THE UTILIZATION OF CONSULTANT CONSTRUCTION MANAGEMENT AND CONSTRUCTION INSPECTION SERVICES BY STATE DEPARTMENTS OF TRANSPORTATION

by

Jeremy Kevin Ketter

B.S. in Civil Engineering, University of Pittsburgh, 2006

Submitted to the Graduate Faculty of the

School of Engineering in partial fulfillment

of the requirements for the degree of

Master of Science in Civil Engineering

University of Pittsburgh

2007

UNIVERSITY OF PITTSBURGH

SCHOOL OF ENGINEERING

This thesis was presented

by

Jeremy Kevin Ketter

It was defended on

November 29th, 2007

and approved by

Amir Koubaa, Ph.D., Academic Coordinator,
Department of Civil and Environmental Engineering

John F. Oyler, Ph.D., P.E., Adjunct Associate Professor,
Department of Civil and Environmental Engineering

Piervincenzo Rizzo, Ph.D., Assistant Professor,
Department of Civil and Environmental Engineering

Thomas J. Zagorski, P.E., Vice President and National Director, Construction Services
Michael Baker Jr., Inc.

Thesis Advisor: Joseph Beck, P.E., Adjunct Assistant Professor,
Department of Civil and Environmental Engineering

THE UTILIZATION OF CONSULTANT CONSTRUCTION MANAGEMENT AND CONSTRUCTION INSPECTION SERVICES BY STATE DEPARTMENTS OF TRANSPORTATION

Jeremy Kevin Ketter, M.S.

University of Pittsburgh, 2007

State departments of transportation are facing a need to perform a greater number of projects than in the past. The nation's infrastructure is not even close to a level that is adequate to serve the needs of its users. State Departments of Transportation (DOT) need to find ways to adequately handle all of the work that is necessary to improve their roads and bridges to a level that can meet the needs of the people that travel on them. Most of the departments do not currently have adequate staffing to perform the construction management and inspection tasks that are associated with the projects that need to be completed. Without the ability to increase their workforce by hiring, the DOTs will have to rely on consultant staffing.

There are many advantages associated with state departments of transportation outsourcing construction management (CM) and inspection to consulting firms. The advantages include the ability to supplement DOT staff without having to layoff employees during slow periods, consultant CM expertise, and specialized services that the DOT may not be able to provide by itself. The disadvantages include high cost, an additional burden on DOT staff to train consultants in department procedures, and a fear of losing employees to the consulting firms.

The goal of this study is to objectively analyze the use of construction management and inspection consultants by state departments of transportation. While the issue will be analyzed from a national perspective, an in-depth study will be performed on two states: one that is performing mostly new construction projects and one that is performing mainly rehabilitation and reconstruction. The State of Texas will be evaluated as a new construction state, and the Commonwealth of Pennsylvania will be examined as the rehabilitation and reconstruction state.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

I would like to thank Mr. Joseph Beck, Dr. Amir Koubaa, Dr. John Oyler, Dr. Piervincenzo Rizzo of the University of Pittsburgh and Mr. Thomas Zagorski of Michael Baker Jr., Inc. for serving on my thesis committee and for their advice which enhanced this study. The support I have received from Professor Beck, who served as my advisor, has been invaluable.

I sincerely appreciate all of the resources that were provided to me by Michael Baker Jr., Inc and the assistance of Mr. Zagorski, Mr. John Kurgan, Mr. Don Truede, Mr. Richard Crimm, and Ms. Pamela Whitehead. I would like to thank the state DOT officials that took the time to respond to the survey, especially Mr. H. Daniel Cessna, Mr. James Foringer, and Mr. Angelo Pampena, of the Pennsylvania Department of Transportation, who took the time to meet with me in person.

I would also like to thank my roommates, Sarah, Andrew, Michael, Peter, Katie, and John, for their patience and encouragement. Most importantly, I would like to thank my parents, Francis and Dorene Ketter, and my younger brother, Justin, for their constant love and support.

NOMENCLATURE

Abbreviations

A/E	architect/engineer
ACE	assistant construction engineer
ASCE	American Society of Civil Engineers
CDA	comprehensive development agreement
CI	construction inspection
CM	construction management
CPM	critical path method
D/B	design/build
DOT	department of transportation
EDA	exclusive development agreement
FHWA	Federal Highway Administration
GC	general contractor
ID/IQ	indefinite demand/indefinite quantity
OSHA	Occupational Safety and Health Administration
P.E.	professional engineer
PennDOT	Pennsylvania Department of Transportation
PPP	public-private partnership

RMA	Regional Mobility Authority
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SHA	state highway administration
S.R.	state route
TEA-21	Transportation Equity Act for the 21st Century
TTA	Texas Turnpike Authority
TTC	Texas Transportation Commission
TxDOT	Texas Department of Transportation

1.0 INTRODUCTION

Every couple of years the American Society of Civil Engineers (ASCE) performs an assessment of the current status of the nation's infrastructure. With this information ASCE publishes a report card based on the condition and performance, capacity versus need, and funding versus need of several different categories of infrastructure. None of the categories assessed in 2005 received a grade higher than a C [1].

The categories in the ASCE Infrastructure Report Card that DOTs are responsible for are roads, bridges, and in a limited capacity, aviation and rail. Approximately 27% of the nation's 590,750 bridges are rated structurally deficient or functionally obsolete. It will cost $9.4 billion a year for 20 years to eliminate all bridge deficiencies according to ASCE [1]. Poor road conditions cost U.S. motorists $54 billion a year in repairs and operating costs. Americans spend 3.5 billion hours a year stuck in traffic, at a cost of $63.2 billion a year to the economy. $59.4 billion is spent annually in the United States on roadway repairs and rehabilitation, but that amount is well below the $94 billion needed annually to improve transportation infrastructure conditions nationally [1].

There is a major concern throughout the industry as to how projects will be funded in the near future; some believe that there could be a funding crisis as soon as 2009, but looking at the data in the infrastructure report card, it is apparent that the nation's infrastructure is already in a state of distress. There is a dire need for rehabilitation and reconstruction projects, but the lack

of funding will make it difficult for DOTs to continue running construction projects as they have in the past.

The intent of this study is to objectively evaluate the current trends in outsourcing construction management and construction inspection tasks employed by state departments of transportation. This study will also assess the different advantages and disadvantages associated with outsourcing CM/CI services. Through literary research and interviewing consultants and DOT officials, the author of this paper will present a forecast for the future of construction management in the transportation industry.

The findings of this study should be useful to the state Departments of Transportation, as well as construction management consulting firms. It is the intent of this author to determine the most efficient and cost effective ways of managing construction projects, so that DOTs will be able to more efficiently allocate funding to remediate our depreciating infrastructure, and CM consulting firms will be able to focus on the methods that are most effective.

Table 1. 2005 ASCE Report Card for America's Infrastructure [1].

Subject	2001 Grade	2005 Grade
Aviation	*D*	D+
Bridges	*C*	*C*
Dams	D	D
Drinking Water	*D*	D-
Energy (National Power Grid)	*D+*	D
Hazardous Waste	*D+*	*D*
Navigable Waterways	*D+*	D-
Public Parks & Recreation	--	*C-*
Rail	--	*C-*
Roads	*D+*	*D*
Schools	*D-*	*D*
Security	--	I
Solid Waste	*C+*	C+
Transit	*C-*	*D+*
Wastewater	*D*	D-

2.0 OVERVIEW OF CONSTRUCTION MANAGEMENT

Construction management refers to “the act of managing the construction process” [2]. It is the construction manager’s responsibility to ensure that the project is successful. In order for a project to be completed successfully, the construction manager must balance the triple constraint of construction: schedule, cost, and quality. The construction manager is also responsible for the safety of those working in and around the project site. The most successful projects will be completed on time, within budget, and with the highest degree of quality and safety.

The most effective way to control the schedule of the project is by creating a critical path method (CPM) schedule. The CPM schedule shows when every activity in the project is expected to begin and complete similar to previous methods of scheduling. Unlike Gantt charts and other scheduling methods of the past, the CPM schedule also shows the relationship between each activity and that activity’s predecessors and successors; it also shows the amount of float associated with each activity. Float is the amount of time that each activity can be delayed without impacting the activities that succeed it or the overall project completion date. Most construction managers today utilize computer programs such as Primavera or Microsoft Project to create computerized CPM schedules. The computerized CPM schedules allow the construction manager the ability to save a baseline of the original schedule and then view the impacts of changes compared with the original schedule, which allows the construction manager to determine the best course of action to complete the project by the original completion date.

Cost is the most important constraint in the eyes of the contractors performing the work on the project. The contractor's goal is to make the largest possible profit. The amount of profit that the contractor makes on a project depends upon the contract type. The three main types of contracts are cost-plus, unit-price and lump-sum. Owners typically prefer the lump-sum contract because it shifts the risk of the project to the contractor. The total cost to the owner remains the same regardless of the cost to the contractor. There are two different types of cost-plus contracts: cost-plus-fixed-fee and cost-plus-percentage-fee. With a cost-plus-fixed fee-contract the contractor's profit is fixed regardless of his cost. The contractor's profit with a cost-plus-percentage-fee is calculated as a percent of the total cost of the project. Unit-price contracts are the most typically used contract type for highway construction projects. This is because exact quantities are rarely known. The contractor bids unit prices for the work to be done on the job based upon estimated quantities provided by the owner. The unit price that the contractor provides includes his profit for work on that item.

The construction manager must be aware of the original estimate and keep track of costs throughout the project to ensure that the contractor is doing what he needs to in order to complete the project at the original contract cost. The construction manager keeps a daily record of the work performed in order to keep the contractor honest when the time comes for the contractor to bill the owner.

The construction manager is also concerned with the overall quality of the project and the safety of those on the project. The owner expects the highest possible quality for the final product. Anything less than that will result in the owner needing to spend money on rehabilitation or replacement sooner than desired. Quality is also very important to the contractor. If the work performed on the project is not completed to the specifications outlined

in the contract, the owner has the right to make the contractor replace the sub-par work. Rework is very costly to the contractor, because it becomes the contractor's responsibility to remove the faulty work and complete the work a second time. The cost associated with that work will come from the contractor's profit. The contractor also loses schedule time during the performance of the rework.

Beyond the obvious concerns in the need to provide a safe working environment to protect the health and welfare of the workers on site; accidents on the jobsite can be very costly to the contractor. Accidents can result in OSHA fines and major increases in insurance premiums. They can also result in a loss of production which will negatively affect the project schedule.

A proficient construction manager will be well aware of the above expectations because of the negative result of not meeting these constraints. Below average construction management practices can lead to:

- Project delays that increase labor and equipment cost and the cost of borrowed funds.
- High material costs caused by poor purchasing procedures, inefficient handling, and/or loss.
- Increased subcontractor cost and poor contractor-subcontractor relations.
- High insurance costs resulting from material and equipment loss or damage or a poor safety record.
- Low profit margin or a loss on construction volume [2].

Therefore, it is very important for the construction manager to properly manage cost, schedule, quality and safety pertaining to the project. Other items that the CM is responsible for include "worker morale, public and professional relations, productivity improvement, innovation, and improvement of technology" [2].

There are two main types of construction management that are typically used in the construction industry today: CM-at-risk and Agency CM. Agency CM is the preferred method;

the CM-at-risk method is used very infrequently by state departments of transportation. Agency CM can be further broken down into 3 categories: Construction Management and Inspection (CMI), Construction Management Professional Support, and Construction Inspection.

2.1 AGENCY CONSTRUCTION MANAGEMENT

The Agency-CM method of construction management is very similar to the traditional design-bid-build project delivery method. In the traditional method the owner has two separate contracts: one with the architect/engineer and one with the general contractor. The owner enters into an agreement with the A/E to design the project. Upon completion of the design the owner then advertises the design to interested contractors. The contractors bid on the project and the owner awards a contract to the most responsible bidder to perform the work on the project. With the Agency-CM method of project delivery, the owner has three distinct contracts: one with the architect/engineer, one with the general contractor, and one with the construction manager. The construction manager acts as an agent to the owner. The CM contract is generally awarded first when using the Agency-CM method. This is so that the construction manager can assist in the selection of the architect/engineer (A/E) and the general contractor. Similar to the traditional method, the GC contract is not awarded until the design is completed. The only difference for the general contractor is that he communicates with the construction manager as opposed to directly communicating with the owner [2].

2.2 CONSTRUCTION-MANAGER-AT-RISK

The owner only has two contracts when using the CM-at-risk method: one with the designer and one with the construction manager. The difference between this method and the tradition method is that the owner advertises the project to interested construction management firms prior to the completion of the design work by the A/E. This is so the construction manager can assist in constructability reviews and value engineering. The winning firm is then responsible for providing the finished product to specifications. The CM then enters into an agreement with a contractor to perform the work and the CM manages the project until it is turned over to the owner. The CM-at-risk method is becoming more popular because it allows for work to be completed faster than the traditional method of project delivery. Hiring the construction manager prior to final design allows construction to begin prior to completion of the plans. This is known as fast-tracking [3].

Despite the advantage of accelerating the project timeframe, state DOTs are very resistant toward using the CM-at-risk method. The limited amount of consultant construction management services that are being utilized by the state DOTs are being contracted using Agency CM. For the most part, the departments of transportation are trying hard to avoid outsourcing construction management and inspection tasks to consulting firms. State DOT officials were willing to provide several advantages and disadvantages to using these consultant services in response to a survey regarding outsourcing construction management.

2.3 ADVANTAGES TO OUTSOURCING CONSTRUCTION MANAGEMENT

2.3.1 Supplementing DOT Workforce

2.3.1.1 Economic Benefit

Construction work is typically cyclical. In colder climates there is usually an abundance of work during the summer months and a lull in work during the winter. Freezing temperatures create conditions that are very unfavorable for construction work, and therefore increase the cost of doing work during the winter months exponentially. Frozen ground will increase the time needed to excavate earth, which will increase the cost per cubic unit of excavation. Cold temperatures will sharply decrease productivity among workers that also results in increased unit costs. The inadequate working conditions and increased costs result in a slowdown of work during the winter months in northern states.

Certain operations can not be performed during cold temperatures that also can not be performed in extreme hot temperatures. An example of an activity such as this is asphalt paving. This also provides for a less dramatic cyclical pattern to construction work in the South, because some work can not be completed during periods when the surface temperatures are very hot in the middle of the summer. In warmer climates much of the work has to be completed during the spring and fall when the temperatures are not too hot or too cold. This tends to lessen the extreme spike in the amount of work being performed in the summer by spreading the construction projects over more months. Despite this fact, there is still a peak in the amount of work being performed during the warmer months of the year.

The cyclical nature of construction work creates an issue when determining the best way to staff the state DOT construction division. The most efficient way for state departments of

transportation to eliminate this problem is to try to eliminate the summertime peak in the workforce need. This would have to be done by spreading out the work equally throughout the year. While there are various tasks like certain bridge work, maintenance of lighting and guide rails, finalization, etc. that can be performed throughout the winter months, there is not enough work that can be done during the winter to effectively eliminate the workforce peak in the summer months [5].

There are three different approaches that can be taken when attempting to staff an operation that has a peak. The first method is to staff at the amount needed to fulfill all of the work at the peak workforce demand. This is a very inefficient way for any operation to be staffed, because during most of the year the organization will have workers that are idle. The second way to staff is to employ only the amount of workers to satisfy the lowest demand throughout the year. While this creates the most efficient use of in-house employees, all work that needs to be performed beyond the base manpower demand requires the allowance of overtime or outsourcing the work to outside workers. The third method involves finding the most efficient staffing point between the other two options. This is the method that is most economical and the most widely used.

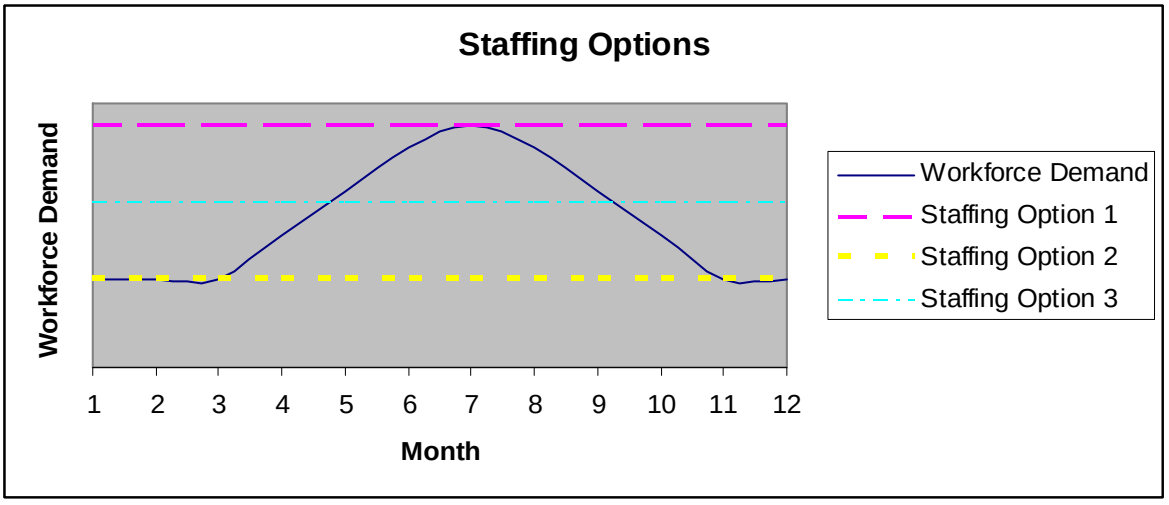

Figure 1. The change in state DOT construction management workforce demand throughout the year and the three different staffing options [4].

The average rate for a consultant employee is 2.2 to 2.5 times the amount of a state DOT in-house employee [6]. This is one of the most common responses for a disadvantage to outsourcing construction management that will be discussed in the next section. It is also a common complaint heard from the general public. Why should a government agency pay a consultant more than twice what it could pay a government employee to perform the same work?

There is a "breakpoint" where it becomes more economical to pay the consultant the increased rate [4]. The breakpoint comparison is a simple way to determine the most financially responsible way to staff a project depending upon the utilization of the necessary employees. If the state DOT follows staffing option 1, then they are responsible for every member of the staff's wages year round regardless of whether the employee is productive or idle. On the contrary, if the DOT uses the third staffing option there is a possibility that the total amount spent on wages could be less even though the DOT would have to pay a higher wage for consultant CM staffing.

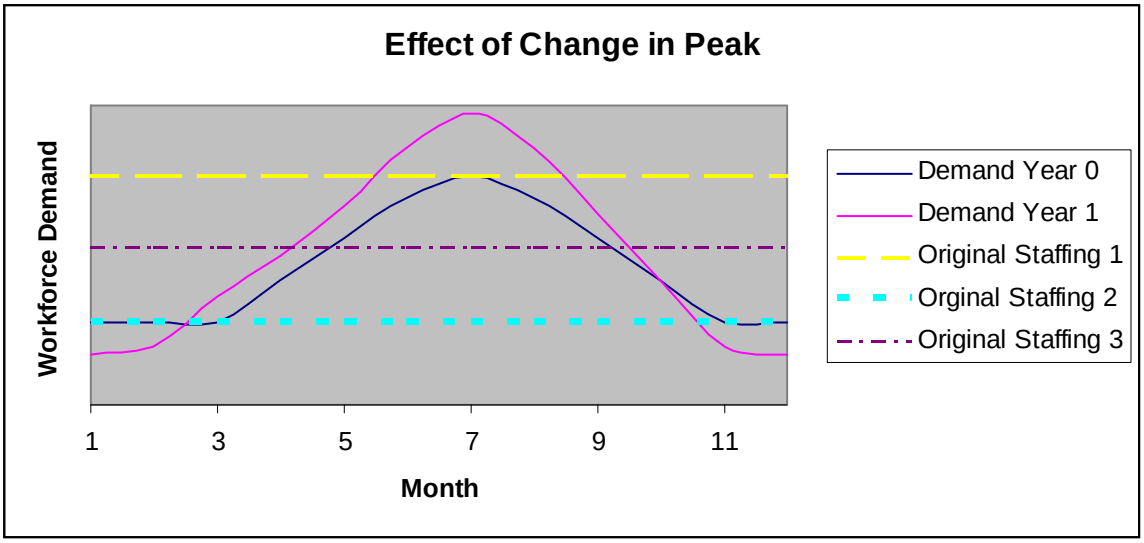

Figure 2. Peak workforce demand changes from one year to the next, which poses another hurdle when determining required state DOT staffing levels [4].

Using a consultant rate of 2.5 times the DOT in-house rate, the breakpoint is 21 weeks or slightly more than five months. Therefore, it is more economical to use consultants for any

employee that is going to be utilized for five months or less. Even though the DOT has to pay a much higher rate for that consultant, the DOT is actually saving money because they are not paying the annual salary of an in-house employee. There are also additional costs associated with the state employee that the DOTs are not taking into consideration like fringe benefits. For this reason, it is most advantageous economically for state DOTs to staff by some combination of in-house and outsourced employees.

2.3.1.2 Required Workforce Fluctuation

Regardless of which method a state DOT decides to employ when structuring its workforce, the DOT is going to be forced to deal with fluctuations in the workforce demand curve. The peak required manpower does not stay the same from year to year. Therefore, each of the three different options to originally staff the DOT will not adequately satisfy the needs of the department. This is especially prevalent with the first method in which the DOT hires enough employees to staff at the peak level. If the peak increases from the previous year, the DOT will have to hire new employees to perform the necessary work. Conversely, if the peak decreases, the DOT will have more employees than it has work. Both hiring more and laying off state employees is very difficult because of the politics involved with these agencies.

When considering the annual fluctuations in demand, staffing the Departments somewhere between the minimum and maximum demand is still the most advantageous method. This allows the state DOT to maintain a fixed staff that can be supplemented with consultants "to react to changes in capital program without impacting project deliveries" according to Ravi Chandran, P.E., Connecticut Department of Transportation Principal Engineer [7]. This is the most prevalent advantage to using outsourced construction management services in the opinion of most DOT officials and consultants. Of the 17 state departments of transportation that

responded to a recent survey regarding consultant construction management and inspection, 12 cited the ability to supplement the DOT workforce during times of expanding construction programs as the major advantage to contracting out management and inspection tasks.

Despite the fact that consultant service cost more than in-house services, there are still many situations where it becomes more valuable to use those services. With the decrepit state of the nation's infrastructure it is becoming more important to be able to complete as many projects as possible. State DOTs are faced with the predicament of performing more work within an atmosphere where the public opinion is that government is too large. Therefore, it is very difficult to get state legislatures to pass legislation allowing state DOTs to grow to accommodate the additional needs. The use of consultant construction managers and construction inspectors allows the DOTs to perform the work that needs to be done, while not stretching their understaffed workforce thin.

2.3.2 CM Expertise and Specialized Services

When consultants bid on construction management contracts from state departments of transportation, the consultants put together a team from their staff with the most experience in the type of work that the DOT is constructing. The competition of bidding for CM services allows the DOTs the opportunity to obtain the most qualified professionals with the highest levels of expertise for the project at hand. It is beneficial to contract with consultants who have "career construction experts on staff. Some of these staff members are actually former senior DOT practitioners who left through downsizing or early out programs" [8]. The DOTs have the opportunity to choose the management team based upon the qualifications that the consultants provide.

Similar to this, consultants can also provide expertise in certain areas that the DOT does not possess qualified personnel. Rather than training in-house employees in a specialized area of construction, it may be more economical and efficient to hire a consultant that already possesses staff members with expertise in that area. An example of such a specialized service provided by George Raymond, Oklahoma State Transportation Engineer, is bridge paint inspection and its associated hazardous waste disposal [9].

The additional level of expertise that can be provided by consultants is important for the departments of transportation, especially with the current trends in retirements. State DOTs have been facing and continue to confront a higher than average retirement rate due to the age of the DOT workforce. Many of the engineers and construction managers that are employed by state DOT are baby boomers who are quickly approaching retirement age. Many states are hiring at a frantic pace to replace employees that are being lost due to these departures. Although replacing these professionals may not seem like such a daunting task at first, the DOTs are still faced with the loss of expertise that the retirees are taking with them; expertise that may take some time for new hires to acquire. Many of the state retirees are moving on to higher paying positions with consultants, which makes it very beneficial for DOTs to outsource construction management to consultants to regain the experience that they are losing to retirements.

2.3.3 Other Advantages

Supplementing in-house staff, consultant expertise, and specialized services were the main advantages to outsourcing construction management services that most of the state DOTs cited in response to a survey on CM. There were a few other advantages that were mentioned in one or two of the DOT correspondences.

The state DOT delegates a portion of the risk associated with that project to the consultant when it enters into an agreement with the consultant to provide construction management services. The consultant is responsible for all of the management and inspection work that is described in the contract. If this work is not performed to DOT standards, the consultant will be held accountable. This is beneficial for the state department of transportation because they do not have to be concerned whether or not the work will be performed appropriately, because if it is not, it will be up to the consultant to correct the mistakes at the consultant's cost.

The state of Florida was one of the first states to fully embrace the use of outsourced construction management services. According to Brian Blanchard, P.E., Director of the Florida DOT Office of Construction, "consultants have a natural incentive to be efficient since they must make a profit to stay in business" [10]. If the consultant's work is not to par, they will be responsible for corrections to align the project with the specifications detailed in the contract. The cost of rework is usually very high. This creates the incentive that Mr. Blanchard referred to in his correspondence. The cost of every correction that the consultant has to make as a result of his own mistakes is a deduction to the consultant's profit on that job. The bottom line is very important to consultants. They are in the business of construction to make a profit and therefore will do all that it takes to ensure that they do not lose profit to rework. This ensures that the consultant will perform to state standards and therefore reduces the risk that the state faces in each job that they employ consultant construction managers and inspectors.

2.4 DISADVANTAGES TO OUTSOURCING CONSTRUCTION MANAGEMENT

2.4.1 High cost

The most prevalent opinion regarding the disadvantages related to using consultant services for state department of transportation construction projects is the high cost of those services. As previously stated, the average cost to the state DOT for consultant construction management services is approximately 2.2 to 2.5 times that of the cost to perform the work in-house. The reason for the high cost is that the DOT has to pay overhead and profit on top of the consultant employee's wage. The employee's wage is considered to be the direct cost to the consulting firm. There are also several indirect costs associated with the consultant's work on the project. These indirect costs are accounted for by overhead. They include the salaries of the consulting firm's upper management, home office rent and utilities, insurance, etc.

The formula used by consultants use to determine the hourly cost required on a given project is

$$\text{Hourly Fee} = (\text{Direct Cost} + \text{Overhead})*(1+\text{Profit})$$

where the direct cost is the consultant employee's hourly wage [6]. Hourly wages are regulated by the state DOTs; therefore, the hourly wage of an in-house CM/CI employee is the same as an outsourced employee. The excess cost to the department comes from overhead and profit. The typical amount charged for overhead is around 100% of direct cost. Profit is a percentage of the total cost incurred by the consultant and is typically around 10% for construction management contracts. Using these values, the cost to the department of transportation will be 2.2 times the cost to use in-house staffing. The higher cost paid for consultant services reduces the funding that can be spent on other projects.

2.4.2 Consultant Learning Curve

All state agencies have standard procedures that pertain to how practically every operation that agency performs is to be appropriately completed. This is especially true with state departments of transportation. Therefore, the in-house employees are very familiar with the procedures and how to fulfill them. Using consultant workforces to perform construction management and construction inspection tasks requires the consultant's employees to be trained in DOT procedures because they have "less experience with [DOT] Standard Specifications and internal contract administration procedures" [11]. The disadvantage that DOT officials see related to the consultant's lack of familiarity with standard procedure is that more time will have to be devoted to training the consultant. As with any task, when an employee has less experience, that employee will require a longer time to perform a task than a person who has more experience with that task. The time spent on training consultants results in a loss of time that can be spent on other functions. Therefore, instead of performing construction management and inspection tasks, state employees have to take time to train consultant managers and inspectors. Losing that productive time increases the cost of the projects to the department. Since state DOTs budgets are fixed by the state government, the DOTs are very adverse to any cause of increases in costs, because as previously stated, increased costs equate to less projects that can be undertaken.

2.4.3 Consultant Burden

In addition to supplementary work associated with familiarizing consultants with standard procedures, there are other burdens on the state departments of transportation related to outsourcing CM/CI services. By entering into an agreement with a consultant the DOT adds an

"additional layer of documentation and paperwork" [12]. The DOT not only has to worry about administering the contract between the state and the contractor, but also has to administer the contract between the state and consultant. The consultant is now performing the construction management work, but the DOT has an additional contract that it has to manage.

Contrary to the belief of the Florida DOT that consultants have an incentive to be efficient, some states also feel that they need to provide an oversight to the consultant to be certain that they are performing the work correctly. This also creates more work for the DOT. Arizona is a state that prescribes to this belief. Julio Alvarado, Arizona DOT Assistant State Construction Engineer, feels that the consultants are "more concerned with protecting their own interests than the owners" [13]. This concern is contradictory to the advantage provided early regarding the consultant's incentive to perform efficiently. The consultant needs to be aware of the owner's interest to effectively protect their own interests, if the DOT drafts the contract appropriately. There is also a concern that the consultant will not have an appropriate "level of dedication to the long term performance of the project [as] someone who is performing the contract administration to make money rather than for the long term benefit to the agency" [9]. This concern can also be negated as long as the department of transportation prepares the contract accordingly.

2.4.4 Other Disadvantages

There were several other disadvantages to outsourcing construction management services that were provided by the state DOTs that responded to the survey. One concern is that the departments of transportation will lose "core competency" [13]. The fear is that if the states begin to outsource more management and inspection work to consultants there is a chance that

the DOT workforce might jump ship. Consultants typically offer higher salaries than the DOTs do. If more work is offered to the consultants, then the consultants will need a larger workforce. It is very realistic to believe that if more work goes to the consultants, the DOTs will lose some of their experienced staff to those consultants.

Another concern that some DOTs have is that the consultants are employing "younger, less experienced engineers and technicians" [12]. These DOTs are concerned that the younger engineers and technicians will result in construction management and inspection that is of lower quality [14]. While it may be true that consultants are hiring younger, less experienced employees, the consultants are also employing DOT retirees. A large number of department of transportation employees are quickly reaching the age where they can retire with a government pension. These employees are retiring from the department, collecting their pensions, and going to work for consultants were they can make much more money. This gives the consultants the advantage of having the DOT knowledge not only to perform CM/CI services on state job, but also to mentor younger engineers and technicians.

Other comments provided regarding the disadvantages to outsourcing construction management services were the fear of "losing cooperative partnership that may exist between [the] DOT and [the] contractor" and the "possible loss of ability to solve problems quickly because of consultant inexperience or because the 'chain of command' prevents quick resolution to problems", a possible increase in the amount of claims against the DOT [12].

3.0 CURRENT ISSUES

Most state departments of transportation are very rigidly against the idea of increasing the use of outsourced construction management services. The prevailing issue limiting the use of outsourcing is the DOTs thought that their states can be better served by state employees. Although paying higher costs for consultant managers and inspectors can be justified through cost analysis, DOT officials are still caught up in the higher hourly wage and do not always consider the whole picture. Therefore, there is still a major resistance to using consultant CM/CI services despite an apparent growing need.

3.1 SAFETEA-LU

In August 2005 President George W. Bush signed a new bill for the funding of transportation related projects. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) "authorizes the Federal surface transportation programs for highways, highway safety, and transit for the 5-year period 2005-2009" [15]. SAFETEA-LU provides almost 50 percent additional funding for transportation projects than the previous federal surface transportation bill, TEA-21. The increase in funding has allowed for state DOTs to undertake many more projects than they could have under the previous funding. This extra work is important because of the alarmingly poor condition of infrastructure nationwide, but state

employees are being stretched thin. State DOTs do not have the opportunity to expand their in-house workforce to meet the new demand. Therefore, the amount of employees that were used to complete work under the previous funding allowances now have to complete about 1.5 times more work than they needed to in the past. Reluctantly, some states are now outsourcing some of this work to consultants using an Agency CM method. This allows the state to augment their forces with the necessary manpower while not losing direct control of the project. It is important that the DOTs retain direct control, because that control is required to receive federal funding [16]. Title 23 in the Code of Federal Regulations pertains to highway construction. Section 635.105(b) states that "although the [state highway administration (SHA)] may employ a consultant to provide construction engineering services, such as inspection or survey work on a project, the SHA shall provide a full-time employed State engineer to be in responsible charge of the project" [17]. The Federal Highway Administration (FHWA) would like to see more state control pertaining to construction management and inspection according to Rob Elliott, P.E., FHWA Construction and Project Management Team Leader. Despite this, Mr. Elliott personally believes that outsourcing construction management and inspection is beneficial to state DOT construction projects.

3.2 NATURE OF CONSTRUCTION WORK BEING PERFORMED

The country is currently split regarding the types of construction work that is being performed by the state DOTs. The two major groups are defined mainly by population. Shifts in population, especially increases, greatly affect the need for new and improved infrastructure. Many of the states in the south and southwest of the United States are experiencing vast

population growth. The increased amount of people also increases the amount of vehicles on the road, which leads to roads and highways being subjected to traffic loads much higher than they were originally designed to handle. This leads to gridlock and roadway user frustration. To accommodate the increased traffic loads, the states that are experiencing the population growth are concerned mainly with building new roadways that can handle the increased flows and retrofitting existing roads with additional lanes.

The other group includes the Northeast, Midwest, and the "rustbelt" states. This area of the country is experiencing very little, if any, in the way of population growth. Most of the infrastructure in these states is old. In a lot of cases the roads and highways have already exceeded their design lives, and they are quickly approaching the end of their useful lives. Almost all of the construction work in these states is concentrated on rehabilitation and reconstruction of the existing roads and highways.

In both cases there is a substantial amount of work that needs to be completed, and most of the state departments of transportation do not have the in-house staff needed to manage and inspect all of the work that is necessary. For the purpose of this study one state was chosen from each group to perform an in-depth case study. The Commonwealth of Pennsylvania was chosen from the group performing mainly rehabilitation work, and the State of Texas was chosen from the group performing mainly new construction.

4.0 PENNSYLVANIA CASE STUDY

4.1 OVERVIEW OF THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION

The Pennsylvania Department of Transportation is currently faced with a major backlog of rehabilitation and reconstruction projects. Similar to the other rust belt, mid-Atlantic, and New England states, there is very little new construction taking place in Pennsylvania. Despite having a focus on rehabilitation and reconstruction, the condition of the existing infrastructure in these states, especially Pennsylvania, is deplorable.

The reason for these unsatisfactory conditions is the age of the infrastructure in these states and a lack of funding to perform the work necessary to repair or replace the state roads and bridges. Over the past 10 years there have been two major federal funding increases for state transportation systems, but the increase in funding has not been as large for Pennsylvania as it has been for other states [18]. According to Mr. Dan Cessna, PennDOT Engineering District 11-0 District Executive, the backlog of projects has been ignored for far too long and has created the current need for more projects than can be undertaken [19].

With the increase in funding from the federal government the condition of state roads has improved in the last 10 years, but there is still a considerable number that are in poor condition. More than one-third of the Pennsylvania's 21,000 miles of state owned roads are rated "poor"

[18]. The average age of a state owned and maintained bridge in the state of Pennsylvania is 50 years, and more than two times the national percentage of the bridges are classified as structurally deficient [18]. The slight improvement in the condition of the state roads has come from preventative maintenance, which is comparable to putting a band aid on a broken arm considering the age and current condition of these roads. Much more significant rehabilitative and reconstruction work is needed to increase the rating of Pennsylvania state roads.

According to the Pennsylvania Transportation Funding and Reform Commission, "the Commonwealth's highway and bridge program is fundamentally sound, but is not keeping pace with inflation" [18]. The Commission feels that revenue streams need to be increased for the state to be able to fix the status of its infrastructure. According to their study, PennDOT has lost approximately $350 million worth of purchasing power in the past 10 years due to inflation, especially with increases in the cost of construction materials like steel, cement, and petroleum [18].

The longer it takes for PennDOT to find the means to fund the work that needs to be performed, the more that work will cost to perform. The Transportation Funding and Reform Commission has found that it will take an additional $1.013 billion annually to return the state's infrastructure to an acceptable level. The additional funding will allow for:

- The elimination of poor ride quality on all highways carrying over 2,000 vehicles a day and on 50 percent of highways carrying less than 2,000 vehicles a day in five (5) years.
- The reduction of the percentage of structurally deficient bridges to the national average in 17 years.
- The modernization of 66 percent of all traffic signals over 10 years.
- The installation of real-time traffic information and management systems in major urban areas in 10 years.
- The implementation of additional safety features targeted to reduce fatalities by 25 annually.
- The addition of targeted capacity expansion projects [18].

The Commission recommended that the state try to obtain only an additional $990 million, because the members of the commission believe that with business practice improvements the state will be able to save $120 million annually. These improved practices will be a continuation of existing practices and implementation of new "management and finance practices at PennDOT". The six business practices outlined in the commission's final report were:

- Implement more disciplined asset management practices.
- Accelerate implementation of Smart Transportation and right-sizing initiatives.
- Streamline the project delivery process.
- Reduce capital costs and delivery duration by greater use of the design/build delivery method and aggressively exploring Public-Private Partnerships.
- Link land use and transportation.
- Develop an incentive based funding program [18].

The first practice, more disciplined asset management practices, refers to the use of preventative maintenance and preservative measures that are currently performed by PennDOT. If these measures are implemented appropriately, they will effectively lengthen the life of a roadway or bridge. An example of preventative maintenance is milling and overlaying. Milling off the top 1.5" to 3" allows the Department to remove the top-down cracks in the pavement that could propagate down into the base layer of asphalt. The milled roadway is then overlaid with asphalt to provide a new smooth riding surface. Without this preventative maintenance the roadway will deteriorate much sooner. Oil and chipping is one example of a preservative measure. This method of increasing the life of a pavement is generally used on less heavily traveled roadways.

The Smart Transportation initiative is the Department's desire to use public involvement in new and innovative ways. The Commission feels that "it is necessary to determine community needs and to ensure that communities are receiving improvements that last long into

the future" [18]. Right-sizing refers to the initiative to provide "a best fit transportation program or project that meets transportation needs and considers community and regional goals, quality of life, economic development initiatives, fiscal constraint, and social/environmental issues" [20]. PennDOT hopes to reduce the cost of future projects by only doing the work necessary as opposed to performing unnecessary additional work that greatly increases the cost. An example of where right-sizing could have been implemented is evident in a recent project that was performed in West Mifflin, Pennsylvania. Sections of S.R. 2048 (Lebanon Church Road) and S.R. 0885 were milled and overlaid to provide a new riding surface and extend the life of the roadways. PennDOT's current regulations require that when rehabilitation work is performed, handicap ramps must be installed at all intersections. Thus, handicap ramps were installed at the intersection of S.R. 2048 and S.R. 0885. The problem with compliance to this regulation is that there are no sidewalks along either of these roadways and therefore, obviously no need for the ramps to be installed. The goal of the right-sizing initiative is to avoid the unnecessary waste of funding as in such a case.

Streamlining the project delivery process, the third practice that the commission suggests be implemented, will be accomplished by "actively engaging resource and regulatory agencies in performing preliminary impact studies and narrowing alternatives in the planning process" [18]. This will eliminate wasted time and resources on designs that will ultimately never even be approved by these agencies. The savings in both time and expense can then be used towards projects that will have no obstacles in gaining final approval.

The fourth suggested business practice advises exploring new project delivery methods. The use of design/build and private-public partnerships, which until recently were frowned upon and in some states forbidden, is becoming the trend nationally as agencies are looking for ways

to function on budgets that do not have adequate funding. Design/build projects allow the project to be completed in a more timely manner than the traditional design-bid-build method. With a design/build project there is one contract between the owner and a contractor, who is responsible for both the design and the construction of the work. As previously discussed, design/build projects allow for fast-tracking, which gives the contractor the ability to begin work prior to the completion of the plans. Private-public partnerships would give the Pennsylvania Department of Transportation the option of entering into an agreement with a private entity to help fund projects. These two rather new project delivery methods will be very beneficial to PennDOT as they will help to reduce project cost and duration.

The fifth practice that the commission has suggested is very similar to the second, as it employs Smart Transportation. The Pennsylvania Transportation Funding and Reform Commission hopes that "link[ing] land use and transportation through the implementation of Smart Transportation practices and preconditioning major capacity improvements on a community land use/transportation vision [will] complement community vision and provide sustainable investments" [18].

The sixth and final suggested business practice advises developing an incentive based funding program "to link land use and multimodal community investments through collaboration with partners including municipalities, Metropolitan Planning Organizations, Rural Planning Organizations and other interested parties" [18]. This suggested practice is important because the demand for transportation projects is closely related to the growth and development of localities. Similar to the other methods proposed, this method revolves around saving money. This practice suggests that money should be spent proportionally to the amount of people in an area and the amount of growth that area is expected to generate. This policy will allow

PennDOT to rehabilitate and reconstruct existing roadways and construct new projects in areas that will have the greatest impact.

4.2 AVAILABLE FUNDING OPTIONS

Funding for highway and bridge work in the Commonwealth of Pennsylvania currently comes from two different sources, the federal government and the Pennsylvania State Motor License Fund. The money from the federal government comes from the Highway Trust Fund as defined by the SAFETEA-LU Act. SAFETEA-LU authorizes that the commonwealth is entitled to at least $8.23 billion from 2005 to 2009, which equates to approximately $1.65 billion per year [15].

The State Motor License Fund derives its money from taxes on gasoline and other fuels, car and truck registration fees, and state police issued fines and other fees. The tax on fuels in 2006 was $ .312 per gallon for gasoline and gasohol, and $ .381 per gallon for undyed diesel and undyed kerosene [21]. Vehicle registration fees are $36 annually per passenger vehicle. In 2006, the annual funding available for highway and bridge construction from the State Motor License Fund was $3.4 billion [22]. Therefore, PennDOT has approximately $5 billion to spend on all of the projects that need to be undertaken each year. The Pennsylvania Transportation Funding and Reform Commission study shows that this is far below the amount needed to improve the state's infrastructure to an adequate level [22].

The nine-member Pennsylvania Transportation Funding and Reform Commission was made up of appointees of the Speaker of the House of Representatives (1), the Minority Leader of the House of Representatives (1), the President *Pro Tempore* of the Senate (1), the Minority

Leader of the Senate (1), and the Governor (5). The members of the commission were Allen D. Biehler, P.E., Secretary of Transportation and Commission Chair; Beverly A. Harper, Portfolio Associates, Inc.; J. Barry Stout, Pennsylvania Senate; Richard A. Geist, Pennsylvania House of Representatives; Keith R. McCall, Pennsylvania House of Representatives; Jeffrey L. Brooks, Sr., Transport Workers Union of America; Alex G. Sciulli, P.E., Mellon Financial Corporation; James C. Roddey, The Hawthorne Group; and Richard P. Voith, Ph.D., Econsult Corporation [22].

The committee investigated three different levels of needed additional capital. The three levels were existing system preservation, incremental improvement, and improved mobility. The additional funding required for each level was determined to be $563 million, $1.013 billion,

Existing System Preservation

- Eliminate Poor Ride on Highest Volume Highways in 5 Years.
- Reduce Percentage of Structurally Deficient Bridges to National Average in 20 years.
- No Additional Capacity Expansion Projects Above Today's Program.
- Just-in-Time Travel Info. in Major Urban Areas for Only Interstate Travelers.
- Modernize 1/2 of Traffic Signals Over 10 Years.
- Implement Additional Safety Features to Reduce Fatalities by 10/Year.

Incremental Improvement

- Eliminate Poor Ride on All High-Volume Highways in 5 Years.
- Reduce Percentage of Structurally Deficient Bridges to National Average in 17 Years.
- Very Limited Capacity Expansion Projects.
- Just-in-Time Travel Info. in Major Urban Areas.
- Modernize 3/4 of Traffic Signals Over 10 Years.
- Implement Additional Safety Features to Reduce Fatalities by 25/Year.

Improved Mobility

- Eliminate Poor Ride on All Highways in 5 Years.
- Reduce Percentage of Structurally Deficient Bridges to National Average in 15 years.
- Limited Capacity Expansion Projects.
- Just-in-Time Travel Information for Major Urban Areas and All Interstates.
- Modernize All Traffic Signals Over 10 Years.
- Implement Additional Safety Features to Reduce Fatalities by 40/Year.

Figure 3. Description of Addition Funding Levels [22].

and $1.464 billion, respectively. The commission recommended the incremental improvement solution to Pennsylvania Governor Edward G. Rendell in the final report submitted in November 2006, but claimed that the state would only need to find an additional $990 million as a result of implementing the improved business practices discussed in the previous section [18].

The commission offered two suggestions as to how the state of Pennsylvania can generate the additional funding needed. The first suggestion was to increase the taxes and fees associated with the Motor License Fund. If this step were to be taken, it would "be accomplished by raising approximately $150 million by increasing various motor vehicle registration and license fees and raising approximately $750 million by adjusting the Oil Company Franchise Tax wholesale price floor and ceiling to a rate reflective of current prices and/or adjusting the millage rate" [18]. The increase in the oil tax needed to generate the amount of funding necessary equates to an increase in gasoline prices of about 11.5 cents per gallon.

The second suggestion was to explore the options presented through public-private partnerships. The public-private partnership (PPP) options that the commission referred to in their report included leasing existing assets such as the Pennsylvania Turnpike, tolling existing roadways, constructing and financing critical capacity expansion on high priority congested corridors, and constructing new toll facilities [18]. This suggestion was given significant consideration as it is part of the new plan for raising the needed funding. The new plan calls for the introduction of tolls on Interstate 80, the increase of tolls on the Pennsylvania Turnpike, and an allocation of 4.4 percent of the revenue from the state sales tax to provide approximately $950 million annually for highways and mass transit [23].

4.3 CONSULTANT CONSTRUCTION MANAGEMENT IN PENNSYLVANIA

There is very little new construction being undertaken by the Pennsylvania Department of Transportation; almost all of the budgeted work in the foreseeable future is rehabilitation and reconstruction. This has been the trend since the 1970s, when the interstate program was finishing up in Pennsylvania. When the interstate projects ended, there was a major restructuring of the Department of Transportation. The Department's workforce was cut in half to approximately 12,000 employees from nearly 24,000 [19]. Also during this time, the Pennsylvania legislature required PennDOT to switch from finance-based funding to cash-based funding. This required a major cut in the amount of work because no work could be performed if PennDOT did not have the funding available to finance the project.

Despite not having large, new construction projects, the amount of work that PennDOT has needed to perform has increased steadily since the personnel cutback, but the amount of employees working for the Department has not changed. On top of the increasing workload, PennDOT is also facing the retirement of the baby boom generation [5]. A popular consensus, especially among local consultants, is that PennDOT's workforce is continuing to shrink. PennDOT Engineering District 11-0 District Executive, Dan Cessna, insist that this is not the case. According to Mr. Cessna, all of the numerous recent retirements statewide have been replaced by new hires. The retirements have created a "major shift in staff" [19]. The Department's current staff is the youngest in terms of years of service since the major interstate projects. PennDOT is committed to promoting from within the department. This has created a need to "push people very quickly" [5]. Therefore some individuals may not be obtaining as much experience as their predecessors prior to being promoted to managerial and supervisory position.

While the Department is not cutting any personnel, the illusion that PennDOT is shrinking is apparent because the Department is taking on more work than in the past. Essentially, both the opinions of the consultants and DOT officials are correct. Considering the number of people that are on the Department's payroll, PennDOT is not shrinking, but proportionally it is. PennDOT employees, especially project managers, are being stretched further than in the past [24]. The size of the program has grown enormously because the state's infrastructure is antiquated and the "backlog of work has been ignored too long" [19].

4.3.1 Outsourced Staffing

The increase of PennDOT's construction program has created an inherent need for more people, but the size of the Department's in-house staff is regulated by the Pennsylvania state legislature. There is a feeling among the general population that government is too large. This feeling has led to a national trend of downsizing of state governments. For this reason, the state legislature will not allow the Department of Transportation to add the additional personnel necessary to staff all of the state's construction projects. The lack of needed workforce has produced a need for PennDOT to outsource certain project management and inspection tasks to consultants. According to Patrick Gardiner, Chief of the Contract Management Division of PennDOT's Bureau of Construction and Materials, the Pennsylvania Department of Transportation currently outsources approximately 45% of the construction inspection work and 10% of the construction management work on Department projects [26].

When a construction management contract is awarded on most private projects, the management of the entire project is handed over to the construction management consultant team. This is not the case with most public projects. PennDOT is "very hands-on". They feel

that they have “too much ownership” to allow the consultant to exclusively run projects [19]. For this reason construction management consultants are always used to supplement department staff, and in most cases construction inspection consultants are used in the same manner. Recently, some of PennDOT’s engineering districts have contracted with consultants to solely perform all of the construction inspection work on a few Department projects. Allowing consultants to have sole responsibility of construction inspection is a new development that has only been in effect within the past year; it wasn’t permitted prior to that [19]. Consultant construction inspectors are utilized on almost every PennDOT project. This is important, because it shows that while PennDOT is very resistant to change, necessity forces the Department to adapt its methods to be able to accomplish the work needed to perform projects successfully.

Unlike construction inspection, PennDOT is still very limited in its use of consultant construction managers. The Department tends to restrict the utilization of CM consultants to the “large scale, fast-paced projects with a large amount of public involvement” [19]. These high-risk, high-profile projects are the most involved projects that include more tasks than the PennDOT project manager can comfortably handle on his/her own while successfully managing the project. Failure is not an option on jobs like these, according to District 11 Executive, Dan Cessna, because the media exposure is too high. PennDOT will do whatever it takes to make sure that these projects are successful, which usually involves putting a consultant construction management staff in place to assist the Department staff.

The department is very selective when it comes to employing construction management consultants; consultant CM is only used on “major projects” [19]. The process of determining whether or not to use consultant CM services is described as being a purely intuitive balancing

act. PennDOT does not have a formula to decide if consultant services should be used. The decision is made based solely upon past experiences.

The Pennsylvania Department of Transportation's Engineering District 11 is responsible for the counties of Allegheny, Beaver, and Lawrence which includes the second most populated city in the state, Pittsburgh. District 11 is responsible for most of the high-profile projects that take place within the state of Pennsylvania along with District 6 that includes the city of Philadelphia. Despite the fact that District 11 has the most high profile projects, there are only four current projects within the District that are utilizing consultant construction management services. Three of the projects are on interstate 79: section A36, section 35M, and section A12, the latter is in the closeout phase. The other project that is using consultant CM is on I-376, more commonly known as the Parkway East. The construction management contract for all four projects was awarded to the same consultant, Michael Baker Jr., Inc., which is headquartered in Moon Township, Pennsylvania. The other major construction management consultants used by PennDOT are Wilbur Smith, Trumbull, Dick Corporation, and McGuire [19].

Thomas J. Zagorski, Vice President and Director of Construction Services of Michael Baker Jr., Inc., refers to the Baker construction management/construction inspection team as an extension of PennDOT. Under the contract between the Pennsylvania Department of Transportation and Michael Baker Jr., Inc., Baker provides "a variety of construction support services focused on safety, budget, schedule, and quality" [27]. Baker is responsible for keeping track of the paper trail of the project to ensure that all aspects of the venture are accurately recorded. This is important to the Department because they can be confident that the documentation is being performed properly and the Department's Assistant Construction Engineer (ACE) can concern himself/herself with more important tasks. If there is no consultant

on a project, the ACE is responsible for tasks such as letter writing and schedule reviews along with all of their other responsibilities. The Pennsylvania Department of Transportation's Assistant Construction Engineer Manual describes 50 distinct duties for which the ACE is responsible, only 11 of those duties are permitted to be performed by consultants [28]. Therefore, if a consultant construction management staff is on a project, the ACE does not have to concern himself/herself with the more menial tasks and can concentrate on the management of the project.

On the District 11 CM projects Baker "tracks every piece of paper involved in the project. [They] draft the required letters, log all customer complaints, conduct all meetings, provide minutes and project documentation – [Baker] serve[s] as the project's eyes and ears, helping PennDOT make responsive and effective decisions" [27]. Project documentation is very important to PennDOT, especially on large, high-risk projects. Good project documentation helps to reduce contractor claims against the Department. On large projects, like the Parkway East repaving project, construction management consultants are responsible for exposure logs, work order logs, request for information logs, etc. This again is an example of the value of consultant staff. On smaller jobs that are managed by PennDOT's in-house staff alone there are usually on the order of 10 to 30 requests for information. On the Parkway East job there have already been over 200 requests for information [24]. If the ACE was responsible for responding to requests for information on that project he would have been overwhelmed with just that one task of the many that he is responsible for.

Another large advantage to consultant construction management is that consultants provide specialized services to a project that would not necessarily be available if the project were being managed by a PennDOT only staff according to James Foringer, PennDOT District

11-0 Assistant District Executive in charge of Construction [5]. These specialized services can include forensics, surveying, aerial mapping, asphalt expertise, cement concrete expertise, media relations, etc.

The major disadvantage, aside from the obvious loss of control that state DOTs fear, is cost. According to PennDOT, outsourcing construction management services is "extremely expensive" compared to using in-house staff [19]. While the average consultant construction management contract value in contracts with PennDOT is only one to two percent of the total project cost, this statement is evidently true. When construction management work is performed by in-house staff, the only cost to the Department is that employee's wage. When the same work is performed by a consultant, the Department is paying the consultant employee's wage in addition to overhead costs and profit to the consultant. PennDOT operates on a fixed budget; therefore, any money that is spent on engineering services such as outsourced construction management is funding that is taken away from the roads [19]. This reasoning leads PennDOT officials in their belief that construction management tasks should only be outsourced when absolutely necessary. It also drives their desire to find the absolute best available consultant to perform the work so that they get the most out of their money.

4.3.2 The Future for CM Consultants

There is not going to be much of change in the amount of construction management and construction inspection work that is contracted out in the next several years. According to the Chief of PennDOT's Contract Management Division, Pat Gardiner, there will be a slight increase in the amount of construction inspection from the current amount of 45% of all CI work to approximately 50% of the Department's construction inspection work. Mr. Gardiner also

believes that PennDOT will continue to use consultant construction management services only on a very limited basis and only on major projects [26]. There are sixteen projects scheduled for 2008 that utilize consultant services. Only one of those contracts call for construction management; the other fifteen are construction inspection only. The major change for the future of outsourced construction management for consultants working with PennDOT is going to be the delivery method.

The current practice is project based. PennDOT advertises the need for construction management support on a particular project. Consultants then prepare a bid to perform the required work on that project and create a team of their personnel that has the most qualifications related to the specific project. The selected team, which is usually comprised of a project manager, civil engineers, a scheduler, a technician, etc., is then responsible for assisting the PennDOT Assistant Construction Engineer on tasks related to the specific project that they are assigned to. PennDOT is trying to transition from this project-based delivery method to a task-based delivery method. This method is going to be employed in District 11 within the next year. PennDOT District 11 is currently advertising an indefinite delivery/indefinite quantity (ID/IQ) contract for construction management support. The idea behind this is to have one consultant team that can be utilized on many projects [5]. The ID/IQ method allows PennDOT to have a consultant always on call, but only on the project when necessary. Therefore, the Department can save a considerable amount of unnecessary expense by enabling them to pay for consultants only when absolutely required.

5.0 TEXAS CASE STUDY

5.1 OVERVIEW OF THE TEXAS DEPARTMENT OF TRANSPORTATION

The state of Texas is one of the leaders in the nation regarding the amount of construction work that is performed annually by the Texas Department of Transportation (TxDOT) and other local agencies. Like the rest of the country, Texas is afflicted with an increasingly inadequate infrastructure and an increase in the gap between available funding and funding needed to perform the work. The state has seen a dramatic increase in population, vehicles ownership, and vehicle miles traveled over the last few decades. Figures published by TxDOT show that the population has increased by 64% since 1960. They also show that vehicle registrations have increased by 214% and vehicle miles traveled have increased by 173% since that same time [29].

Infrastructure that was designed 30 and 40 years ago is becoming functionally obsolete much sooner than it was designed to last. More vehicles on the state's roads and highways are leading to gridlock. There are not enough lanes to support the amount of traffic that is present on the roads today. The increase in traffic is detrimental not only to highway capacity, but also to roadway and bridge structure. Increased loading shortens the life of a structure and leads to premature failure. The state now has to figure out how to fund projects to rehabilitate the aging infrastructure and continue building new infrastructure to alleviate the increased volume of traffic.

The Texas Department of Transportation has determined that the gap in mobility funding needed by 2030 and the available funding to be approximately $86 billion. TxDOT officials believe that if the Department is able to meet the gap, the new and rehabilitated infrastructure will have a large economic benefit of approximately $18.4 billion annually [29].

TxDOT officials recently submitted a plan to the Texas legislature to solve the "Texas Transportation Challenge". The plan outlined TxDOT's goals and the strategies they planned to implement to meet the goals. The five goals outlined in the plan are to "reduce congestion, enhance safety, expand economic opportunity, improve air quality, and increase asset value" [29].

TxDOT's goals are inherently related; each of the other goals can be achieved by reducing congestion. The level of safety on a roadway is inversely proportional to the density of traffic. Building new roads and improving old roadways by adding more travel lanes help to reduce the density of traffic and improve safety. Lower traffic densities will also help to improve air quality with fewer instances of gridlock. Traffic jams result in vehicles just idling, which wastes gasoline and emits exhaust into the atmosphere. New roadways will also provide access to new areas for development. The new development will help to boost the economy.

The Texas Department of Transportation has developed four strategies for improving Texas' infrastructure, decreasing the gap between needed and available funds, and striving to meet the five goals previously discussed. The four strategies are:

1. Use all available financial options to build transportation projects.
2. Empower local and regional leaders to solve local and regional transportation problems.
3. Increase competitive pressure to drive down the cost of transportation projects.
4. Dmand consumer-driven decisions that respond to traditional market forces [29].

5.1.1 Available Financial Options

The demand for new and rehabilitative construction work in the state of Texas is increasing at a rate that is higher than the state's ability to finance and perform the work. The reasons behind this unmanageable increase in the gap between the needed funding and available funding include transfers of transportation-related revenue, unreliable federal funding, and a steady erosion of the purchasing power of the State Highway Fund [29]. An example of transportation-related revenue is turnpike tolls. These revenues that are meant to be reinvested in the state infrastructure are being siphoned to other parts of government. This is very similar to Pennsylvania where the department of transportation funding is being reallocated to public transportation.

The State Highway Fund derives its finances from various sources including state motor fuels tax, federal funds, motor vehicle registration fees, and sales tax on lubricants. The increase in population, vehicles, and vehicle miles traveled in Texas increases the amount of money that is available in the State Highway Fund, but this increase does not meet the increased demand. Therefore, Texas DOT officials had to devise new ways to fund the necessary infrastructure projects.

The Texas legislature recently approved several new revenue generating devices as a means to overcome the lack of funding to build new transportation projects. The major new means of providing funding for projects include the Texas Mobility Fund, toll equity, toll debt, and private funding.

The Texas Mobility Fund is a "revolving fund to finance the cost of acquisition of right-of-way and the design, construction, reconstruction, acquisition, and expansion of state highways" [30]. The money in the fund is authorized to pay for the expansion and rehabilitation

of the state highway system and part of the costs for construction and publicly owned toll roads and other public transportation projects. The revenue that is placed in this fund is generated from state traffic fines, various state vehicle fees, and proceeds from the issuance and sale of obligations.

Toll equity and toll debt are very similar ways of obtaining the financial means to undertake a construction project by issuing obtaining loans and grants. This allows for the acquisition, construction, maintenance, and operation to occur immediately while the financing is spread out over time. Money is the most important constraint in construction. If the money is not available, a project can not be completed. The use of toll equity and toll debt allows for the acceleration of the project's completion. The Texas Transportation Commission is encouraging the entities responsible for designing and constructing infrastructure to issue debt to finance projects by leveraging existing tax and toll revenues.

The Texas Transportation Commission (TTC) is the five-member board that is appointed by the governor of Texas to oversee the Texas Department of Transportation. The TTC is responsible for planning and managing policies for the location, construction, and maintenance of state highways, and for overseeing the design, construction, maintenance, and operation of the state highway system. The members of the TTC are also responsible for developing a statewide transportation plan; awarding contracts for the improvement of the state highway system; and "encouraging, fostering, and assisting in the development of public and mass transportation in Texas" [31].

The most significant new way the TTC and TxDOT are financing infrastructure is through the private sector. The TTC believes that the most efficient long-term solution is to have the amount of private sector capital match the amount of public sector capital being used to fund

transportation projects [29]. The introduction of private sector financing has opened the door to new project delivery systems that will be discussed in following sections.

5.1.2 Empowering Local and Regional Leaders

Within the state of Texas there are several smaller transportation entities that the Texas Department of Transportation hopes to utilize to solve local and regional transportation problems. TxDOT is reaching out to local and regional leaders to be partners in projects that specifically affect their locality. TxDOT authorities believe that by separating the planning and the execution of local projects, regional projects, and state projects more work will be completed in a more expeditious manner. The desire to empower regional leaders led the TTC to develop Regional Mobility Authorities.

Regional Mobility Authorities (RMA) are formed by one or more counties with approval from the TTC to design, finance, and construct projects within their county or counties. The approval of an RMA is based on sufficient public support and an assessment of how the projects will improve mobility. Approval is also dependent upon whether or not the projects will benefit local and state government and the traveling public. Once approved, the RMA is a completely separate entity from TxDOT with power equivalent to TxDOT to design projects and award contracts for the construction of those projects [31]. There are two primary sources of funding for RMAs: toll equity and pass-through toll financing.

Regional Mobility Authorities may issue bonds to the public in order to finance the work within their region. This is an example of toll equity. Another way that RMAs apply toll equity is by seeking loans from TxDOT. The alternate form of funding projects for an RMA is pass-through toll financing.

Pass-through toll financing is a “means of funding and reimbursing upfront costs of construction” that is employed by the Texas Department of Transportation for both private entities and public entities, such as an RMA [32]. The RMA or other entity developing the project is responsible for financing, designing, constructing, maintaining, and/or operating the project depending upon the terms of the contract. TxDOT then reimburses a portion of the project cost by making periodic payments to the developer for each vehicle that drives on the highway. The monies paid to the RMA can then be used to fund future projects.

The TTC has set up very strict guidelines pertaining to how RMA funds may be spent. Surplus revenues may be used to reduce tolls on RMA turnpikes, enhance the Texas Mobility Fund, and fund other regional transportation projects including commercial airports, public transit facilities, the Gulf Intra-Coastal Waterway, planned state highways, passenger and freight rail facilities, and pedestrian and bike facilities. RMA surplus revenues may not be used to fund the construction of local roads, rural minor collectors, or for converted state highways [32].

With these means of generating money, RMAs are useful in accelerating the completion of projects. Projects that would have to be put off because of TxDOT’s lack of available funding are now being constructed by these separate entities that are able to focus energy on generating funding to complete the projects. TxDOT officials believe that RMAs are “the most efficient use of limited available fund” according to a TxDOT RMA handbook. Another benefit associated with the creation of Regional Mobility Authorities is a reduction in TxDOT maintenance costs. When an RMA constructs a highway or turnpike, it is responsible for the upkeep on that roadway. RMAs are looked upon favorably by local governments in Texas because they are seeing an increase in control over the transportation system in their area. The TTC has

developed indices to measure the results of RMA projects [32]. The approval of future projects is based upon the success of the results.

5.1.3 Increasing Competitive Pressure

The third strategy that the Texas Department of Transportation plans to employ is increasing competition to decrease the cost of transportation projects. Competition is a driving force in all business. The more competition there is in the market, the lower the prices will be. This is a result of each competitor trying to beat out the rest by having the best price. Officials believe that the "private sector will play a major role in developing Texas' future transportation system" [29].

The way that TxDOT hopes to increase competition is through the use of Public-Private Partnerships. According to the FHWA, Public-Private Partnerships (PPP) are "contractual agreements formed between a public agency and private sector entity that allow for greater private sector participation in the delivery of transportation projects" [33]. Increasing the role played by the private sector will allow the Texas DOT to decrease its own risk in the construction process, while more importantly increase the amount of funding available to design and construct the projects that need to be built. Another benefit that TxDOT expects to see by utilizing PPPs is an accelerated rate of project completion. This is done by using project delivery systems such as design-build and build-operate.

Design-build (D/B) is a highly applied project delivery system in the modern field of construction. D/B groups the responsibility for the design and construction of a project into one contract. With only one firm responsible for design and construction, work on the project can be fast tracked, meaning the construction can begin prior to completion of the plans. This will

allow firms to compete by price and project duration so that TxDOT can select the firm that will provide the project at the most affordable price and in the shortest timeframe.

5.1.4 Demanding Consumer Driven Decisions

There is a major need for improvements and additions to the infrastructure of the state of Texas. The final strategy that TxDOT outlined in their submittal to the Texas legislature is basically a desire to build projects that matter. They want to respond to "traditional market forces", basically supply and demand [29]. There is a limited amount of funding available for infrastructure that is less than the amount that is actually needed to complete all of the needed work, so it is very important that the available funding is spent in efficient ways. That means TxDOT needs to concentrate on areas with the largest demand for new and improved infrastructure. TxDOT officials hope to provide roadway users with "alternatives to the increasingly congested roads and highways" by constructing new toll roads, corridors, and consumer friendly commuter rail systems. Decisions regarding new infrastructure should be based upon short-term and long-term solutions. With population and vehicles growing at an exceptionally large rate, it is important that TxDOT officials focus on the projects and project delivery systems that will provide the greatest positive impact to the state's infrastructure.

5.2 CONSULTANT CONSTRUCTION MANAGEMENT IN TEXAS

The Texas Department of Transportation has traditionally had very little use for consultant construction management firms. "TxDOT feels that they have to hold onto all of the

construction management duties in order to guarantee the quality of work", according to Mr. Don Truede, Vice President of Michael Baker Corporation in Arlington, Texas [34]. With the increased urgency in the need for new and rehabilitative infrastructure construction, new opportunities are surfacing for construction management firms in conjunction with the Texas DOT.

The Texas Department of Transportation is split into several different sub-entities. Geographically, TxDOT is split into 25 districts. Each district is responsible for the "construction and maintenance of state highways within their jurisdiction" [35]. The Department is also split into several divisions including aviation, bridge, construction, design, etc. A division that is of particular interest to construction management firms is the Texas Turnpike Authority. The Texas Turnpike Authority Division (TTA) "strives to improve mobility and safety through the development and operation of a safe, reliable and cost-effective system of toll roads using private-sector partners and financing options to accelerate project delivery" [36]. Since the TTA has a staff of only 27 employees, a majority of the construction management and inspection work on TTA projects are contracted out.

5.2.1 Project Delivery Systems

Mr. Thomas Zagorski, Director of Construction Services with Michael Baker Jr., Inc., referred to the Texas Department of Transportation as the leader in the construction industry with project delivery systems [6]. Michael Baker Jr., Inc. is a civil engineering company based in Pittsburgh, Pennsylvania, that is entertaining the idea of trying to enter the construction management market in Texas.

TxDOT is very traditional in its project delivery systems. Almost all of the projects that TxDOT completes are Design-Bid-Build. These projects are completely designed by TxDOT engineers. They are then advertised and bid on by prospective contractors. The Texas Turnpike Authority is using innovative new project delivery systems that are not being used elsewhere. These delivery systems include Exclusive Development Agreements, which evolved into Comprehensive Development Agreements.

Exclusive Development Agreements (EDA) were contracts between TxDOT and a "consortia consisting of designers and construction contractors that perform any or all of the design, construction, operation, maintenance, and financing of construction projects" [37]. If the consortium financed the construction work of a toll road, then they were reimbursed by the state of Texas with collected tolls upon completion. When the construction debt was paid off, the state could then reduce tolls to a level that would cover maintenance and operation costs. EDAs were the frontrunner for the current project delivery system used by the TTA, Comprehensive Development Agreements.

Comprehensive Development Agreements (CDA) are a means of project delivery that enable private investments in the Texas transportation system. CDAs are a type of private-public partnership. As previously discussed, PPPs are important because they allow for an acceleration in financing, design, construction, operation, and maintenance of much needed infrastructure projects. Similar to the Exclusive Development Agreements that preceded them, Comprehensive Development Agreements are contracts entered into between the Texas Department of Transportation and a consortium of engineering and construction firms. CDAs allow for "the work of property acquisition, design and construction to be undertaken simultaneously" [38].

There are three different types of Comprehensive Development Agreements: design-build, predevelopment, and concession. All three may be either solicited or unsolicited. Design-build CDA contracts are fulfilled upon completion of the project, at which time the consortium is paid for the work that it has performed. Predevelopment agreements pertain only to "the project's overall master development plan, master financial plan and facility implementation plan" [37]. Concession agreements are completed at the end of a concession period. The concession period is a timeframe set up in the contract in which the consortium is repaid a portion of the tolls for each vehicle that uses the turnpike. The consortium is responsible for the operation and maintenance of the toll road during the concession period.

The Texas Department of Transportation still maintains project oversight on all projects despite contracting out all of the design and construction work. TxDOT may provide this oversight or they may retain a consultant to oversee the project as an extension of their staff. Consultant oversight is especially prevalent on TTA projects because of the division's limited staffing. Project oversight on these jobs includes facilitating effective coordination between the consortium and TxDOT and other local transportation agencies. It also includes facilitating "procurement, construction, and operation of a new toll road and may also provide independent quality verification for design and construction" [37].

5.2.1.1 State Highway 130

The first project to be developed under a Comprehensive Development Agreement is the SH 130 turnpike that is projected to be completed in December 2007. SH 130 is a 49-mile tollway that runs from Interstate 35 north of Georgetown southward to U.S. 183 southeast of Austin. SH 130 is the largest element of the 2002 Central Texas Turnpike System project [38].

The SH 130 project was successfully bid on by Lone Star Infrastructure, a consortium that includes Flour Corporation, Balfour Beatty Construction, T.J. Lambrecht Company, and DMJM+Harris among nearly a dozen others. The cost of the project is expected to be approximately $1.5 billion, which includes utility relocation, right-of-way, design, and construction. Right-of-way costs are estimated at $389 million. TxDOT entered into an agreement with PBS&J to provide project oversight on the project [38].

5.2.2 Different Roles Performed by CM Firms

There are four different major roles that construction management firms are responsible for within the Texas market. They include procurement engineering, design engineering, independent engineering, and general engineering consulting. Procurement engineers are utilized by TxDOT to assist in evaluation of prospective consortia and awarding the contracts for Comprehensive Development Agreements. Procurement engineers are prohibited by TxDOT from performing any design work on CDAs [34]. The major firms that are in the procurement engineering arena in Texas are Carter & Burgess, HNTB, PBS&J, HDR, and URS. The design engineering work being contracted out by the Texas Department of Transportation is traditional design work. Most of the firms offering construction management services are multi-faceted and are winning awarded these contracts along with other divisions within their company. Independent engineering is a more pure form of construction management. Independent engineers are contracted to provide independent oversight between the CDA consortium and the TTA.

The first three roles described are all agreements between the construction management firm and the Texas Department of Transportation. The other role that construction management

firms in Texas are engaged in is between the CM firm and the CDA consortium. The consortium enters into an agreement to provide its own oversight on the project and to provide quality control and quality assurance services.

5.2.3 Future for CM Consultants in Texas

The need for new and rehabilitative construction in the state of Texas is growing at an alarming pace. The Texas Department of Transportation does not have the available funding to continue using traditional methods to finance, design, construct, operate, and maintain the state's infrastructure. This has opened the door for construction management firms to provide their services to TxDOT. The top four construction management firms in the Texas market, HNTB, Parsons Brinckerhoff, Carter & Burgess, and PBS&J, have provided construction management services in the state of Texas for the amount of $153.7, $129, $93, and $61.4 million, respectively from 2002 to 2004 [34]. The use of innovative project delivery systems has allowed TxDOT to begin more projects than they have the funding for through the assistance of private funding; it also allows for an accelerated schedule that helps alleviate congestion sooner.

Despite losing many employees and experience due to retirement, TxDOT does not plan on deviating from the design-bid-build method of project delivery, nor do they plan on outsourcing any construction management work in the near future according to Bunny Neible of the Texas Department of Transportation Construction Division. Ms. Neible confirmed that there will be plenty of opportunity for construction management consultants in the new design/build and public-private partnerships that the regional mobility authorities and TxDOT's Texas Turnpike Authority are beginning to use [39].

6.0 NATIONAL CONSTRUCTION MANAGEMENT/CONSTRUCTION INSPECTION USE

In order to analyze the outsourcing of construction management and construction inspection tasks on a national level, a questionnaire was sent to the state construction engineer or similar official at every state department of transportation. 18 of the 50 state DOT officials responded to the survey. A table has been created from the responses, which can be found in Appendix B.

Similar to Pennsylvania and Texas, most of the state departments of transportation are not outsourcing very much construction management work. The average amount of construction management that is outsourced to consultants nationally is equal to approximately 11% of the total DOT construction management work. This number becomes much lower if Florida and Oregon are removed from the analysis. The Florida DOT outsources 80% of its construction management work, and the Oregon DOT outsources 50% of its construction management work. Excluding those two states, the national average of outsourced CM work plummets to 4%; none of the remaining states that responded to the survey outsource more than 15% of their construction management tasks.

State DOTs are less apprehensive about using consultants to perform inspection tasks. Outsourcing construction inspection does not take away from the DOT's control of the project; therefore, the DOTs are open to using consultant inspection services more readily than consultant construction management services. The national average for the amount of construction

inspection work that state DOTs outsource to consultants is approximately 23%. There are more states using upwards of 50% outsourced construction inspection services than management services including Connecticut, Florida, Maryland, and Oregon. Pennsylvania currently outsources 45% of its construction inspection.

6.1.1 Analysis of Survey Results

There are several factors that can sway a department of transportation to outsource CM/CI services; the most logical factor is funding. The amount of construction work that a DOT can perform and the available funding to that DOT are directly proportional. There will never be enough funding to perform all of the work that is needed to improve the nation's infrastructure at one time. The roads and highways that are in the worst condition are repaired first. Therefore, DOTs are staffed only to a level that will enable them to perform work for which there is available funding. These DOT staffs have been at the same level of manpower for the past several years. Staffing in some states has actually decreased. But with additional funding available through SAFETEA-LU, states will have the ability to perform more work. The problem that many states are facing is that by undertaking additional work, their staffs will not be able to properly inspect and manage all of the work that is being performed. This has led to the DOTs reluctantly using more outsourced services.

It seems reasonable that the more funding that a state is provided through SAFETEA-LU, the more use that they would have for consultant services. The percentage of outsourced CM/CI data from the survey shows a slight trend toward this idea, but it does not appear to be the best explanation to which states are outsourcing and why. Many states are not outsourcing any construction management at all. The most glaring opposition to the idea that more funding

should equate to more outsourcing is the state of Texas. Texas ranks second only to the state of California in the amount of federally allocated funding that they receive annually for transportation projects. Therefore, it seems reasonable that Texas would utilize a considerable amount of consultant managers and inspectors, but the Texas Department of Transportation does not outsource any of its CM/CI work. It is apparent from the graphs in Figure 10 that the amount of funding that a DOT recieves does not directly relate to the amount of work that the DOT outsources. There are other factors that affect the decision to outsource management and inspection work. The mindset of DOT officials seems to have the most impact on the amount of outsourcing. TxDOT officials feel that "the public's interests are best served if overall CM is handled in-house" [40]. Therefore, the state does not outsource any of its CM/CI work. On the contrary, Florida DOT officials feel that they have no other choice. It is the best way for Florida to "manage the fluxuations in the work program without having to lay off employees" [41]. Most DOT officials are adamantly against using outsourced construction management and will only do so if

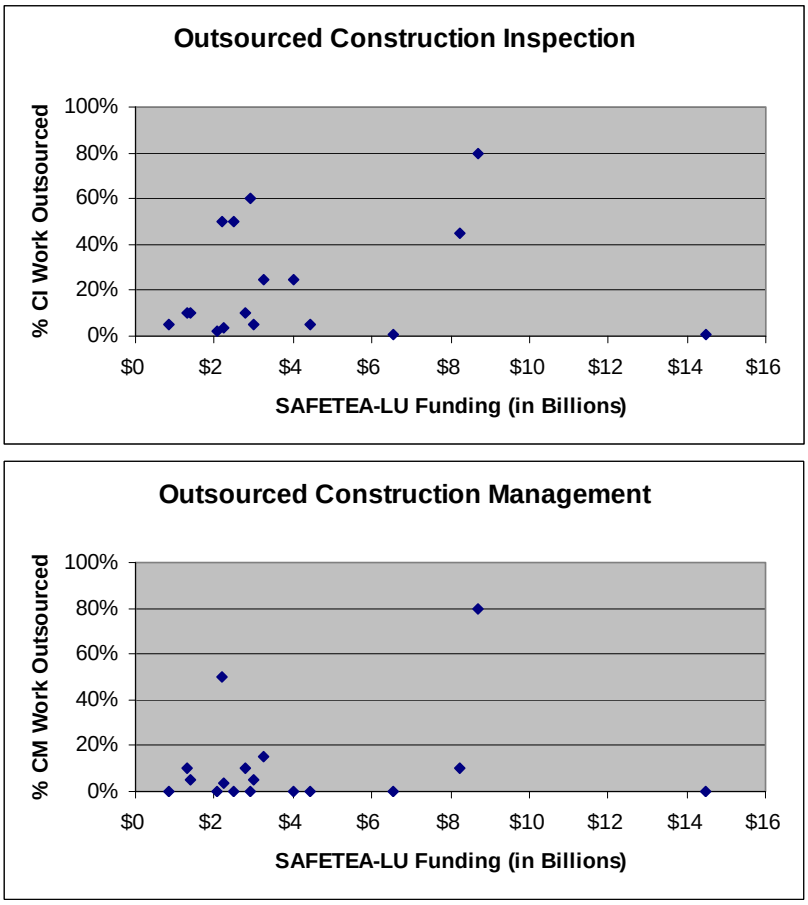

Figure 4. Graphical representation of relationship between funding and outsourcing construction management and inspection services [Appendix A].

absolutely necessary. The unpleasant reality for those officials is that outsourcing is becoming necessity that must be used.

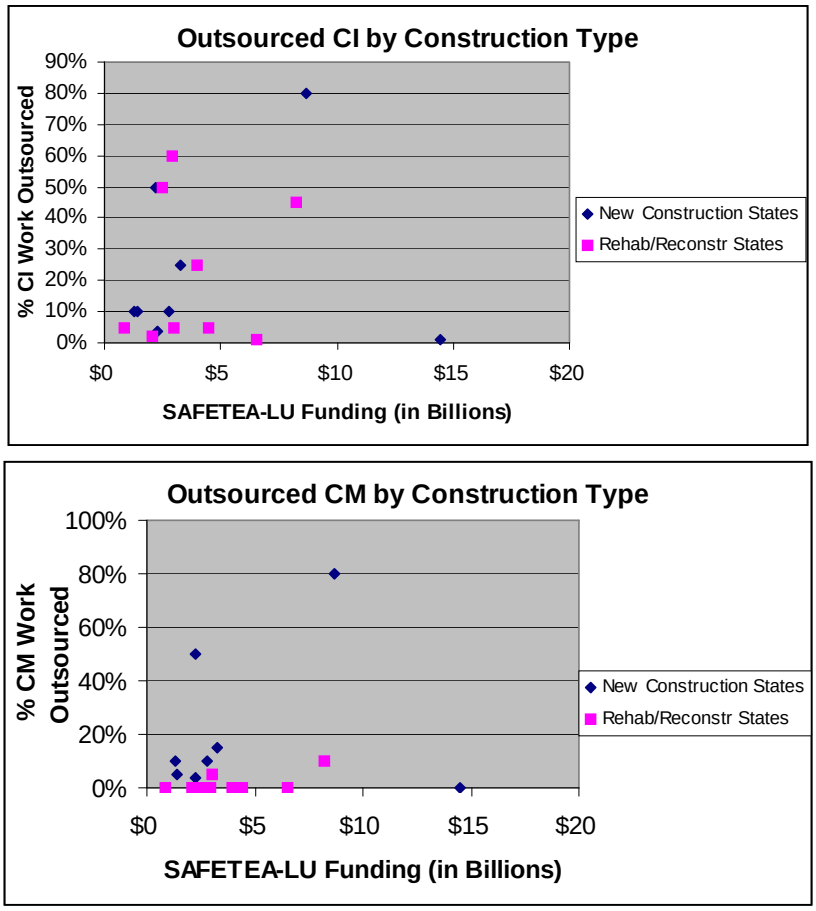

Figure 5. Graphical representation of relationship between funding and outsourcing construction management and inspection services organized by the prevailing type of construction performed in each state.

Another factor that seems to have a large impact on the amount of construction management and construction inspection that is outsourced by a state DOT is the type of construction work that is prevalent in that state. As previously discussed, there are two major types of construction: new construction and rehabilitation/ reconstruction. The graphs from Figure 10 become more useful when they are organized to show the type of work being performed. It becomes apparent that a higher percentage of work is being outsourced by states that are performing more new construction with the exception of Texas. The two separate groups also show a pronounced trend toward increased outsourcing when more funding is available, especially when considering construction management.

7.0 FUTURE OF OUTSOURCING CONSTRUCTION MANAGEMENT AND INSPECTION

A major problem that the state DOTs are facing currently is the uncertainty of federal funding beyond 2009 when SAFETEA-LU expires. There are currently several Congressional commissions researching new ideas to fund construction projects in the future. Their reports, which are due in December 2007, will likely be the "road map for change" in the highway construction industry [16]. A lot of current speculation in the industry is that there will be much less funding available after 2009. Congress will not allow this to happen, because the current status of the nation's infrastructure is deplorable. This has been ignored for many years, but in light of the recent bridge collapse in Minnesota, which resulted in several deaths and more injuries, the abysmal condition of the nation's infrastructure can no longer be disregarded. It will take decades in order to upgrade the nation's infrastructure to an acceptable level and funding will be available annually to make the needed upgrades.

Department of Transportation programs are going to see a continued growth over the next several years. Without the ability to increase their workforce, the DOTs will inevitably be forced to utilize more consultant construction management and inspection services. The issue of state DOTs outsourcing CM/CI work to consultants is not a question of whether or not the DOTs will use more or less outsourcing, but rather how long will it take for the DOTs to take advantage of the available consultant services.

State DOTs are very slow to change as is evident in the use of other innovative project delivery methods. The bureaucracy involved in state government is the cause of this resistance to change. States have very rigid protocol for the design and construction of DOT projects. These standard operating procedures have resulted in successful projects in the past, so DOT officials see no need for change. As a result, state DOTs are generally 5-10 years behind the rest of the construction industry in terms of usage of new project delivery methods. Two examples of this are design/build and public-private partnerships. Both project delivery methods, which have been described earlier in this study, are very useful tools for decreasing cost and schedule time to the owner. DOTs were extremely opposed to using these methods; some states even passed laws that made it illegal for the DOT to enter into D/B or PPP contracts. With the recent trend toward improving infrastructure and eliminating congestion, many states have reversed their opinion toward these methods. DOT officials are using Design/build contacts and Public-private partnerships more and more frequently because of the DOTs need to complete projects as quickly as possible and for the most responsible price possible.

The same shift in department of transportation mentality toward D/B and PPP is going to occur with consultant CM/CI services. DOT officials have been very much in opposition to outsourcing construction management to consultants for many of the same reasons that they opposed D/B and PPPs. Their main concern is that the DOT is going to lose some of its power. The first time that construction management work was outsourced by the Pennsylvania Department of Transportation was on the Airport Expressway project outside of Pittsburgh, PA. Mr. Henry Nutbrown, the PennDOT District 11-0 Executive at the time, made certain that the consultants on the project from Michael Baker Jr., Inc. were well aware that they were not working on that project because he wanted them to, but because he had no other choice [42].

The schedule and level of resources required on that job were such that PennDOT's in-house staff was unable to perform the work alone [42].

Necessity has opened the door for consultant CM/CI services in many states and the rest will follow. In addition to lacking the ability to grow, DOTs are also losing expertise to retirement. While some of the retirees are actually entering into retirement, a significant amount are retiring from the DOT because they have reached the amount of years necessary to retire from the state. These individuals are being employed by consultants because of their knowledge of state procedures in addition to collecting their state pensions. Consultant jobs are more enticing to new graduates as well, because DOT salary is not competitive with the firms in the private sector. As a result DOTs are having a more difficult time replacing retirees with competent applicants.

The loss of staff to consultants is one of the concerns that many of the survey respondents included in their list of disadvantages related to outsourcing CM/CI. It is a legitimate fear for the DOT officials to have, because it will be one of the driving forces toward the use of more outsourced construction management and construction inspection. With the current trend toward improved infrastructure, state DOTs will inevitably have to outsource a portion of the construction management and construction inspection work on some projects because they lack the necessary staffing. This will give the DOT employees the opportunity to see the benefits of working for a consultant as opposed to working for the DOT, and many more will transfer into jobs with the consultant. The loss of more employees will create a need within the departments that DOTs will not be able to fill, and they will have to outsource more and more CM/CI work. This chain of events has already begun in some states and the rest will inevitably "follow suit" [41].

8.0 CONCLUSION

The nation's infrastructure is in dire need of improvement. Roads and bridges do not meet the needs of the traveling public throughout the United States. Most of the problems in the northern states are a result of the states allowing their transportation systems to deteriorate beyond repair. The roads and bridges are quickly approaching a point that they are dangerous to the public. A lot of money and work needs to be put into the infrastructure to reconstruct these roadways and bridges.

The state of Pennsylvania was chosen as a representation of the states that are performing mostly rehabilitation and reconstruction work. PennDOT uses a very limited amount of outsourced construction management, reserving it for large projects with significant media exposure. The Department currently uses project-based CM services, where a consultant enters into an agreement with PennDOT to perform CM tasks on one particular project. The plan for the future entails switching to a task-based method. With this method, PennDOT will enter into an indefinite demand/indefinite quantity contract with one consulting firm to provide CM services on any of PennDOT's projects when needed. Department officials feel that there will be no need to increase the amount of outsourcing higher than the level it is currently at, which is approximately 10% of the total CM work completed on PennDOT projects.

Population is growing drastically in the southern and western states resulting in a transportation system that is not able to handle the traffic loads that it is being subjected to

carrying. The increased traffic is resulting in gridlock, which increases user costs and negatively affects the economy. The states facing major population growth are in the process of constructing new roads to alleviate the stress on the existing infrastructure.

The state that was studied in-depth as an example of the new construction states was Texas. All of the projects that are completed traditionally by TxDOT are performed completely in-house, and TxDOT officials do not foresee this changing anytime in the future. They feel that their own employees can perform the work better than consultants. Despite this, there are several new opportunities for construction management firms in the state of Texas. While TxDOT is not outsourcing any CM/CI on its traditional design-bid-build projects, the department is beginning to use several new methods of project delivery that utilize construction management teams that are entirely comprised of consultant staff.

Every state department of transportation in the country is facing the need to perform a much larger amount of projects than in the past. Most of these departments do not have the available personnel to manage and inspect all of the necessary projects. Regardless of the need to do so, most DOT official are averse to utilizing consultant construction management and construction inspection staffing as they feel that their states can be better served by state employees.

There are many advantages to using consultant construction management and inspection services including the ability to supplement DOT staff without having to layoff employees during slow periods, consultant CM expertise, and specialized services that the DOT may not be able to provide by itself. There are also many disadvantages that DOT officials associate with outsourcing CM/CI work to consultants. The disadvantages include high cost, an additional

burden on DOT staff to train consultants in department procedures, and a fear of losing employees to the consulting firms.

Regardless of reluctance of the majority of DOT officials to outsource construction management and construction inspection to consulting firms, the utilization of these firms is becoming more prevalent. There is not going to be a decrease in the size of DOT programs in the foreseeable future. In fact, many programs will actually grow. Without the ability to increase department staffing, state DOTs will be forced to outsource a portion of their CM/CI work. Once the departments begin outsourcing CM work, they enter into a cycle that will inevitably result in the DOT utilizing consultant services more and more frequently.

APPENDIX

SURVEY RESULTS

Table 2. Responses provided by DOT officials

State	SAFETEA-LU (in billions) [43]	Contact	Title	Percent CI	Percent CM	Future Trend
Arizona	$3.26	Julio Alvarado	Asst. State Engineer, Construction	**25%**	**15%**	
Connecticut	$2.48	Ravi Chandran	Transportation Principal Engineer	**50%**	**0%**	
Florida	$8.68	Brian Blanchard	Director, Office of Construction	**80%**	**80%**	No change - other states will follow suit
Indiana	$4.45	Mark Miller		**<5%**	**0%**	No change
Iowa	$2.06	John Smythe	Construction Engineer	**<2%**	**0%**	Decrease - contractors will hire CMs
Maryland	$2.92	Mark Flack	Director, Office of Construction	**60%**	**0%**	Slight increase
Minnesota	$3.00	Gennadiy Begelman	Project Development Engineer	**<5%**	**<5%**	No change
Mississippi	$2.25	Brad Lewis		**2-5%**	**2-5%**	No change
Nevada	$1.30	Gary Selmi	Chief Construction Engineer	**10%**	**10%**	No change
New Hampshire	$0.84	Ted Kitsis	Administrator, Bureau of Construction	**<5%**	**0%**	Slight increase
Ohio	$6.55	Gary Angles	State Construction Engineer	**1%**	**0%**	No change
Oklahoma	$2.79	George Raymond	State Construction Engineer	**10%**	**10%**	No change
Oregon	$2.21	Jeff Gower	State Construction Engineer	**50%**	**50%**	No change until 2012, dependent on funding after that
Pennsylvania	$8.23	Pat Gardiner	Chief, Contract Management Division	**45%**	**10%**	Slight increase in CI, CM on major projects
Tennessee	$3.99	David Donoho	Director of Construction	**25%**	**0%**	Increase due to workforce decrease
Texas	$14.47	Ken Barnett	Construction Section Director	**<2%**	**0%**	
Utah	$1.41	Larry Myers		**10%**	**5%**	Slight increase
AVERAGE				**23%**	**11%**	

WORKS CITED

[1] 2005 Report Card for America's Infrastructure. American Society of Civil Engineers. http://www.asce.org/reportcard/2005/index2005.cfm.

[2] Nunnally, S.W. *Construction Methods and Management*. 7th edition. Pearson - Prentice Hall. Upper Saddle River, New Jersey, 2007.

[3] Holm, Len and Schaufelberger, John E. *Management of Construction Projects: A Constructor's Perspective.* Prentice Hall. Upper Saddle River, New Jersey, 2002.

[4] Norman, Brian A., Ph.D. Personal interview. 13 November 2007.

[5] Foringer, James A., P.E. Personal interview. 25 October 2007.

[6] Zagorski, Thomas J., P.E. Telephone interview. 15 November 2007.

[7] Chandran, Ravi V., P.E. Email correspondence. 7 November 2007.

[8] Routon, Steven A., P.E. "Outsourcing Program and Construction Management". *Structural Engineer*. September 2001.

[9] Raymond, George, P.E. Email correspondence. 31 October 2007.

[10] Blanchard, Brian A., P.E. Email correspondence. 31 October 2007.

[11] Gower, Jeffrey L., P.E. Email correspondence. 1 November 2007.

[12] Kitsis, Theodore, P.E. Email correspondence. 31 October 2007.

[13] Hurst, Paul, P.E. Email correspondence. 7 November 2007.

[14] Miller, Mark R., P.E. Email correspondence. 2 November 2007.

[15] SAFETEA-LU. U.S. Department of Transportation. Federal Highway Administration. http://www.fhwa.dot.gov/safetealu/index.htm. 2007.

[16] Elliott, G. Rob, P.E. Telephone Interview. 23 October 2007.

[17] 23CFR635.105. Code of Federal Regulations. Title 23, Volume 1. 01 April 2001.

[18] *Investing in Our Future: Addressing Pennsylvania's Transportation Funding Crisis*. Pennsylvania Transportation Funding and Reform Commission Final Report. ftp://ftp.dot.state.pa.us/public/pdf/TFRCReport/04FinalReportExec%20Summary.pdf. November 2006.

[19] Cessna, H. Daniel, P.E. Personal interview. 25 October 2007.

[20] Biehler, Allen D., P.E. Pennsylvania Planning Association 2005 Convention Presentation. http://www.planningpa.org/presentations/05/puzzle.pdf

[21] Liquid Fuels and Fuels Tax. Bulletin No. 2005-1. http://www.ppmcsa.org/content/2006%20Fuel%20Rates.pdf. 1 December 2005.

[22] *Investing in Our Future: Addressing Pennsylvania's Transportation Funding Crisis*. Commission's Initial Findings and Request for Public Input. ftp://ftp.dot.state.pa.us/public/pdf/TransFunding8-06.pdf. September 2006

[23] Nussbaum, Paul. "I-80 tolls: Up to 10 booths in three years". *Philadelphia Inquirer*. 21 August 2007.

[24] Pampena, Angelo A. Personal Interview. 25 October 2007.

[25] Engineering District 11-0 Construction Division Organizational Chart. Pennsylvania Department of Transportation. 20 August 2007.

[26] Gardiner, J. Patrick, P.E. Email correspondence. 1 November 2007.

[27] *Signature*. Michael Baker Corporation. October 2007. Page 23.

[28] *Assistant Construction Engineer Manual*. Pennsylvania Department of Transportation. Publication XX. Revised XX 2005.

[29] *The Texas Transportation Challenge*. Texas Department of Transportation. http://www.dot.state.tx.us/publications/government_and_public_affairs/challenge.pdf. May 2006.

[30] *General Overview of State Highway Fund*. Legislative Budget Board. http://www.senate.state.tx.us/75r/senate/commit/c865/assets/c865.overview.pdf. 19 April 2006.

[31] Stull, Linda. "Crossroads of the Americas: Trans Texas Corridor Plan". http://www.corridorwatch.org/ttc/cw-plan0206-11finance.htm. 31 December 2006.

[32] *Keep Texas Moving*. Texas Department of Transportation. http://www.keeptexasmoving.com/var/files/File/PassThroughTollOnline.pdf. 2007.

[33] Public-Private Partnerships". U.S. Department of Transportation. Federal Highway Adminstration. http://www.fhwa.dot.gov/ppp/defined.htm#1. 2007.

[34] Truede, Don, P.E. Personal interview. 20 September 2007.

[35] "Local Information". Texas Department of Transportation. http://www.dot.state.tx.us/local_information/default.htm. 2007.

[36] "Texas Turnpike Authority Division". Texas Department of Transportation. http://www.dot.state.tx.us/services/texas_turnpike_authority/default.htm. 2007.

[37] *TxDOT: Open for Business*. Texas Department of Transportation. http://www.keeptexasmoving.com/var/files/File/CDABook.pdf. Winter 2006.

[38] "Who is LSI?" Lone Star Infrastructure. http://www.sh130.com/about/. 2005.

[39] Neible, Bunny. TxDOT Construction Division. Telephone interview. 28 September 2007.

[40] Barnett, Kenneth, P.E. Email correspondence. 26 October 2007.

[41] Blanchard, Brian A., P.E. Email correspondence. 31 October 2007.

[42] Kurgan, John, P.E. Personal Interview. 16 November 2007.

[43] "Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users". *Engineering News-Record*. McGraw Hill Construction.