JOINT TRANSPORTATION
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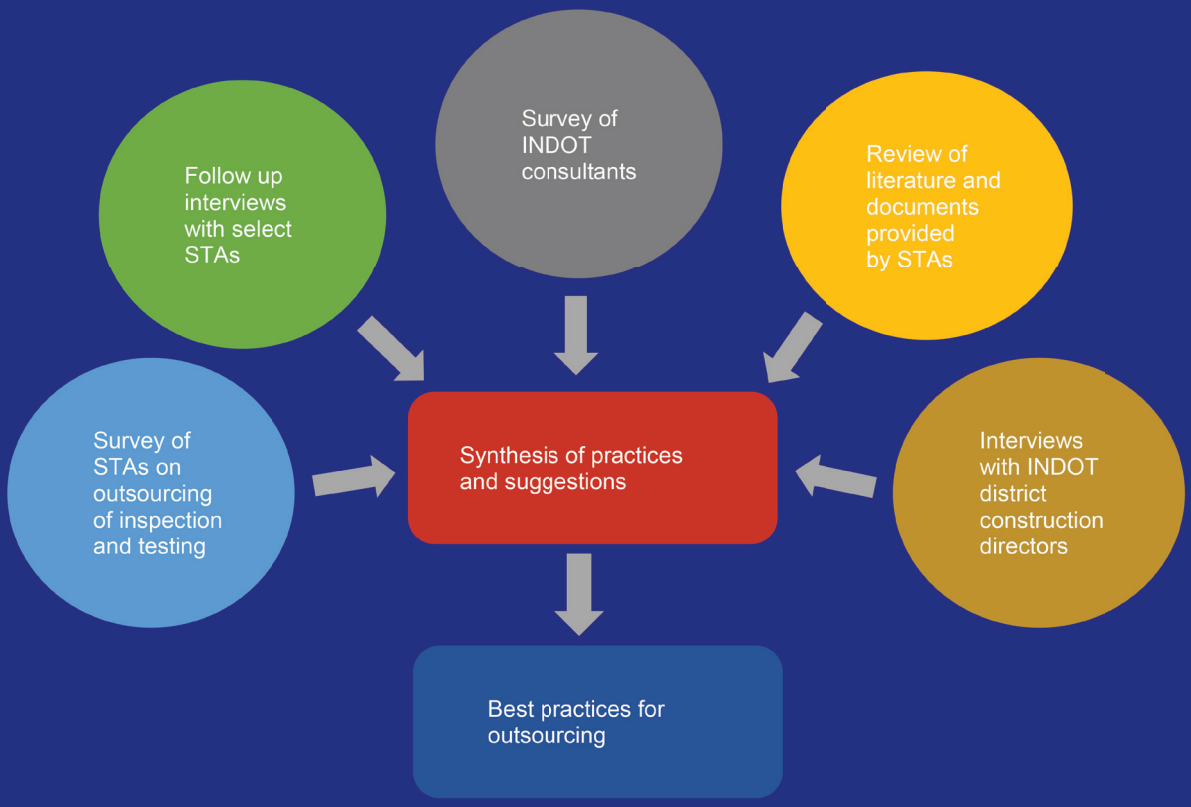
Outsourcing of Laboratory Testing and Inspection Activities at State Transportation Agencies: Synthesis of Current Practices



David Carlson, Bhavik Ranka, Dulcy M. Abraham

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AUTHORS

David Carlson
Graduate Research Assistant
Lyles School of Civil Engineering
Purdue University

Bhavik Ranka
Graduate Research Assistant
Lyles School of Civil Engineering
Purdue University

Dulcy M. Abraham, PhD
Professor of Civil Engineering
Lyles School of Civil Engineering
Purdue University
(765) 494-2239
dulcy@purdue.edu
Corresponding Author

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16. Abstract

Outsourcing of project activities at State Transportation Agencies (STA) to the private sector has become ubiquitous over the last several decades. This trend of increased outsourcing is primarily driven by the continued demand for public transportation infrastructure coupled with static or declining levels of in-house STA employees. Many prior studies have reported on the trends, impacts, challenges and costs of outsourcing functions, such as design, but few have focused on the use of consultants specifically for testing and inspection. This paper synthesizes the current state of practice of outsourcing testing and inspection activities across STAs within the United States. Specifically the study used a qualitative approach which included a literature review, surveys of STAs on their current state of practice for outsourcing testing and inspection, questionnaires of consultants that provide inspection services to the Indiana Department of Transportation (INDOT), follow-on interviews with key STAs, and interviews with five Indiana DOT district construction directors to determine the following:

1. Factors/criteria for determining the basis for outsourcing inspections and testing
2. Factors influencing the motivation and decision to outsource testing and inspection
3. Documents and guidelines used for ensuring quality in outsourced tests and inspections
4. Benefits and advantages realized through outsourcing testing and inspection

In addition to a synthesis of the current state of outsourcing across the STAs, five key strategies were identified to guide STAs with outsourcing testing and inspection activities. The key strategies include: (1) conducting strategic level planning, (2) developing a system of record to track in-house versus consultant cost, (3) maintaining a strong prequalification program, (4) consistently evaluating consultant performance, and (5) providing training to in-house staff and consultants. Application of these strategies can assist STAs in developing, sustaining, and guiding a quality testing and inspection outsourcing program.

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EXECUTIVE SUMMARY

OUTSOURCING OF LABORATORY TESTING AND INSPECTION ACTIVITIES AT STATE TRANSPORTATION AGENCIES: A SYNTHESIS STUDY

Introduction

Over the last several decades, state transportation agencies (STAs) have experienced continued growth in the volume of capacity improvement while in-house workforce levels have remained constant or declined (Warne, 2003). The resulting lack of personnel to manage the additional work has led STAs to increase outsourcing of key project responsibilities to consultants, including testing and inspection (Leahy, 2011).

The Indiana Department of Transportation (INDOT) is committed to identifying and implementing effective ways to inspect, test, and verify the quality and placement of materials on transportation projects. INDOT recognizes the trend of increased outsourcing to the private sector and the lack of information available on the effects, challenges, and benefits of specifically outsourcing testing and inspection of materials. Therefore, INDOT commissioned this synthesis study (SPR-4105) to review current inspection and testing practices used by STAs across the United States and internationally to assist the department in determining where it should place its resources to get the best value and quality for testing and inspection. Additionally, the study seeks to compare the management and administration requirements of in-house testing and inspection activities with outsourced activities. Using a qualitative approach of surveys, interviews, and questionnaires with STAs and consultants, this study focuses on the following:

1. Factors/criteria for determining the basis for outsourcing inspections and testing
2. Factors influencing the motivation and decision to outsource testing and inspection
3. Documents and guidelines used for ensuring quality in outsourced tests and inspections
4. Benefits and advantages realized through outsourcing of testing and inspection

Findings and Implementation

All STAs that responded to the inspection survey outsourced at least some inspection activities, while 80% of the respondents to the testing survey outsourced at least some testing activities. The primary decision factors for outsourcing were staffing capacity, lack of in-house expertise, and managing schedule constraints. Outsourcing of testing and inspection activities proved advantageous in handling increased workloads, especially during seasonal fluctuation, and provided the STAs flexibility in allocating in-house staff to field and administrative activities. The top two concerns or challenges with outsourcing of inspection and testing activities were the comparatively higher cost associated with outsourcing and consultants' lack of familiarity with STA procedures. The surveys and interviews strongly indicate that STAs with high volumes of outsourced inspection and testing activities have established strong prequalification requirements, clear conflict of interest policies, contract administration procedures, and consultant evaluation systems.

Five key strategies were identified from the surveys, interviews, and questionnaires to guide STAs with outsourcing of testing and inspection activities: (1) conduct strategic-level planning, (2) develop a system of record to track in-house versus consultant costs, (3) maintain a strong prequalification program, (4) consistently evaluate consultant performance, and (5) provide training to in-house staff and consultants. Application of these strategies can assist STAs in developing, sustaining, and guiding a quality testing and inspection outsourcing program.

Conduct Strategic Level Planning

STAs must create a strategic-level outsourcing plan for testing and inspection with input from the appropriate levels of management that clearly identifies the objectives and measures of effectiveness for directing the outsourcing program. The outputs of this planning must include a written policy that guides the STA in its outsourcing decisions as well as all administrative, procurement, management, and monitoring procedures for consultant contracts.

Develop a System of Record to Track In-house Costs

STAs must establish a system of record that tracks the actual costs of completing inspection and testing by consultant versus in-house staff in order to drive the strategic-level planning. The system would assist in accurately determining which activities consultants can perform more efficiently than in-house staff and vice versa. The system would also provide the basis for allocating the right personnel resources to projects. The data required should include the following (for inspection):

1. Project scope (include the contractor, designer, and project schedule)
2. Total and itemized costs (as planned, final, change orders)
3. Funds paid to consultants by activity (include the qualifications/training/experience of each consultant employee assigned to the project)
4. Selected consultant's letter of intent
5. STA personnel, role, and costs (allocation of time on each project)
6. Performance evaluation of the consultants on the projects
7. Completed construction inspection reports
8. List of other STA resources used on the project (resources in addition to personnel, for instance, access to field office, access to STA-sponsored training and STA labs)
9. Administrative costs on the project (e.g., preparing the outsourcing RFP, evaluation of the Letters of Intent, contract creation and evaluation)

Maintain a Strong Prequalification Program

STAs must maintain stringent prequalification requirements and procedures to ensure consultants selected for testing and inspection are reliable, fully qualified, and capable of quality work.

Consistently Evaluate Consultant Performance

STAs must provide knowledgeable in-house personnel to monitor and manage consultants' work on projects to ensure compliance to standards, specification, quality, and any additional conditions specified in the contract. The STA must have established formal and informal processes to evaluate the performance of consultants providing inspection and testing services to the STA. Most important, the evaluations (positive or negative) must have an impact on future selection of the consultant on STA projects.

Provide Training to In-house Staff and Consultants

STAs must be prepared to provide the necessary training to consultants to ensure they are familiar with STA processes and procedures. The more control and oversight the STA has over the training that consultants receive, the greater confidence the STA can have in ensuring that consultants working on STA projects are uniformly trained and qualified. STAs should also consider the importance of providing training to in-house staff on contract management and procurement to ensure appropriate experience with contract management.

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LIST OF ABBREVIATIONS

3D	3-Dimensional
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADA	Americans with Disability Act
AK	Alaska
APAI	Asphalt Pavement Association of Indiana
AR	Arkansas
BBR	Bending Beam Rheometer
CA	California
CAP	Compliance Assessment Program
CEI	Construction Engineering and Inspection
CESSSWI	Certified Erosion, Sediment and Stormwater Inspector
CFR	Code of Federal Regulation
CPESC	Certified Professional in Erosion and Sediment Control
CPQM	Consultant Prequalification Manual
CT	Connecticut
CTP	Certified Technician Program
CTQP	Construction Training and Quality Program
CWI	Certified Welding Inspector
DBE	Disadvantaged Business Enterprise
DCP	Dynamic Cone Penetrometer
DE	Denver
DOT	Department of Transportation
DPW	RPR Department of Public Works Resident Project Representative
EEO	Equal Employment Opportunity
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FL	Florida
FCR	Final Contract Record
GA	Georgia
GIFE	General Instructions to Field Employees
GPR	Ground Penetrating Radar
HMA	Hot Mix Asphalt
IA	Iowa
IA	Independent Assurance
IN	Indiana
INDOT	Indiana Department of Transportation
IT	Information Technology
KY	Kentucky
LPA	Local Public Agency
LQP	Laboratory Qualification Program
LWD	Light Weight Deflectometer
LOI	Letter of Intent
ME	Maine
MI	Michigan
MN	Minnesota
MO	Missouri
MS	Mississippi
MT	Montana
MTO	Ministry of Transportation of Ontario
NCHRP	National Cooperative Highway Research Program
NE	Nebraska
NEPA	National Environmental Policy Act
NH	New Hampshire
NICET	National Institute for Certification in Engineering Technologies
NJ	New Jersey
NM	New Mexico
NV	Nevada
OH	Ohio

OK	Oklahoma
ON	Ontario
OR	Oregon
PA	Pennsylvania
PCCP	Portland Cement Concrete Pavement
PQI	Pavement Quality Indicator
PSCS	Professional Services Contracting System
QA	Quality Assurance
QC	Quality Control
QPL	Qualified Products List
RFP	Request for Proposal
SAC	Study Advisory Committee
SAFETEA-LU	Safe, Accountable, Flexible, Efficient, Transportation, Equity Act: A Legacy of Users
SAM	Super-Air Meter
SCB	Semi-Circular Bending Beam
STA	State Transportation Agency
TEA	Transportation Equity Act
TN	Tennessee
TQDBS	Training and Qualification Data Base System
TTQP	Transportation Technician Qualification Program
TX	Texas
USNRC	United States Nuclear Regulatory Commission
UT	Utah
VA	Virginia
VDOT	Virginia Department of Transportation
VT	Vermont
WA	Washington
WAQTC	Western Alliance for Quality Transportation Construction
WI	Wisconsin
WSDOT	Washington State Department of Transportation
WY	Wyoming

1. INTRODUCTION

State transportation agencies (STAs) have experienced continued fluctuation in federal and state funding for construction projects over the last several decades. Historic events such as the 1998 Transportation Equity Act for the 21st Century (TEA-21), the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in 2005, and other unique funding mechanisms enabled STAs to rapidly expand their construction programs to satisfy public demand for increased capacity (Warne, 2003). However, during the same period, in-house workforces at many STAs declined or remained constant, resulting in a lack of personnel to manage the additional work (Warne, 2001). In more recent years, while population growth has continued to raise demand for public transportation infrastructure, federal funding available to STAs has dropped significantly as the American Recovery and Reinvestment Act of 2009 and other stimulus funding became exhausted (Bausman et al., 2014).

As a result of these fiscal constraints and staffing limits, STAs have looked to reduce costs, increase efficiency, and refine their management approaches to continue delivering quality transportation projects (Bausman et. al. 2014). One of the primary means STAs have accomplished this is through outsourcing key project responsibilities to the private sector. Additionally, STAs specifically hire consultants for testing and inspection and to implement innovative quality assurance (QA) practices (Leahy, 2011).

1.1 Background

Many contributing factors have led to increased outsourcing within STAs over the last several decades. A 1989 National Cooperative Highway Research Program (NCHRP) study stated that the primary reasons STAs use consultants for construction engineer and inspection (CEI) work were to: (1) supplement agency staff, (2) handle peak workloads, and (3) obtain expertise not available in-house (Newman, 1989). In a 2003 NCHRP synthesis study on outsourcing and private-sector utilization within STAs, Warne (2003), reported that the two major factors influencing STAs to outsource activities were (1) staff constraints and (2) the lack of specialty skills or equipment. Cost-effectiveness was seldom selected as a factor considered for outsourcing in that survey. Gen and Kingsley (2007) summarized the results of eight prior surveys and/or studies of STAs (Hancher & Werkmeister, 2001; Liddle, 1997; Newman, 1989; Thompson & Elling 2000; Ugboro, Obeng, & Talley, 2001; Witheford, 1997, 1999; Yates & Mukherjee, 1994) into a list of six factors that include: (1) increased service demand as a result of population growth, (2) public demand for faster service with reduced delays, (3) political or public pressures, (4) need for specialized skill or innovation, (5) control of staff size, and (6) to achieve greater efficiency (Gen & Kingsley, 2007). A recent NCHRP report shows that STAs are increasingly turning to alternative contracting methods (ACMs) to deliver transportation projects and programs. Since the staffing and organizational needs of the ACMs are often more complex and undocumented than the traditional design-bid-build (DBB) the report identified the increased use of consultants to supplement in-house staff and provide expertise to deliver ACM projects (Tran, Gransberg, & Harper, 2018).

Additionally, several state-level studies have focused on conditions that led to increased outsourcing. For example, a case study of Georgia Department of Transportation outsourcing practices in 2007 cited the following factors leading to increased outsourcing: (1) sharp expansion of public transportation programs, (2) public finance rules limiting the ability to hire and use state employees on transportation projects, (3) downsizing of the state workforce, (4) increase in retirements by an aging workforce, and (5) changing civil service rules that make it possible for state employees to retire early and work for consultant firms (Ponomariov & Kingsley, 2008). In a study conducted by Hancher and Werkmeister in 2000–2001 with the Florida Department of Transportation (FDOT), the agency cited the following factors driving outsourcing: (1) the ability to assign resources only when needed, (2) the ability to quickly adjust to changes in the department's work program and (3) the ability to contract for specific expertise not readily available using in-house resources.

Numerous studies also provide information on the trends and current state of practice of outsourcing across STAs within the United States. A 1997 Transportation Research Board study reported a tenfold increase in the amount of outsourcing across all agency functions between 1950 and 1997 (Witheford, 1997). According to the NCHRP Synthesis Report 313 (Warne, 2003), between 1997 and 2001 outsourcing increased or stayed the same for 95% of all STA activities sampled (38 states replied to survey) and that amongst all activities outsourced by STAs, construction engineering (inspection) and materials testing were among the most common. Ellis, Guertin, and Shannon (2001) found through their survey (48 different STAs responded) that 85% of reporting STAs were using consultants to perform part of their construction engineer and inspection (CEI) activities. Finally, a survey conducted by Yusuf and O'Connell in 2003 (30 STAs responded) indicated that 87% of states outsource materials testing and 74% outsource construction engineering (oversight, inspection, QA/QC).

The literature highlights many concerns, advantages, disadvantages and risks from increased outsourcing. In the 42 separate STA responses collected by Newman (1989), there was a general lack of consensus on the advantages and disadvantages between the point of view from the STAs, consultants, and contractors on the advantages and disadvantages. From the agency point of view, the top three advantages of using CEI consultants were: (1) improved ability to handle peak workloads, (2) ease in controlling in-house staff size, and (3) improved flexibility to add or reduce staff more quickly. Consultants see many of the same advantages but believe they provide better-qualified and more ambitious inspectors

and technicians. Contractors generally rate the consultants' performance as superior to in-house primarily due to the effects of free enterprise versus bureaucracy. The top three disadvantages of using CEI consultants from the agency perspective were: (1) higher costs, (2) lack of familiarity with procedures, and (3) duplication of effort/increased paperwork in monitoring projects (Newman, 1989). Consultants agree that they may lack understanding of the agency's systems and procedures but also site a lack of continuity between actual procedures used by the STA with those outlined in the provided specification and procedures manuals. Most contractors prefer to have projects administered by the STA because consultants are slower to make decisions, have less experience, may be more strict or "by the book" resulting in more change orders, and often become "middlemen" between the state and the contractor (Newman, 1989). Gen and Kingsley (2007) also studied the advantages and disadvantages of contracting out professional services in STAs in the areas of cost, workforce, workload, and quality. They explored the consequences of a brain drain or the "hollowing out" of the capabilities of an agency leading to its inability to complete its core competencies and properly monitor contracts (Gen & Kingsley, 2007). Furthermore, the NCHRP 2018 synthesis report highlighted Ohio DOT's concern (where 60%–70% of project staff may be consultants) that when the project is completed the consultants move on and any of their experience or knowledge gained on the project is not retained within the agency (Tran et al., 2018). Additionally they studied the impacts on the management systems of the STA such as an increased demand for more contract administrators (Gen & Kingsley, 2007).

Finally, STAs are also concerned with the costs associated with outsourcing. Warne's study in 2003 highlighted the need to measure cost effectiveness of outsourcing (not just testing and inspection), and attempted to do so by measuring overall satisfaction with outsourcing through surveys of STA personnel. The study concluded that although many efforts by researchers in both the private and public sector attempted to compare the cost of outsourcing to in-house efforts, there is a lack of consensus based on available data of which method provides the best value to the transportation agency and the taxpayer (Alwin, 1997; Cameron & Donly 1998; ConnDOT, 1994; Gibson & Wallace, 2012; MoDOT, 1992; Porter, 1996; Renfrow, 1992; Joint Legislative Audit and Review Commission, 1998; Warne, 2003; Wilmot, Deis, & Xu, 1999; Wisconsin Legislative Audit Bureau, 1990, 1997; Yusuf & O'Connell, 2014). This lack of consistent data can be mostly attributed to the complexity of determining the actual costs of in-house employees. A study completed by Ellis et al. (2010) on construction engineering and inspection costs within Florida DOT observed that CEI costs when completed in-house were about 9% of total project costs but were 12% when performed by consultants. When the DOT factored in the additional monitoring and administration costs, the total outsourced work was then 15% of the total project volume.

1.2 Problem Statement and Research Objectives

The Indiana Department of Transportation (INDOT) remains committed to identifying and implementing effective ways to inspect, test, and verify the quality and placement of materials on transportation projects. INDOT recognizes the trend across STAs to increase the number of functions that are outsourced to the private sector in order to meet rising demands for service with shrinking resources. However, little information is available on the advantages, challenges, and risks associated with specifically outsourcing testing and inspection of materials within STAs. This synthesis study (SPR-4105) was commissioned by INDOT to provide a review of current inspection and testing practices used by STAs within the United States to assist the department in determining where it should place its resources to get the best value and quality for testing and inspection. Additionally, the study seeks to compare the management and administration requirements of in-house testing and inspection activities compared with outsourced activities. This study focuses on the following themes through the use of surveys, interviews and questionnaires with STAs and consultants:

1. Factors/criteria for determining the basis for outsourcing inspections and testing
2. Factors influencing the decision and motivation to outsource testing and inspection
3. Documents and guidelines used for ensuring quality in outsourced tests and inspections
4. Benefits and advantages realized through outsourcing specific activities

2. METHODOLOGY

This synthesis study explored the current state of practice of outsourcing testing and inspection by STAs. Five methods were used to gather information: (1) two surveys sent out to all 50 STAs and the Ministry of Transportation of Ontario (see Appendix A and Appendix B), (2) follow-on interviews with select STAs, (3) literature review and review of documents provided by STAs, (4) questionnaires of consultants (see Appendix C), and (5) interviews with INDOT District Construction Directors. Figure 2.1 shows the project methodology.

The INDOT Study Advisory Committee (SAC) and research team developed two surveys to access current practices of outsourcing testing and inspection with the following themes:

1. Basic information on STA's work volume
2. Percent of activities outsourced
3. Decision factors considered when outsourcing
4. Key concerns, challenges, and advantages of outsourcing
5. Cost savings associated with outsourcing
6. Quality assurance practices
7. Resources available for testing and inspection
8. Addressing conflicts of interest

The two surveys were distributed by the SAC to all State Transportation Agencies (STA) and the Ministry

of Transportation of Ontario in June 2017 through the online Qualtrics software. Responses were collected through November 2017. Seventeen (17) STAs participated in the inspection survey including; Arkansas DOT, Connecticut DOT, Florida DOT, Iowa DOT, Kentucky DOT, Maine DOT, Michigan DOT, Missouri DOT, New Mexico DOT, New Hampshire DOT, Ohio DOT, Oklahoma DOT, Pennsylvania DOT, Utah, DOT,

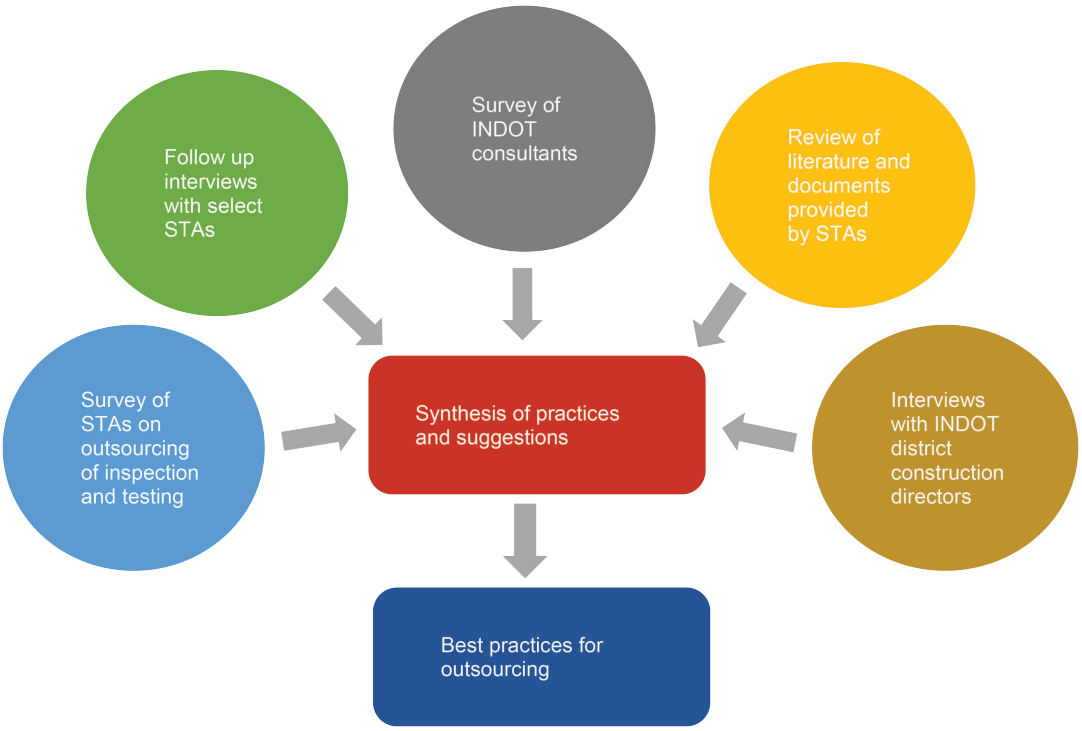

Figure 2.1 Project methodology.

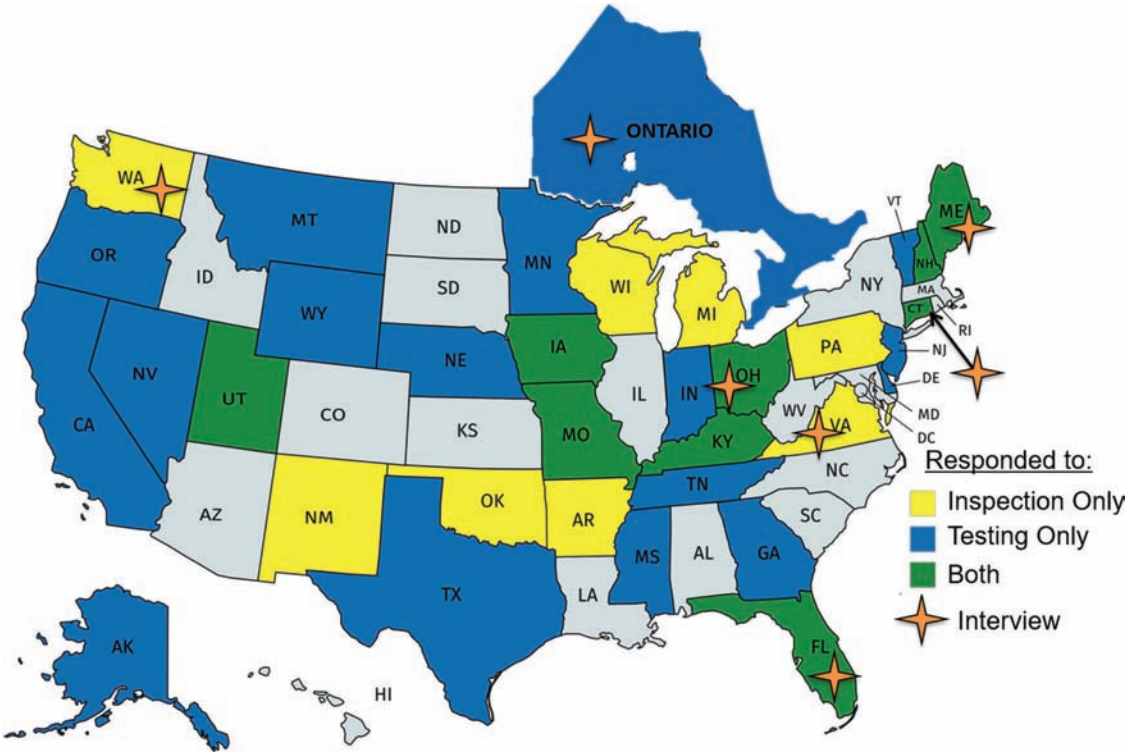

Figure 2.2 Geographical representation of interviewees.

Virginia DOT, Washington State DOT, and Wisconsin DOT. Twenty-six (26) STAs participated in the testing survey including; Alaska DOT, California DOT, Connecticut DOT, Delaware DOT, Florida DOT, Georgia DOT, Indiana DOT, Iowa DOT, Kentucky DOT, Maine DOT, Minnesota DOT, Mississippi DOT, Montana DOT, Nebraska DOT, Nevada DOT, New Hampshire DOT, New Jersey DOT, Ohio DOT, Oregon DOT, Tennessee DOT, Texas DOT, Utah DOT, Vermont DOT, Wyoming DOT and the Ministry of Transportation of Ontario. Figure 2.2 shows the geographical representation of the respondents to the two surveys. Yellow fill indicates the STA only responded to the material inspection survey, blue fill indicates the STA only responded to the inspection survey, and green fill indicates the STA responded to both surveys.

Following the completion of the surveys, the SAC and research team identified STAs of interest to gather more specific information on their outsourcing program. Seven STAs participated in follow-on interviews with the research team including; Connecticut DOT, Florida DOT, Maine DOT, Ohio DOT, Virginia DOT, Washington State DOT (WSDOT) and the Ontario Ministry of Transportation. STAs that participated in the follow-up interviews are depicted with an orange star in Figure 2.2.

3. EXPERIENCES OF STAS IN OUTSOURCING TESTING AND INSPECTION

This section provides a summary of the responses from the outsourcing surveys and follow-on interviews with select STAs. All STAs that responded to the inspection survey outsourced at least some inspection activities while about 80% of the respondents to the testing survey outsource at least some testing activities. About 56% of the respondents outsource 50% or fewer testing activities and 70% of respondents outsource 50% or fewer inspection activities. Figure 3.1 provide a graphical representation of the percent of activities outsourced for testing and inspection by each STA. Table 3.1 includes the summary of work volume information of each STA that participated in the survey and/or interviews.

3.1 Decision Factors for Outsourcing Testing and Inspection Activities

Respondents selected from a list of factors that influence their STA's decision to outsource testing and inspection activities. They were able to select multiple factors from the list and also explain any other factors (not provided in the list) impacting their STA's decision to outsource. The decision factors were based on:

1. Policy (for instance, private organization can perform the tasks equally well, state's goal for increasing privatization)
2. Staffing capacity (to handle peak workloads)
3. Schedule constraints (to handle critical and/or fast-track projects)
4. Lack of special expertise (STA lacks required in-house expertise)
5. Need for innovation
6. Better management of risk (if risk can be shifted to the consultant)
7. Improving quality (past performance of consultants/testing agencies on STA projects)
8. Cost effectiveness
9. Lack of certain equipment
10. Political pressures
11. Lack of sufficient funds

The top three factors selected for outsourcing testing by the 26 respondents were (1) staffing capacity (60%), (2) schedule constraints (32%), and (3) lack of in-house expertise (24%). Other factors selected by the STAs, in descending order of selection include; lack of equipment or breakdown, policies, cost effectiveness of outsourcing, need for innovation, better management of risks and political pressures. Figure 3.2 provides a graphical summary of the selected decision factors driving the outsourcing of testing activities.

From the seventeen responses received for outsourcing of inspection activities, staffing capacity (88%),

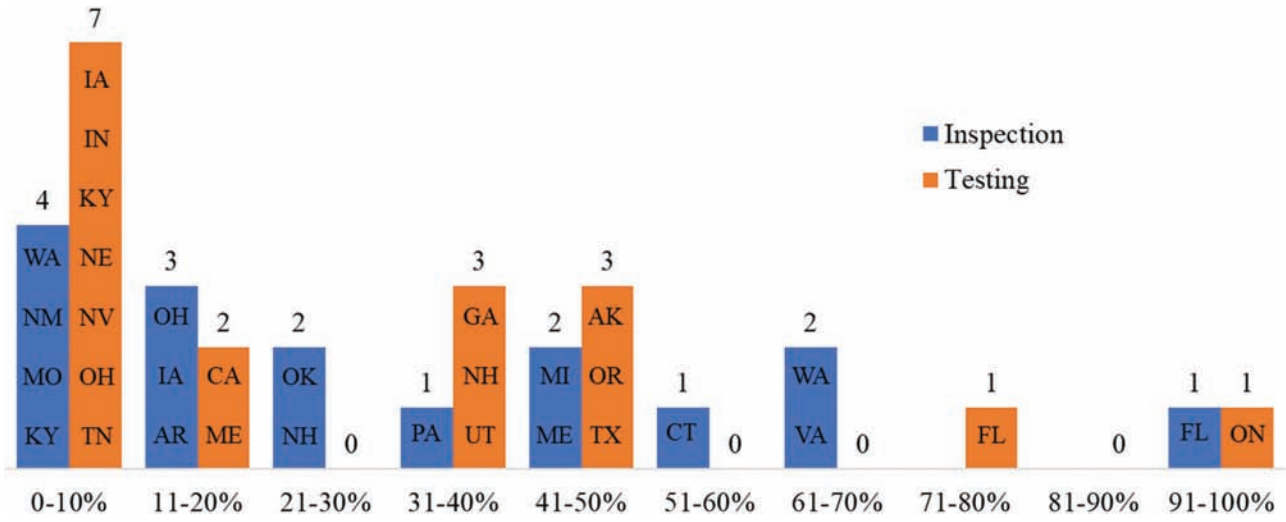

Figure 3.1 Percentage of inspection and testing activities outsourced in 2016.

TABLE 3.1
Summary of work volume data provided by the STAs that participated in the study

STA	Number of districts/ regions	Annual capacity improvement volume (2016, $ million)	Annual maintenance volume (2016, $ million)	Outsource testing	Percent of testing outsourced	Outsource inspection	Percent of inspection outsourced
Alaska	3	550		Yes	50		
California	12			Yes	15		
Georgia	7	812	165	Yes	40		
Minnesota	8	1000		No			
Mississippi	7			Yes			
Montana	5	400	10	Yes			
Nebraska	8			Yes			
New Jersey	3			No			
Oregon	5	350	100	Yes	100 QC		
Tennessee	4	700	200	Yes	10		
Texas	25	3100	2700	Yes	50		
Vermont	9	283	90	Yes			
Wyoming	5	22		No			
Ontario	5			Yes	95	Yes	85–90
Arkansas	10	892	208			Yes	
Michigan	7	50	300			Yes	50
New Mexico	6/2	250	50			Yes	1
Oklahoma	8	1053				Yes	28
Pennsylvania	11	2500				Yes	68
Virginia	9	1500				Yes	60
Washington	6	1300	300	Yes	30–40	Yes	5
Wisconsin	5	1200				Yes	70
Connecticut	4	400	80–100	No	0	Yes	60
Florida	8	4500	3977	Yes	75	Yes	100
Iowa	6	957	28	Yes	2	Yes	15
Kentucky	12	535	300	Yes	4	Yes	5
Maine	5	340	60	Yes	15	Yes	50
Missouri	7	800	750	No		Yes	2
New Hampshire	6	160	160	Yes	25–35	Yes	25
Ohio	12	2300	500	Yes	5	Yes	20
Utah	4	374	243	Yes	35	Yes	

lack of special expertise (70%) and schedule constraints (65%) were the top three decision factors selected. These were followed by cost effectiveness and lack of certain equipment. Figure 3.3 provides a graphical summary of the selected decision factors driving the outsourcing of inspection activities.

3.1.1 In-House Staffing Capacity

The surveys and additional comments provided by STAs confirm that the decision to outsource testing and inspection activities is primarily driven by limited in-house staffing capacity. Often, the STA does not have the staffing capacity to handle the inspection or testing requirements of all scheduled projects. Outsourcing provides an STA with flexibility to reallocate personnel resources and provide a supplemental workforce to the STAs during fluctuations in work volume due to seasonal or budgetary changes. Some STAs make the decision to outsource in order to reduce the number of in-house laboratory and field technicians or prevent hiring of additional in-house staff to maintain or meet staffing quotas. For example, in 1996, Oregon DOT made the decision to outsource all testing activities with the exception of verification testing in order to reduce in-house staffing levels.

Many initiatives to reduce in-house staffing levels and increase the amount of outsourcing can be attributed to legislative policies or political pressures. Both Florida DOT and the Ministry of Transportation of Ontario are prime examples of a policy driven decision to outsource. Both agencies went through a period of significant government staff downsizing in the 1990s. In the case of Ontario, this was directly attributed to the conservative political agenda during that time.

3.1.2 Lack of Special Expertise or Capabilities

The use of consultants allows the STA to expand its capabilities and expertise in other areas. STAs do not have to maintain the overhead, training requirements or equipment required for any specialized, out of the ordinary, or low frequency test or inspection. Additionally, consultants are used by some STAs to provide testing and inspection outside its normal geographical reach.

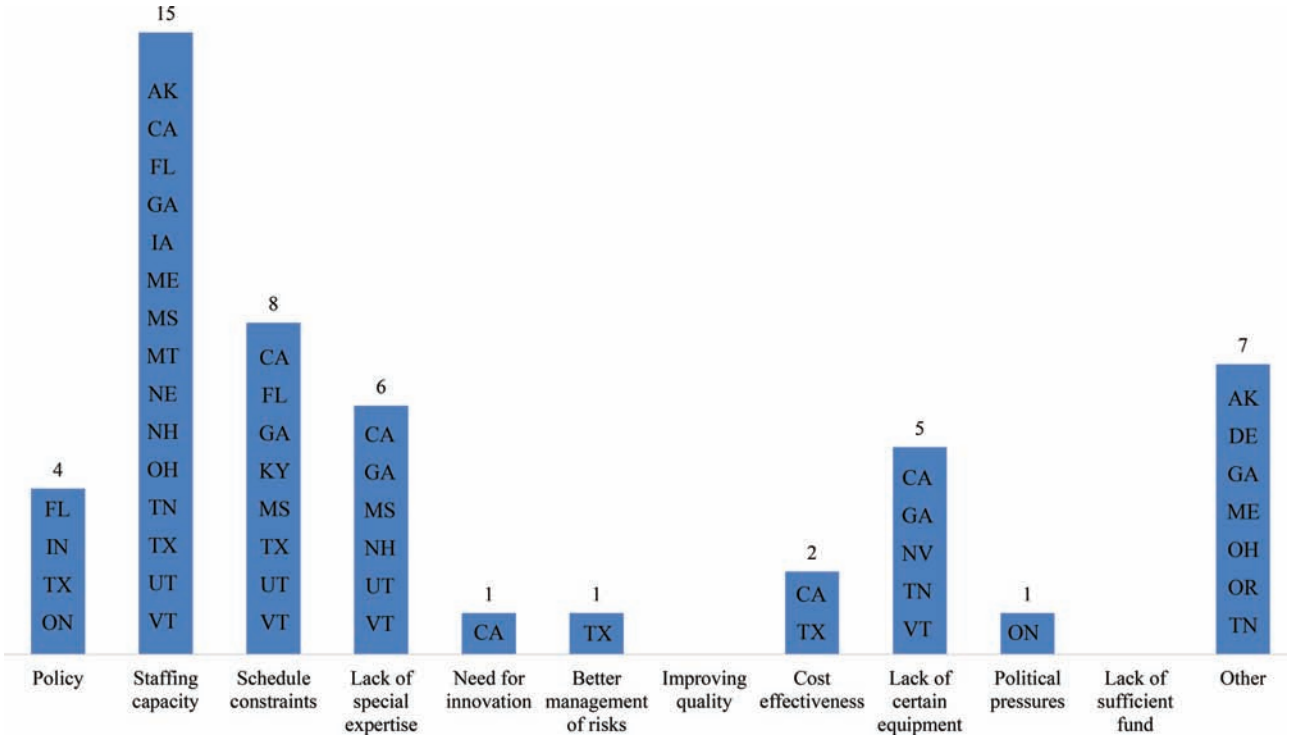

Figure 3.2 Factors driving the outsourcing decision for testing activities.

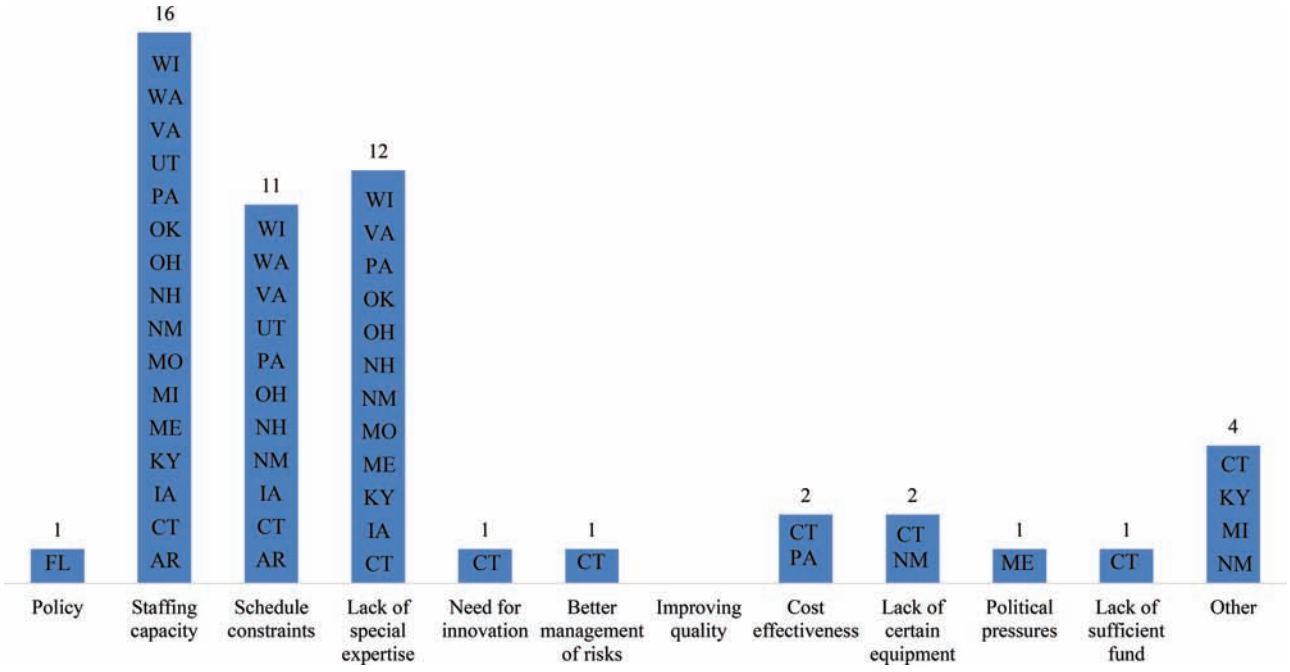

Figure 3.3 Factors driving the outsourcing decision for inspection activities.

3.1.3 Typical Activities Outsourced

In general, consultants are used to fill any role expected of in-house employees. For example, Ohio DOT indicated that supplemental staff outsourced from consultants included general inspector, structural inspector, coatings inspector, traffic signals and lighting inspector, soils and aggregate inspector, and construction engineer. Specialized or low- frequency activities that are outsourced are cable stay inspection, movable bridge inspections, pile driving, underwater inspection, bridge rehabilitation, roadway reconstruction, and testing using strain gauges.

Connecticut DOT does not allow testing firms to perform 100% of the QA functions, but hires testing firms to provide supplemental staff to assist with QA inspection of material that is produced out of state. Furthermore, Ohio DOT claimed that all the activities that are currently outsourced could be better accomplished in-house as the DOT employees took more ownership of the project. In contrast, interviewees from Virginia DOT stated that both in-house and consultant employees maintain the same level of expertise and qualifications and can therefore be assigned the same duties on projects. Sometimes the activities outsourced to consultants are based on level of risk. For example, the interviewee from WSDOT stated that they primarily outsourced lower risk activities to consultants while the DOT staff assumed higher risk roles.

3.1.4 Future Trends of Outsourcing

Several STAs anticipate a slight increase in outsourcing of testing and inspection activities due to expected increases in work volume while maintaining current in-house staff levels. Other factors for an anticipated increase provided by STAs include higher number of retirees with no plans for filling these positions (Connecticut DOT) and changing project delivery methods. The representative from Washington State DOT foresees a probable increase in WSDOT's outsourcing of inspection activities over the next five to seven years in order to meet its staffing needs given the current personnel count placed on STA employees. Furthermore, as WSDOT moves towards 75% of its projects being design-build in which the state only performs verification testing more of the QA process will be completed by consultants. STAs (Virginia and Maine DOTs) expect only minor fluctuations in consultant use that reflect the fluctuations in federal funding. Ohio DOT and Ministry of Transportation of Ontario (MTO) plan to decrease the amount of outsourcing of inspection activities to about 20% in order to rebuild in-house expertise and ensure work force development opportunities for in-house staff.

3.2 Key Concerns and Challenges When Outsourcing Testing or Inspection Activities

The respondents were asked to select from a list of key concerns the STA has when outsourcing testing or inspection activities on construction projects. They were able to select multiple concerns from the provided list and also explain any other concerns (not provided in the list). The list of provided key concerns included:

1. Higher costs compared to performing the same work with in-house staff
2. Consultant's lack familiarity with specific in-house STA procedures
3. Duplication of effort and increased paperwork when monitoring consultants' work
4. Diminished training opportunities for STA employees
5. Salary disparities causing morale problems at STAs
6. Active recruitment of STA employees by consultants
7. Consultants more concerned with protecting themselves than the agency
8. Effort required by STA to maintain consultants' familiarity with in-house processes

3.2.1 Key Concerns and Challenges with Outsourcing Testing

The top concern selected by twenty-two (85%) of twenty-six respondents was the higher costs of outsourced testers when compared to performing the work in-house. The second highest, with twenty (77%) responses, was the concern that consultants may not be familiar with specifications of the STAs. Fifteen (57%) respondents also selected that the monitoring of testing agency's work would require a duplication of effort and lead to increased paperwork for the STA. Figure 3.4 provides a graphical summary of the selected concerns for outsourcing of testing activities.

3.2.1.1 Higher costs. The higher cost of consultants than in-house staff for the same work was the most frequently selected concern. However, it is notable that the higher cost was not listed as a significant challenge to outsourcing. When asked in follow-on interviews with key STAs if the agency had completed a cost benefit analysis on outsourcing of testing, all responded that no official report of that nature had been completed. Florida DOT does track and maintain a record of the costs of CEI and testing outsourcing. FDOT reported the cost of outsourced testing to be 1.5%–2% of total project costs and CEI to be 9.1% of total project costs for 2016/2017. Washington DOT speculated the short-term cost of outsourcing to be about 300% of the cost of completing the same work in-house. However, when the long-term costs (for instance, paying for benefits and retirement) associated with in-house employees are factored in, the costs of outsourcing would be comparable.

3.2.1.2 Lack of familiarity and knowledge of STA procedures by consultants. A common concern among several STAs is the consultants' lack of familiarity with the STA's processes, procedures, and standards. Alaska DOT cited the lack of understanding of federal-aid requirements that the DOT is charged with upholding as well as the role of quality assurance as a major challenge when using external testing companies. Georgia DOT is primarily concerned with the amount of training that must still be provided to consultants to be successful on projects with the DOT. For example, the technicians can pass the written exams but do not have the training required for tests that are commonly required by the DOT on projects. Several STAs (Florida, Ontario) with established outsourcing programs require consultants to attend a regularly scheduled meeting with the agency to review any changes to specifications, policies, or other important updates. Washington State DOT utilizes the resources provided by the Western Alliance for Quality Transportation Construction (WAQTC) to ensure the

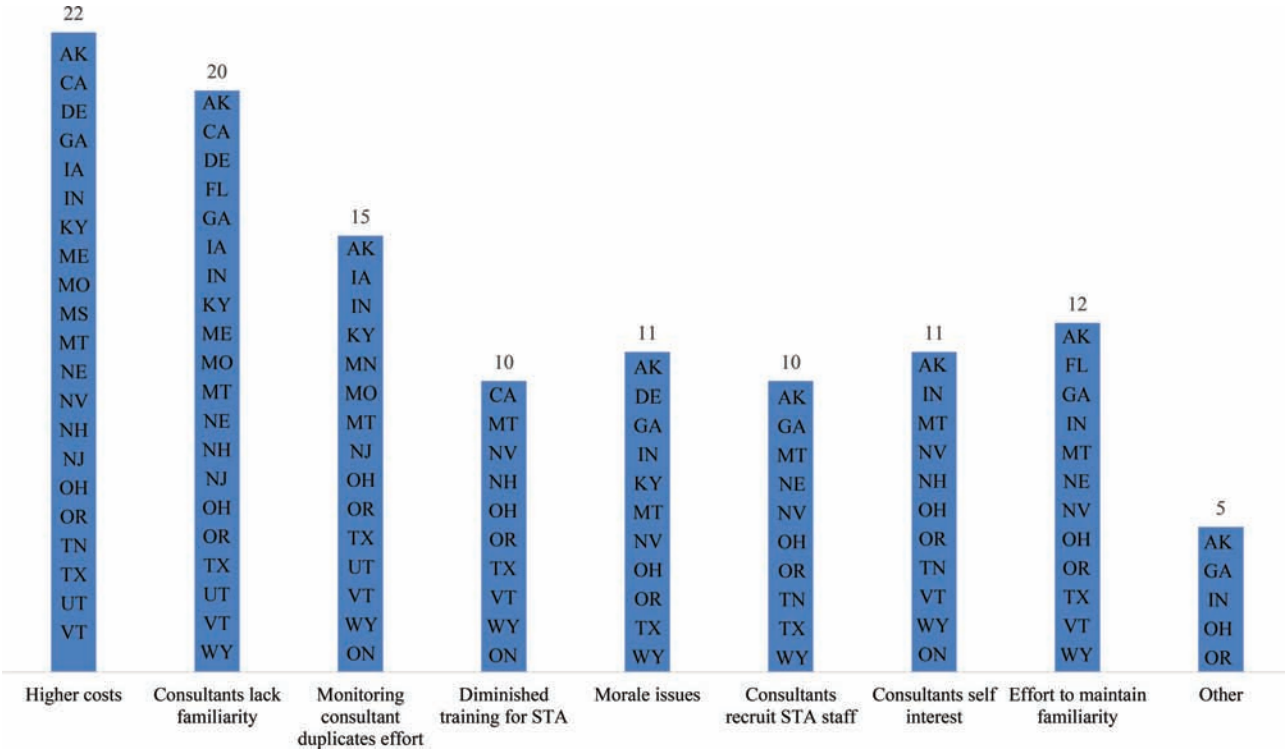

Figure 3.4 Key concerns when outsourcing testing activities.

consultants hired on the agency's projects are familiar with its procedures, perform uniform test standards, and are knowledgeable of the requirements for proper interaction between government agencies and the private sector.

3.2.1.3 Effects on in-house (STA) culture and morale. Over 40% of respondents selected resulting in-house morale issues as a concern with outsourcing testing activities. The Alaska DOT respondent stated that an increase in the amount of consultants causes erosion in the culture within the in-house staff of truly understanding quality assurance and holding contractors to high standards. Additionally, the Alaska DOT stated that the politics involved with outsourcing could cause "cognitive friction" for state employees and make them more likely to seek employment outside the agency.

3.2.1.4 Loss of in-house knowledge. Many of the STAs expressed some level of concern over the potential loss of in-house knowledge and experience that could result from increased outsourcing of testing. As an example, the Georgia DOT respondent described loss of subject matter experts within the DOT that causes problems when investigations result from failed material or critical decisions need to be made at the state level. As a STA increases the amount of outsourcing, the concern over consultant firms' recruiting of STA employees also increases. However, in follow-on interviews, several STAs stated that the recruitment of their former STA employees into consultant positions following any required "cooling off" period had a "net positive impact" to the STA-consultant relationship, since former state employees are already familiar with the STA procedures and performance expectations.

3.2.1.5 Availability of qualified technicians and laboratories. The additional administration requirements for the contracts pose a challenge for some STAs (for instance, New Hampshire). Requirements include; tracking and verifying certifications of each consultant, ensuring consultants meet qualifications for the work as outlined in the bid documents, and managing the contract documents. Additionally, the quantity of available and qualified individual technicians presents a challenge for many STAs. Georgia and Maine DOT described obtaining experienced and qualified technicians in a short time as a challenge since the pool of qualified individuals is diminishing as the districts are all pulling from the same pool for an increasing number of transportation projects. Montana DOT also reports that getting the consultant to understand the contracting process can be a challenge.

STAs with historically high percentages of outsourcing, such as Florida and Connecticut DOTs, have established a robust program with standard procedures to guide consultants through the process of qualification and selection. Several STAs interviewed (Connecticut, Ohio, Maine, and Ontario) also maintain an online database of qualified technicians and/or laboratories to ensure a ready source to fill contracts. STAs with robust outsourcing programs also provide a clear prequalification process to consultants intending to work with the STA. Section 3.5 includes information on several STAs' prequalification programs interviewed in this study.

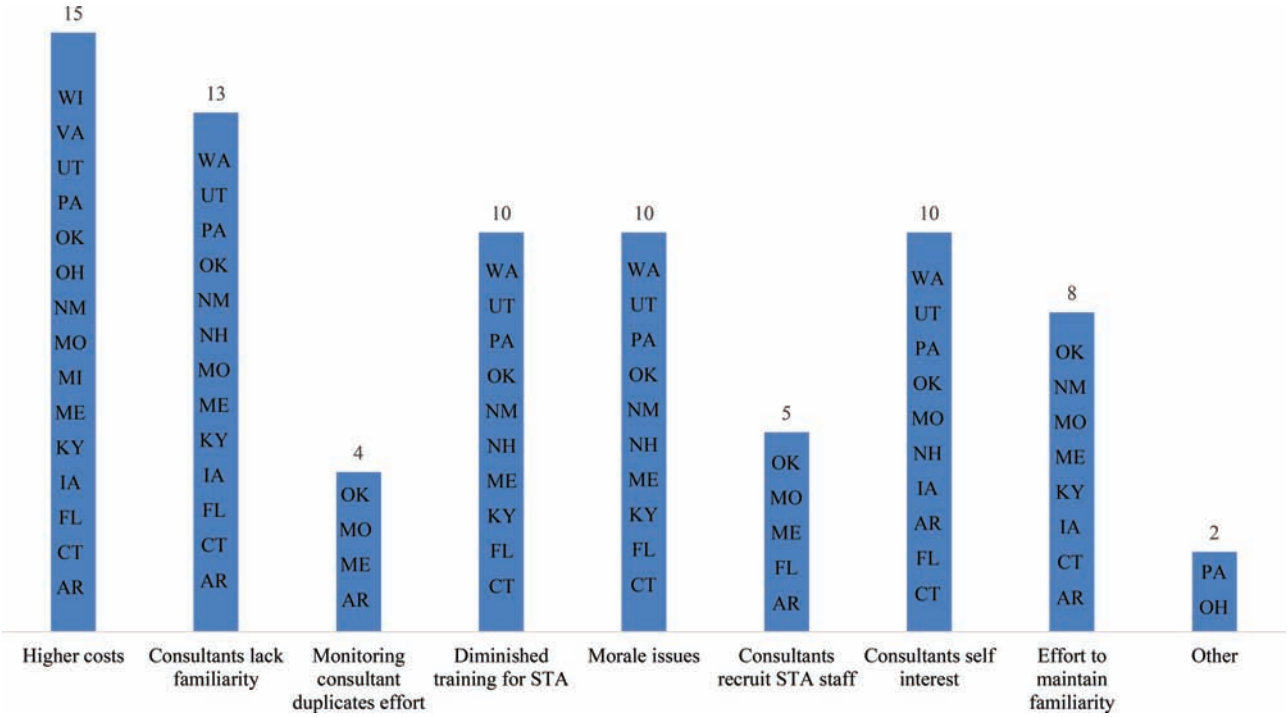

Figure 3.5 Key concerns when outsourcing inspection activities.

New Hampshire DOT is challenged to evenly distribute the work among the contracted consultants to keep them interested in bidding on work and increasing competition. Additionally, New Jersey DOT stated that many of the consultant companies face high turnover rates that can lead to a loss in available technicians. Nevada DOT reported that high turnover rates within consultant firms contribute to inconsistency on project staffing.

3.2.1.6 Conflicts of interest and trust. Many respondents highlighted their concerns over dealing with potential conflicts of interests. Significant measures are taken by STAs (Ohio) to ensure that design, construction management, quality control (QC), and quality assurance (QA) are performed by separate organizations to avoid potential conflicts of interest. Section 3.7 discusses the issues related with conflicts of interests in more detail. Additionally, several responding STAs (Alaska, Delaware, Ohio, and Washington State DOT) voiced concerns over the unwillingness of consultants to take responsibility and represent the agency in the same manner as state employee would.

3.2.2 Key Concerns and Challenges with Outsourcing Inspection

Similar to the results obtained from the testing survey, the top two concerns with outsourcing inspection activities on transportation projects were; the higher costs of outsourced inspectors compared to costs of in-house staff performing the same work, (15 respondents or 88%) and the consultant's lack of familiarity with specific in-house STA procedures (13 respondents or 76%). Other significant concerns were; diminished training opportunities for STA staff, salary disparities between consultant staff and STA staff can cause in-house morale problems, and consultants being more concerned with protecting themselves than the agency. Figure 3.5 provides a graphical summary of the selected concerns for outsourcing of inspection activities.

3.2.2.1 Lack of familiarity and knowledge with STA procedures by consultants. The STAs of New Hampshire, Arkansas, and Iowa cited external inspection agency's lack of knowledge of department policies, procedures, and specifications as a major challenge. Arkansas DOT states that bringing the consultants up to the same efficiency level as in-house employees takes a tremendous amount of effort and training. The lack of familiarity and knowledge puts a burden on some STAs (for instance, Oklahoma, New Hampshire, Utah, Virginia, Connecticut, and Arkansas) that must bridge the gap through additional training and monitoring of the consultants' work.

3.2.2.2 Lack of qualified inspectors. Several STAs (for instance, Connecticut, Florida, Iowa, Maine, Michigan) responding to the surveys stated that the demand for qualified consultant inspectors often exceeds the available pool. Both the Pennsylvania and Wisconsin DOTs listed consultant firms changing the team actually assigned to the project after the proposal as a challenge.

3.2.2.3 Loss of in-house knowledge. The Washington State DOT (WSDOT) is concerned about the long-term knowledge and experience gap that may occur from

increased outsourcing. The increased use of consultant inspectors may also affect WSDOT's long term staffing as the outsourcing prevents key WSDOT entry-level staff from engaging in professional development activities. Similarly, increased outsourcing can adversely affect retention of state employees as they focus more on contract oversight rather than on engineering and inspection activities. The Ontario Ministry of Transportation plans to buffer against the loss of in-house knowledge by retaining 20% of inspection work in-house. Additionally, the ministry believes retaining that knowledge in-house is essential to be able to relate to owners and contactors because the staff would retain the necessary technical competencies related to the project.

3.2.2.4 Conflicts of interest and trust. Similar to the concerns with testing, respondents included concerns over potential conflicts of interests and the challenge of dealing with such issues. Section 3.7 discusses in more detail the issues related to conflicts of interests from respondents and interviews. The Pennsylvania DOT stated labor union agreements as another issue of concern when outsourcing.

3.2.2.5 Undefined levels of responsibility. Several STAs discussed the challenge of providing the right balance of in-house staff to oversee consultant staff assigned to a project. Washington DOT received reports from some contractors that the consultant inspectors do not always provide the same timely, direct responses that a WSDOT inspector would typically provide. Similarly, Missouri DOT stated that outsourcing inspections that 'require judgment calls' are a challenge because the outsourced company or individual inspector is reluctant to make decisions that could incur liability. This reluctance by the consultants results in duplication of effort where the STA still has to be involved with the inspection, and could result in delays to projects. Florida and Washington State DOT highlighted the importance of clearly defining the levels of authority for both the consultant and in-house staff to avoid delays associated with decision-making authority on projects.

3.3 Opportunities When Outsourcing

The most common advantage for both testing and inspection were the reduced workload for in-house staff and ability to handle fluctuations in workload. A popular advantage of outsourcing among the STAs was the ability to reduce in-house staff or create better flexibility in allocating in-house staff. Another commonly shared advantage identified was the elimination of over-staffing of full-time employees during downtime. Workload fluctuations generally occur due to seasonal construction or fluctuations in project funding.

Outsourcing of testing and inspection activities often provides STAs with a wider pool of experienced and qualified technicians and inspectors. The consultant firms provide specialized inspection and testing services for stay bridges, geotechnical investigation, paint coatings, and pile driving. Outsourcing these particular services eliminates the need for STAs to retain specialized inspectors or technicians as full- time employees with the associated benefits and overhead costs. The consultant firms also provided exposure of STA employees to new perspectives, and different or innovative approaches of inspection. As a result of accurate and timely acceptance testing of materials through consultants, construction delays are avoided. Moreover, outsourcing certain tests enables the STA to expand its testing capabilities and open lab space for other tests.

3.4 Resources Available to the STA in Conducting Material Testing and Inspection

State Transportation Agencies (STAs) provided information on the resources available to conduct materials testing or inspection by using only in-house staff. The resources are separated into two main categories: personnel, and facilities, laboratories and equipment.

3.4.1 Personnel

Generally, all STAs provide qualified, in-house staff for testing and inspection to construction project sourced from resident construction engineering and materials staff. STAs provide staffing up to the levels allowed by funding or established by staffing policy limits. As discussed in earlier sections, STAs are often limited by legislation or other pressures to not exceed certain state employee numbers. Therefore, some STAs, such as Georgia DOT, only maintain a core group of personnel to retain knowledge capacity in-house and enable decision-making by managers with a high-level of experience in materials testing and inspection. Oregon DOT only maintains personnel to perform verification, independent assurance and third-party testing.

3.4.2 Facilities, Laboratories, and Equipment

STAs organize their material testing programs differently across district and central labs. Additionally, STAs may choose to maintain different certifications for each lab or prescribe specific tests or materials to be tested at each lab. For example, in Georgia DOT, four of its six branch labs are AASHTO certified in different areas and its central lab maintains AASHTO certification in multiple areas. As contractor QC increases, many STAs have reduced the amount of in house testing. For example, New Hampshire only maintains a central laboratory staffed with DOT supplied equipment to perform acceptance or independent assurance (IA) testing. Likewise, the Ministry of Transportation of Ontario only maintains a central lab as a third party or "referee" lab to resolve disputes. In additional, New Hampshire DOT field staff perform acceptance testing with field equipment and laboratories supplied by the contractor as part of the project. Oregon DOT maintains five regional laboratories for verification testing and one central lab for third party testing. In most cases, necessary

equipment for testing and inspection is provided by the STA. In some cases (New Hampshire DOT) the contractor will provide the necessary on-site testing equipment to in-house staff at the project site.

3.5 Resources Available to the STA for Outsourcing (Training and Prequalification Programs)

STAs also provided a list of resources that are available to the agency for outsourcing testing and inspection activities. Since outsourcing brings additional requirements in terms of contract administration and training, the responses are separated into the following categories: defined contract administration and prequalification processes; training programs; and facilities, laboratories, and equipment.

3.5.1 Defined Contract Administration, Prequalification, and Evaluation Processes

A responsible, responsive and well-defined contract administrative program is vital for a successful testing and inspection outsourcing program. Most STAs manage the process through well-established procedures. For example, Connecticut DOT follows its Consultant Selection Office Procedures Manual to guide the consultant contract process and ensure a fair and quality program. The Ministry of Transportation of Ontario developed a Construction Administration and Inspection Task Manual (CAITM), which specifically outline the requirements for construction administration from the time of contract award to the final project deliverables (Ontario MTO, 2012).

Some STAs have robust prequalification programs established for consultants wishing to provide testing and inspection services to the STA. Many of these STAs maintain information readily accessible to consultants on the agency's website or through published documents. For example, Connecticut DOT publishes a document called the Construction Engineering and Inspection (CEI) Information Pamphlet for Consulting Engineers that describes the functions and responsibilities of consulting engineers providing services for the department. In the case of Connecticut DOT, the information specifically targets consultant construction engineering inspectors. However, many STAs use one document to outline the administration of all professional services contracts, which may be too general for actual control of outsourcing testing and inspection. These established documents ensure the consultants are aware of required qualifications, their role, the contacting process and many other aspects required for a quality and smooth program.

Additionally, the STA provides knowledgeable in-house personnel to monitor and manage the consultants and ensure compliance with the terms and conditions of the contract. Many STAs have a formal process to evaluate and track the performance of consultants on projects. For example, Florida DOT outlines in the department's consultant guide (FL 14-75.0052) a professional consultant work performance evaluation system that provides evaluation throughout the duration of the contract. The FDOT project manager is responsible for evaluating the consultant in the categories of schedule, management, and quality with ratings on a 1 to 5 point scale (1 = poor performance; 5 = outstanding performance). These systems increase accountability of consultant work and also provide a means to quantify the performance of consultants and increase quality. Most often, the results of the performance evaluations impact the future selection of consultants on STA contracts (FLRules, 2006).

3.5.2 Training Programs

Many of the STAs interviewed described the continued need to provide extensive training to consultants. The training generally serves two purposes. The first purpose is to provide training to the consultants on applicable STA processes and procedures. The second purpose is to satisfy technical requirements and qualifications by providing training on properly performing the testing or inspection activities. When the Ministry of Transportation of Ontario implemented outsourcing as a policy, it anticipated industry would pick up the training requirement but quickly found out that it would have to continue providing the required training. Florida DOT (FDOT, 2015) established the Construction Training and Qualification Program (CTQP) in order to train and qualify consultants and employees to perform the work required by FDOT construction contracts. The CTQP also includes the Training and Qualification Data Base System (TQDBS) containing all the certificates of training completed by consultants through the FDOT recognized CTQP. FDOT retains direct control of the content and implementation of the CTQP in order to ensure uniformity of certification standards and the overall success of the consultant program.

Additionally, many of the STAs (Ontario, Maine) hold regularly scheduled meetings (annually) with consultants to provide consultants with updates on STA policies, procedures, guidelines, specification changes, and relevant information needed to be competitive for bidding on future projects. These meetings may also highlight additional training requirements for consultants working on STA projects. STAs have also found it useful to provide the consultants with documents to assist the consultant in carrying out inspections and testing to the correct standard. As a minimum, these documents include DOT specifications and construction manuals. Some STAs have also created more in-depth manuals to outline specific inspection or testing procedures that must be followed. The Ministry of Transportation of Ontario developed the Construction Administration and Inspection Task Manual (CAITM) as a means to control quality on construction projects. The manual consists of all the inspection tasks and serves as a checklist to assist the inspector (consultant) to ensure all work is completed in accordance with Ministry specifications, standards and procedures (Ontario MTO, 2012). CAITM also

clarifies what is expected from consultants and can help them when bidding for work with Ministry of Transportation of Ontario (MTO).

Several STAs work directly with regional or outside agency quality and certification organizations. For example, Washington State DOT is a member of a regional training organization called the Western Alliance for Quality Transportation Construction (WAQTC). This organization is dedicated to the pursuit of improving quality in transportation construction through standardizing test methods, accreditation of samplers/testers, and working through partnerships on significant national programs of research, training and technology deployment (WAQTC, 2017). The WAQTP also includes the Transportation Technician Qualification Program (TTQP) and the Laboratory Qualification Program (LQP). These programs ensure consultants are fully qualified and all laboratories that perform materials testing meet specific qualifications and requirements. Another example of leveraging outside resources to conduct training and certifications is the MTO's involvement with the Canadian Council of Independent Laboratories (CCIL) that works to certifies both lab technicians and laboratories. The MTO also works with the Ontario AOCETT (Ontario Association of Certified Engineering Technicians and Technologies) to ensure certification and training of consultants.

3.5.3 Facilities, Laboratories, and Equipment

The consultant firm provides the laboratories and equipment required in the contract. However, the STA may provide the STA facilities and laboratories to the consultant if the consultant is hired as additional or supplemental staff to the in-house staff. The STA may also provide computers and other information technology (IT) requirements to the consultant. This is generally always the case when STAs hire consultants as supplemental staff to state employees.

3.6 Outsourcing Independent Assurance

The FHWA under 23 CFR 637 (2011) requires each State Department of Transportation (DOT) to establish and maintain an Independent Assurance (IA) program as part of the overall quality assurance (QA) program. The IA program is defined as the activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program. The STAs were also asked to provide information about their IA practices, specifically, whether the STA performs IA in-house or by using consultants. Over 90% of the responding STAs selected that IA is completed in-house. The respondents were limited to select either "In-house" or "By-consultant" and not both. Therefore, it is possible more STAs would have selected both if it were an option. For example, Washington, Virginia, and Ohio DOTs selected that IA is completed in-house but also stated that the selection is based on the type of project delivery method.

3.7 Addressing Conflicts of Interests

The survey sought information about the methods adopted by the STAs to address conflict of interest. Although respondents from Washington State DOT, New Hampshire DOT and Virginia DOT noted that conflicts of interest are rarely observed, various methods have been put in place by the other STAs as a measure to address conflicts of interest. The respondent from WSDOT noted that conflict of interest is largely associated with design-build projects. Similarly, the interviewee from Virginia DOT conveyed that careful attention was given to projects where consultants were also involved in the design. In addition, many STAs developed policies to safeguard against any conflicts. In Kentucky, consultants are required to sign a conflict of interest document. Other STAs including those of Georgia and New Jersey mitigate conflict of interest issues by performing QA in-house.

Prequalification requirements of the Alaska, Maine, Missouri, and Wisconsin DOTs forbid appointed consultants from assuming any other role on the same project. This requirement is in accordance with the FHWA Compliance Assessment Program (CAP) that disqualifies an agency from performing testing for both the DOT as well as the contractors on the same project. Moreover, the consultants of Virginia DOT are required to notify the DOT about any potential conflict of interest for de-confliction. Ohio DOT defines conflicts of interest in the department's Specifications for Consulting Services and requires consultants to identify potential conflicts to the agency. Additionally, Ohio DOT established a formal conflict of interest waiver process for consultants and to ensure consistent application of the department's conflict of interest policies.

3.8 Realized Cost Savings or Benefits

The respondents were asked whether they had realized any cost savings, for both hot mix asphalt (HMA) and Portland cement concrete pavement (PCCP), through implementation of contractor quality control, independent assurance procedures (IA), certification practices, outsourcing of inspection and testing, lab practices, or inspection by STA personnel. The survey revealed that very few state transportation agencies realized cost savings or benefits from outsourcing testing or inspection activities. Findings from the survey are provided in Figure 3.6 and Figure 3.7.

The majority of respondents (15) identified contractor quality control as a key means to provide cost savings for HMA testing. Other methods identified to provide cost savings, in order, were testing certification practices (14) and independent assurance procedures (12). While in the case of concrete testing, IA (12), testing and certification practices (11) and, contractor quality control (10), were the top three methods that provided cost savings. Only four respondents (California, Florida, Maine, and Ontario) stated that their STA realized cost savings for both HMA and concrete by outsourcing

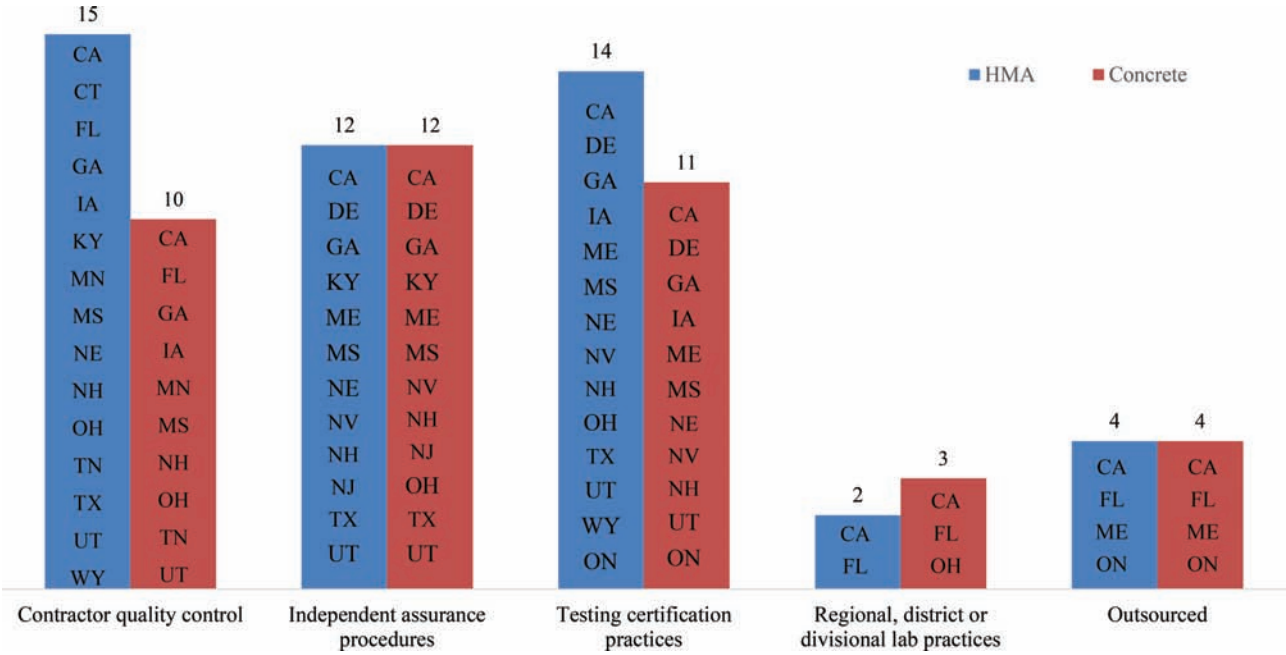

Figure 3.6 Cost savings or benefits realized through different methods for testing.

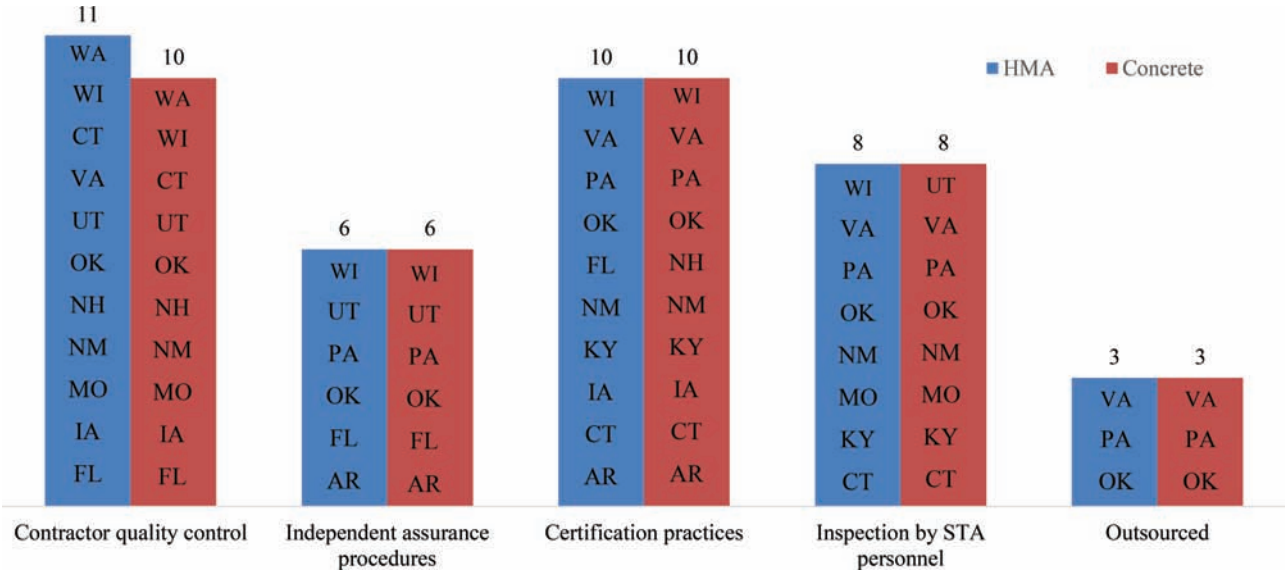

Figure 3.7 Cost savings or benefits realized through different methods for inspection.

testing activities. The respondent from Alaska DOT reported that outsourced staff cost more compared to in-house staff and did not provide any additional cost savings or benefits, apart from supplementing staff.

Similar responses were received in the case of cost savings realized through outsourcing of inspection activities. Only three respondents stated that outsourcing of inspection of HMA as well as concrete provided cost savings. The top three alternatives that provided cost savings for both HMA and concrete were contractor quality control, certification practices and inspection by STA personnel. It was observed from the responses that contractors were inherently responsible for quality and including contractors in the quality control process can increase the quality of the product.

Interviews with STA personnel indicated that cost savings from outsourcing of inspection and testing activities could not be quantified, since it is difficult to differentiate cost savings obtained by outsourcing activities and that obtained through other sources. However, the interviewee from Florida DOT claimed that the Construction Engineering and Inspection (CEI) services cost for the fiscal year 2016/2017 was 9.1%, which was lower when compared to the CEI cost in the past six

years. Further, the cost of outsourcing testing activities at Florida DOT was estimated to be 1.5%–2% of the total project cost. Interviews with WSDOT and the Ministry of Transportation of Ontario revealed that, although the cost of consultants is higher, reduction of overhead costs due to reduced in-house staff provided savings. In addition, a short-term gain was that DOTs could reduce expenditure on training of in-house staff.

3.9 Optimizing Sampling Frequency for Cost, Importance and/or Risk

The respondents were asked if the frequency of materials sampling was based on initial cost, life cycle cost or risk of failure and to explain how the STA optimizes the sampling or inspection frequency. Close to 50% of the responding STAs optimize sampling frequency based on risk of failure and initial cost for testing. On the other hand, it was found that about 30% (5) of the responding STAs based the frequency of sampling for inspection activities on risk of failure. Certain DOTs also reported other factors upon which the frequency of material sampling was determined. For instance, Oregon DOT and New Hampshire DOT base their frequency of sampling on the guidelines provided by Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO). Montana and Missouri DOTs have established a risk-based matrix of "possibility of failure" versus "consequences of failure" to determine the sampling frequency. Other factors considered by DOTs to determine the sampling frequency include historical results, material type, importance of route, volume of traffic on the route, and quantities of material provided. A risk-based prioritization approach has been described by Yuan et al. (2018) to allocate the limited resources of the STAs to the critical inspection items. The two aspects of risk assessment were: (i) possibility of not meeting the specification requirements and (ii) severity of consequences of not meeting the specification requirements (Yuan et al., 2018). The study involved narrowing down of inspection items to a core set based on interviews and survey responses of experts from the domain (Yuan et. al., 2018). The resulting list of prioritized inspection items facilitated the optimization of resource allocation for inspection (Yuan et al., 2018).

3.10 Measuring Quality of Workmanship and/or Materials

The survey asked if the STA measures the quality of workmanship and materials. Title 23 of the Code of Federal Regulations (CFR) 637 requires the state agency's quality assurance program to include measurement of *both* quality of workmanship and materials. Over 84% of the responding STAs measure both workmanship and materials. On the outsourcing of testing survey, four STAs (Alaska, Kentucky, Montana, and New Hampshire), reported measuring the quality of materials only. On the outsourcing of inspection survey, one STA (Florida) reported measuring the quality of workmanship only, and two STAs (Washington and New Hampshire) reported measuring the quality of materials only. New Hampshire DOT only observes workmanship but does not measure quality of materials. Likewise, Washington DOT only verifies contractual compliance of workmanship and does not have a process in place to actually measure workmanship quality. Florida reported inspection of workmanship only since consultants provide reports related to materials sampling and testing and quantity measurements of work completed.

3.11 Frequency of Review for Quality Assurance (QA) Practices and Procedures

The survey asked how often the STA reviews their quality assurance (QA) practices and procedures in the four categories of: (1) workmanship standards, (2) acceptance limits, (3) prescriptive work practices and, (4) sampling frequency. Close to 75% (18) of the responding DOTs do not have a fixed period of review for their QA procedures for testing. In contrast to the majority of respondents, Minnesota and Nevada DOTs review their QA practices and procedures for acceptance limits, workmanship standards, prescriptive work practices, and sampling frequencies, annually. Similarly, Iowa DOT reviews its QA procedures for testing on a bi-annual basis. The respondent from Georgia DOT revealed that sampling and testing discrepancies from each district are reviewed monthly where in material certificates are reviewed along with letters of disposition for failing or untested materials that were accepted by the project engineer. The Oregon DOT has a Quality Program document and Manual of Field Test procedures that is updated annually and approved by a steering committee. However, changes are also made to these documents on an as-needed basis. Similarly, in Ontario, there is no specified frequency of review of QA procedures for testing. Instead, a review is generally triggered by a reaction to any issues that may arise.

Around 65% (11 out of 17) of the responding DOTs do not have a constant frequency for the review of their QA practices and procedures for inspection. Of the seventeen respondents, only Florida DOT, Michigan DOT and New Mexico DOT review the QA procedures and practices with respect to acceptance limits, workmanship standards, prescriptive work practices and inspection frequency, on an annual basis.

3.12 Testing, Acceptance, and Innovative Methods

Sixty-eight percent of the respondents were exploring innovative methods for testing of HMA. The responses revealed that the primary significance of adopting any testing approach was accuracy of result. Time taken to conduct and obtain the results of a test was the second factor considered while implementing a method for testing, In-place density approach was reported as the most popular innovative testing method, providing reduction in time, cost, and staff while providing accurate results. Smoothness approach was the next most reported

innovative testing approach. Some of the other innovative testing approaches being explored are intelligent compaction, performance-based tests like Hamburg wheel test, bending beam rheometer (BBR) test for mixes, and semi-circular bending beam (SCB) test. Ground penetrating radar (GPR) is currently used in Alaska for total mat density and longitudinal joint density.

There were fewer responses for innovative testing methods for PCCP than those for HMA. Only nine (36%) of the twenty-six respondents indicated that the agency is exploring innovative testing for PCCP, most likely due to geographic location of some DOTs that limit or eliminate the use of PCCP as a pavement option. An example is Alaska DOT, which does not use PCCP. Overall, most approaches focus on the results obtained from the innovative testing. Utah DOT is exploring the use of Super Air Meter (SAM) and has incorporated the use of surface resistivity test. Georgia and Iowa DOTs are exploring the use of non-destructive testing by maturity meters to reduce the number of concrete cylinders.

The respondents were asked to select innovative acceptance methods used by the STA for testing and inspection. Warranty contracts, 3D design modeling and intelligent compaction were reported to be the most popular. The use of quality checkpoints, requirement verification, and risk profiling were the next most commonly reported innovative acceptance approaches for inspection. However, less than 16% of the respondents implemented these acceptance approaches for testing. In Florida, a two-year warranty contract bond is required on latent defects in construction. In the case of HMA, the warranty is for three years. While the warranty required for PCCP, bridge components and special products is for five years. Oregon DOT and CTDOT have been trying to pilot the use of intelligent compaction for asphalt testing. Utah DOT has been implementing intelligent compaction in a limited number of projects. New Mexico DOT is actively working on intelligent compaction and 3D modeling approaches for acceptance. Maine DOT reported the use of intelligent compaction on a trial basis and noted the benefits realized were not significant enough to change the specifications of inspection. In addition, the use of 3D modeling for inspection provided increase in efficiency and decrease in rework. Consultants of VDOT (Virginia Department of Transportation) use drones on some projects. However, the interviewee from Virginia DOT stated that return on investment from the use of drones had not materialized. The respondents from Virginia DOT and Florida DOT believe that the consultants are ahead of the STAs in incorporating technology to expedite the inspection process.

3.13 Failed Materials

Respondents were asked if their STA allows materials or workmanship that fail testing or inspection to remain in place and to list the factors used in that determination. If failed materials or workmanship were not allowed to remain in place, respondents were asked to explain how the STA addresses delays associated with removing and replacing the material or work. In additional, respondents explained how a failed test or inspection affects the future use of a supplier's product or a contractor's work on construction projects within the state.

3.13.1 Failed Materials or Workmanship during Inspection or Testing

Eighty-two percent (82%) of respondents on the inspection survey and all respondents on the testing survey stated their STA does allow material or workmanship that fails inspection to stay in place. Generally, allowing material to stay in place is the exception to the rule and it is up to the STA to pragmatically determine if the material or workmanship should be removed or allowed to stay in place. In most instances, if the STA does make the determination to allow the failed work or material to stay in place, there is a corresponding deduction in payment or even no payment made to the contractor. Only three respondents, Connecticut, New Hampshire and Pennsylvania DOTs, stated that they did not allow material or workmanship that failed inspection to remain in place.

There are many considerations that can influence an STA's decision to allow the failed material or workmanship to stay in place. First, several STAs reported considering the extent of failure or how far the material or workmanship is out of specification. If the failed material is determined to be within tolerable limits of the specification, then the material is accepted and allowed to stay in place, usually with a price adjustment. In addition, the risk of failure in terms of failure and safety are considered, through an engineering review and investigation. The potential impact that replacing material may have on the traveling public in terms of additional traffic control and schedule delays may also impact the decision. The impracticality of replacing the material in terms of added schedule was cited as a decision factor by several STAs. The long-term performance or lifecycle costs of allowing failed material or workmanship to remain in place are also considerations. Payment adjustments for failed material left in place may be adjusted to reflect a shorter life cycle or offset anticipated added maintenance costs in the future.

In general, when failed material or workmanship is not allowed to stay in place, the replacement is completed at no cost to the STA and liquidated damages are typically accessed on the contractor. In most cases, no change orders are granted to extend the project time, and therefore any delay is solely the responsibility of the contractor. New Hampshire DOT on occasion does provide additional time but no compensation to the contractor for the period of time the STA takes to determine the course of action for failed material or work.

3.13.2 Failed Material or Workmanship's Effect on Supplier or Contractor's Future Work

The effect of failed inspection or testing of material or workmanship on the future use of a supplier's product

or contractor's work varied greatly across the responding STAs. Responses varied from no effect to having the supplier's product removed from a pre-acceptance list for two years (Missouri DOT) or removal of the contractor from pre-qualification. However, most responses indicated that repeated failure of material or workmanship could affect the bidding privileges of the contractor and even cause the removal of the contractor from the prequalification list. Similar to the Missouri DOT, in Arkansas DOT, the product that failed testing will be removed from the Department's Qualified Products List (QPL). If a pattern of failure occurs by a supplier or contractor in California, the DOT takes action by requiring QC plans, third party certification and redesigned mixes depending on the material. Similarly, in Georgia DOT, the supplier or contractor may be removed from the Qualified Product List (QPL) and put under an improvement plan where they are monitored more closely. Several states such as Washington and Virginia have contractor performance evaluations for each project that encourage contractors to reduce failure rates and adhere to specifications. New Mexico DOT developed an innovative prequalification program for contractors that objectively measures six separate criteria used in calculating a pre-qualification factor. This process directly rewards good performers and encourages poor performers to improve (NM DOT Time 18, Chapter 27, Part 5). One performance factor, *disincentives*, is a performance measurement of a contractor's quality of work related to certain contract items. Disincentive accounts for 30% of the overall prequalification factor so any failed material or workmanship directly affects the future work of the contractor for the state.

4. EXPERIENCES OF CONSULTANTS INVOLVED WITH INSPECTION AND TESTING ACTIVITIES AT INDOT

The Study Advisory Committee (SAC) and research team developed a questionnaire (see Appendix C) geared towards consultant companies currently providing inspection services to INDOT. The responses from the questionnaire provide insight into the consultants' qualifications, resources, and value added to the STA. The responses also provide an understanding of the consultants' perspective on the services provided. The questionnaire was sent to 14 consultants having construction inspection contracts with INDOT. Responses were received from 10 consultants (see list in Appendix D), with a portfolio of INDOT projects ranging from 5%–40% for Portland cement concrete pavement (PCCP)-related inspection activities to 10%–50% for hot-mix asphalt HMA-related inspection activities. In addition, the consultants also provided inspection services for other activities such as bridge rehabilitation, bridge construction, and inspection of soils, embankments, subgrades, utilities, sewers, sign replacement, sidewalks, pipes, and ramps.

4.1 Value Added by Consultants and Expertise Provided Solely by STA Employees

In alignment with the responses from the surveys, the consultant firms cited the flexibility in staffing and provision of supplemental staff as an added value when activities are outsourced by STAs. Consultants provide STAs the resources to test materials on an as-needed basis and expand the geographic reach of the STA. In addition, since consultant firms also provide services to other local clients, the consultants have a more diverse background in transportation related projects and are often certified and cross-trained for different types of inspections. While most of the consultants are likely to suggest innovative or alternate methods of inspection to the STAs, they are restricted to the testing procedures and equipment that are standardized across the industry or specified in the contract. Since the contractor determines the work process and project schedule, the consultants' ability to implement alternate methods is limited. Thus, consultants are more likely to suggest alternatives to the design rather than alternatives in inspection methods. However, consultants may have access to designers in specialty areas, and can provide constructability alternatives. The consultants are more adept with current technology and have better access to advanced equipment compared to the STA. For instance, thermal imaging cameras, Pavement Quality Indicator (PQI) density meters and, nuclear density gauges are widely utilized by consultants. On specialized inspections like bridges, consultants often have access to advanced technology that may not be available to STAs.

Although consultant firms do not actively seek to hire active STA employees, they often hire retired STA staff due to their experience and familiarity with INDOT procedures. Most consultants stated that their firms had detailed knowledge of INDOT procedures through former INDOT employees who are presently working for the consultants. Between 3% and 90% of former STA employees constitute the current staff strength of the consultant firms.

4.2 Cost Savings Provided by the Consultants

The most common cost savings are attributed to reduction in STA staff. Hiring a consultant firm eliminates the need for a field office in areas where consultants have local offices. Moreover, the consultant firms minimize overtime and increase efficiency by having a single staff member working on multiple projects. Through effective communication with both the owner and the contractor, and proper record keeping, the consultants can produce the final construction record well within the timeframe, which in turn produces cost savings by reducing billable time. Cost saving alternatives of work procedures and specifications proposed by experienced consultant staff have generated cost savings for the STAs. For example, a consultant firm appointed for inspection of a roadway reconstruction project in Warrick County, Indiana, suggested an

alternative to avoid conflicts in the elevation of the roadway and proposed side ditches of a pipeline. The alternative with revised ditch grades eliminated relocation of the pipeline and saved approximately one million dollars of reimbursable cost of relocation. Across the responses provided by the 10 consultants, consultant firms claimed to have provided INDOT with cost savings ranging from $80,000 to $1,000,000 or 10% to 30% for a single project. The consultants determined these cost savings by comparing the actual cost and budgeted cost. For instance, by comparing the actual fee of the consultant staff with the budgeted cost for staff on a project.

4.3 Risk Factors Considered by the Consultant Firms Providing Inspection Services

The consultants consider various risks associated with the size and complexity of a project while assigning staff to DOT inspection activities. These risks include project location, safety of public and employees, optimum utilization of personnel, expense of certifications required, liability for decisions made in the field, volume and maintenance of traffic, potential claims of damage resulting from actions taken under direction of the consultant inspection staff or in the event of an on-site accident. The consultants also have to plan and manage staff adequately in order to avoid carrying staff as an overhead cost between project assignments. Storage of hazardous materials is another risk factor reported by a consultant when considering the costs and safety aspects of projects they inspect for INDOT. For instance, use and storage of nuclear density gauges pose potential health risks that can be costly to mitigate. Moreover, the United States Nuclear Regulatory Commission (USNRC) has stringent requirements for licensing, securing, monitoring, and disposing of nuclear material and nuclear waste, which can be expensive. Hence, many consultants are replacing tests using nuclear density gauges with dynamic cone penetrometer (DCP) and lightweight deflectometer (LWD) tests. These tests also eliminate the cost of maintaining and administering a nuclear density gauge program.

4.4 STA Controls to Oversee Consultants' Inspection Work and Ensure Quality

INDOT requires qualifications and certifications for the consultant personnel performing inspection. For instance, a consulting firm performing construction inspection must have at least one technician who is certified as per INDOT's Certified Technician Program (CTP) or INDOT's Highway Technician Academy. In addition, the technician must have a minimum of one-year experience in performing material testing and sampling on road, bridge and/or signalization construction projects (INDOT, 2015). The technician must also possess the ability to pass written and proficiency tests for INDOT's Qualified Technician Program for Construction personnel. Furthermore, INDOT Consultant Prequalification Manual (CPQM) requires that, for prequalification, the consulting firm must have at least one employee meeting the criteria for a supervisor. The supervisor must be a Licensed Professional Civil Engineer, graduated from an accredited college with a B.S. in Civil Engineering or be certified as per INDOT's CTP or INDOT's Highway Technician Academy. Additionally, the supervisor must have a minimum three years of experience in supervision of administration of and performing material sampling and testing of road, bridge, and/or signalization construction projects (INDOT, 2015). Basic computer skills and proficiency with INDOT's Construction Records Application or SiteManager software is required in addition to passing the written or proficiency tests for INDOT's Qualified Technician Program (INDOT, 2015).

The consultant engineers regularly communicate with INDOT's Area Engineer for the project, and inform INDOT project engineers of any change orders. On projects where the INDOT project supervisors/engineers are on site, the consultants communicate with them face-to-face on a daily basis. Consultant project engineers interact with the area engineers either bi-weekly or weekly via email, phone calls, text messages, SiteManager program, or progress meetings.

The consultant engineers have responsibilities similar to those of the INDOT project engineers, which include verification of INDOT specifications and requirements. INDOT has a scoring system for consultants on LPA (Local Public Agency) projects, which is linked to the quality of work. The categories of evaluation are: 1) past performance, 2) capacity of team to do work, 3) team's demonstrated qualifications, 4) project manager, and 5) approach to project. The scoring systems affect the selection of the consultants on future LPA projects. Similarly, INDOT has established a scoring and evaluation process for consultants on INDOT projects. The evaluation of consultants on INDOT projects is discussed in Section 5.3.2.

4.5 Improving Quality and Schedule on a Project

Most of the consultants mentioned that they have well trained and highly experienced staff assigned to inspection activities. In the interest of verifying test results and ensuring quality, consultant firms may perform more than the required number of tests provided in the INDOT frequency manual. The consultants strive to maintain positive working relationship with the contractors and effectively communicate to maintain and improve quality of the project. In addition, the consultants provide regular training to the inspection staff through in-house training. Training may also be offered by INDOT. The typical training topics are construction safety, new INDOT policies or areas of concern, and construction lessons learned. Consultants also encourage their staff to seek and attend training conferences such as INDOT Stormwater Management Training and Asphalt Pavement Association of Indiana (APAI) Winter Conference.

Consultant staff frequently engages with the STA and contractor staff to discover and implement procedures

that reduce the schedule. The consultants mentioned that regular review of the schedule, coordination of the contractors' maintenance of traffic, phasing, and coordination between subcontractors have helped in reducing project schedules. Consultants anticipate issues and try to resolve them by providing alternate ways of constructing the project. However, the consultant firms are wary of being held responsible if the project fails to meet its schedule.

4.6 Familiarity with Regulations Involved with Federally Funded Projects and Conflict of Interest Issues

All the respondent consultant firms are familiar with Title 23 of the Code of Federal Regulations. Two of the responding consultants stated that at least 50% of projects in their portfolio are federally funded. As the consultant firms are familiar with Title 23 of the CFR, conflict of interest issues are avoided by strict adherence and early communication with applicable stakeholders. Consultants follow INDOT guidelines concerning conflict of interest and seek guidance from INDOT for clarity. Some respondent firms have an established compliance staff that monitors conflict of interest issues as a part of internal quality management.

On LPA projects administered through INDOT, the consultants often provide both design and inspection services since such projects are awarded with a full-service contract for survey, design and construction inspection. Serving as designers and inspectors on the same project provides direct in-house lines of communication and direct access to the drawings, thus expediting response time for resolution of issues.

4.7 Certifications Held by Employees of the Consulting Firm

The staff at consultant firms include licensed professional engineers and engineers-in-training. Employees from consulting firms involved in inspection and testing are required to have the same qualifications and certifications as an INDOT employee for the same tasks performed. In addition, the employees of consulting firms may hold certifications required for the specialized testing or inspection services provided by the firm. Some of the certifications held by the consultant firm employees are Site Manager training, Certified Technician training, Storm Water Quality Management training, Utility Coordination certification, Independence Assurance Materials Sampling/Testing qualifications, Certified Professional in Erosion and Sediment Control (CPESC) and Certified Erosion, Sediment and Stormwater Inspector (CESSWI) certification, Indiana Water Environment Association (IWEA) certification, Certified Welding Inspector (CWI) certification, National Institute for Certification in Engineering Technologies (NICET) certification, painting, post-tensioning, prestressed, bolting, geotechnical, advanced concrete and asphalt certifications, and American Concrete Institute (ACI) certification.

4.8 In-House Staff Training

All respondent consultant firms have training requirements in place that deal with standards and specifications prescribed by INDOT. A few firms have in-house seminars that cover both INDOT standards and specifications and general inspection and testing training. Typical annual seminars include Purdue Road School, Indiana Concrete Pavement Association winter seminar, and the Indianapolis Department of Public Works Resident Project Representative (DPW RPR) annual training. In addition to seminars, consultant firms provide certified technician training courses, material testing training, software training, and safety training. Consultant firm employees are also encouraged to participate in classes offered by INDOT including the Certified Technician Program (CTP), Utility Coordinator Certification Training, and National Environmental Policy Act (NEPA) training.

5. EXPERIENCES OF INDOT DISTRICT CONSTRUCTION DIRECTORS WITH OUTSOURCING OF TESTING AND INSPECTION

The research team conducted phone interviews with INDOT District Construction Directors to assess the use of inspection consultants by district. Five (Crawfordsville, Greenfield, LaPorte, Seymour, and Vincennes) out of the six INDOT districts participated in the interviews.

The interview questions were structured along the following themes: (1) consultant use within the district, (2) prequalification and training of consultants (3) contract administration, and (4) advantages and disadvantages of the use of consultants. The interview questions and the list of respondents are provided in Appendix E. The following section summarizes and compares the responses from the five INDOT districts.

5.1 Consultant Use within the District

All INDOT districts use consultants on projects. The estimated percentage of construction program administered by the consultants for CEI (Construction, Engineering and Inspection) ranged from 5% to 20% of the project dollar value. Consultants are generally used to supplement the in-house staff during peak workloads and are not involved in developing the staffing plan of the projects. The development of the staffing plan consists of three stages. First, the area engineers determine the staff needs based on the anticipated volume of work for the upcoming year. Next, the work is distributed among the in-house employees and staffing gaps are identified. The projects that cannot be staffed with in-house employees become candidate projects for outsourcing. Finally, requests for proposals (RFP) are sent out to address the staffing gaps. The ratio of the INDOT employees to consultant employees for inspection activities on a project ranges from 1:1 to 1:3 across the districts. District construction directors prefer to keep an INDOT employee as the lead on projects with both

in-house employees and consultants. INDOT construction directors believe INDOT employees and consultant employees have similar capabilities in terms of testing of materials and inspection and therefore all activities can potentially be outsourced. All the construction directors anticipate an increase in the outsourcing of testing and inspection activities in the next few years due to expected increases in work volume with a steady or reduced in-house work force.

Typically, consultant contracts are either on-call or project specific. On-call consultants have open-ended construction contracts in which the assignments are not defined. Consultants with on-call contracts can be brought in when a staff shortage or increase in workload for inspection is anticipated. Consultants with on call contracts are preferred when the STA is unsure of the contractor's schedule. On-call contracts give the STA the ability to add and remove staff for short durations. However, since on-call consultant consultants are billed to a specific job moving them between projects can be tedious and take up to three months. Project-specific contracts provide an option of picking individual employees from the consultant firms. The construction director from LaPorte District stated that project-specific contracts provide more opportunities to smaller consultant companies. Further, the construction director from the Crawfordsville district stated that the projects themselves do not have much bearing on whether or not consultants are used on them. However, for unique projects as in the case of the disassembly and reassembly of an old historic bridge over the Eel River, the entire project was outsourced. The disassembled historic bridge was planned to be transported and reassembled at Brown County. The decision to outsource was driven by the fact that the district did not have in-house staff living around the Brown County where as the consultants had staff local to the Brown County. District Construction Directors recognized the value of having employees from the community or close to the community assigned to the project as the individual could have a great interest (and hence, more impact) on the project.

5.2 Prequalification and Training

The requirements for consultant employees are similar to those of INDOT employees. The prequalification requirements of consultants for inspection are defined in Section 13.1 of the Consultant Prequalification Manual of INDOT. Both INDOT and consultant technicians have to complete the Certified Technician Program for the specific category of work they will perform. The Certified Technician Training program consists of six subject areas; (i) bridge construction and deck repair, (ii) concrete paving, (iii) construction earthworks, (iv) construction procedures part 1, (v) construction procedures part 2, and (vi) hot mix asphalt paving. Two courses are taught, in rotation, each year over the winter months.

Prequalification of consultants is completed at the department level. However, the Construction Director from the Crawfordsville District indicated that the districts may request the Central Office add qualifications for consultants on unique projects (for instance, on fiber optics installation projects).

The consultant employees are treated as in-house employees and share the office space with the INDOT employees. The Construction Director from Seymour district reported that the consultants set-up and use their own office on jobs which are solely administered by the consultants. At Crawfordsville, however, the contractor provides the office facilities of the project. The Construction Director of LaPorte district reported that the consultants are provided documentation training as an additional resource.

5.3 Contract Administration

Typically, contracts are administered at the district level. INDOT ensures uniform implementation of inspection and contract administration by the standard procedures described in the GIFE (INDOT, 2018). Consultants are given authority similar to INDOT employees and are expected to administer the contracts using the same specifications book, General Instructions to Field Employees (GIFE) manual, and Final Contract Record (FCR) manual. Consultants may have former INDOT employees that already have a good understanding of INDOT operating procedures. The construction director from Crawfordsville district stated that detailed and descriptive boilerplate contracts have been used over the years. Further, the central office negotiates and enters into agreement with the consultant while the district administers the contract and pays the invoices. At Seymour district, a project manager coordinates the administration of capital programs with the central office. The capital project management division administers the contracts for projects undertaken in the LaPorte district.

5.3.1 Selection Process

The selection process consists of scoring of the Letter of Intent (LOI) submitted by the consultant in response to the Request for Proposal (RFP). Usually, two to three area engineers in the district score the LOI. The scores are then combined and reviewed by the contracts division in the Central Office. The most qualified, responsive consultant is considered as opposed to the consultant with the lowest bid (Brooks Act). Additionally, the selection committee may or may not select the top scorer depending on the capacity of the consultant. For instance, in a situation where a consultant is a top scorer on two or more LOIs, the second top-scoring consultant may be selected for subsequent projects. Typically, it takes nine months or more to bring the consultant on board once the need for a consultant is identified. The onboarding process takes about two to three months after the scoring and selection process is complete. The LaPorte construction director stated that the process can be fast-tracked to about six to eight months in case of project specific contracts.

5.3.2 Monitoring, Evaluation of Performance, and Future Selection of Consultants

Generally, area engineers evaluate the field performance at the end of the contract with the agency wide Professional Services Contracting System (PSCS). A FCR review officer evaluates the FCR performance in the PSCS. The online scoring system consists of two parts: (i) Part A – filled by the scorers and (ii) Part B – automatically populated based on history of performance evaluations. The INDOT Consultant Performance Evaluation Guidelines (2017) requires consultants' performance evaluation at the time of submittal of each deliverable or as deemed appropriate. The rating criteria and corresponding data are grouped in five categories including: quality, schedule, responsiveness, budget, and constructability (INDOT, 2017). Further, each evaluation is linked to a consultant employee with the required licensing and certifications, who performed either the services or oversight, to take responsibility of the end product (INDOT, 2017). In the case of disagreement with a performance evaluation, the responsible person has three opportunities for Consultant Comment through the PSCS, within thirty days of performance evaluation approval date (INDOT, 2017). The districts also provide regular feedback to the consultant firms and may replace individuals who do not perform up to their expectations. The scoring system affects the future selection of the consultants.

5.4 Advantages and Disadvantages of Outsourcing to the District

The advantages of outsourcing stated by the interviewees from the INDOT districts were in alignment with the responses received in the surveys of other STAs. Primarily, outsourcing helps in supplementing in-house staff during the peak workloads and enables the districts to increase capacity on temporary basis. In addition, the construction directors also shared a common opinion on not having to carry the overhead of the excess staff during the off-peak season. However, as in the case of other STAs, a true cost comparison could not be made due to complexity and lack of consensus in determining the overhead costs. District construction directors reported that there might not be enough work to keep the staff engaged during the off-peak season if the agency was staffed for peak workloads. Consultants help to fill in for surprise retirements and for engineers or supervisors who are moved to new jobs. The consultants can also provide services in unique or special projects for which the agencies may not have the necessary expertise. For instance, LaPorte district outsourced a project which had landscaping as the major scope as the consultants had the landscape architects available. Additionally, consultants that have offices close to the project locations may not require field offices. Thus, the consultants may continue working on other projects from their offices on rain days and do not bill the district for those hours.

As observed in the survey of the STAs, the higher cost of consultants was the most common disadvantage of outsourcing inspection and testing activities in the interviews with INDOT districts. According to the district directors, the cost of consultants ranged from two to four time for the same services when compared to the in-house staff. Additionally, the consultants may also be paid mileage to travel to jobs in locations where they do not have staff available locally. The Crawfordsville construction director cited hollowing out of knowledge from within the STA as another risk associated with outsourcing. Further, the interviewee stated that morale issues may arise when inspectors or supervisors compare themselves with the consultants. Some consultants may have divided loyalty between the contractors and INDOT. Such situations may arise as the consultant and the contractor may be working on the same LPA projects. The construction director from the Greenfield District expressed a concern that the consultants may advertise a specific individual to be available for the project on the LOI. However, there is no guarantee that the same individual will be available for the project after the consultant is awarded the project.

5.4.1 Influence on Quality

Four out of the five directors stated that the level of quality of projects obtained from the use of consultants was more or less the same as that from INDOT employees. The director from Crawfordsville reported the initiation of performance evaluation increased the level of engagement of the consultants and hence improvement in the quality. The Greenfield director stated that the in-house employees exhibit more ownership of the project which results in higher quality when projects are inspected by INDOT staff. The district construction director of LaPorte stated that consultant project engineers, supervisors, and inspectors who have previously worked for INDOT or have been trained by INDOT ensure good quality of work. Issues with quality typically arise when consultants with no previous experience are assigned to INDOT projects.

5.4.2 Challenges Faced by the Districts with the Use of Consultants

A common challenge reported by three (Crawfordsville, Seymour, and LaPorte) out of the five districts is the time it takes between identifying the need for a consultant to finalizing the contract and getting the consultant on board. Moreover, there is little flexibility to move the consultant employees between different projects and the process can take close to thirty days. The Greenfield director expressed the lack of experience of some consultants assigned to INDOT projects as another challenge. Another concern is divided loyalty of consultants working with the same contractor on LPA projects.

5.4.3 Improving Outsourcing Efforts within INDOT Districts

The current scoring system considers historical performance of the consultants so it is not favorable for considering new consultant firms with no prior experience on INDOT projects. The LaPorte construction director suggested implementing a program, which allows new consultant firms to provide services on projects under a fixed value. Another suggestion was the use of project-specific contracts on smaller jobs, as individuals from new consultant firms could be tried and evaluated on these projects. The Seymour construction director stated that consultants commit their employees on other jobs and sub-contract the work to other consultant firms who may also have filed a LOI for the same project. Hence, INDOT must be mindful that it does not create its own shortage of consultants. Building relationships with the consultants and establishing expectations with the firm and individuals assigned to INDOT projects provides a valuable means for ensuring close attention is paid to the quality of work performed on INDOT projects.

6. EVALUATING THE EFFECTIVENESS OF OUTSOURCING

The surveys and interviews provided little consensus on determining the cost effectiveness of outsourcing testing and inspection. This is attributed to many reasons. First, STAs may have different interpretations on what is meant by cost effectiveness. Some STAs may only consider the short-term costs of outsourcing while other STAs may consider the entire life cycle costs. Second, many STAs seem to lack the data to even support such comparisons between in-house and consultant costs. Establishing equitable and accurate overhead rates for comparison is the most difficult task (Schneider, Deis, Coates, & Wilmot, 1998). There is often little agreement on what direct and indirect costs should be included in the cost comparisons.

Several studies have been undertaken to provide meaningful comparison of cost consultants and in-house staff. Warne (2003) described two approaches to scrutinize and evaluate cost-effectiveness of outsourcing. The first approach is the comparison of the immediate or "current" cost of outsourcing and in-house cost which includes direct labor costs, overhead, and equipment cost (Warne, 2003). The second approach or "life-cycle approach" considers the long-term costs accrued by the organization during the period for which the resources are a part of the organization (Warne, 2003). In an investigation conducted for the Louisiana Department of Transportation and Development (DOTD), the actual cost of design using in-house staff was compared to the estimated consultant cost using predetermined design-cost estimation formulae (Schneider et al., 1998). Some assumptions used to arrive at the simulated consulting fees were: (a) the man-hours recorded for in-house employees is accurate, (b) the cost of in-house supervision which is not recorded will become a part of the overhead cost - inflating overhead cost, (c) the in-house overhead calculation does not include support services and utilities – underestimating the overhead rate (Schneider et al., 1998). In the study by Schneider et al. (1998), three commonly used methods of comparing in-house and consultant design costs reported were: (a) pairing of projects- which eliminated the effects of project type, (b) using ratio of design cost and construction cost- which eliminated the effect of project size, and (c) sampling to form similar mixes of projects among those designed by in-house staff and consultants. Yet another approach that has been used is determining an average mix of consultant staff used on projects and arriving at the average cost of one design hour by applying labor and overhead rates (Schneider et al., 1998). This average hourly cost can then be compared to the average cost of one in-house design hour (Schneider et al., 1998).

In order to conduct a similar cost comparison for testing and inspection, an STA must have substantial data on the true costs of activities performed by both in-house and consultant employees. The sample should comprise of projects that have been either entirely outsourced to consultants or completely executed by in-house staff, which are similar in size and complexity. Criteria to determine department overhead costs must be defined and the overhead costs must be accurately tracked and allocated. The proposed data for comparison by project should include the:

1. Project scope (and general information on the contractor, designer, and project schedule)
2. Total cost and itemized costs (as planned, final, change orders)
3. Funds paid to consultants by activity (include the qualifications/training/experience of each consultant employee assigned to the project)
4. Selected consultant's letter of intent
5. STA personnel, role and costs (allocation of time on each project)
6. Performance evaluation of the consultants on the projects
7. Completed construction inspection reports
8. List of other STA resources used on the project (resources in addition to personnel, for instance, access to field office, access to STA-sponsored training and STA labs)
9. Administrative costs on the project (for instance, preparing the outsourcing RFP, evaluation of the Letters of Intent, contract creation and evaluation)

7. CONCLUSIONS AND RECOMMMENDATIONS

STAs have diverse policies and practices regarding outsourcing of testing and inspection activities. Washington DOT and Connecticut DOT projected an increase in outsourcing of activities in the future, while the volume of work outsourced may decrease in the case of Ohio DOT. Other STAs like Maine DOT and Virginia DOT do not expect any significant change in the volume of work outsourced to consultants. The decision to outsource inspection and testing activities is largely associated with the volume of construction projects and STA staff available to undertake the testing and inspection

activities. Policies to limit or reduce the number of state staff have prompted STAs to supplement their staff with consultants to balance the workload and maintain project schedule. Doing so enables the STAs to undertake more projects without increasing their overhead costs. During downtime, the flexibility of hiring and withdrawing consultants is advantageous in managing fluctuations in staffing. Specialty inspection and testing activities, particularly for bridges and coatings, are typically outsourced due to lack of in-house expertise at many STAs to undertake such activities. A well-planned and implemented outsourcing strategy enables the STAs to remain flexible in staffing options, particularly during fluctuations in work volume.

7.1 Findings

Despite offering several advantages, the primary concern linked with outsourcing of testing and inspection activities is the high cost associated with hourly cost of consultant employees. The findings from the surveys show that the cost of outsourcing is up to three times when compared to cost of employing in-house STA staff. Moreover, no additional savings or benefits have been observed by a majority of the STAs through outsourcing of testing and inspection activities. Although cost savings resulting from outsourcing have not been formally quantified, it was acknowledged that the cost of supplementing in-house staff was comparable when reduction in training cost, overhead cost and overstaffing during downtime were taken into account. Another concern raised was the lack of consultants' familiarity with the STA procedures. Stringent prequalification requirements, provision of adequate training and regular meetings with the STAs would ensure that the consultants are well versed in STA practices and procedures.

Extended outsourcing of inspection and testing activities may lead to the loss of in-house expertise or knowledge resulting in the hollowing out of the agency staff. Another concern is that STA employees will be enticed by the higher compensation provided by the consultant firms to leave the STAs and work as consultants. In addition, the consultant firms may actively seek out STA employees, especially retirees due to their deep knowledge of the STA procedures. Several STAs stated that the recruitment of the former STA employees into consultant positions following any required "cooling off" period had a "net positive impact" to the STA-consultant relationship, since former state employees are already familiar with the STA procedures and performance expectations.

A key lesson learned from this study is the importance of ensuring that required experience is maintained by both the STA and the consultants to avoid disruption in project progress. For smooth operation of projects, it is necessary to clearly define the roles, responsibilities and authority of the consultants and in-house STA employees. Consultants should be empowered to make decisions rather than contemplating the consequences of their independent actions and be expected to represent STA in the same manner as in-house STA employees. There should be no difference in the quality of the delivered project, since consultants primarily supplement STA staff and are bound by the same set of practices, procedures and regulations as the STA staff.

Finally, appropriate policies must be developed and implemented in order to avoid and resolve conflicts of interest. Some methods adopted to deal with conflict of interest include: (1) prohibition of any organization to perform both design and inspection, on the same project, (2) consultants alerting the STAs and discussing potential conflicts of interest, (3) consultants signing conflict of interest documents, and (4) performing QA in-house. Performing Independent Assurance (IA) in-house as a part of the QA would also ensure compliance with Title 23 of CFR 637. To retain a good measure of in-house STA expertise and knowledge, 100% outsourcing of activities is not recommended. The agencies must have adequate resources to oversee the consultants and ensure that specifications are being met. Performance of the consultants on projects must be monitored and gauged by means of an evaluation system and frequent audits. These performance evaluation systems can increase accountability of consultants if they are rigidly enforced.

7.2 Best Practices for Outsourcing of Inspection and Testing Activities

Five key strategies were developed from the surveys, interview and questionnaires to guide STAs with outsourcing of testing and inspection activities. The key strategies include; (1) conduct strategic level planning, (2) develop a system of record to track in-house versus consultant cost, (3) maintain a strong prequalification program, (4) consistently evaluate consultant performance, and (5) provide training to in-house staff and consultants. Application of these strategies can assist STAs in developing, sustaining, and guiding a quality testing and inspection outsourcing program.

1. *Conduct Strategic Level Planning:* STAs must create a strategic level outsourcing plan for testing and inspection with input from the appropriate levels of management that clearly identifies the objective and measures of effectiveness for directing the outsourcing program. The outputs of this planning must include a written policy that guides the STA in its outsourcing decisions as well as all administrative, procurement, management, and monitoring procedures of consultant contracts.
2. *Develop a System of Record to Track In-house Costs:* STAs must establish a system of record that tracks the actual costs of completing inspection and testing by consultants versus in-house staff in order to drive the strategic level planning. The system would assist in accurately determining which activities consultants can perform more efficiently than in-house staff and provide the basis for allocating personnel resources to projects. The data required should include the nine areas provided in section six.
3. *Maintain a Strong Prequalification Program:* STAs must maintain stringent prequalification requirements and procedures to ensure consultants selected for testing and inspection are reliable, fully qualified, and capable of quality work.

4. *Consistently Evaluate Consultant Performance:* STAs must provide knowledgeable in-house personnel to monitor and manage the consultants work on projects to ensure compliance to standards, specification, quality, and any additional condition specified in the contract. The STA must have established formal and informal process to subjectively evaluate the performance of consultants providing inspection and testing services to the STA. Most importantly, the evaluations (positive or negative) must have an impact on future selection of the consultant on STA projects.
5. *Provide Training to In-house Staff and Consultants:* STAs must be prepared to provide the necessary training to consultants to ensure they are familiar with STA processes and procedures. The more control that the STA has over the training that consultants receive the more sure it can be that consultants working projects and uniformly training and qualified. STA should also consider the importance of providing training to in-house staff on contract management and procurement to ensure appropriate experience with contract management.

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- Alaska Department of Transportation (ADOT)
- Arkansas Department of Transportation (AHTD)
- California Department of Transportation (Caltrans)
- Colorado Department of Transportation (CDOT)
- Connecticut Department of Transportation (CTDOT)
- Delaware Department of Transportation (DelDOT)
- Florida Department of Transportation (FDOT)
- Indiana Department of Transportation (INDOT)
- Iowa Department of Transportation (Iowa DOT)
- Kansas Department of Transportation (KDOT)
- Kentucky Transportation Cabinet (KYTC)
- Maine Department of Transportation (Maine DOT)
- Michigan Department of Transportation (MDOT)
- Minnesota Department of Transportation (MnDOT)
- Ministry of Transportation of Ontario (MTO)
- Mississippi Department of Transportation (MiDOT)
- Missouri Department of Transportation (MoDOT)
- Montana Department of Transportation (MDT)
- Nebraska Department of Transportation (NDOR)
- Nevada Department of Road (NDOT)
- New Hampshire Department of Transportation (NHDOT)
- New Jersey Department of Transportation (NJDOT)
- New Mexico Department of Transportation (NMSHTD)
- Ohio Department of Transportation (ODOT)
- Oklahoma Department of Transportation (OkDOT)
- Oregon Department of Transportation (OrDOT)
- Pennsylvania Department of Transportation (PennDOT)
- Tennessee Department of Transportation (TDOT)
- Texas Department of Transportation (TxDOT)
- Utah Department of Transportation (UDOT)
- Vermont Agency of Transportation (VTrans)
- Virginia Department of Transportation (VDOT)
- Washington State Department of Transportation (WSDOT)
- Wisconsin Department of Transportation (WisDOT)
- Wyoming Department of Transportation (WYDOT)

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APPENDIX A. STA SURVEY QUESTIONNAIRE ON OUTSOURCING OF TESTING ACTIVITIES

PURDUE UNIVERSITY

Purdue University is partnering with the Indiana Department of Transportation (INDOT) to develop a synthesis report of the state of practice in outsourcing of materials testing and construction inspection at State Transportation Agencies (STAs).

This survey is geared towards outsourcing of testing activities and will take approximately 15 minutes for completion. The information collected is confidential and will be used only for research purposes. Findings of the study will be aggregated and shared with INDOT.

Thank you for participating in this survey.

1. State Transportation Agency (STA):
2. Number of regions/districts (if applicable):
3. Annual work volume 2016 (Capacity improvement): $ million
4. Annual work volume 2016 (Maintenance): $ million
5. Does your STA outsource testing activities? (Yes/No)
6. If the answer to the previous question is "Yes," select how the decision to outsource is determined:

   Please check all that apply

   a. based on policy (for instance, private organizations can perform the tasks equally well, state's goal for increasing privatization, etc.)
   b. based on staffing capacity (to handle peak workloads)
   c. based on schedule constraints (to handle critical and/or fast-track projects)
   d. based on lack of special expertise (STA lacks required in-house expertise)
   e. based on the need for innovation
   f. based on better management of risks (if risk can be shifted to the consultant)
   g. based on improving quality (past performance of consultants/testing agencies on STA projects)
   h. based on cost effectiveness
   i. based on lack of certain equipment
   j. based on political pressures
   k. based on the lack of sufficient fund
   l. Other (please explain)

7. What is the percentage of total testing activities in 2016 that was outsourced?
8. What are key concerns when outsourcing testing activities on transportation construction projects

   Please check all that apply

   a. Costs can be higher compared to doing the same work with in-house staff
   b. The consultant's familiarity with specific in-house STA procedures can be lacking
   c. Monitoring of inspectors and testing agency's work requires a duplication of effort and increased paperwork
   d. Training opportunities for STA employees are diminished
   e. Salary disparities between consultant staff and STA staff can cause in-house morale problems
   f. Consultants can sometime actively recruit STA employees
   g. Consultants can be more concerned with protecting themselves than the agency
   h. Need to engage continually with the consultant/testing agency to maintain their familiarity with the STA's in-house processes
   i. Other (please explain) _____

9. What are the challenges experienced by your STA when outsourcing inspection activities?
10. What are the advantages/new opportunities experienced by the STA when outsourcing inspection activities?
11. Does your State Transportation Agency (STA) measure the quality of workmanship and materials?

    a. Workmanship only
    b. Materials only
    c. Both workmanship and materials

Comments:

12. Is the material sampling frequency plan optimized for cost, importance or/and risk?

	Yes	No
Initial cost		
Life cycle cost		
Risk for failure		

13. If your answer to the previous question is "Yes", please explain how your STA optimizes sampling frequency for cost, importance, or risk.
14. Has your STA realized cost savings and/or benefits through the use of the following alternatives for testing? Please check all that apply

Comments:

	Contractor Quality Control (sampling and testing)	Independent Assurance (IA) procedures	Testing certification practices	Regional, district or divisional lab practices	Outsourced
For HMA					
For Concrete					

15. Does your agency apply Independent Assurance (IA) in-house or by consultant?
    a. In-house □
    b. By consultant □

Comments:

16. How often does your STA review their quality assurance (QA) practices and procedures?

	Annually	Bi-annual	Varies	Never
Acceptance limits				
Workmanship standards				
Prescriptive work practices				
Sampling frequency				

Comments:

17. Is the STA currently using or exploring innovative testing methods for HMA (such as quick and non-destructive)? (Yes/No)
18. If the answer to the previous question is "Yes", check all methods that apply and indicate their significance in terms of cost, time, staff reduction or accuracy of results.

	Cost	Time	Results
Asphalt content approach			
In place density approach			
Air voids approach			
Smoothness approach			
Sieve approach			
Void in mineral aggregate approach			
Void in fine aggregate approach			
Others:			

Comments:

19. Is the STA currently using or exploring innovative testing methods for PCCP (such as quick and non-destructive)? (Yes/No)
20. If the answer to the previous question is "Yes", check all methods that apply and indicate their significance in terms of cost, time, staff reduction or accuracy of results.

	Cost	Time	Results
Compressive strength (by core) approach			
Flexural strength (by cast beam) approach			
Air content approach			
Slump/Spread approach			
Temperature approach			
Others:			

Comments:

21. Has your STA implemented any innovative acceptance approaches as follows:

	Yes	No	Comments
Requirement Verification			
Risk Profiling			
Lean 6 Sigma			
Agile processes			
Just In Time sampling			
Quality Check Points			
Intelligent Compaction			
3D design modeling			
Warranty Contracts			

Comments:

22. Does your agency allow materials that fail testing to remain in place? (Yes/No)
23. If the answer to the previous question is "Yes", what factors are used to make this determination to allow the materials that fail testing to remain in place?
24. If the answer to question 22 is "No", how does the STA address the delays associated with removing and replacing the material?
25. How does failed test affect future use of a supplier's product or a contractor's work?
26. What resources are available to the STA in conducting materials testing in-house?

    a. Personnel
    b. Laboratories
    c. Equipment

27. What resources are available to the STA for outsourcing tests?
28. What are the methods used by your STA to address concerns related to conflict of interest between entities that perform the outsourced testing activities for the STA and the contractors who perform the work for the STA?

    If you are interested in engaging further with the research team on this project and for receiving a copy of the final results, please fill in the following information:
    Name:
    State Transportation Agency (STA):
    Role in STA:
    Email Address:
    Phone number:
    Postal Address:

APPENDIX B. STA SURVEY QUESTIONNAIRE ON OUTSOURCING OF INSPECTION ACTIVITIES

Purdue University is partnering with the Indiana Department of Transportation (INDOT) to develop a synthesis report of the state of practice in outsourcing of materials testing and construction inspection at State Transportation Agencies (STAs).

This survey is geared towards outsourcing of inspection activities and will take approximately 15 minutes for completion. The information collected is confidential and will be used only for research purposes. Findings of the study will be aggregated and shared with INDOT.

Thank you for participating in this survey.

1. State Transportation Agency (STA):
2. Number of regions/districts (if applicable):
3. Annual work volume in 2016 (Capacity improvement): $ million
4. Annual work volume 2016 (Maintenance): $ million
5. Does your STA outsource inspection activities? (Yes/No)
6. If the answer to the previous question is "Yes," select how the decision to outsource is determined.

Please circle all that apply.

   a. based on policy (for instance, private organizations can perform the tasks equally well, state's goal for increasing privatization, etc.)
   b. based on staffing capacity (to handle peak workloads)
   c. based on schedule constraints (to handle critical and/or fast-track projects)
   d. based on lack of special expertise (SHA lacks required in-house expertise)
   e. based on the need for innovation
   f. based on better management of risks (if risk can be shifted to the consultant)
   g. based on improving quality (past performance of consultants/inspection agencies on SHA projects)
   h. based on cost effectiveness
   i. based on lack of certain equipment
   j. based on political pressures
   k. based on the lack of sufficient fund
   l. Other (please explain)

7. What is the percentage of total inspection activities in 2016 that was outsourced?
8. What are key concerns when outsourcing inspection activities on transportation construction projects?

Please circle all that apply.

   a. Costs can be higher compared to doing the same work with in-house staff
   b. The consultant's familiarity with specific in-house STA procedures can be lacking
   c. Monitoring of inspectors and testing agency's work requires a duplication of effort and increased paperwork
   d. Training opportunities for STA employees are diminished
   e. Salary disparities between consultant staff and STA staff can cause in-house morale problems
   f. Consultants can sometime actively recruit STA employees
   g. Consultants can be more concerned with protecting themselves than the agency
   h. Need to engage continually with the consultant/testing agency to maintain their familiarity with the STA's in-house processes
   i. Other (please explain)

9. What are the challenges experienced by your STA when outsourcing inspection activities?
10. What are the advantages/new opportunities experienced by the STA when outsourcing inspection activities?
11. Does your State Transportation Agency (STA) measure the quality of workmanship and materials?

   a. Workmanship only
   b. Materials only
   c. Both workmanship and materials

Comments:

12. Is the material sampling frequency plan optimized for cost, importance or/and risk?

	Yes	No
Initial Cost		
Life Cycle Cost		
Risk for failure		

13. If your answer to the previous question is "Yes", please explain how your STA optimizes inspection frequency for cost, importance, or risk.
14. Has your STA realized cost savings and/or benefits through the use of the following alternatives for inspection?

    Please check all that apply.

	Contractor Quality Control (sampling and inspection)	Independent Assurance (IA) procedures	Certification practices	Inspection by STA personnel	Outsourced
For HMA					
For Concrete					

Comments:

15. Does your agency apply Independent Assurance (IA) in-house or by consultant?

    a. In-house ☐
    b. By consultant ☐

Comments:

16. How often does your STA review its QA practices and procedures for:

	Annually	Bi-annual	Varies	Never
Acceptance limits				
Workmanship standards				
Prescriptive work practices				
Sampling frequency				

Comments:

17. Has your STA implemented any innovative acceptance approaches such as:

	Yes	No	Comments
Requirement Verification			
Risk Profiling			
Lean 6 Sigma			
Agile processes			
Just In Time sampling			
Quality Check Points			
Intelligent Compaction			
3D design modeling			
Warranty Contracts			

Comments:

18. Does your agency allow materials that fail inspection to remain in place? (Yes/No)
19. If the answer to the previous question is "Yes", what factors are used to make the determination to allow the materials that fail inspection to remain in place?
20. If the answer to Question 18 is "No", how does the SHA address the delays associated with removing and replacing the material?
21. How does failed inspections affect future use of a supplier's product or a contractor's work?
22. What resources are available to the STA in conducting materials inspection in-house?

    a. Personnel

b. Equipment
c. Other Resources

23. What resources are available to the STA for outsourcing inspection activities?
24. What are the methods used by your STA to address concerns related to conflict of interest between entities that perform the outsourced inspection activities for the STA and the contractors who perform the work for the contractors?

If you are interested in engaging further with the research team on this project and for receiving a copy of the final results, please fill in the following information:
Name:
State Transportation Agency (STA):
Role in STA:
Email Address:
Phone number:
Postal Address:

APPENDIX C. INSPECTION CONSULTANTS SURVEY QUESTIONNAIRE

1. What training is provided to staff for inspection of materials? What certifications are held by consultant employees?
2. What is the frequency of staff training? Does the training program deal with standards and specifications prescribed by the DOT?
3. What additional certifications or qualifications does the consultant firm maintain?
4. What are the risk factors considered by the consultancy to provide inspection service?
5. What percentage of the consultancy inspection work is performed for DOT?

    a. For PCCP
    b. For HMA
    c. Other

6. What added value or expertise does the consultant firm bring to projects that the DOT cannot provide by itself? Please explain.
7. What are the inspection methods followed by the consultancy that the DOT does not use?

    a. For PCCP
    b. For HMA

8. What are the innovative inspection approaches implemented by the consultancy?

    a. For PCCP
    b. For HMA

9. Has the consultancy provided cost-savings on any project for the DOT with any of its testing approaches? If yes, what are these approaches and what was the estimated cost savings?
10. Has the consultancy inspection helped to improve quality?
11. How has the consultant firm helped to improve quality on a project through inspection?
12. How has the consultant firm helped to reduce a project schedule?
13. What are the innovative approaches which have helped in quality and/or schedule improvements:

    a. PCCP
    b. HMA

Please comment on the cost-benefits associated with the above innovative approaches, if any.

APPENDIX D. INDOT CONSULTANTS THAT PARTICIPATED IN THE SURVEY

Company	Respondent
Lawson-Fisher Associates P.C.	Paul Hummel
S&ME Inc.	Dexter Newman
Lochmueller Group, Inc.	Daryoosh Farvadin
RQAW Corporation	Chriss Jobe
DLZ Indiana, LLC	Gary Fisk
Primera Engineers, Ltd	Brad Minnick
WSP USA Inc.	Kevin Hall
Butler, Fairman and Seufert, Inc.	Jeremy Books
Parsons Transportation Group, Inc.	Robert Fisher
Corradino, LLC	Kirk Stafford

APPENDIX E. DISCUSSION QUESTIONS FOR INDOT DISTRICT CONSTRUCTION DIRECTORS

SPR-4105—Outsourcing of Testing and Inspection Activities at State Transportation Agencies (STAs)
Discussion with INDOT Districts

I. BASIC INFORMATION

1. INDOT District:
2. Interviewee(s) Name(s):
3. Roles(s) within District:
4. Date of Interview:
5. Annual construction volume in $ for the district (2017):

II. CONSULTANT USE WITHIN DISTRICT

1. Does your District use consultants for construction engineering, inspection and/or testing?
2. Does the District solely specify the consultant staffing levels for the project or does the consultant have some input into the development of the staffing plan?
3. What is the estimated percent of the construction program that is administered/completed by consultants for CEI and/or testing of materials within your District?
4. What is the basis of determining whether inspection/testing activities are to be outsourced on a certain project in your District?
5. What tests and/or inspection activities are currently outsourced to consultants?
6. Are there any CEI tasks or tests that can only be conducted by in-house staff and not outsourced to consultants?
7. What is the approximate ratio of INDOT engineers to consultant employees for inspection/testing activities on a project?
8. Do you anticipate the amount of outsourcing testing/inspection to increase, decrease or remain the same within your district over the next few years?

III. PREQUALIFICATION AND TRAINING

1. What are the minimum requirements required for consultants? Are these requirements greater or lower than what is required for in-house INDOT staff?
2. Does the District pre-qualify consultants?
3. What procedures are used in selecting consultants? Does the District have formal procedures?
4. How does the District ensure that consultant labs are certified and test equipment is calibrated/accurate?
5. Is consultants' lack of familiarity with STA procedures and specifications a concern? If yes, how do you ensure that the consultants are up to date with STA procedures?
6. What resources (support, equipment, documentation, additional training, office space, etc) are provided to the consultant by the district?

IV. CONTRACT ADMINISTRATION

1. How long does the selection process take for CEI/testing contracts? (time from when the decision is made to use a consultant to the notice to proceed)
2. What guidelines or processes are in place to define the work, responsibilities and authority of the consultants? Who within the District is responsible for administering the contracts?
3. Does the District have established procedures for monitoring and evaluating consultant performance? Does the evaluation affect future selection for work?

V. ADVANTAGES AND DISADVANTAGES TO THE DISTRICT

1. Are there any advantages to the District by using consultants?
2. Are there any disadvantages to the district by using consultants?
3. Has outsourcing of activities provided any cost savings? If yes, what is the basis of determination of cost savings?
4. Have you observed or recorded any increase or decrease in the level of quality on projects that have been outsourced?
5. Is the district open to adopting new testing methods and/or inspection approaches (value engineering proposals) that are suggested by the consultants? How do you evaluate these suggestions?
6. What are the challenges faced by your District when outsourcing inspection and/or testing activities?
7. What suggestions/recommendations that you would pass on to an agency looking into increasing/beginning its outsourcing of inspection/testing activities?

About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1—evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at: http://docs.lib.purdue.edu/jtrp

Further information about JTRP and its current research program is available at: http://www.purdue.edu/jtrp

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