66
Total	28	38	66

#### CROSSTABS: C by R

##### Chi-Square

$\chi^2 = 1.515$  df = 1 p-value = 0.218

### 8.6 Chi-Square Analysis for Table 32 Determination of Number of Meetings

	C=1	C=2	C=3	Total
R=1	21	30	31	82
Total	21	30	31	82

#### CROSSTABS: C by R

##### Chi-Square

$\chi^2 = 2.220$  df = 2 p-value = 0.330