EVALUATION OF OREGON DEPARTMENT OF TRANSPORTATION PROJECT DELIVERY

Outsourcing Project Delivery
in
State Departments of Transportation

Literature Review and DOT Survey

SPR PROJECT 351

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16. Abstract

This report summarizes a review of literature regarding outsourcing by Departments of Transportation (DOT), with particular emphasis on outsourcing of project delivery, and on performance measures for project delivery. The report also summarizes information obtained from a brief e-mail survey of the 50 US DOTs, and a follow-up detailed questionnaire survey and telephone interviews. The information in this report lays the groundwork for comparative evaluation, over a three-year period, of projects delivered by the Oregon Department of Transportation using insourced design-bid-build, outsourced design-bid-build, and design-build. The results of this analysis and the proposed guidelines for selecting project delivery methods for specific projects will be included in the final report in 2006.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

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DISCLAIMER

EVALUATION OF OREGON DEPARTMENT OF TRANSPORTATION PROJECT DELIVERY
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EXECUTIVE SUMMARY

In August 2002, Oregon State University (OSU) and the Oregon Department of Transportation (ODOT) began an evaluation of insourced and outsourced project delivery. Traditional insourced design-bid-build delivery (DBB), outsourced design-bid-build (ODBB), and outsourced design-build (DB) are included in the study. The end products will be an evaluation of ODOT project delivery effectiveness and guidelines for outsourcing. The initial tasks have included a comprehensive literature review and a survey of state Department's of Transportation (DOT). This interim report highlights the progress through June 2003.

Outsourcing of project delivery has become a popular concept within state DOT's. The increased use of outsourcing has resulted from two major factors. Most states have been legally restrained from increasing the size of the work force, even though project load has sometimes increased dramatically. The second factor is that capital improvement programs may be funded with strict schedule restraints that may only be met through the use of outsourcing. Cost comparisons are not generally a determining factor with respect to outsourcing and are seldom made. When they are made, it is difficult to achieve agreement on correct handling of DOT overhead costs.

A brief screening survey of all 50 state DOT's was conducted in January 2003. The intent was to determine which states should be studied further. Based on this survey and information from the literature review, 22 states were targeted for an in-depth survey. Contacts with 14 of these 22 states produced useful information. In most cases, information was collected by telephone interview. In some cases, the researchers were directed to website materials.

The most significant information came from South Carolina, Louisiana, Oklahoma, Florida, Connecticut, and Indiana.

- South Carolina, Louisiana, and Oklahoma provided the most dramatic examples of outsourced design-bid-build projects.
- Florida and Utah have had the most design-build experience out of the states surveyed.
- Florida had the best documented experience with outsourced construction engineering and inspection (CEI).
- Connecticut and Indiana have had the greatest length of experience with outsourcing preliminary engineering (PE).
- Connecticut has also implemented program management on a significant scale in recent years.

- Florida and Louisiana have done a significant amount of work in developing cost models and comparing insourced versus outsourced costs.

OUTSOURCING DESIGN-BID-BUILD

Methods for utilizing outsourcing to delivery projects vary widely. Simple outsourcing of specialized design as part of the development of contract documents has been widely practiced for many years. A minimal approach to outsourcing construction engineering (CE) functions is the provision of inspection personnel by consultants. Outsourcing the preliminary engineering (PE) responsibility for projects to consultants is a widespread practice. Total outsourcing of CE is less prevalent, but is common practice for a few states.

The most comprehensive approach to outsourcing project delivery is contracting with one or more consultants to deliver all PE and CE for an entire program, consisting of multiple projects. In this outsourced program management approach, although the construction contracts remain between the DOT and the construction contractors, the program managers are expected to maintain control over a comprehensive plan and schedule for the program that assures that the projects will be delivered on time and within established budgets. The entity to which total project delivery is outsourced may even be charged with providing or developing financial reporting systems.

States with experience outsourcing PE have developed a comfort level with doing so. The biggest concern with outsourced PE is losing in-house technical expertise.

Outsourcing CE appears to create a greater challenge. States have less experience outsourcing CE and have shown less satisfaction and comfort with the process. Administration of construction contracts is usually decentralized, resulting in variations of approach and experience.

The most dramatic example of outsourced project delivery was found in the South Carolina DOT with their "27 in 7" program. Begun in 1999, the seven-year project will accomplish delivery of projects that would have taken 27 years without the program. By outsourcing the entire program to two "Construction and Resource Managers" (CRM's), SCDOT avoided hiring "an estimated 500 employees to handle the additional workload." One program manager was chosen to deliver the program in the eastern region of the state, and another was chosen to deliver the program in the western region. SCDOT reported in 2002, at the half-way point, that the program "is meeting all expectations."

South Carolina was one of two featured DOT's in an internal ODOT document on outsourcing project delivery authored in 2002 by former ODOT Region Manager, Steve Macnab. Louisiana was the other. No significant changes have occurred since the Macnab report. Both states continue to be pleased with the progress of their programs.

One document, from the literature review, is of particular interest with respect to outsourcing design-bid-build. This is the "Contracting Out – Benchmarking Study" reported in 2000 by the Office of Federal Lands Highway. The study included on-site

interviews with high-level managers of 11 state DOT's. From the information obtained, a computer-based cost model for agency staffing at various levels of construction programs and various levels of outsourcing was developed. Recommendations for outsourcing design-bid-build were also made.

OUTSOURCING WITH DESIGN-BUILD

Design-build (DB) is a method of outsourcing where the agency contracts with one entity for design and construction. To outsource using DB, the agency must conduct enough front-end planning and engineering to be able to adequately define the scope of work required by the DB contractor.

Florida DOT (FDOT) has broad experience with design-build project delivery. They are currently using DB for, "major bridge replacements, roadway widening and resurfacing, rest areas, ITS projects, and more." The Federal Highway Administration (FHWA) Florida Division is partnering with FDOT in developing "State-of-the-Art DB documents, including: RFP Guidelines, Design and Construction Criteria Guidelines, Construction Inspection Scopes, Specifications, Utility Agreements, and Warranties." They are also working together to, "develop processes for DB firms to acquire right-of-way and to develop innovative approaches to construction engineering and inspection."

FDOT published DB guidelines, "to establish the Department's process for procuring and administering the design, construction, and Construction Engineering and Inspection (CEI) services, (unless a federally funded project) within one contract." The guidelines became available February 28, 2002, and are available at the FDOT website. The 106-page document includes information on: procurement and administration, the bid process, developing the design and construction criteria package, encumbrance, federal-aid, right-of-way, project development and environment processes, geotechnical and structures processes, estimating processes, contract administration, and materials acceptance. A contracting flowchart is also included.

OREGON DOT'S APPROACH TO OUTSOURCING DESIGN-BID-BUILD

ODOT's approach to outsourced design-bid-build is more ambitious than the practices of some states, but does not go as far as the South Carolina, Louisiana, and Oklahoma models. The approach utilizes a pool of pre-qualified on-call consultants who are assigned PE and CE responsibility for specific projects. ODOT Region offices are staffed with ODOT employees serving as Consultant Project Managers (CPM). Only time will tell if there is a best approach to outsourcing project delivery, and if so, which approach is that best. There is no reason to believe that ODOT's approach is not a sound one.

PERFORMANCE MEASUREMENT

An important part of the on-going research will be an emphasis on performance measurement across the different ODOT project delivery methods, including traditional insourced DBB, outsourced DBB, and outsourced DB. Performance measures of state DOT's have been reported in the National Cooperative Highway Research Program (NCHRP) Synthesis Report 238 – Performance Measurement in State Departments of Transportation. The Construction Industry Institute (CII) has also defined performance measures for project delivery. ODOT's Office of Project Delivery and ODOT's Construction Section have developed, and are implementing measures of project delivery effectiveness for ODOT. Information from these sources is also summarized in this report.

1.0 INTRODUCTION

1.1 BACKGROUND

This interim report was written as part of a broader research project being conducted for the Oregon Department of Transportation (ODOT) by the Construction Engineering Management (CEM) Program in the Department of Civil, Construction, and Environmental Engineering at Oregon State University (OSU). The purpose of this interim report is to document what other states are doing and what ODOT is doing, with respect to outsourcing of project delivery. This report summarizes the information obtained in the literature review and from a survey of state DOTs. More detailed information is available in the original documents cited in the literature review, and in two graduate student project reports (*Carbonell 2003; Setiawan 2003*). Future reports from this project will document ODOT's experience with outsourced project delivery.

1.2 RESEARCH OBJECTIVES

The objectives of the research project are as follows:

1. Evaluate methods used to deliver the Oregon Transportation Investment Act (OTIA) and State Transportation Improvement Program (STIP) projects.
2. Assess resource requirements and implications of implementing different types of project delivery models.
3. Develop guidelines for ODOT staff to make informed decisions on which delivery method is best suited for a particular project.

1.3 DEFINITIONS

Definitions for three important terms used in this report are provided:

Insourcing: Insourcing is the practice of an agency using direct employees of that agency to provide services which are the responsibility of the agency.

Outsourcing: Outsourcing is the practice of an agency contracting with one or more entities (private businesses or other agencies) to provide services which are the responsibility of the agency.

Project Delivery: The starting point for project delivery is the point in time when the project is approved for the Statewide Transportation Improvement Program (STIP). The ending point for project delivery is final acceptance by ODOT. All project management, engineering, contract administration, construction oversight and inspection activities required to take place during this time frame represent the project delivery function. Many DOTs use the terminology preliminary engineering (PE) and construction engineering (CE or CEI) to cover the functions traditionally executed by agency personnel during project delivery.

2.0 COMMON CONSTRUCTION PROJECT DELIVERY PRACTICES

2.1 TRADITIONAL DESIGN-BID-BUILD APPROACH (DBB)

The design-bid-build (DBB) process is the traditional approach to delivering public construction projects. Traditionally, transportation agencies have designed and developed project plans and specifications through the efforts of engineers employed by the agency. Once the construction documents are ready, they are announced for bidding. Construction contractors who are interested in bidding for the project can review the documents and submit bids for the construction work. After receiving, opening and evaluating the bids, and confirmation by the owner that sufficient funding exists, the contract is awarded to the lowest responsive bidder. The contractor then proceeds to construct the project according to the plans and specifications. During construction, agency personnel observe the work to ensure that the project is built according to the design plans and specifications.

Advantages and disadvantages of traditional DBB are as follows:

- Advantages
    - Widespread use and familiarity
    - A perceived fairness in the process
    - Incentive for contractors to perform efficiently
    - Bid based upon completed documents
- Disadvantages
    - Lengthy, sequential process
    - Potential adversarial relationship between owner, designer, and contractor
    - Cost unknown until bids finalized
    - Low bidder potentially undesirable
    - Intensifies the potential for change orders
    - Fast track option (construction beginning prior to design completion) is not available

2.2 DESIGN-BUILD (DB)

Design-build (DB) is a project delivery method in which the transportation agency contracts with a single legal entity to provide both design and construction services. The design-build entity may be a single firm, a group of experts, or a joint venture. Typically, the team includes an engineer and a contractor; who may be partners in the undertaking or one a subcontractor to the other. Both, the engineer's and the contractor's services are provided under one contract awarded by the transportation agency. The selected design-build contractor completes the design and performs the construction. The DB contractor

accepts construction risk and assumes all responsibility for change orders due to errors and omissions in the plans or specifications.

A design-build procurement method provides a single source of accountability to a client to meet the design, cost control, and quality requirements for the project. The contract incentives encourage value engineering and constructability.

The design-build team has the ability to balance and define the cost, schedule, and quality of the project. Construction work can often start when the design phase is only partially completed. This provides an opportunity for faster completion of the project.

Advantages and disadvantages of DB are as follows:

- Advantages
    - Single source contract to complete both design and construction
    - Early cost and schedule control of the project
    - Reduced overall project duration
    - Reduced change order liability to the agency
    - Fast track option is available
    - Potential to reduce complex claims exposure
- Disadvantages
    - Complexity of structure, especially in the public sector
    - Either design or construction could suffer if the right team is not assembled
    - Potential adversarial relationship between agency and the DB contractor
    - Potential to limit agency/engineer communication
    - Potential loss of agency control over project
    - Desired level of quality may not be achieved

2.3 PROGRAM MANAGEMENT

Program management is a concept implemented for the execution of very large projects or for a group of projects. Program management is the contracted oversight of project delivery of agency projects. Services included in the program management scope may or may not comprise design or direct construction. However, the program manager would be responsible for the overall management of a number of individual projects related to an overall program.

As defined by Barrie and Paulson (*1992*), "The program management concept utilizes an overall management organization that may manage a number of design firms, construction contractors, material and equipment suppliers, and other participants in the building program. The program manager serves as the single point of contact to the owner to coordinate and manage the various other parties involved in planning, design, procurement, and construction." The program manager may assist the agency with: funding options, professional service provider selection, insurance options, master schedule and budget, program procedures and design criteria, regulatory agency

interface, community and bond oversight committee relationships, bulk purchasing, and construction contract administration.

Advantages and disadvantages of program management are as follows:

- Advantages
    - Extends agency staff without the burden of hiring new full-time employees
    - Program budget and schedule determined early in the process
- Disadvantages
    - Could duplicate in-house expertise
    - Could lead to attrition of agency professionals which would leave the agency without expertise when the program is over
    - Could be more expensive in the short term due to the extra level of supervision and communication

2.4 ODOT'S MODEL FOR OUTSOURCING PROJECT DELIVERY

Figure 2.1 graphically portrays ODOT's model for insourced and outsourced project delivery. Sections 2.4.1 and 2.4.2 discuss these models.

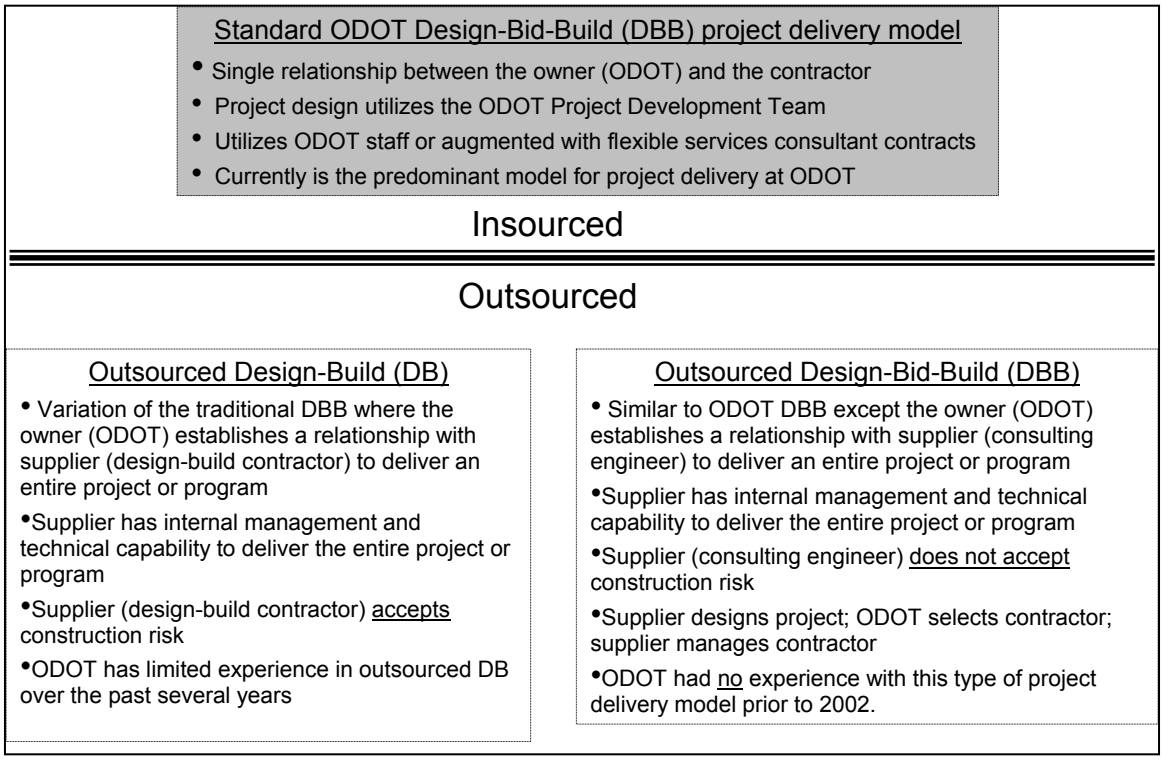

Figure 2.1: ODOT models for project delivery (*Wolfe 2002*)

It should be noted that even in the insourced model, ODOT frequently outsources specific packages of work to consultants. Specific studies or design activities may be outsourced during the design phase of a project. Construction surveying, formerly done by ODOT, is now an assigned responsibility of construction contractors. Material testing, formerly done by ODOT, is a contract requirement for field testing of materials and is incidental to the bid item.

What distinguishes the outsourced project delivery model discussed in Section 2.4.2 is the assignment of overall accountability for project delivery to a single business entity outside of ODOT.

2.4.1 ODOT's Insourced Project Delivery

ODOT has traditionally delivered projects according to the traditional design-bid-build (DBB) model described above in Section 2.1. Projects are designed using the Project Development Team, led by the project leader and consisting of ODOT employees augmented with flexible services consultant contracts as needed. At the completion of PS&E (Plans, Specifications, and Estimates), projects are advertised for bid. Contracts for construction are awarded to the lowest responsive bidders. During construction an ODOT project manager leads a construction engineering (CE) team responsible for assuring that both ODOT and the contractor fulfill the requirements of the contract. The construction contractor is accountable to the project manager.

2.4.2 ODOT's Outsourced Project Delivery

The authorization of the Oregon Transportation Investment Act (OTIA) funding in 2001 resulted in a need to deliver an increased project load without expanding the ODOT organization proportionally. ODOT had developed some knowledge of DB project delivery through research and implementation of two DB pilot projects beginning in 1998 (*Simas and Rogge 1998; Rogge 2001*). DB had proven to be a viable project delivery option, but it would not be feasible to use only DB to deliver the greatly increased project load. DB would be one of the methods used to deliver projects.

An evaluation by ODOT's Office of Project Delivery led to the formulation of an outsourced design-bid-build (ODBB) strategy. This strategy qualifies a pool of full-service consulting engineering companies. The consultants are qualified to deliver preliminary engineering (PE) and construction engineering (CE) for projects. ODOT intends that the same consultant will deliver a project through PE and CE. (*State of Oregon 2002*) Thus, ODBB is similar to ODOT's traditional DBB, except the owner (ODOT) establishes a relationship with a consulting firm to deliver an entire project or program. The consulting firm has internal management and the technical capability to deliver the entire project or program, but does not accept construction risk (assigned to construction contractor). The consulting firm designs the project, ODOT selects and contracts with the construction contractor, and the consultant manages the contractor. This approach is in agreement with the findings of the ODOT Consultant Strategy Committee (*ODOT Consultant Strategy Committee 2000*).

The consulting engineers enter into agreement-to-agree (ATA) contracts with ODOT (*State of Oregon 2002*). The ATA contracts are for six years, the last two years of which

allow for completion of projects initiated in the first four years. After the consulting firm has entered into an ATA, projects are assigned with a work order contract (WOC). ODOT assigns projects to the ATA pool, with the "top ranked firm selecting first, and the remaining firms selecting in order of their evaluation ranking until all projects on the initial list are assigned (*State of Oregon 2002)*." All subsequent project assignments or "rounds" use a simple rotation, where the next available firm is assigned the next consecutive project.

As consulting firms deliver their projects, they earn performance evaluation scores ranging from -5 to +5. There are criteria established for evaluation at the completion of each key milestone in PE, and semiannually for CE. There is also an extensive end-of-project evaluation. Performance evaluation forms are included in the ATA as Exhibit E. Each consulting firm starts with a performance evaluation score of zero. As a performance incentive, firms that improve their performance evaluation score to a +5 are eligible for two projects when their turn in the rotation comes up. Firms falling to -5 are removed from the project rotation cycle. When a firm is removed from the rotation cycle they must submit a performance management plan to ODOT for review and approval. When approved, the firm is reinserted into the project rotation cycle at the bottom of the list for the current round.

WOCs for PE are written with lump sum values for key milestones and progress payments are made based on the percent that a milestone is completed. A maximum of five key milestones are allowed. WOCs for CE are written on a time and materials/labor-hours basis, with progress payments based on hours billed and expenses incurred at approved rates. Both PE and CE WOCs are written with *not-to-exceed values*.

Exhibit C of the ATA contract delineates the insurance requirements for the consulting engineers to whom project delivery is outsourced. The consultants are required to carry workers' compensation, professional liability, general liability, and automobile liability insurance. The general liability policy must include contractual liability coverage for the indemnity provided under the ATA. Automobile and general liability policies must name "The State of Oregon, The Oregon Transportation Commission and its members, and the Oregon Department of Transportation, its officers and employees" as additional insured's.

Attachment D of the ATA provides checklists of PE and CE activities with columns for assignment to ODOT, the consulting engineer, or the construction contractor (CE only). Where appropriate, each checklist item has subdivisions further delineating the types of activities to be performed. For each WOC, the checklists are completed.

To manage the outsourced projects, ODOT created the position of Consultant Project Manager (CPM). In 2002, six individuals were assigned to be CPM's, operating in ODOT's five regions. The CPMs report to Area Managers in their regions, similar to the way that ODOT Project Managers report for insourced projects.

2.4.3 Assigning the Project Delivery Method

ODOT has organizational capabilities to deliver a construction program resulting in construction contractor payments of approximately $250 million per year. This has been

the approximate level of construction contract volume for ODOT for approximately the last ten years. OTIA I and II have resulted in project loads much greater than $250 million per year, resulting in the need for outsourcing, and the utilization of the models shown in Figure 2.1.

The target for ODOT's Technical Services and Construction Section is to be staffed at a capacity to deliver a $250 million program with 70% permanent staffing and 30% flexible services contracts. ODOT has a capacity to deliver up to 2 projects totaling $40 million per year with design-build contracts. Remaining projects must be delivered using outsourced DBB.

The process for assigning a delivery method to projects is shown in Figure 2.2. Block A, at the bottom of the diagram, shows that projects that have progressed past design approval for insourced projects or past the work order assignment for outsourced projects, are to be finished with no change to the original resourcing decision. Projects that have not progressed to those points are to be assigned a project delivery method.

The criteria presented in Tables 2.1, 2.2, and 2.3 are to be used by ODOT Region Managers, Area Managers, Program Managers, Technical Services Region Managers, Alternative Delivery Unit, Project Leaders, Consultant Project Managers, and Project Managers for assigning projects to one of the three delivery methods. Block 1 of Figure 2.2 shows a screening using Table 2.1 to determine if design-build is a good option. If so, the project is recommended to ODOT's Project Delivery Leadership Team (PDLT) for approval. The PDLT must balance the recommendation against available capacity. The PDLT consists of six high-level ODOT managers and is co-chaired by the Deputy for Statewide Project Delivery and the Technical Services Manager. Projects that are not likely candidates for design-build delivery must be assigned either insourced DBB (see Block 2, Figure 2.2) or outsourced DBB (see Block 3, Figure 2.2) based on the criteria of Tables 2.2 and 2.3. If agreement can not be reached, or if insourcing or outsourcing capacity would be exceeded, the decision is referred to the PDLT.

Table 2.1: Outsourced DB Preferred (*Wolfe 2003*)

Selection Criteria – Outsourced DB
Need for innovation, alternatives, or economies of scale.
Use of innovative construction methods to meet performance criteria.
Clearly definable and transferable risk elements.
Minimizes user costs.
Expedited delivery requirements.
Committed funding strategy for the project.
Consultant Project Manager and DB program capacity available.
Desire to build DB experience with various project work types.

Table 2.2: Insourced DBB Preferred (*Wolfe 2003*)

Selection Criteria – Insourced DBB
Extremely complex in high-risk areas or tasks.
Maintains critical skill sets in project development and construction.
Construction capacity is available.
Scope is not locked down – public is not committed to project.
Financing is unstable or uncommitted.

Table 2.3: Outsourced DBB Preferred (*Wolfe 2003*)

Selection Criteria – Outsourced DBB
Clearly definable project elements/tasks.
Concise project documentation – prospectus, purpose, and need.
Expedited delivery requirements.
Minimal management or delivery risks.
Financing is committed.
Capacity available in statewide ATA or separate RFP to meet the delivery timeline.
Consultant Project Manager capacity is available.

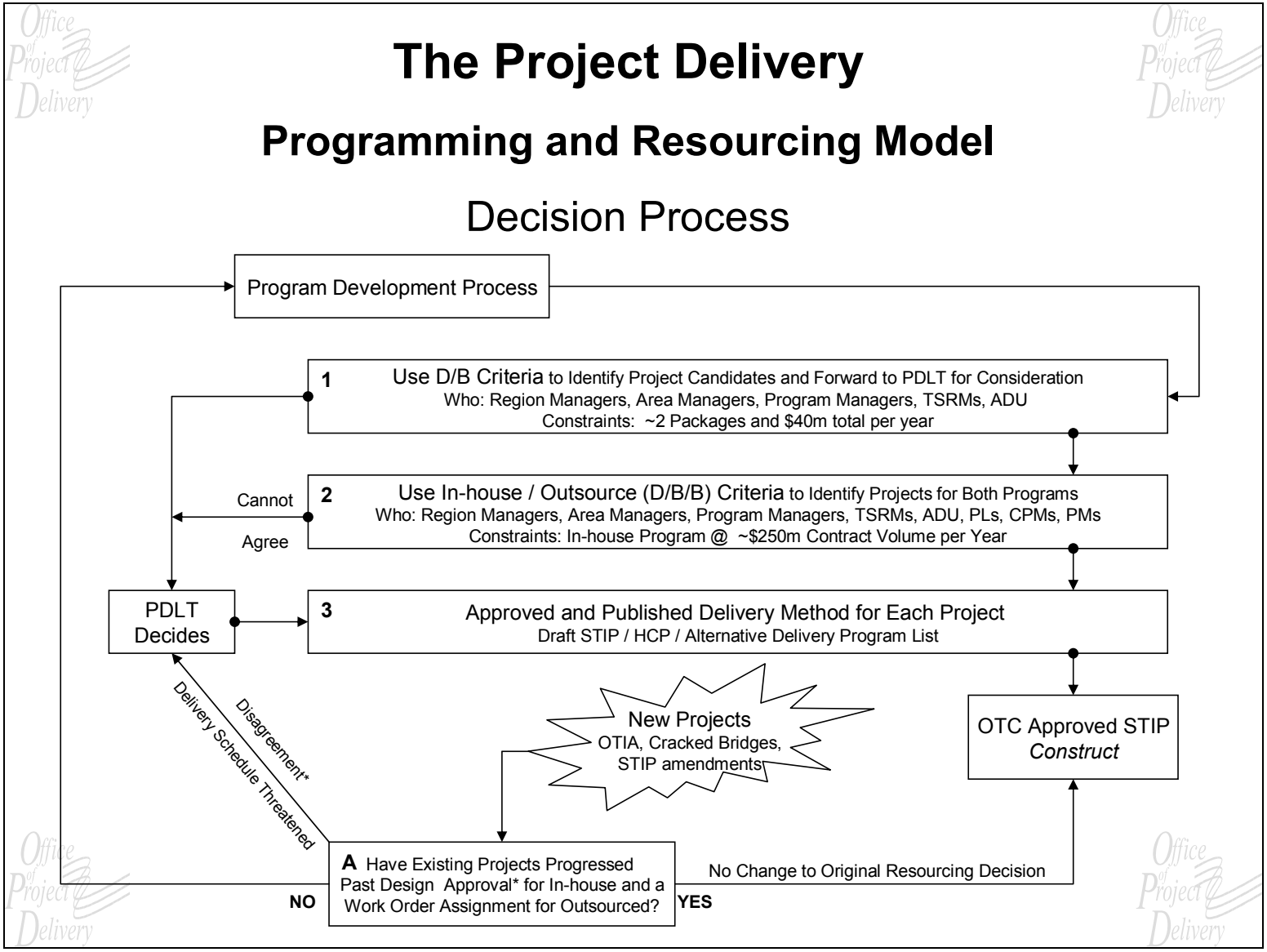

Figure 2.2: Process for assigning project delivery method (*Wolfe 2003*)

3.0 LITERATURE REVIEW

3.1 OUTSOURCING TRENDS IN TRANSPORTATION AGENCIES

Outsourcing of functions relating to transportation agencies is not unique to the United States. Outsourcing is seeing increased usage worldwide. The literature review on outsourcing trends includes a paper from Finland discussing worldwide trends. The remaining papers in this section specifically address outsourcing trends and practices from DOTs in the United States.

3.1.1 International Perspective of Project Delivery Methods

Source: Pakkala, P. 2002. *Innovative project delivery methods for infrastructure: An international perspective.* Finish Road Enterprise. Helsinki, Finland.

The purpose of this study was to identify different practices and methods utilized worldwide by transportation agencies to more effectively secure products and services. The goal was to share information about some of the methods used for outsourcing in different countries.

This study differentiated between capital projects and maintenance contracts. It is a compilation of findings summarizing practices in three main areas in different countries:

- Procurement delivery methods
- Type of contract
- Contractor selection methods

However, in addition to current practices, trends and innovations in outsourcing played an important role in the study. The compilation of information for this study came from Australia, Canada (Alberta, British Columbia and Ontario), England, Finland, New Zealand, Sweden and the United States.

3.1.1.1 Capital Projects

Conclusions from this study show that a large number of countries are using the design-build method. Nevertheless, different project delivery methods are available to the client organizations when planning a project's development. When selecting the project delivery method there are several factors involved in making the decision. These include the: type of project, client expectations, and political regulations.

Even though there is a strong trend towards the design-build method, the following innovative project delivery methods were also identified in this study:

- Design-Build-Operate-Maintain (DBOM)
- Design-Build-Finance-Operate (DBFO)
- Build-Own-Operate and Build-Own-Operate-Transfer (BOOT)
- Full Delivery or Program Management

As a means of providing some kind of "quality-based selection criteria" to the contractor selection method, innovative considerations for minimizing road user impacts have been taken into consideration. They are:

- Multi-parameter bidding, known as A+B, and A+B & Quality (warranty)
- Lane rental
- Incentives and Disincentives

Other innovative concepts associated with current trends in alternate project delivery methods are:

- Partnering
- Constructability reviews
- Value engineering
- Performance and outcome-based criteria

3.1.1.2 Maintenance contracts

There is an increasing tendency to outsource maintenance projects to the private sector. Various innovative practices are currently being used. Some of these practices may be transferable to outsourcing project delivery.

Many countries practice long-term maintenance contracts. Popular practices include:

- Long-term agreements – greater than 7 years
- Partnering (client and sub-contractors)
- Lump sum contracts
- Quality-based contractor selection
- Provisions that include some of the sub-contractors sharing the same long-term agreement or at least sharing the risks/rewards
- Outcome-based criteria
- Ability to use innovations throughout the length of the contract

A new method of long-term maintenance contracting under consideration in England is called, Privately Financed Managing Agent Contractor (PFMAC). This is a model that has not been tested yet. It involves private funding for managing and delivering maintenance projects. Its main features are: greater risk transferred, longer term contracts (15-30 years), and similar techniques to the Design-Build-Finance-Operate model for capital projects.

There are several advantages to long-term maintenance contracts, including:

- Potential cost savings
- Fully integrated client services
- Transferring risks
- Innovation potential
- Better asset management
- Easier budgeting
- Better level of service
- Partnering potential

Disadvantages and risks associated with long-term maintenance contracts include:

- Costly tendering for Performance Specified Maintenance Contracts (PSMC) when using rehabilitation and resurfacing in the contract
- Longer tendering period for PSMC when using rehabilitation and resurfacing in the contract
- Reduction of competition
- Client role changes (loss of experts)
- Uncertainty of long term relationships
- Mobilization issues need to be addressed
- Specifying inappropriate outcome criteria
- Loss of control
- Challenges of applying changes during the life of the contract

3.1.2 Innovations in Private Involvement

Source: Hancher, D. E., and R. F. Werkmeister. 2001. *Managing change in state departments of transportation: Scan 2 of 8, Innovations in private involvement in project delivery.* National Research Council. Washington, D.C. (April).

This study was performed by the National Cooperative Highway Research Program (NCHRP) in 2001. The NCHRP project, 20-24(14), "Managing Changes in State Departments of Transportation," identifies and classifies different approaches for involving the private sector in project delivery for state DOTs.

Different types of functions have been identified as being performed by DOTs. These functions have been categorized as: primary, traditional, and support functions. Senior management is the primary function in the DOTs. Traditional functions within the DOTs are: planning, design, pre-construction, construction, and operations and maintenance. Support functions are research and development, and administration.

For many years, DOTs have performed primary, traditional, and support functions by themselves using their own resources. However, construction activities have generally been outsourced. Outsourcing has also been extended to design activities to a lesser degree. Research on alternate project delivery methods to accomplish DOTs' essential functions has been encouraged due to the increasing demand put on DOTs and changing

resources. The demand for outsourcing has been induced by many factors. Among the more influential are the following:

- User demand for better and quicker service, and minimal delays.
- Reduction in the DOT workforce and/or loss of in-house specialty capabilities.
- Need to handle peaks in demand for services.
- Legislators like outsourcing.

Among the most crucial factors influencing potential outsourcing is the reduction in the DOT workforce and the DOTs' necessity to find and develop alternatives to deliver projects. Outsourcing may be beneficial if, by finding external sources to perform non-primary functions, more management attention can be given to the overall process and to primary functions.

Each DOT is independently autonomous to decide the amount of activities to outsource. Regardless of what they outsource, they still retain the executive program management role, which makes them responsible for performance.

The rate of outsourcing the construction phase of projects to contractors by DOTs is almost 100%. The rate of outsourced design related services ranges between 15% and 90% on a state by state basis. Even though other types of activities are being outsourced (planning, surveying, construction inspection, right of way, purchasing, maintenance, and even major program management) the percentages of the total work done are still small. Outsourcing of maintenance activities received mixed reviews.

Many evaluations have been conducted on the results obtained from outsourcing activities by the DOTs. There have been variations in the results obtained. Opinions about outsourcing performance for DOT projects are divided. Some view that quality, time management, and general public satisfaction has been satisfactory. Others view that outsourcing is much more expensive than conducting projects with in-house resources.

Cost comparison criteria and accuracy are major concerns that allow the disagreements mentioned above. Private companies do a good job maintaining records for both direct and overhead costs of every project they perform. Procedures for DOTs accounting for buildings, utility costs, and other overhead items are not standardized, uniform, and/or consistent. Therefore, it is concluded that the agencies need to develop a strategy of study for cost comparisons between in-house and outsourced projects.

Conclusions and recommendations from "Scan 2" (*Hancher 2001*) are as follows:

- Most of the research on outsourcing by DOTs has been conducted by surveys and/or internal study teams.
- Collected results have often been based on personal judgment and insufficient data collection.
- Desired data for comparisons are hard to obtain.
- More organized research is needed to address this major issue confronting transportation agencies.
- Outsourcing offers many potential benefits to DOTs in delivering their future projects.

- More research and more collaborative efforts are required by transportation agencies to identify best practices and possible standard procedures.
- Potential benefits of outsourcing are:
    - DOTs can provide projects for the general public while resource-restrained.
    - Costs are incurred only when services are used.
    - A smaller workforce would be required with peak demands handled by outsourcing.
    - Potential for cost savings to DOTs.
    - Access to special private sector skills on an as-needed basis.
- Potential concerns of outsourcing:
    - DOTs may have less control on the quality, time and cost of its primary functions.
    - DOTs may lose the skills and expertise to conduct essential functions in-house, or to effectively check, evaluate or approve the work of external sources.
    - Conflict with DOT's workforce and possible legal restrictions.
    - DOTs would need new employees with different expertise and management skills.
    - DOTs would have less capacity to serve a traditional role for hiring entry-level engineers to gain competent experience in the road building industry.
- An effective evaluation means for comparisons between private sector and agency performance is reachable through the establishment and measurement of valid evaluation criteria. A North Carolina DOT study team has used the following criteria:
    - Cost of product or service
    - Quality of product or service
    - Time to produce product or service
    - Effect on in-house personnel
    - Availability of qualified firms
    - Cost to administer outsourcing
    - Impact on DOTs program delivery
    - Customer satisfaction with output

3.1.3 Outsourcing of State Services

Source: Witheford, D. K. 1996. *Outsourcing of state highway facilities and services.* NCHRP Synthesis of Highway Practice 246. National Research Council: Washington D.C.

Outsourcing has appeared as an alternative to government agencies' downsizing during the last several years. It has resulted from increased workload, coupled with static or reduced state agency employment levels. Agencies have transferred considerable amounts of workload to contractors and consultants to perform activities formerly performed by in–house staff. One of the concerns has been the impact on human

resources. Loss of specialized skilled employees and in-house production capabilities is a significant consequence of the downsizing phenomenon and the outsourcing process.

This report analyzed outsourcing procedures concerning traditional contracting methods and the newer alternate methods used to contract out. Agencies were surveyed to gather information about the reasons for outsourcing, changes and trends, monitoring and evaluation methods, and lessons learned from these practices.

Contracting out has been a practice used among the state agencies since before World War II. Its practice has been increasing through the years becoming a more common practice during the last 30 years. During the post-war age, design activities started being outsourced. In the 1970's, maintenance activities were the trend. In the 1980's, administrative functions began to be contracted out. Through the 1990's contracting out or outsourcing has become a common practice for most transportation related activities across the United States.

Outsourcing practices vary from state to state. The range of activities outsourced includes: administrative functions, training, planning, design, construction management, operations and maintenance. The trend to use outsourcing is growing rapidly across the United States. The variety of activities outsourced is also increasing each year and varies from state to state depending on the characteristics of each state agency.

Outsourcing occurs when agencies have to handle peak workloads or when projects require special skills not available with the in-house staff. As a generalized feature in most states, there is no formal procedure to establish what activities and in what proportion should an activity be outsourced.

Agencies reported that quality assurance has been well provided within the outsourcing process. It was noted, that even though the responsibility of safeguarding public health and safety should not be transferred to a third party, the considerable experience of the agencies contracting major activities, ensures that monitoring and quality assurance contracts can be carried out satisfactorily.

Due to the extensive experience with contracting out, it has been found that procedures for obtaining contract services are standardized and well documented. Performance evaluations, benchmarking, quality assurance and monitoring have been recognized as important practices within the outsourcing process. Evaluation processes are very well defined in some states for contracting construction related activities and for professional services. However, there is no uniformity concerning procedures and applications to pre-awarding or pre-qualification processes. It is particularly difficult to determine how evaluation procedures are handled when it comes to alternate project delivery methods.

Benefits have been derived from outsourcing different activities within the state agencies. The most significant benefit of outsourcing is the accomplishment of departmental workloads and project deadlines. Other benefits found included: the availability of specialized equipment and skills, cost savings, obtaining third party views and public relations.

During the early 1980's new procedures were introduced associating public and private entities in the development and execution of highway projects. These are now known as

"public-private partnerships". They provide the mechanisms to set agreements with property developers and to permit the private construction of major highway facilities.

3.1.4 Outsourcing and Private Sector Utilization

Source: Warne, T. R. 2003. *Survey of state department of transportation practice: Outsourcing and private sector utilization*. NCHRP Project 20-7(158). National Research Council, Washington, D.C.

There are two major forces driving the current trend of outsourcing in the state agencies. The first is the general growth of state highway programs. The second is the downsizing in the state agencies' staff. After the signing of the TEA-21 (Transportation Equity Act for the 21st Century) in 1998, the states were given an average increase of more than 44% in their federal programs. Although there were significantly increased funds for highway development programs, 80% of the states show either steady or decreasing staff levels. This imbalance results in the DOTs' need for contracting out, to the private sector, the amount of work that they cannot handle in-house.

Outsourced activities vary largely from basic maintenance functions, such as litter removal and landscaping, to the most complex and specialized high technology engineering services available in the industry. The outsourcing of project delivery functions has also been increasing. This literature review addresses the material in the Warne report dealing with project delivery.

3.1.4.1 Outsourcing Design Engineering

Warne's report breaks outsourced activities into three groups: a design group, a construction group, and a non-project delivery related group. The design group of activities is maybe the most diverse group of activities outsourced in a state DOT and is second to the construction activities group in budget and volume. Among the most common design activities outsourced include:

- Surveying and Mapping
- Location Studies
- Environmental Impact Studies
- Design-Build
- Program Management
- Engineering/Design

It was found that three of the seven predominant activities reported by the states showed annual volumes in excess of $10 million. They were: environmental impacts, design-build, and engineering/design. The volumes of design-build and engineering activities are very likely to increase the overall outsourced volume within the next two years.

3.1.4.2 Outsourcing Construction Engineering and Inspection Activities

The most commonly outsourced activities in the construction group are construction engineering and materials testing. A total of 24 states outsource one or both of these activities, representing a total of 63 percent of the states responding to the survey for the mentioned report. Field inspection and engineering work is being assigned, by most states, to their own forces. Usually, small to middle size projects are the most outsourced jobs; however, quite a few states are outsourcing over $1 million per year to consultants in this area. The increasing trend in the last several years appears likely to continue through the next two years, increasing the volume of work outsourced.

Typically, when Construction Engineering (CE) is outsourced, it is performed by a consultant who has been pre-qualified and is paid by a cost-plus contract. The most common reason cited for outsourcing CE is staff constraints. Materials testing is performed by a consultant who is paid a pre-established hourly wage and is selected by either low bid or through a consultant qualification-based selection process.

3.1.4.3 Outsourcing Program Management

TEA-21 has brought unbalanced funding to the transportation programs of every state, but with no staff balancing within the state agencies. In order to fulfill the promise of TEA-21 and keep their customers satisfied, agencies are rethinking their way to deliver projects to the general public.

This alternative project delivery method allows the state agency to manipulate their staff resources by supervising a consultant team that can be made responsible for managing the delivery of one or more projects. In this case, it is the consultant who is in charge of providing qualified people to deliver a quality program, on schedule and on budget. This potentially results in lower program costs and time savings for the agency.

One of the most significant advantages of outsourcing program management is gaining the benefit of new ideas and resources of an external consultant. This process can lead to money savings, which, in the end, may pay for the program management fee paid to the consultant. Outsourcing program management to a consultant is one of the approaches gaining popularity.

Every state is trying to implement what they think is the most efficient way to deliver TEA-21 programs in a proper manner to their customers. Although this alternate project delivery method has not been proven to be the best, outsourcing program management attempts to organize the resources of consultants who can prioritize, package and manage the design and construction of these multi-million dollar programs.

3.1.5 Assessing Outsourcing Potential

Source: Wilmot, C. G., D. R. Deis, R. Xu. 2002. Assessing outsourcing potential in state departments of transportation. (Unpublished document).

This study was performed for the Louisiana Department of Transportation and Development (LADOTD) in an attempt to implement a procedure to assess the decision-making process for determining whether different activities and functions within the department should be outsourced. The primary purpose of this study was to develop a computer model able to evaluate the qualitative and cost aspects of contracting out activities and functions. The computer model should be understood as a decision-making support aid for agencies' managers, rather than as a tool to propose outsourcing. The final computer model is available from the Louisiana Transportation Research Center (*Wilmot, et. al.,User manual 2002*).

When practicing outsourcing assessment, one of the initial tasks is to identify the core competencies of the organization. Core competencies are defined as specialized technical or scientific activities that must be conducted by an organization in order to fulfill its mission and execute its responsibilities (*OMB 1996*).

For this study, in the LADOTD, the following functions and activities were found to be related to the department's organization:

1. Service to the public,
2. Service to the government,
3. Maintenance of required expertise in the organization,
4. Retention of the ability to effectively contract and manage outsourcing, and,
5. Maintenance of attractive career growth opportunities within the department.

Activities related to core competencies within the state agency are not considered for outsourcing.

State agencies' practices for assessing outsourcing potential were investigated. A study carried out in New Mexico by the state DOT found that ten states (Arizona, Connecticut, Florida, Idaho, Maryland, Michigan, North Carolina, Utah, Virginia, and Washington) had recently reviewed their outsourcing process; but only two (Arizona and Florida) employed a comprehensive method of assessment (*Albright 1998*). Arizona's model was used to assess all of the activities, while Florida's was only used to assess maintenance activities. Arizona's model employs two "sub-models". The first is used to evaluate qualitative aspects of an activity and the second is a cost analysis.

New Mexico implemented its own assessment procedure using the Arizona model's cost analysis procedure. The process involved differentiating "core" and "non-core" activities and then applying the cost analysis to the non-core activities.

Pennsylvania DOT has an eight-question questionnaire to develop a contractibility score for maintenance activities. These questions are answered and scored so that the higher

the score, the more advisable outsourcing is. A disadvantage of this is the difficulty adapting to other activities within the department.

In 1999, the Texas DOT started a study to assess the potential of outsourcing nine activities. The principle was rating the activities on six factors. Factors described different aspects of the outsourcing potential of an activity such as legal, organizational, and functional implications of its outsourcing. Subsequently, the factors were weighted to reflect their relative importance. The performance of each activity was evaluated using between three and nine criteria for each factor. The outsourcing potential of any activity was determined by, multiplying each criterion rating by its corresponding factor weighting, and totaling.

Building on these models, Wilmot, et. al., began the development of a computer model with a qualitative and quantitative component. An initial qualitative model was prepared based on the factors and criteria used in the Texas model. Visual Basic was used to write the model, making it more user friendly. This initial qualitative model was tested with LADOTD officials using highway striping and marking activities, and rest area maintenance. Since each of these activities had been either, outsourced in the past or was in consideration to be outsourced, the results of the model analysis were compared with past experiences or previous studies performed by LADOTD. In all the cases, the results of the computer model agreed with the predictions of experienced personnel and/or the results of previous studies by LADOTD. Based on the feedback from this model, changes were made and the final model was produced.

One change was made to the qualitative model, adopting the "balanced scorecard" approach developed by the Harvard Business School (*Kaplan and Norton 1992*). The balanced scorecard approach is a method used by businesses to assess non-cost factors. The approach observes four areas of qualitative analysis pertaining to: (1) customer, (2) internal business, (3) innovation and control, and (4) financial perspectives. To make a better approach for public sector agencies, and the outsourcing decision in particular; employee and contractor market perspectives were added to the balanced scorecard. The revised computer model presents the six broad factor areas renamed as "perspectives" for qualitative analysis. Table 3.1 is from the model's user guide, and presents the six "perspectives" with a description for each.

Table 3.1: "Balanced Scorecard" perspectives and descriptions (*Wilmot et al. 2002*)

Perspective	Description
Customer Perspective	Focus on the interests of citizens, legislators, public officials, and special interest groups, and the compliance with laws and regulations related to the function or activity under consideration.
Internal Business Perspective	Focus on agency core competencies, processes, technology capability, and technical expertise
Innovation and Control Perspective	Focus on agency need to monitor and control the function, ability to outsource on a limited basis, and effects on other agencies should outsourcing occur

Financial (Cost) Perspective	Focus on cost aspects, capital investment issues, and timeliness of function or activity under consideration
Employee Perspective	Focus on employee morale, retraining, and relocation
Contractor Market Perspective	Focus on availability of qualified private sector contractors, potential of establishing a "monopoly," and the degree of prior outsourcing experience in the agency for the function or activity under consideration

Users of the computer model indicate their level of agreement or disagreement with twenty-five assessment statements. The user must also assign a weight of importance from low to high. Scores for the assessment statements are aggregated into the "perspective" categories. A qualitative index (QI) with a score between 0 and 1 is generated by the computer model. Values below 0.5 favor in-house provision while values over 0.5 favor outsourcing.

Once the qualitative assessments have been defined, the second phase of the computer model is the cost analysis. It is assumed that the program user is an experienced person familiar with in-house and contractors' costs estimating. The model was based on separating in-house costs into direct and indirect costs categories. Subsequently, direct costs were split into labor and non-labor categories. Indirect costs comprise supervision, support services, and general overhead costs. The computer model leads the user through a series of questions to gather information on in-house costs such as: personnel required, amount of time needed, equipment, supplies, materials and indirect costs (insurance and supervision). Once the costs are sub-totaled, the user is asked to input the estimated cost of contracting out. This includes the costs of letting the contract, monitoring the contractor's performance, and inspecting the work. The computer model uses this information to produce a cost index (CI), with values ranging from 0 to 1. Values below 0.5 favor in-house provision while values over 0.5 favor outsourcing.

If the model suggests possible cost savings through outsourcing, it is advisable to perform an in-depth analysis of in-house costs simultaneously with the solicitation of contractor bids. The object is to identify in-house costs that can be removed if the activity is outsourced. These costs are then compared to contractor costs to determine the amount of any potential savings.

One benefit of the model is that several managers can perform the analysis separately and then compare their results. If the results are not consistent they can be discussed to propose a feasible solution. The decision to outsource is up to the managers and is not an answer given by the model. If there is any activity found advisable to outsource, it is prudent that some further analysis involving contractor bids and detailed costs analysis be conducted.

3.2 OUTSOURCING PRECONSTRUCTION ENGINEERING WORK

Highlights from two papers addressing issues associated with outsourcing preconstruction engineering work are presented below.

3.2.1 Consultants for Preconstruction Engineering Work

Source: Witheford, D. K. 1999. *Consultants for DOT preconstruction engineering work.* NCHRP Synthesis of Highway Practice 277. National Research Council: Washington D.C.

This study summarizes the DOTs' practices regarding the use of consultants for preconstruction engineering activities. The information was gathered by surveying both DOTs and consultants; in addition to reviewing the available related literature.

One of the first findings was a considerable increase in the amount of work outsourced to external consultants during the 1990's. In the late 1990's half of the states were outsourcing more than 50% of their design activities. In comparison, during the late 1980's only one-fifth of the states contracted out 50% of their design activities. In the same manner, the number of states performing over 80% of the design activities in-house decreased from over 50% to only one-sixth of the total. The increasing trend in the outsourcing practice is expected to grow in the coming years due to a number of reasons. Downsizing of state agencies, limited ability of the DOTs to retain the expertise needed to meet the workload demand and schedules, and the increasing funding from federal programs like TEA-21 are the main reasons leading to an increase of outsourcing preconstruction activities.

The strongest factor for the DOTs to outsource preconstruction engineering activities is the reduction in staff. The increased project load makes it necessary to transfer a considerable amount of workload to the private sector. Some states found that design costs have increased as a result of this practice; however, cost analyses have seldom been definite. Another consequence of outsourcing is the shift of DOT's staff from, in-house design work to consultant project manager roles, and an increase in the use of "indefinite delivery of services" or "on-call" contracts. State agencies are also concerned about retaining skilled staff in order to properly handle in-house workload. DOTs keep a level of diverse projects in-house for the purpose of maintaining the interest, training, and challenging environment to keep their personnel updated on the state-of-the-art of design activities. State agencies are interested in maintaining "core competence" within their organizations. Contracting out approximately 50% of the program appears as a common, reasonable, and balanced practice to retain a skilled staff.

There is no homogeneous opinion regarding the comparison of design costs between state agencies and external consultants. One strong source of disagreement is the inaccurate representation of agencies' overhead costs. Estimating the value of the consultant contribution of expertise and availability from an overall program delivery standpoint is also an issue.

The universal practice to choose a consultant is the qualifications-based selection (QBS) process. In addition to the qualitative criteria, some states have incorporated cost-related considerations into the selection process.

Selection committee makeup and practices are different in every state depending on considerations such as the roles of central and district offices in consultant procurement and management. Selection committees vary in size, assignments, and in the criteria they use to rate consultants for shortlists. The committee may employ any, or all of the following criteria: prequalification records, letters of interest, consultant workload, and past performance. One major concern is the level of effort invested by consultants to compete in the process. This level of effort depends on factors such as prequalification requirements, short-listing practices, and proposal requirements.

In the negotiation stage, it is essential to reach a consensus between the parties involved when establishing and interpreting the scope of the project. The scope of the project statements are important for cost estimates made by both the DOTs and the consultants.

The project manager role varies from state to state. Sometimes the project manager is in charge of developing the scope of the project statements. Other times, the project manager can be the only negotiator. Usually, the project manager is part of the negotiating team responsible for evaluating the costs and technical information.

Prolonged proceedings are very likely to occur when pre-award audits are carried out during the negotiation stage. The American Association of State Highway and Transportation Officials (AASHTO) and the American Consulting Engineers Council (ACEC) have expressed an interest in shortening this procedure. The overhead rates charged by consultants in half of the states ranged between 120 and 170 percent. Fixed fees also varied in the survey responses.

The time from the initial advertisement of a project to the actual start of consultant work has decreased during the 1990's. One state reported having accomplished the process in only seven weeks. However, the average is closer to six months and it sometimes can extend to one year or more.

To expedite the negation process, both consultants and DOTs recognized the necessity for more training of agency staff, especially in project management techniques. Most of the consultants benefited from taking part in joint training programs with the DOTs.

A final evaluation usually occurs and evaluations during the duration of the project are widely recognized as useful. The majority of states then share the evaluation findings with the consultants.

As a bottom-line, no major problems have risen from the working procedures and/or the relationships between the DOTs and their consultants. Since every state is unique in nature due to differences in program size, management practices, and different external influences, no uniformity or preferred models for consultant management have been established.

Suggested areas for future research were as follows:

- Optimum level of the proportion of work performed in-house versus that contracted to the consultants.
- Data on the dollar volumes and nature of work contracted out annually.
- Contract methods employed.

3.2.2 In-House Versus Consultant Design Costs

Source: Wilmot, C. G., D. R. Deis, H. Schneider, C. Coates, Jr. 1999. *In-house versus consultant design costs in department of transportation*. Transportation Research Record 1654.

When DOTs consider outsourcing they must first address what to outsource and what to do in-house. This paper addressed cost issues related to making this choice for design activities.

The purpose of this study was to review methodologies used in former studies and propose some improvements to compare design costs between in-house and outsourced projects. The new methods consisted of comparing in-house to consultant design cost ratios generated from road and bridge projects carried out between 1995 and 1997 for the Louisiana Department of Transportation and Development (LADOTD).

Throughout the years, the results of many studies have concluded that the consultant design costs are more expensive than in-house performed projects. Nevertheless, these studies present a wide variation in the results found. It is thought that the reason for this deviation is either the oversight, or mishandling, of many significant factors that considerably affect the final values being compared. The methods proposed in this study suggest an improved handling of the relevant factors that have a strong impact on the final value of the design costs. This study found that consultants are about 20 percent more expensive than in-house staff when producing road and bridge designs. The difference was almost completely due to the extra costs of contract preparation and the in-house supervision required for consultant designs.

The common practice has been to compare the ratio of design to construction costs. The new approach suggests comparing design costs through the use of the ratio of in-house to consultant design costs using the same project to generate the values to be observed. This ratio was called the Design Cost Ratio (DCR). This is the difference from the traditional approach to cost comparisons. Whereas most of the studies use different, but similar projects, the proposed method uses the same project to compare design costs between the state agency and the external consultant. Since the projects have been executed for only one entity, it is necessary to estimate the design cost for the entity that did not perform the job. The estimate is then compared to the actual value to obtain the ratio. Detailed analysis of overhead rates that are comparable between state agencies and consultants were definitive. The study also identified factors other than costs that are used in the decision-making process to employ consultants.

Many past studies have not adequately addressed the costs of contract preparation and consultant supervision for consultant designs. The study carried out by LADOTD found that these costs can vary between 15 and 25 percent of total design costs and can significantly alter any findings if omitted. Also, many studies have omitted the cost of utilities, office rent, upper management support costs, and insurance costs from the cost

of in-house designs. It is important to realize that tort liability for the state considerably raises the state insurance costs over the indemnity costs experienced by the consultants.

The most complicated issue when comparing design costs between in-house and consultants' staff is the establishment of reliable and comparable overhead rates. This can be reached by learning from the private sector how to identify and assign overhead costs throughout the organization.

In studying overhead costs, it was found that support services constitute 19.4 % of total operating costs for the department. This cost includes: insurance, utilities, rent, administration, data processing, legal expenses, financial services, auditing, duplication and other support services. Management and supervision costs were found to add an additional 2 % to the total operating costs of each section. This includes the total operating costs of upper management units in charge of supervising sections involved in design work. Section overhead rates were 56% for road design and 59% for bridge design. These costs included fringe benefits, leave, training, administration, etc. The final total overhead costs (overhead cost divided by direct costs) were found to be 186 % for road design and 212 % for bridges designed in the department.

The consultants' overhead rate was found to be 158 % and it was determined by collecting information from audits of 37 consultants within Louisiana during fiscal year 1996. If the costs of consultant contract preparation and supervision, and the profit of 13.3 % are considered as an additional expense, then, the overhead rates for consultants increase to 236 % for road design and 265 % for bridge design.

Results from the study show that the in-house average DCR was 65 % for road design and 76 % for bridge design. The average DCR for consultants' projects was found to be 81% and 83% for roads and bridges respectively. DCR is the ratio of in-house to consultant design costs using the same project to generate the values to be observed.

It was found that hours worked by in-house staff on bridge projects exceeded the consultants' amount of hours worked by 3%. For road projects, in-house hours were 5% less than consultants' hours. In-house personnel earn around 17% less than consultants. If fringe benefits are considered, the remuneration scale becomes similar. It was established that the average cost of one in-house hour is approximately 77 % of the cost of an average design hour by consultants.

Summarizing the results for this study, the in-house design costs are less than 96% of consultant costs for bridge design and less than 88% of consultant costs for road design. The principal cause of divergence between in-house and consultants design costs is the cost of consultant contract preparation and supervision.

Several studies in the past have shown that even though the cost is very important, it is not the primary factor to make the decision to outsource. Other important factors for decision-making on whether to outsource design work are: the feasibility to accommodate peak demand by using consultants, being able to meet deadlines, gaining access to special expertise, having access to a larger workforce, helping maintain a

healthy consulting industry, and maintaining expertise among both in-house staff and consultants.

3.3 OUTSOURCING CONSTRUCTION ENGINEERING (AND INSPECTION)

This section presents highlights of a paper addressing issues associated with outsourcing construction engineering and inspection services.

3.3.1 Best Management Practices for Outsourcing Construction Engineering Services

Source: Ellis, R., B. D. Guertin, and J. Shannon. 2000. *Best management practices for the outsourcing of design and construction engineering services on Florida Department of Transportation construction projects.* Department of Civil Engineering, University of Florida. (December)

This was a study carried out by Dr. Ralph Ellis and others from the University of Florida at Gainesville for the Florida Department of Transportation (FDOT) in 2000. Although the title infers analysis of outsourcing of design, the report deals only with what FDOT calls Construction Engineering and Inspection (CEI). The study obtained data on practices of outsourcing CEI for DOTs nationwide through the use of a survey. The study also analyzed cost information for 580 FDOT projects between 1994 and 1999. About 25% (141) of these projects used external consultants for CEI activities. Project costs were separately analyzed by type and size.

The following summarizes the analysis of the survey of state transportation agencies:

- 48 states responded to the survey.
- 85% of the state agencies use consultants to perform CEI activities.
- Different agencies reported having used CEI consultants for a period of time ranging from more than 49 years and less than one year.
- For CEI consultants used in DOT projects, the most typical scope of work is a "*comprehensive management"* of the project (73%).
- Consultants were most commonly compensated for their services with cost plus fixed fee contracts (68%).
- A generalized lack of information and data was observed.
- The average of CEI costs, when CEI was outsourced to consultants, for states responding to the survey (38) was 11.1% of the contract amount. The response was to the question, "For projects in which your consultants perform CEI functions, what is the estimated average CEI cost as a percentage of total construction contract costs?" It is not known whether respondents included the costs of contract preparation and award and/or the costs of consultant contract supervision in their responses.

- The average of CEI costs when CEI was performed in-house for states responding to the survey (38) was 8.6% of the contract amount. The response was to the question, "For projects in which you perform the CEI functions with your own DOT personnel, what is the estimated average CEI cost as a percentage of total construction contract cost?"

The following summarizes the analysis of the survey FDOT CEI project cost data:

- FDOT CEI costs were 9.2% of the construction amounts when performed by in-house personnel.
- FDOT CEI costs when outsourced were 11.6% of construction amounts for consultants' contract costs, plus 3.1% of construction amounts for FDOT administration, for a total of 14.7%
- Regression analysis of the cost database led to the conclusion that CEI costs are influenced by the following:
    - outsourced or insourced
    - project size as measured by dollar amount of construction contract
    - project type
    - scope of consultant services
    - market conditions for consultant services
    - supplemental agreements (changes in project duration and contract amount)

After the data gathering and analysis were concluded, the study led to the following conclusions:

- Determining the scope of service to be performed by a CEI consultant is a very important management issue.
- Administrative functions that can be better performed by the state agencies should not be included in the consultants' scope of work.
- Activities that do not represent added value to the project must be eliminated.
- Consultant selection should follow these steps:
    - measure consultants' capabilities;
    - evaluate past performance;
    - agencies' PMs develop project plans to discuss with the consultants;
    - standard rates for CEI consultant contracts are set.
- Implementing a multi-project contract program is a good alternative that leads to a more efficient use of resources and more continuous experience and knowledge base from the consultant.
- Determining who is going to perform what project is still an issue. It is very important to establish parameters and criteria to assign projects to the most cost effective entity, either state agency or private consultant.
- FDOT should design and implement a CEI cost information system to provide cost management information concerning CEI cost within the FDOT program.

The report provides one-page summaries for each of the following suggested best practices for outsourcing CEI services:

- Assign to the consultant only those tasks that can be efficiently performed by the consultant. (Scope of services should be developed for each project based upon the project requirements and the availability of alternative sources.)
- Insure that the outcome of the consultant negotiation will be a staffing plan which is appropriate for the specific project at an appropriate cost.
- When possible, use multi-project consultant contracts for CEI. Establish guidelines for the formation of multi-project CEI consultant contracts.
- Maintain a continually updated analysis of project costs, including CEI costs. Allocate CEI responsibility on the basis of cost effectiveness.
- Attention should be given to delay avoidance and mitigation. Utilities and plan errors remain frequent causes. Increasing project duration directly increases CEI cost.

3.4 UNIFIED APPROACH TO OUTSOURCING DESIGN-BID-BUILD (ODBB)

The papers of this section explore issues associated with outsourcing of the entire project delivery function, including preliminary engineering and construction engineering.

3.4.1 Best Outsourcing Practices of DOTs

Source: *Macnab, S. 2002. Best practices of state DOTs: Interstate maintenance outsourcing project.* ODOT Internal Document.

In 2002, in anticipation of a proposed Interstate Maintenance Program, ODOT surveyed the 50 state DOTs to determine what experience they had with outsourcing program level management, design, and construction services. Eleven states were targeted for a telephone survey for more in-depth information. Contacts with eight of these were successful. In reality, two of these eight successful contacts did not have experience with program level outsourcing. The experiences of Idaho and Massachusetts were with maintenance programs. Texas had experience with outsourcing maintenance activities and with "exclusive development agreements." Virginia's experience was with maintenance and design-build. That left South Carolina and Louisiana as the responding states with the most extensive, relevant experience and information.

3.4.1.1 South Carolina DOT

The South Carolina "27 in 7" program (*South Carolina 2002*) was the most comprehensive example of ODBB found. To deliver a $760 million road and bridge program, SCDOT contracted in 1999 with two Construction Resource Managers (CRM) that each serve as program manager's for about half of the state. Aside from delivering the program, other management functions were assigned to the CRM's. They included developing a strategic plan for the program and developing a financial management tool. Each CRM was supervised by a SCDOT senior manager.

The CRM's duties related to budgeting, scheduling, and design work. They provided oversight of design by their own staff or by design consultants. They also provided oversight of construction contracts.

Specific documents that CRM's were required to provide included:

- Strategic plan for the program
- Overall right-of-way acquisition plan
- Work process flow diagram
- Project delivery strategy for each project
- Project's procedure manual
- QC/QA manual for construction

Specific duties include:

- Preliminary engineering
- Permits & approvals
- Right-of-way acquisition
- Materials procurement
- Utility relocation
- Construction
- Maintenance of records
- Public information and managing public involvement
- Periodic progress reporting to SCDOT

SCDOT retained the environmental impact statement work.

3.4.1.2 Louisiana DOTD

In 1989, the Louisiana Legislature authorized the "Transportation Infrastructure Model for Economic Development (TIMED)" program, authorizing 16 major projects. As of 2002, four major projects had been completed. The remaining 12 projects were subdivided into approximately 145 project segments, of which, approximately 95 had been completed in 2002. Preliminary plans and basic designs have been initiated on all project segments.

According to a 2001 estimate, it is about a $2.5 billion program. The program is funded by a $0.04 per gallon fuel tax, authorized until the projects are completed. Because completion was forecast for 2030 on a pay-as-you-go basis, a financing package utilizing revenue bond sales was authorized to allow all projects to be under construction by 2010.

To accomplish this, a consortium of consulting engineers were assigned as program managers, with responsibilities for:

- Managing the schedule

- Acquisition of required rights-of-way
- Relocation of utilities
- Securing needed permits and project clearances
- Completion of project plans and bid documents
- Financial requirements
- Construction administration

The program management contract is a ten-year contract. It is an incentive/disincentive contract and there are provisions for inflation. The program management firm expanded their insurance requirements and must provide a 3-year warranty on construction defects due to non-conforming work.

The program manager has the responsibility for budget, schedule, and oversight of design and construction. At the program level, the program manager must provide the following:

- Program strategy document for the entire program
- Partnering process during startup
- Program schedule
- Financial management services, including cash flow forecasting, planning, and reporting
- Program schedule

For each project in the program, the program is responsible for the following:

- Design oversight
- Right-of-way management and acquisition
- Utility relocation
- Public involvement
- Site assessment of abandoned hazardous waste sites
- Construction administration and inspection

For more information on program outsourcing in Louisiana and South Carolina, readers are referred to the Macnab report (*2002*) and to South Carolina's "27 in 7 Program" booklet (*2002*).

3.4.2 FHWA Study-Contracting Out Project Delivery

In the year 2000, the Federal Lands Highway (FLH) Division of the Federal Highway Administration (FHWA) executed and reported a benchmarking study of practices for contracting out project delivery. The Phase 1 report (*Calderon 2000*) summarizes the data collection. Phase 2 (*Smith 2000*) analyzed the data from Phase 1, suggested some recommendations on industry practices, and recommends a staffing model for project delivery to optimize the agency's capability to handle future workloads. Phase 3 (*FHWA FLH 2000*) made an evaluation to implement the recommendations from the Phase 2 analysis and determined the appropriate level of support staff required for an efficient

FLH division. Since Phase 3 does not relate directly to the topic of the current study, it is not discussed further.

3.4.2.1 Phase 1

Data collection began with an e-mail to the 50 state DOTs requesting information regarding their levels of outsourcing. Thirty-three states responded. Based on the responses, fourteen states were targeted for on-site interviews. Prior to the interviews, the states were given a sixteen-question survey to complete. Twelve states responded to the questionnaire. Interviews of top DOT executives were conducted on-site by the FHWA FLH team for eleven DOTs. These eleven DOTs were: Arizona, Colorado, Connecticut, Florida, Illinois, Indiana, Kansas, Kentucky, Maryland, Nevada, New Mexico, Oregon, and Tennessee. Survey responses and compiled notes from the interviews are available in the Phase 1 report (*Calderon 2000*). The project of Oregon State University graduate student Himawan Setiawan (*Setiawan 2003*) presents an independent analysis of the information presented in the Phase 1 report. Recommendations, partly based on the interviews are reported in the Phase 2 report (*Smith 2000*).

3.4.2.2 Phase 2

Analysis of the Phase 1 information produced recommendations for outsourcing project delivery. Table 3.2 is adapted from the reports' recommendations. It shows the most common recommended practices that were compiled among the different DOTs from the Phase 1 report. Recommendations supported by five or more state DOT interviews are included in the table. Specific questions regarding these practices were not posed to every state DOT. Consequently, there may be more states using these practices than indicated (*Smith 2002*).

Table 3.2.: Recommended Practices from State DOTs (*Smith 2002*)

Recommended Practices from State DOTs	Number of State DOT Interviews Supporting this Recommended Practice	Does FLH currently do this?	Degree of Difficulty in Implementing
Retain complex and interesting projects in-house	7	Yes	
Pay banding, recruitment, retention bonuses, and alternative pay schedules for EIT and PE licenses	6	No	Difficult
Work repeatedly with specific A/E firms	9	Yes	Moderate /Difficult
Keep design team on board through construction	9	No	Easy
Combine the training for project management, construction & other in-house and consultants personnel	8	Some	Moderate

Require construction inspector training and certification	5	Encouraged	Easy
Hold frequent status meetings and employ good scheduling methods	8	Yes	
Hold contract retainage for task order work	8	Available	Easy
Use a consultant evaluation process	5	Yes	

The following are less common recommended practices among the state agencies interviewed (*Smith 2002*):

- Develop scholarship programs to attract prospective recruits.
- Develop a design matrix to determine which projects go to A/E.
- Require A/E design firms to use the same software packages as used in-house.
- Establish post contract reviews to learn what went well and what did not.
- Bundle small or similar projects into more manageable and economic sizes.
- Limit the outsource work to no more than 80%.
- Lump-Sum design for more efficient and timely deliveries.
- Use partnering during contract work and continuous periodic partnering with contractor industry, prior to contract work.
- Compete for work against consultants.
- Be sensitive to where people want to work.
- Provide flexibility and family friendly policies.
- Include construction contingency pay items in PS&E.
- Review consultant designs for scope and guidelines, not for technical accuracy.
- Use standard clause for consultant liability in all contracts.
- Give employees projects with increasing difficulty.
- Have consultants prepare SOW for task order work at no charge to State DOT.
- Use constructability reviews or VE studies during project development.
- Employ prequalification process once per year for A/E's.
- Use A + B bidding to reduce contract time and oversight time.
- Perform preliminary design and environmental scoping before contract task order work. The whole cross-functional team should participate.
- Require that consultants live in, and pay taxes in state.
- Provide checklist review for consultant designs.
- Require that all design employees attend context sensitive design training.
- Limit overtime and comprehensive time to retain employee quality of life.
- Utilize graduate engineer training programs.
- Establish technical career track positions.
- Establish consultant overhead and salary caps.

- Categorize contract change orders to identify trends.
- Have cross-functional team develop project delivery schedule and include construction liaison.
- Include disincentive clause on A/E contracts for contracts not completed on time.
- Assist employees to become PEs.
- Improve performance recognition system.

The Phase 2 report (Smith 2000) also utilized a computer model to make recommendations for staffing levels for construction programs at various levels. The first step was to identify the number and skill level of qualified technical and professional personnel required to staff the project delivery section of a generic FLH division. This level of staffing should be able to achieve the following five key objectives (Smith 2002):

1) Deliver the FLH project delivery program.
2) Blend the social, environmental, economic and political philosophies of the Federal Land Management agencies and Tribal governments into their unique highway infrastructures.
3) Maintain the ability to provide state-of-the-art technical assistance to Federal Land Management agencies, Tribal governments, and Federal-aid.
4) Provide for training and development of FHWA and Federal Land Management Agencies (FLMA) employees.
5) Maintain a sustainable and renewable supply of expert transportation engineers who can manage a diverse program of projects.

The staffing model recognized the fact that TEA-21 increased the Federal Lands Highway Program by nearly 50 percent. This implied a need and support for additional increases during the next legislation, in the year 2003. Model calculations were generated for FLH Division construction program levels of $50, $100, $150, $250 and $350 million dollars in order to account for a range of potential program increases.

Twelve engineering activities that belong to the agencies' core functions were evaluated. The activities evaluated were considered to be necessary to a project delivery office and represent around 72% of a division office's staffing requirements (*Smith 2002*). The activities are:

1) roadway design,
2) hydraulics,
3) project management,
4) structural design,
5) geotechnical,
6) environment,
7) construction management,
8) survey and mapping,

9) right-of-way and utilities,
10) materials,
11) safety,
12) and traffic engineering.

The optimum staffing level for a generic, three-division, project delivery office was studied by creating a cost-based computer model. The twelve core functions were used to create the model, and the five key objectives were the basis for staffing the core functions. Three different levels of experience were considered in staffing the core activities: Novice, Journey level and Senior Engineers. To ensure that the considerations assumed were valid, the model was compared against various state, consultant and FLH engineering staffing and production rates.

Table 3.3 describes the distribution of the staffing for the program delivery portion of a generic division office for a $40 million annual program (*Smith 2002*). This model shows that 127 engineers and technicians are required to execute a $40 million annual program, achieving the five key objectives mentioned before.

Table 3.3: Generic Division – Core function staffing distribution for a $40 million program (*Smith 2002*)

Program Delivery Core Functions	Novice	Journey level	Sr. Engineers	Total
Roadway Design	8	8	4	20
Hydraulics	1	1	1	3
Project Management	4	4	2	10
Structural Design	6	5	2	13
Geotechnical	4	4	2	10
Environment	4	4	2	10
Construction Management	12	12	6	30
Survey and Mapping	2	8	2	12
Right-of-way and Utilities	1	1	1	3
Materials	4	4	2	10
Safety	1	1	1	3
Traffic Engineering	1	1	1	3
Core Function Total	**48**	**53**	**26**	**127**

Over this base amount, additional contract managers would need to be hired to address increased program levels. These contract managers would supervise consultant contracts to meet FHWA FLH program requirements.

Figure 3.1 shows how the required staff levels increase when the program value increases (*Smith 2002*). The top section of the bars refers to the additional external personnel required to meet the objectives when performing the project delivery program. The middle section of the bars represents the additional internal personnel required to supervise the external consultants.

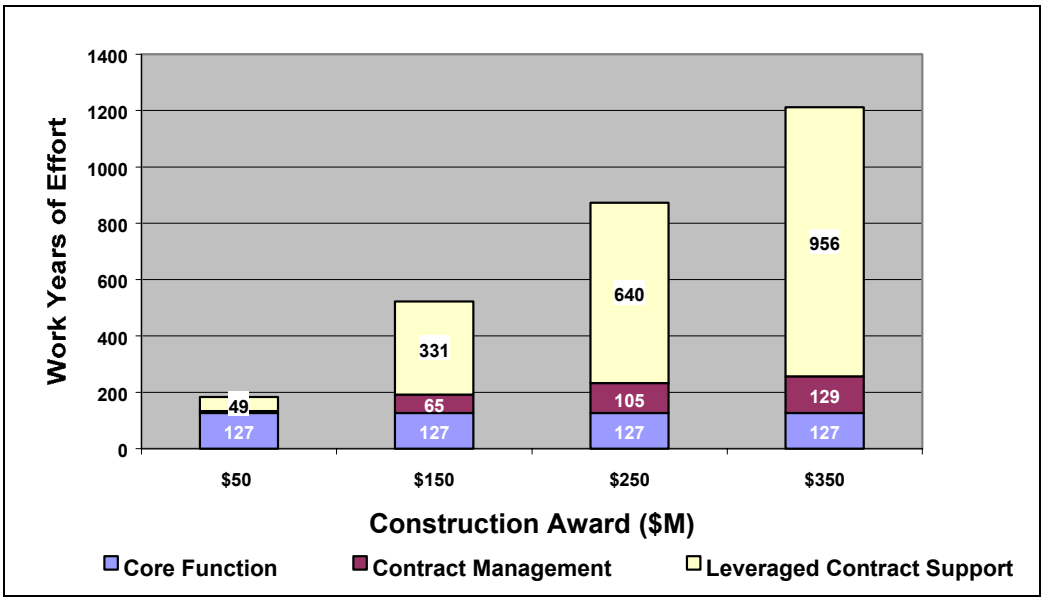

Figure 3.1: Project delivery core function with contract support (*Smith 2002*)

The cost-based staffing model can also determine the percentage of outsourced engineering services as the generic division's program increases. Figure 3.2 shows the trend followed by the percentages of outsourced construction activities as the program values increase. These percentages are the maximum amount that a generic division can outsource in order to maintain core function expertise. (*Smith 2002*)

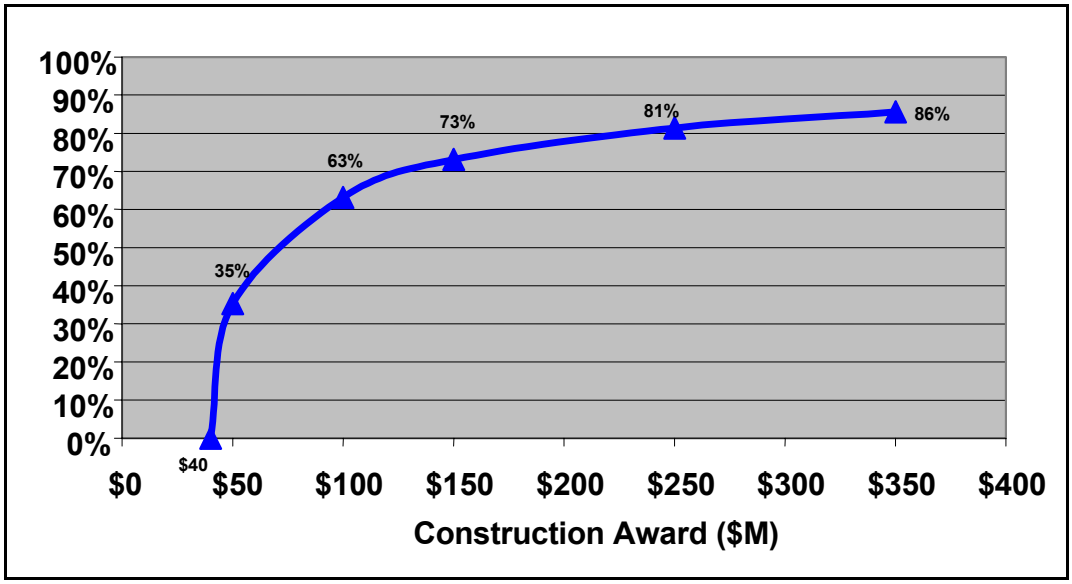

Figure 3.2: Total engineering budget contracted out (*Smith 2002*)

The importance of adding additional contract management staff, over and above the core staff, to properly administer outsourcing is one of the most important findings of this Benchmarking study. The following figure shows graphically how the outsource management staff numbers must grow, with each increase in the size of the program. This figure also shows that as the program level increases, an outsource management development pool must be established to provide the necessary personnel to assure that the required number of Journey level and Senior engineers will always be available to replace experienced contract managers lost through attrition. These staffing levels are based on minimum critical mass in each core function plus the minimum internal support to properly manage the outsourced engineering activities. (*Smith 2002*)

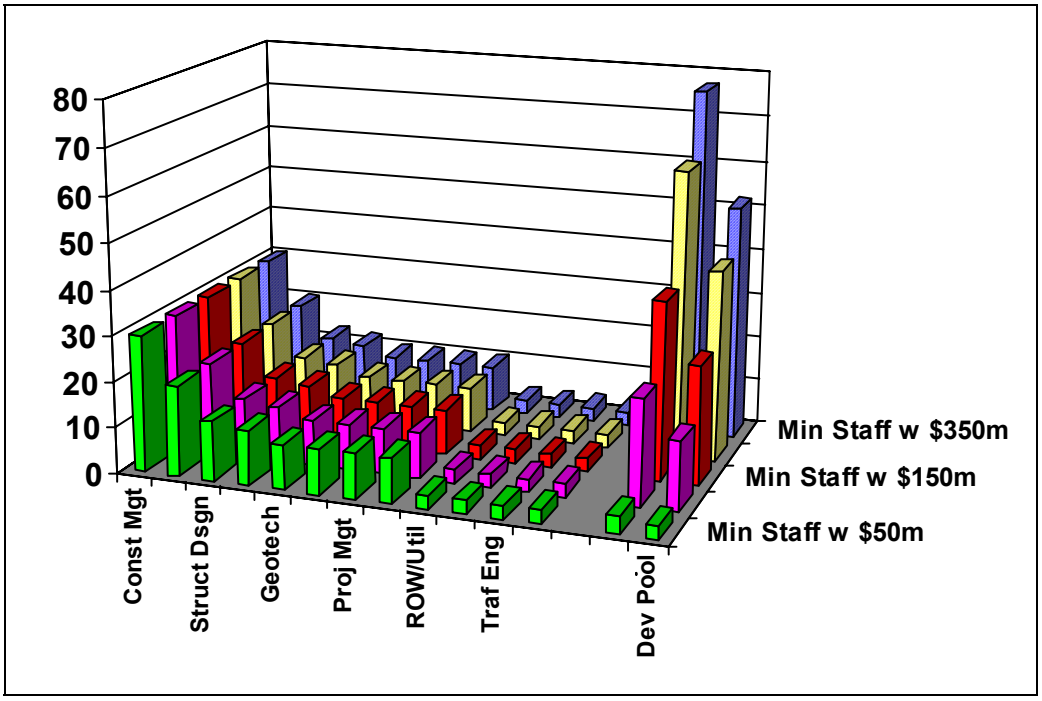

Figure 3.3: Minimum staff levels with outsourcing support staff (FTE) (*Smith 2002*)

The staffing model and the information from the interviews of state DOTs made it clear that three important issues must be addressed by FHWA FLH in outsourcing project delivery. These are (*Smith 2002*):

- The in-house staff needs to be increased, even when a considerable amount of work is outsourced, due to contract management and supervision needs.

- Agencies have to recruit at least 10 to 13% entry-level technicians and engineers to replace the loss of personnel, annually. This percentage is much higher than what FLH is currently attracting.
- Technical and contract management training must be provided for the program managers who will enable the divisions to successfully deliver the larger programs through the effective use of outsourcing.

3.5 DESIGN-BUILD

Beginning in the 1990's, Design-Build (DB) project delivery has been well publicized. The use of DB delivery, which began in the private building sector, has expanded into public building work and into transportation infrastructure projects. UTAH DOT's (UDOT) multi-billion dollar reconstruction of I-15 through Salt Lake City prior to the 2002 Winter Olympics presents the most dramatic use of DB project delivery for transportation projects. A great deal of information about DB, including public sector delivery of transportation projects, is available. For example, in early July 2003, a website at the University of Colorado lists over 250 DB references, including over 40 FHWA special experimental project (SEP-14) documents. The website may be found at, (http://construction.colorado.edu/Design-Build/Desktop.aspx?tabindex=2&tabid=6).

Two Websites maintained by the Utah (*Nelson* 2003) and Florida DOT's (*Prasad 2002*) provided the best current literature, with respect to DB delivery of transportation projects. Highlights from literature obtained from those websites are presented in the following sections, followed by a brief discussion of ODOT's DB experience.

3.5.1 Utah's Design-Build Project

Source: Baxter, J. R. 2003. *Utah's I-15 design-build project: Meeting the challenge through innovation.* Region 4 Quality Management Workshop. <http://www.fhwa.dot.gov/utdiv/projects/i15inovt.htm>.

In 1997 the Utah Department of Transportation (UDOT) let a $1.59 billion Design/Build (DB) mega project contract involving reconstruction of Interstate 15 in Salt Lake City, Utah. Lanes were increased from 6 to 12 for a 26-kilometer (16 mile) section. High Occupancy Vehicle (HOV) lanes were added, 137 structures were replaced, an Advanced Traffic Management System (ATMS) was installed, and geometric, aesthetic and drainage improvements were made. The project had been under study due to service life expiration and capacity expansion needs as a design-bid-build (DBB) project for several years, but took on a new expediency due to the 2002 Winter Olympic Games and a 10-year, $2.6 billion funding authorization in February 1996. In order to meet the timing constraint, the design/build method of project delivery was selected, incorporating FHWA Special Experimental Project (SEP) 14 guidelines.

UDOT implemented a three-step procurement process comprised of the following items: Request for Qualifications (RFQ), Request for Proposals (RFP) and Best & Final Offer (BAFO). Since UDOT did not have the expertise to develop such a large and innovative

project, they hired Parsons-Brinkerhoff (PB) to develop the RFQ and RFP packages. For external oversight, a separate I-15 Management Team was also formed. Five months later RFQs were issued and three months later RFPs were issued to three short-listed consortiums. One year from initiation, BAFOs were requested and one month later Wasatch Constructors was selected. Their bid included: $565 million for structures, $197 million for earthwork, $110 million for pavements, $67 million for ATMS infrastructure, $32 million for maintenance of traffic, and $104 million for engineering/design.

Innovations in the procurement method included the RFQ/RFP/BAFO approach. UDOT provided drafts of the RFP to a short-list of proposers prior to the official release. This was done so that proposals could be modified to accommodate owner insights and ongoing technical concept reviews. This approach greatly aided in proposal development. Lump-sum price proposals were also required, due to extensive use of performance specifications in the RFPs. The designer/builder was also relegated responsibility for work quantities. A $950,000 stipend was granted to unsuccessful proposers to encourage bidding and innovation while giving UDOT exposure to more ideas. This stipend represented approximately 1/4 to 1/3 of the proposal cost.

The project was awarded based on a "best value" selection approach. Technical factors represented approximately 50 percent of the selection criteria, and cost represented the other 50 percent. Evaluators of each were "blinded" to the other and a 64 person team from UDOT, FHWA, PB and the Wasatch Front Regional Council made the selection in conjunction with the Proposal Evaluation Board (PEB) and the UDOT Executive Director. The technical evaluation was comprised and weighted in this order: technical solutions, work plan/schedule, management and organizational qualifications. Technical solutions contained several sub-factors: maintenance of traffic, geotechnical, pavement, structures, maintainability, geometrics, ATMS and drainage. Each level of the evaluation was rolled-up to the final PEB review and the final executive decision.

The contract was administered with diligent concern for Disadvantaged Business Enterprises (DBE). Ten percent of the estimated Federal support ($200 million) was allocated for subcontracting to local DBEs. All subcontracts over $3 million were competitively bid. UDOT developed an Owner-Controlled Insurance Program (OCIP) that covered worker's compensation and several types of liability. OCIP saved several million dollars and rewarded the DB firm for enhanced safety performance. To support the selected DB consortium, UDOT took responsibility for securing right-of-way (ROW) parcels and formalizing agreements with utilities and railroads allowing direct DB relocation activities.

Quality was a major consideration in the project. UDOT required ISO 9000 certification of the DB selectee and transferred both the Quality Control (QC) and Quality Assurance (QA) responsibilities to the selectee. This was a major shift from previous history in quality management. UDOT served their stewardship responsibilities by implementing an owner assurance-testing program, along with utilizing an independent testing facility. This shift in QA/QC responsibility was afforded by extensive use of performance specifications in the execution of the project. These promoted such innovations as: using

high performance concrete, incorporating silica fume in the bridge decks, using lime cement columns to stabilize embankments, reducing weight by using geofoam fill in embankments, incorporating extensive seismic design technology and using wick drains to decrease settlement time.

Another area of quality that UDOT also showed flexibility was relinquishing a 20-year maintenance warranty requirement in lieu of a five-year maintenance option, with 5 additional one-year options. Yet another innovation in quality came from creating a $50 million award fee that rewarded timely performance, quality of work, management, community relations, and maintenance of traffic. Partnering was strongly emphasized and six project goals were established: safety, quality, schedule, budget, performance and teamwork.

The project achieved completion of a majority of the design effort, expending $1 million per day and was 20% completed by, April 1998. The DB firm was also meeting the award criteria and one increment had been paid out. The first UDOT mega project was proceeding well under DB auspices and is a point of pride for the Utah Department of Transportation. They have prepared extensive documentation of the project concept, guidelines and evaluation (*Postma and Cisneros 2002; Nelson 2003*).

3.5.2 Review of Design-Build

Source: Sumner, D. 2002. *State of the Practice Review in Design-Build,* Joint Florida DOT and FHWA Review. Internal Document.

This paper provides information on the Florida Department of Transportation's (FDOT) experience with DB. However, the majority of the paper summarizes information obtained about DB practices during visits to South Carolina DOT (SCDOT) and Arizona DOT (ADOT) by an interview team of FDOT and FHWA personnel.

3.5.2.1 Florida

FDOT views the expected benefits from DB to include, reducing the number of supplemental agreements and change orders during construction and obviating supplemental agreements in consultant design contracts. Another clear value is transferring project liability and many project administrative costs to the DB firm. Other expected benefits include, more efficient construction methods and a reduction in consultant design and inspection fees. In 2002, FDOT had completed half of their committed use of DB to deliver over $660 million in ongoing projects.

One area of focus by FDOT had been the developments of state of the art DB documents. These now include: RFP guidelines, design and construction criteria guidelines, construction inspection scopes, specifications, utility agreements and

warranties, as well as processes for acquiring right-of-way and more innovative construction engineering inspection (CEI).

FDOT awards DB contracts from a three minimum short list of qualified firms, choosing the lowest adjusted score using the A+B method as the selection criterion. However, FDOT distances itself from the DB firm by calling them, "an independent contractor who is their representative" and retaining right-of-way acquisition themselves.

3.5.2.2 South Carolina

The South Carolina Department of Transportation (SCDOT) has a ten year history of using DB for delivering projects, ranging from $3-$531 million. Even so, they have not developed DB guidelines or specifications. They only use DB selectively and have done ten DB projects in that time. Firms were chosen from a pre-qualified short list, using a one step (RFP only) or two step (RFQ + RFP) process. The selection process has been specific to the project, but has included prorated minimum contract time. They are planning on using the A + B method on a currently proposed project. Historically, they have also used fixed scope, low bid, and fixed price / best value selection methods.

SCDOT has historically elected not to pay stipends for developing DB project proposals, but takes on the responsibility for obtaining all of the required permits and provides the pavement design as a part of the RFP. To date, they have, "not received any Value Engineering Change Proposals (VECP) on their DB projects". They also provide the service of reviewing and stamping shop drawings as "reviewed". They further allow the DB firm to do utility coordination and right-of-way acquisition.

Although they have historically let the DB firm hire the construction inspection consultant, they recently have felt the need to do the hiring themselves. They have also changed their construction oversight to allow more hands-on control, possibly in response to non-compliance for erosion control methods and storm water management. They also request their DB firms to provide a warranty, but are not specific on its terms.

The lessons that SCDOT has learned include: applying DB to projects with well defined scopes, making sure the environmental approvals and permits are obtained prior to letting the contract, constraining right-of-way acquisition to limit their risk, sharing the risk on utilities, diligent use of liquidated damages and incentives, and continual monitoring of progress associated with payments against a clear schedule of values that is included in the contract. In addition, SCDOT emphasizes the need to focus on: partnering and communication, making sure the RFP clearly defines design and construction items, requiring a warranty, and including a draft contract in the RFP. They also underscore the value of flexibility in the selection process.

3.5.2.3 Arizona

The Arizona Department of Transportation (ADOT) has experienced four DB projects, prior to 2002, in the $40-$185 million range. As a result, they have developed DB guidelines and a framework for specifications. ADOT is limited by law to two DB projects a year, with a minimum value of $40 million each. Similar to SCDOT, ADOT uses a two step RFQ selection process from a pre-selected short list, with price and technical proposals submitted together. A + B method bidding is used and ADOT estimates that this results in reducing contract times by approximately one third.

ADOT provides a token stipend for preparing proposals and does not require warranties; other than what comes with equipment and systems. They feel enforcement costs outweigh the purported value of contractor provided warranties. They also limit DB proposals to 25 pages of technical specifications and 200 pages of plans and general information. They score proposals on the basis of: approach, safety, constructability, maintenance of traffic, innovation, DB firm's capabilities, quality, and the interview process.

To encourage proposals, it is a stated goal at ADOT to lower the DB firm's risk. To do so, they provide the following such services prior to awarding the DB project: pavement design, right-of-way acquisition, initial utility location, obtaining environmental permits, and geotechnical borings. ADOT, in concert with a general consultant, also provides design oversight reviews. However, they relegate review of the shop drawings to the Designer of Record, who performs this function and stamps them "reviewed" when ready. To further manage costs, ADOT requires the proposers to provide a cash flow curve with their bids, and then pays by achievement of milestones as verified by the project resident engineer.

After plan review, a cover letter that is signed by all parties, releases work for construction. ADOT then uses quality checkpoints in construction and quality incentive specifications to improve quality. They have allowed the DB firm to provide independent inspections and materials testing, with ADOT providing oversight, independent sampling and testing. For DB, ADOT has used a "hold" system, where the contractor is fully responsible for quality, but alerts ADOT when quality milestones are reached. ADOT has the option of verifying and then releasing the project to the next phase. ADOT offers the following lessons learned from using DB:

- modify the specifications as appropriate to each project,
- add an incentive/disincentive for potentially reusable material,
- include a travel time incentive,
- use quality management checklists,
- continue to have ADOT inspectors responsible for QA and DB responsible for QC,

- continued use of joint contractor/ADOT safety meetings, and
- using co-location to lessen the gap between design and construction.

3.5.3 Florida Design-Build Guidelines

Source: Prasad, A. 2002. *Florida Department of Transportation design-build guidelines.* <http://www11.myflorida.com/construction/design%20build/DB%20Rules/DesignBuildGuidelines_Feb.%2003.doc> (February 28).

The Florida Department of Transportation (FDOT) is a national leader in the practice of Design-Build (DB) project delivery. They have used it on a variety of transportation, structure and rail corridor projects. In addition, they hosted the third annual Design-Build Conference in Orlando during July 2003. They also maintain a website supporting FDOT DB activities at http://www11.myflorida.com/construction/design%20build/design-build.htm .

The published FDOT Guidelines are a very comprehensive overview of how Florida practices DB. In several sections there are actual programming instructions on how to code project-related data into their in-house project management system. Many aspects of FDOT construction project management, with and without Federal funding, are covered, including non-DB-specific project factors.

FDOT defines DB as including the design, construction and (with Federal approval on Federally-funded projects) Construction Engineering & Inspection (CEI). FDOT views DB as advantageous because these projects, "allow the contractor to participate in the design process, in an effort to reduce costs and expedite construction." In 1995 the Florida legislature first authorized "Design Build Major"; a contracting technique allowing the department to combine the design and construction phases of a project into a single contract. This included projects on buildings, major bridges and rail corridor projects over $10 million. In 1996, "Design Build Minor" followed, providing for projects under $10 million. Both programs each had an overall $120 million annual cap under the auspices of "innovative practices".

FDOT segments DB projects into two general types; Adjusted Score DB (ASDB) and Low Bid DB (LBDB). Flowcharts for each of these processes are available in the Design-Build Guidelines (*Prasad 2002*).

3.5.3.1 Adjusted Score Design Build (ASDB)

The largest section in the guideline is dedicated to the ASDB process. The ASDB process is used when overall outcomes can be clearly defined; however, a number of alternatives may exist which could provide the outcomes desired. An example of this is a bridge project where alternative foundations, spans and material types are acceptable. This method is designed to encourage the bidding firms to innovate for the best cost and delivery. However, it puts a further burden on the department to screen the field of contenders in order to present the Response for Proposals (RFP) only to firms capable of achieving the project goals. The

adjusted score method factors technical score, along with both cost and planned project time, into a combined value that rewards the lowest adjusted score. This is accomplished by: multiplying the FDOT-assigned daily project time value, by, the DB firm bid number of days, and then adding this, to the estimated project cost, for a combined score, that is then divided, by the technical score, to provide the adjusted score. The project is awarded to the firm with the lowest adjusted score who is judged to be technically responsive. To deter bidder manipulation of estimated project days, an incentive/disincentive is often also tied to these project duration estimates in the contract that is let with the selected DB firm.

The ASDB selection process is more complicated than the LBDB approach at FDOT in that, the RFP is provided only to pre-qualified, short-listed, DB firms for bidding. To achieve this short list, FDOT project managers must identify and define the project and create the design and construction criteria. Then they create the RFP, achieve FWHA approval (if federally funded), determine permits and right-of-way requirements and advertise the project. For this, they next review Letters of Intent (LOI) from properly qualified bidders by working with the Technical Review Committee (TRC), to create the long-list of qualified bidders that is then provided to the selection committee to develop the short list. At this point the RFP is issued. Since the ASDB method provides more freedom in the technical solution, the method to evaluate the technical proposal is also emphasized in the guidelines. FDOT requires that the TRC conduct the evaluation, drawing directly on members in their specific expertise areas. The previously-mentioned formula is used to determine the winning bid in the ASDB project. Once the DB firm is selected, the ASBD and LBDB processes proceed through execution, similarly.

3.5.3.2 Low Bid Design Build (LBDB)

The low bid approach is used on projects where the design and construction criteria are concise, clearly defined, and innovation or alternatives are not sought. This might include bridge projects with a specified foundation type, span lengths and beam type. Resurfacing projects are restricted to LBDB as well.

All of the steps that preceded the bid opening in the ASDB process entailing project creation and RFP generation are still necessary in the LBDB process, but the screening steps involving the letters of intent and long list reduction to a short list are bypassed. RFPs are issued and bids are received for technical proposals and cost as before. The LBDB selection process next involves opening the price bids and having the TRC evaluate the lowest bid for technical responsiveness only. A bid proposal is considered non-responsive if it does not contain all the required information and level of detail, or is non-compliant with the design and construction criteria defined in the RFP. If none are responsive then all bids may be rejected. The option of including the value of time factor in determining a low bid score is sometimes called for in the RFP on LBDB projects where project timing is a key parameter along with cost. An adjusted score is then computed,

similar to the ASDB process, but a technical score is not computed since only technical responsiveness is a criterion in the LBDB process.

3.5.3.3 Common Design Build Considerations

Although each RFP and contract is subject to project-specific requirements, it is generally FDOT policy to relegate the Quality Control Engineering (QC) function to a designated, registered engineer in the design build firm. FDOT allows the DB firm the option of providing their own CEI, but further requires that the DB firm use the latest QC2000 Specifications in their price and technical proposals. Regardless of whether the DB firm includes CEI services, FDOT provides verification testing and inspection services in accordance with the latest QC2000 specifications. FDOT takes full responsibility for Quality Assurance Engineering (QA) and further makes it clear that all QC and QA personnel are subject to the Department's Independent Assurance (IA) procedures.

Consistent with the purpose of FDOT using DB to foster innovation in cost and time savings on projects, they feel it is appropriate to reward bidders who have made the short list, but did not get awarded the contract by providing a stipend to them for their efforts. To accomplish this, the PM encumbers funds from FDOT's Financial Management Office. The stipend is not intended to fully cover the proposal costs, but to reduce the investment loss to those who fail to be awarded the contract. FDOT uses a payout schedule that ranges from 0.1-0.5% of the project cost estimate, dependent on project size and complexity.

Since the RFP must clearly define all functions and responsibilities required of the DB firm, a great deal of emphasis is placed on the elements required by the RFP in the guidelines. These include technical proposals, price due dates, the selection schedule, and design and construction requirements that all clearly define the project specifications ensuring that the project needs and goals are met. Further guidelines for technical proposals include: proposal evaluation criteria, price proposal requirements, insurance requirements, subcontract services, minority business enterprise (MBE) and disadvantaged business enterprise (DBE) requirements, as well as bonding requirements.

Throughout the guidelines FDOT emphasizes the interaction with FHWA in their DB projects during all phases, from inception to closure. Since the Federal Special Experimental Projects (SEP –14) authorizes federal funding for DB projects FDOT has worked with the Florida FHWA division extensively. FDOT has agreed that FHWA shall perform the following review and approval functions on federal–aid DB oversight projects, if applicable: Typical Section Package, Pavement Design Package, Phase Roadway and Bridge Plan Submittals, Specifications, Revisions, Bridge Hydraulic Report (BHR), Utility Agreements, Railroad Agreements, Concurrence in Award, Value Engineering Change Proposals, Time Extensions, Supplemental Agreements, Contract Claims and Final Acceptance. It is further noted that DB projects differ from regular construction projects. Federal fund dispersal for DB projects requires ROW clear

certifications, written approval of the RFP and signed electronic forms authorizing Federal funds for specific projects.

Right-of-way is specifically addressed for DB in the guidelines. DB contracts may be advertised and awarded prior to right-of-way activities being completed. "However, construction activities may not begin on any portion of such projects until such time as title to all necessary right of way and easements necessary for the construction of that portion of the project has been vested in the state or local government entity… and a right of way certification for construction for that portion of the project has been issued." In DB projects, ROW services may be included as a part of the contract. In addition, ROW may be certified for construction on any portion of a project that is deemed a buildable section by the contractor; however, this certification must clearly indicate that it is a partial project certification and include the associated limits. If ROW services are included in the DB contract, FDOT must issue a Notice to Commence ROW Acquisition and then further issue a Notice to Commence Construction Activities before actual construction begins. This section of the guideline concludes with the disclaimer, that due to the complexity of ROW acquisition and the necessity of FDOT involvement, "it is recommended that DB contracts include a proper *no damages* delay provision" so that DB firms are not penalized for circumstances beyond their control.

The latter recommendation is characteristic of the attitude and guidance provided throughout the FDOT DB Guidelines document. FDOT is highly supportive of the concept and has a great deal of practical experience in many different venues of D/ B project definition, execution and closure. This is reflected in the section on soils and foundations, where the responsibilities of DB contractors and FDOT are broken down. Making it clear that geotechnical and soils survey data would be analyzed by FDOT in DBB projects that are now only presented, so that the DB firm can make the appropriate determinations with FDOT serving only in an oversight role.

The last area covered in the guideline is the Material Acceptance Program (MAP) as it applies to DB. FDOT provides a website for Quality Control Reporting (QCR) at http://www11.myflorida.com/statematerialsoffice/Administration/programs/qc2000.htm).

3.5.4 ODOT' Experience With Design-Build

The experiences of ODOT with DB contracting prior to 2002 are summarized in four documents. An interim report provided background information on DB contracting and documented the process by which ODOT developed procedures for two DB pilot projects (*Simas and Rogge 1998*). At the completion of the two DB pilot projects, they were evaluated with respect to the exemptions required for their delivery. The evaluations also

recorded lessons learned for use on future DB projects. These evaluations are summarized in three volumes:

> *Evaluation of ODOT Design-Build Pilot Projects Evaluation, Volume 1, Executive Summary* by Rogge (*2001*) summarizes the more detailed documents for the two pilot projects.
>
> *Evaluation of ODOT Design-Build Pilot Projects Evaluation Volume II, Evaluation -- Evans Creek - Rock Point Design-Build Pilot Project* by Rogge, Pinto and Gobble (*2001*), provides an evaluation and serves as the FHWA SEP-14 report for the Evans Creek-Rock Point Surface Preservation Project. The SEP-14 report is required as part of the exemption from ORS 279.103 is included as an appendix to the report.
>
> *Evaluation of ODOT Design-Build Pilot Projects Evaluation Volume III, Evaluation -- Harrisburg Bridge Design-Build Pilot Project* by Rogge and Pinto (*2001*) provides an evaluation of the Harrisburg Bridge deck replacement project and includes the exemption evaluation report as an appendix.

The primary consideration in selecting the two DB pilot projects was controlling risk while developing DB capability. That mission was accomplished successfully.

The Harrisburg Bridge project required bridge deck replacement of the only highway bridge that crossed the Willamette River between Corvallis and Eugene. It was a $2.4 million project. The bridge had to be replaced while maintaining daily traffic. The DB contractor proposed a detour bridge rather than the original ODOT concept of nightly replacement of the bridge deck with precast panels. Construction with the detour bridge resulted in significant road user savings. The finished bridge was opened to traffic four months ahead of schedule. According to Rogge (*Volume I 2001*), "ODOT probably paid a small premium…" (about 10%) "…for a higher quality bridge deck, and the dramatic savings in user costs provided by construction of a detour bridge. Superior value was achieved."

The Evans Creek-Rock Point project was an $8.7 million surface preservation and guardrail project. It would probably best be described as a "detail-build" project because ODOT had already completed a high percentage of the design before the decision to deliver the project using DB was made. The paving was completed two months ahead of ODOT's target, and the entire project was completed one year sooner than the contract requirement. Results of cost analyses show a 5% to 10% savings premium for project costs through DB delivery. A 3% savings from DB delivery is the best estimate based on the detailed evaluation of change orders in that analysis.

As of July 2003, ODOT was in the process of delivering additional DB projects. Approximately one-third of the OTIA project volume will be delivered using DB.

3.6 PERFORMANCE MEASURES FOR PROJECT DELIVERY

One of the objectives of the current research project, SPR 351, is to compare project delivery performance for projects delivered with traditional insourced DBB, outsourced DBB, and DB. One of the early steps in this process is determining what performance measures to use.

The quality movement of the 1980's and 1990's popularized the concept that, "what gets measured gets done." As organizations, private and public, introduced quality management concepts, establishing metrics upon which to benchmark performance became a common practice. The following section summarizes information on performance measures obtained from an NCHRP synthesis, a Construction Industry Institute (CII) benchmarking and metrics report, and from an investigation of existing ODOT performance measures.

3.6.1 Performance Measurement in State DOTs

Source: Poister, T. H. 1997. *Performance measurement in state department of transportation.* NCHRP Synthesis of Highway Practice 238. National Research Council. Washington D.C.

This NCHRP synthesis was compiled to identify the kind of performance measures used in state DOTs. Performance measurement is employed in every form of transportation and program area. The synthesis reports what is being measured and how.

Measuring the performance of programs and services has become a very important tool in the effective management strategies of DOTs. DOTs are dedicating significant efforts in tracking measures of their performance. Appropriate performance measurement is essential to monitoring and enhancing performance in the future.

Since the 1980's, DOTs have shown more interest in performance measurement as is reflected in the use of highway maintenance and pavement management systems, and in the use of performance measurement for allocating funds to transit agencies in some states.

Among the most significant factors causing renewed interest in performance measurement are the following (*Poister 1997*):

1. Need to support strategic planning and strategic management processes with information on the performance of DOTs.

2. Demands for increased accountability from the public, legislatures, and governor's offices.

3. Government-wide mandates in many states for agencies to develop strategic plans and supporting performance measures.

4. Threats of privatization and the need to be competitive.

5. Growing commitments to identify and meet customer needs.

The most commonly reported uses of performance measures by management are for: program planning and evaluation, strategic planning and management, and external reporting. A large number of states reported performance measures in the areas of highway construction, public transportation, and aviation. Traditional programs of highway maintenance and traffic safety show widespread use of performance measurement.

The characteristics of the new generation of performance measures are as follows:

- Outcome oriented
- Tied to strategic goals and objectives
- Focused on quality and customer service

In many cases, this new stream of performance measurement began as part of strategic planning processes or Total Quality Management programs in the state agencies. In other cases, the DOTs created performance measurement systems as part of government systems ordered by state legislatures. Several agencies keep an internal on-going development process of performance measures aimed to enhance their own decision-making and management capabilities.

3.6.1.1 Highway Construction Programs and Management

Regarding highway construction programs, many states reported using performance measures to follow the performance of their programs and as process indicators for the adequacy of their overall highway systems. A good example is the Arizona DOT (ADOT). ADOT keeps track of the following factors:

- Bid prices versus engineering estimates (To assess the estimates' level of accuracy.)
- Number of change orders (To determine the accuracy and overall performance of the design and engineering process.)
- Actual construction costs versus bid prices and the percent of projects completed on time (To measure the contractors' performance in building roads.)
- Quality of contractors' work by certification acceptance (Field review of each project.)

Several different DOTs measure the performance of their highway design and engineering units. Some measurement factors employed by DOT are as follows:

- Number and amount of project cost increases/decreases (FL)
- Actual versus planned project letting schedules (NC)
- Percent of engineering work requiring rework (OR)
- Ratio of engineering costs to total project costs (OR)

- Ratio of design engineering costs to state road construction dollars let (MN)
- Ratio of construction engineering costs to state road construction dollars let (MN)
- Percent of preliminary engineering redo, monthly (OR)
- Highway construction administrative costs by project (CT)
- Number of construction projects completed on time (FL, NC, OR)
- Number of delinquent projects (FL)
- Number of time extensions granted (FL)
- Number of additional days required to complete projects (FL)
- Number of accidents in construction zones (NC)
- Actual project costs versus award costs (NC)
- Percent change from awarded amounts (NY)
- Smoothness of completed paving (various)
- Dollar per mile of highway constructed, urban and rural together (AR)
- Dollar per lane mile constructed, urban and rural separately (GA)

DOTs also have set some parameters to measure the quality of highway construction projects. For instance, Oregon DOT tracks an index of construction quality on a quarterly basis. This index incorporates the following:

- Technical rating of workmanship by final inspection rating team
- Materials compliance rating
- Pavement smoothness within 6 months of project completion
- Survey of contractors evaluating construction process

Wisconsin DOT has established a group of outcome-oriented performance measures for the design and engineering activities, both at the corporate and functional levels, as indicated in Table 3.4.

Table 3.4: Corporate and functional measures WISDOT Division of Highways. (*Poister 1997*)

Corporate and Functional Measures WISDOT Division of Highways	
Corporate Measures	**Targets**
Unprogrammed Costs	14%
Production Index	3.4%
Engineering Delivery Cost	30%
Designs on Time	80%
Design on Budget	80%
Product Quality Index	80%
Functional Measures	**Targets**
Design	
On Time	80%
On Budget	80%
Delivery Cost	16%
Quality	80%
Construction	
On Time	80%
On Budget	80%
Delivery Cost	16%
Quality	80%

The agency sets goals in advance and annually measures performance against the goals set. Each of these indicators measures specific relationships between different features of the project delivery process.

Unprogrammed costs refer to the calculation of the dollar value and percentage of unexpected costs caused by unforeseen expenses in the field due to change orders, errors in materials estimates, and/or similar mistakes.

The production index is the ratio of outputs to inputs and it is used as a measure of productivity. It is computed as the ratio of all contract lettings, public utilities costs, real estate acquisition, construction costs, construction change orders, and cost overruns; divided by staff costs, consultant contracts, and design construction change orders.(*Poister 1997*)

The engineering delivery cost, measures design and construction engineering costs of both in-house and external consultants as a percentage of the total cost of highway projects for the year. The design engineering cost, also measures the efficiency of the design process from the beginning to the project letting, as a percentage of the awarded cost. The construction engineering cost is a ratio that evaluates the efficiency of construction contract administration between letting and contract completion as a percentage of total construction.

The designs-on-time measure represents the percentage of plans ready to let in the fiscal year in which they are scheduled. This indicates the capacity to deliver

projects for bid letting after they have been committed to the public. The design-on-budget measure represents the agency's ability to estimate project award costs precisely and to deliver designs that are let at those estimates.

The product quality index consists of a mix of two functional level measures, the design quality index and the construction quality index. These indicators are based on an internal customer perspective. The design quality index measures the quality of the project's plans from the contractor's and the project manager's standpoint. This index is rated based on the percent of projects that require few or no major changes due to plans errors. The construction quality index measures the quality of completed projects from the maintenance manager's point of view. This rating is granted by the maintenance managers after inspecting the projects some months after having been put into service.

3.6.2 CII Benchmarking and Metrics

The Construction Industry Institute (CII) is a research organization whose membership includes Fortune 500 companies, large government agencies, and the design and construction firms that deliver capital projects for them. Since the late 1990's, CII has conducted a benchmarking service for member companies. The 1997 summary prepared by the CII Benchmarking and Metrics Committee includes a description of project delivery metrics used. Table 3.5 is an adaptation, for the transportation infrastructure industry, of a similar CII table (*Thomas 1998*).

Table 3.5: Metrics framework

Category	Overall Project	Pre-Project Planning	Design	Bid & Award	Construction
Safety, Health & Environment					OSHA Safety • RIR • LWCIR
Schedule	• Schedule Factor • Schedule Growth • Actual Project Duration	• PPP Duration Factor	• Design Duration Factor	• Bid & Award Duration Factor	• Construction Duration Factor • Construction Phase Duration
Cost	• Budget Factor • Cost Growth	• PPP Cost Factor	• Design Cost Factor • Cost Growth	• B&A Cost Factor • Cost Growth	• Construction Cost Factor • Cost Factor
Changes	• Change Cost Factor				
Quality					

3.6.3 ODOT Performance Measures

Oregon state government has been recognized as a leader in setting performance targets and measuring performance against those targets. The Oregon Benchmarks (OBM) provides the highest level of performance measurement for the State of Oregon.

ODOT has established 22 key performance measures that are linked to specific Oregon Benchmarks, including the following: Rural Jobs (OBM#1), Net Job Growth (OBM#4), Independent Seniors (OBM#58), Disabled Employment (OBM#59), Premature Death (OBM#45), Travel Delay (OBM#68), Alternatives to One Person Commuting (OBM#70), Vehicle Miles Traveled (OBM#71), Road Condition (OBM#72), Air Quality (OBM#75), and Salmon Recovery (#85). These key performance measures are used to determine how well ODOT meets four major goals in support of its mission. ODOT's mission is to provide a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians. ODOT's four major goals are: improving traveler safety in Oregon, moving people and goods efficiently, providing a transportation system that supports livability and economic prosperity in Oregon, and providing excellent customer service (*Conrad 2002*).

Much of what ODOT does to meet its goals and support its mission is accomplished through the delivery of capital projects; the design and construction of roadways, bridges, and related facilities. For example, improving efficiency of project delivery will, for a

given funding level, result in an improvement in Pavement Condition (Performance Measure 730-15) and Bridge Condition (Performance Measure 730-16).

Three overall performance indicators have been identified for the project delivery business line (*ODOT 2003*), with measures broken out by the five ODOT regions. These are: STIP Delivery, Percent PE, and Percent CE. STIP Delivery reports the percent of projects that are let within 90 days of the scheduled bid date. Percent PE reports the actual PE expenditures, divided by the total project cost (sum of PE and construction) at the time of contract awarding. Percent CE reports the dollars of CE, divided by the construction authorization amount, less CE expenditures. Figures 3.4, 3.5 and 3.6 show values for the STIP Delivery, PE, and CE measures over time (*ODOT 2001*).

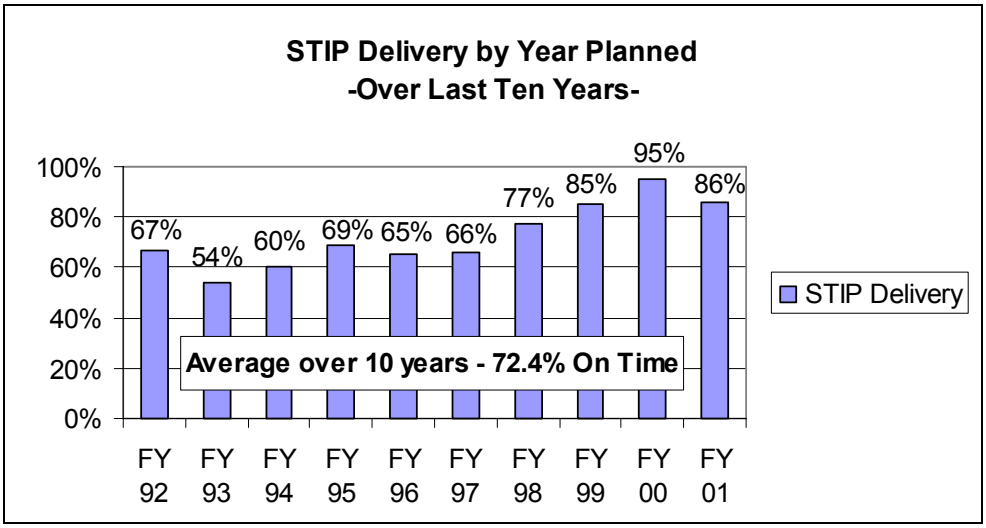

Figure 3.4: STIP delivery by year planned.

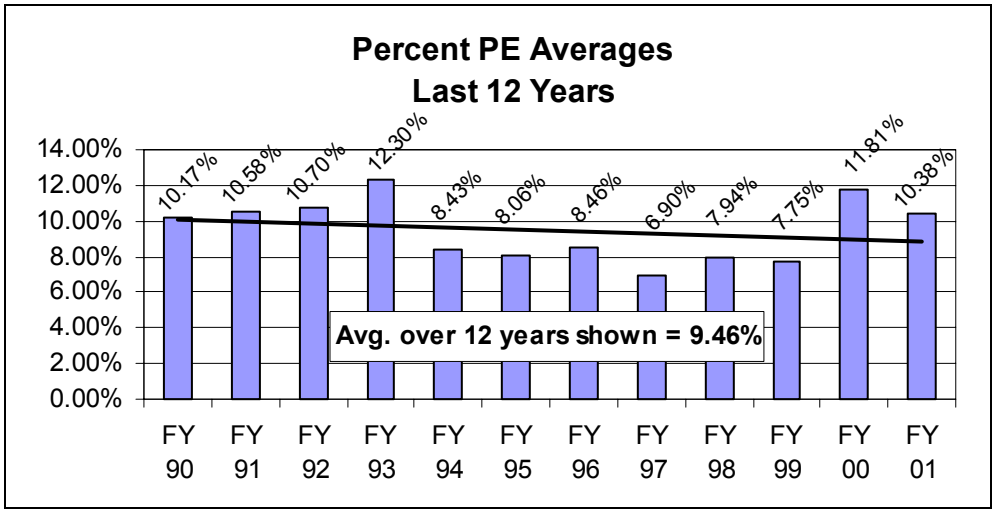

Figure 3.5: Percent PE, FY 90 – FY 01

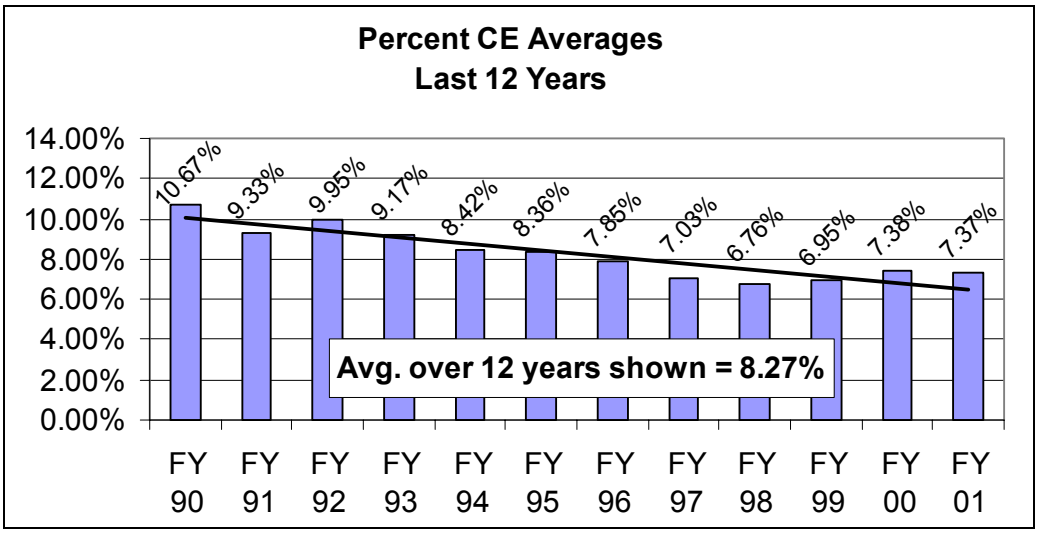

Figure 3.6: Percent CE, FY 90 – FY 01

In addition, status reports, referred to as green, yellow, and red reports, are generated monthly for each OTIA project to measure the success of scope definition, schedule performance, and budget performance. The *Oregon Highway Construction Plan Quarterly Status Reports* shows originally estimated and actual bid opening dates, originally estimated and currently predicted construction completion dates, budget shown in the Highway Construction Plan, current cost estimates, and the amount spent-to-date for each project (*ODOT 2002*).

The construction phase is a vital part of the delivery of any capital project. ODOT's Construction Section plans to track 21 performance measures to aid in performance improvement. The 13 measures for which information is currently available are defined and graphically portrayed in Figures 3.7 – 3.19 (*Stoneman 2003*). Important safety, quality, environmental, and contract administration measures are tracked. Contract Administration issues include: magnitude of claims, speed of claim processing, speed of progress payments, Percent CE (CE/total project costs), project management office costs, actual contract expenditures versus original contract authorizations, and speed of close-out. As of May, 2003, measures for customer satisfaction and contractor relations were still being developed. Securing of the data for safety, claims submitted, value of claims submitted and paid, time for claim resolution, project manager indirect expenses, and project manager office overtime hours was still a work-in-progress. In addition, a separate database records detailed causes for contract changes documented as contract change orders (CCO), extra work orders (EWO), force orders (FO), and revision letters (RL) for each project (*Stoneman 2003*).

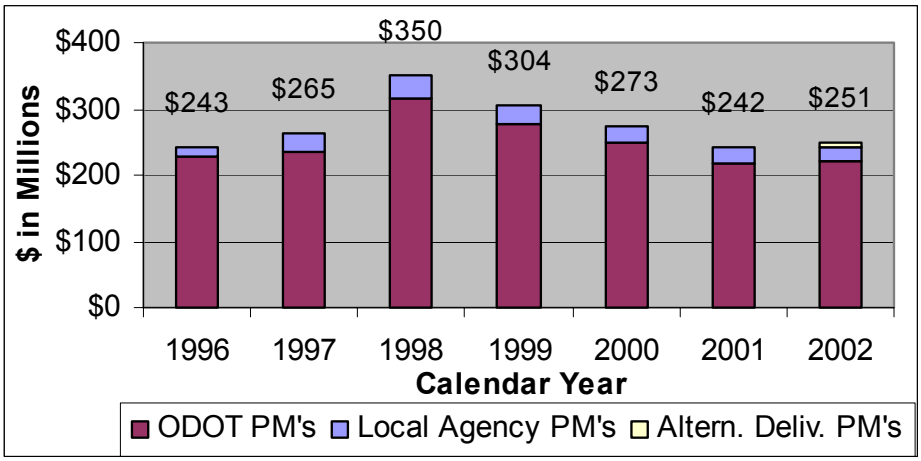

Figure 3.7: How much has ODOT paid contractors to build construction projects per calendar year?

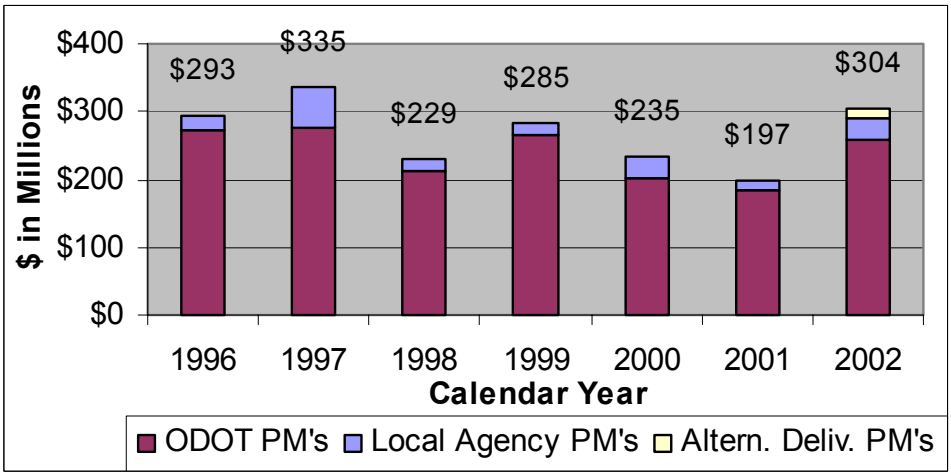

Figure 3.8: How much has ODOT awarded to contractors to build construction projects per calendar year?

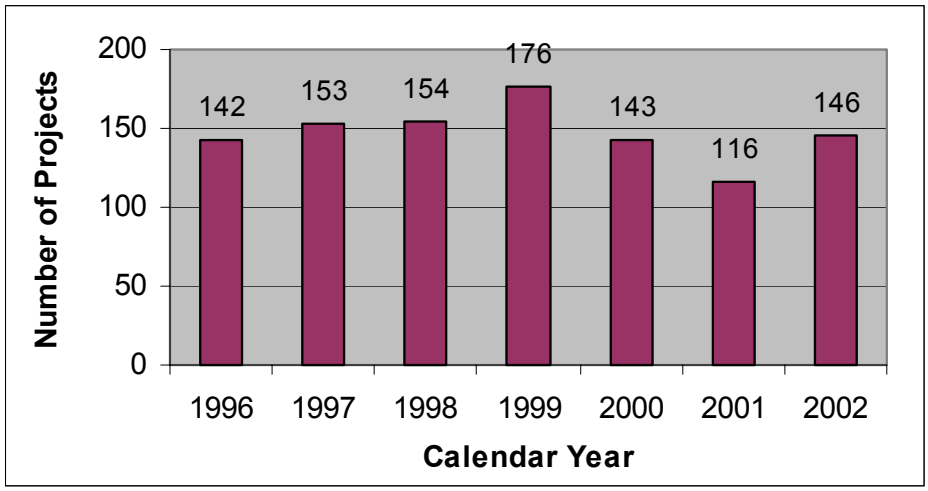

Figure 3.9: How many construction projects were completed during each calendar year?

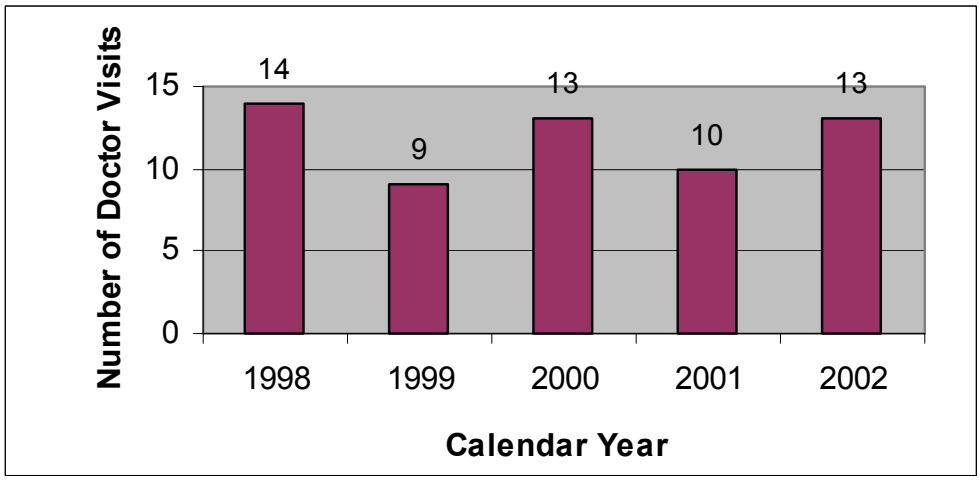

Figure 3.10: How many accidents involving ODOT project manager crews resulted in a doctor visit by ODOT personnel?

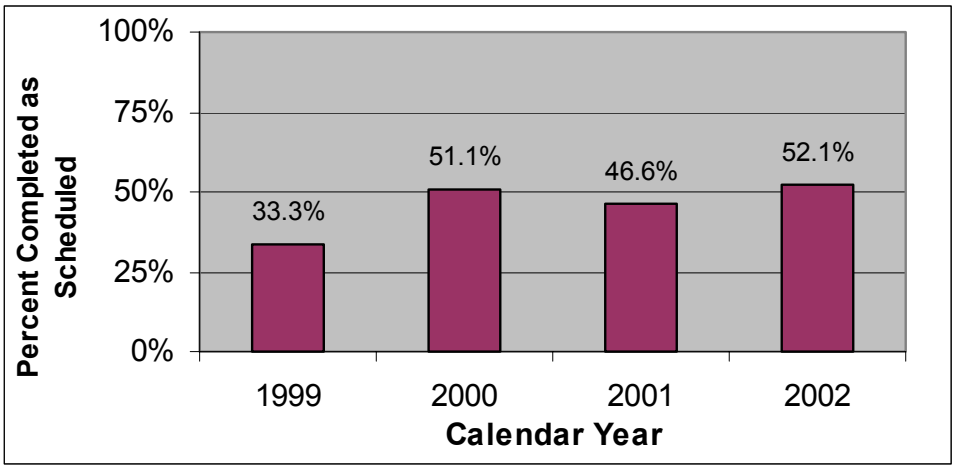

Figure 3.11: What percent of projects completed during the calendar year were completed on or before the original completion date?

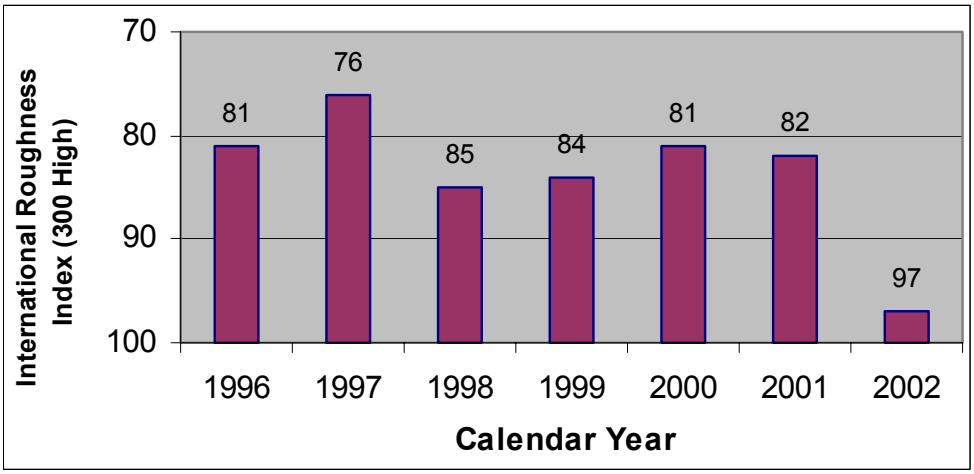

Figure 3.12: For construction projects involving pavements that were completed during the calendar year, what was the final average pavement smoothness index?

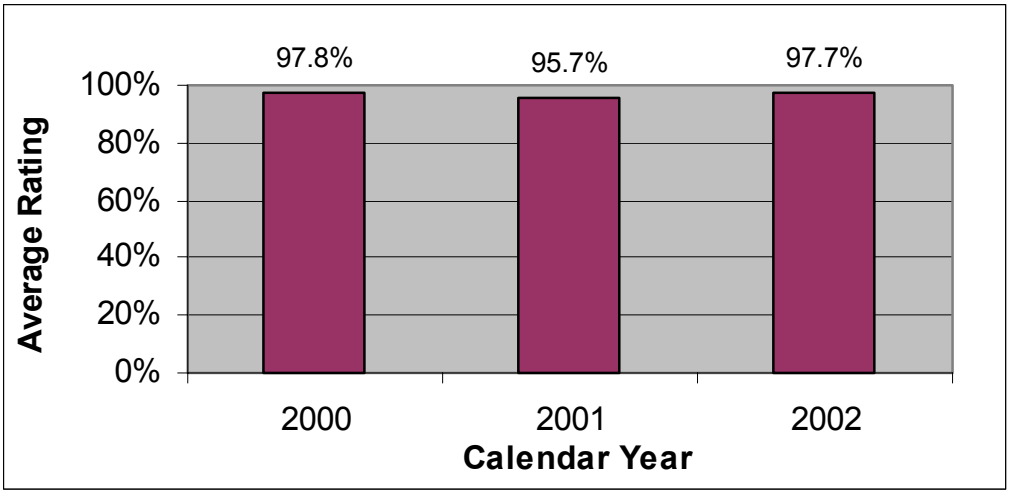

Figure 3.13: For evaluations received during the calendar year, what was the average rating given to contractors by project managers?

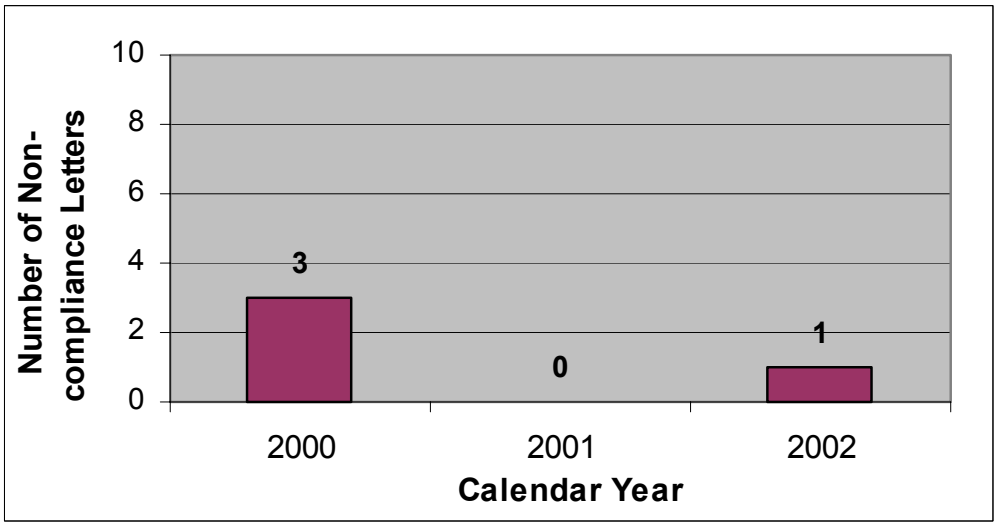

Figure 3.14: How many letters of non-compliance did ODOT receive from regulatory agencies on ODOT construction contracts?

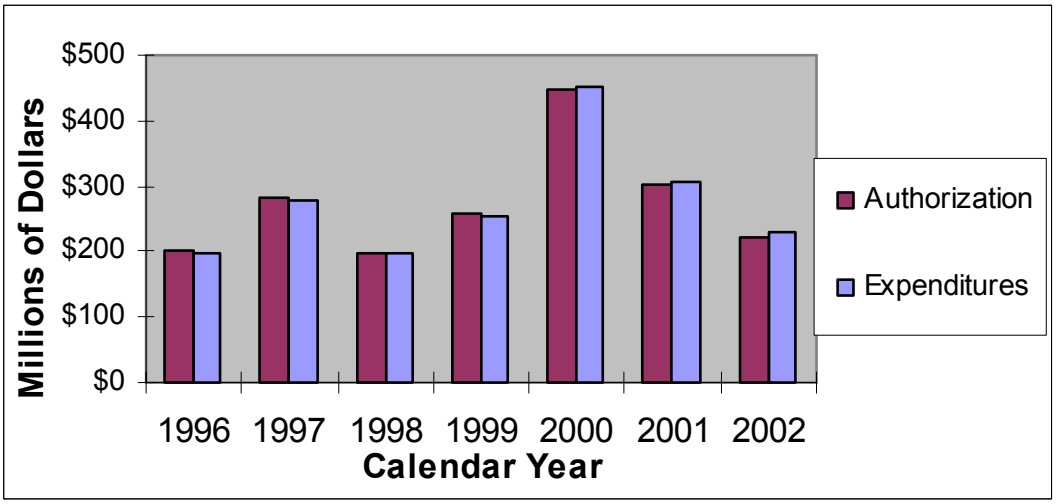

Figure 3.15: For projects 3rd noted during the calendar year, what was the difference between total contract expenditures and total original contract authorizations?

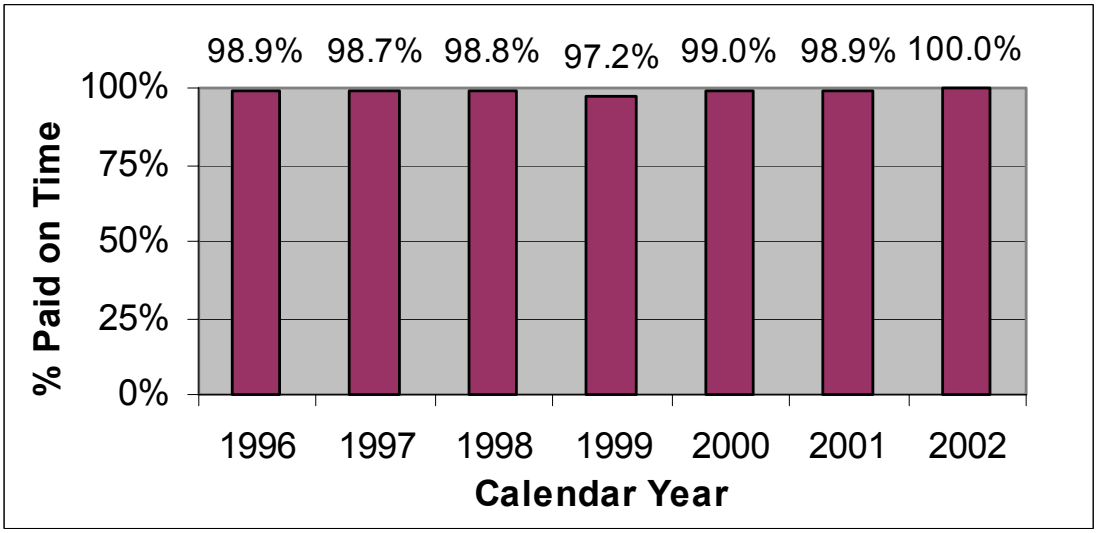

Figure 3.16: For active projects (up to 2nd note) during the calendar year, what percent of all regularly scheduled progress estimates were paid to contractors on time?

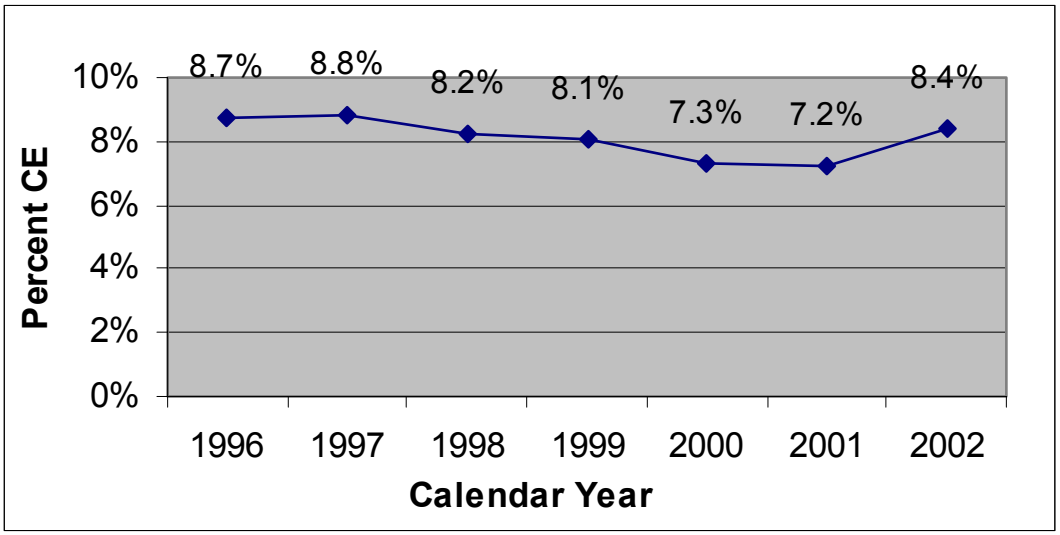

Figure 3.17: For projects 3rd noted during the calendar year, what percent of total project costs were construction engineering expenses?

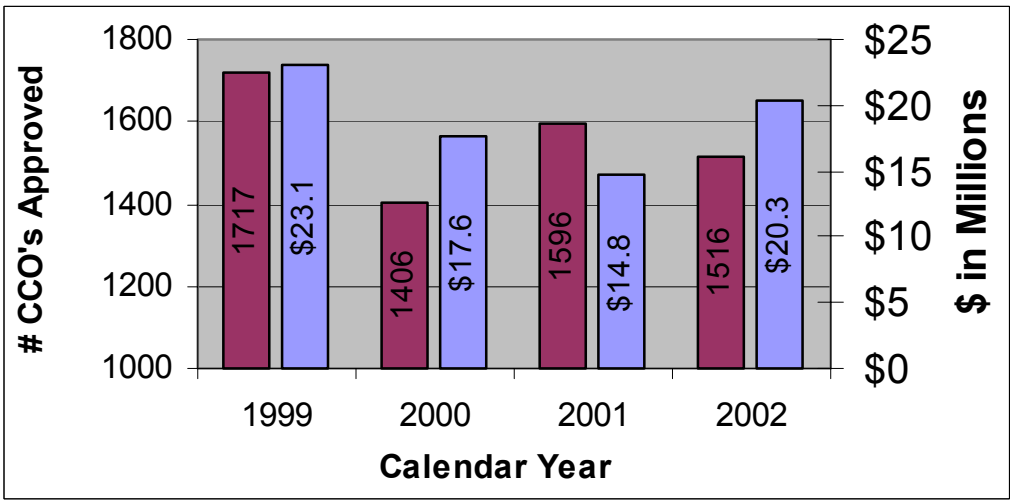

Figure 3.18: During the calendar year, how many contract change orders were approved and for how much?

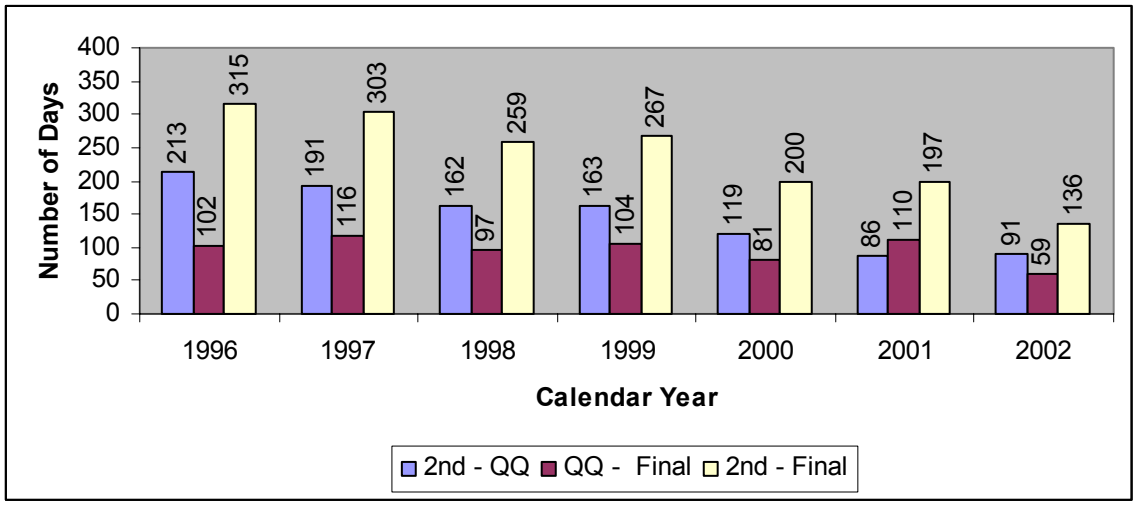

Figure 3.19: For projects with a 2nd Note during the calendar year, what was the average number of days between 2nd note and Q&Q acceptance? Q&Q acceptance and Final Payment? 2nd Note and final payment?

4.0 DEPARTMENT OF TRANSPORTATION SURVEYS

4.1 STAGE 1 SURVEY

Although many recent comprehensive studies of outsourcing by transportation agencies were reviewed in the literature review, the research also attempted to obtain more current information from transportation agencies related specifically to outsourcing of project delivery functions. A two-stage approach was chosen. In January of 2003, a very brief e-mail questionnaire (Appendix A) was distributed to all 50 state DOTs. The intent of this, first-stage, questionnaire was to identify the states with the most significant and relevant information, and then identify specific contacts for follow-up investigations.

Figures 4.1 – 4.11 graphically portray the survey questions and the responses of the state DOTs to the stage one survey. Twenty-one states responded to the survey. Of these, sixteen responded that they had practiced or investigated outsourcing of traditional agency functions related to project delivery "very much", with the other five states responding "some" (Figure 4.1). The similar question dealing specifically with "project design" produced an identical response (Figure 4.4). Project design was the area that responding states had the most information and/or experience pertaining to outsourcing. Obtaining permits (Figure 4.5), construction contract administration (Figure 4.7), and program management (Figure 4.9) were the areas where state DOTs had the least information and/or experience.

Only three of the responding states indicated that they had an organizational unit specifically responsible for the investigation of, or practices for, the effective use of outsourcing agency functions (Figure 4.10). Those states were Hawaii, New Hampshire, and Oklahoma.

Outsourcing Project Delivery

How much has your agency investigated or practiced outsourcing of traditional agency functions related to project delivery?

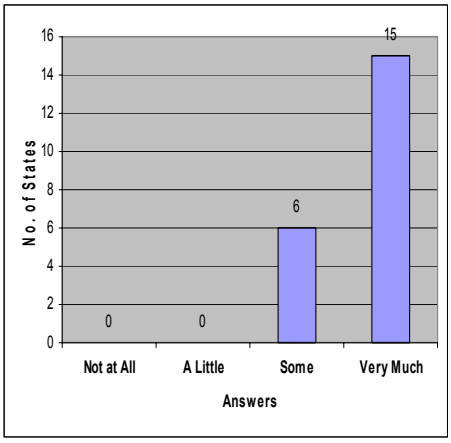

Figure 4.1: Outsourcing project delivery

Outsourcing Environmental Studies

How much has your agency investigated or practiced outsourcing of environmental studies?

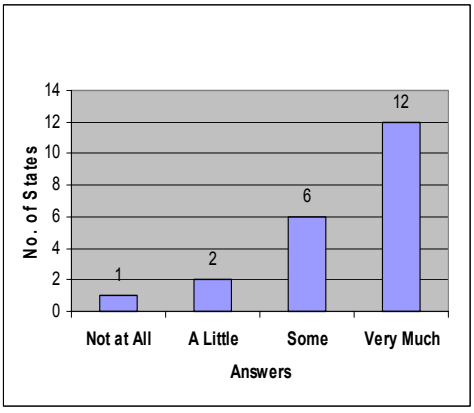

Figure 4.2: Outsourcing environmental studies

Outsourcing Right-of-way

How much has your agency investigated or practiced outsourcing of right-of-way acquisition?

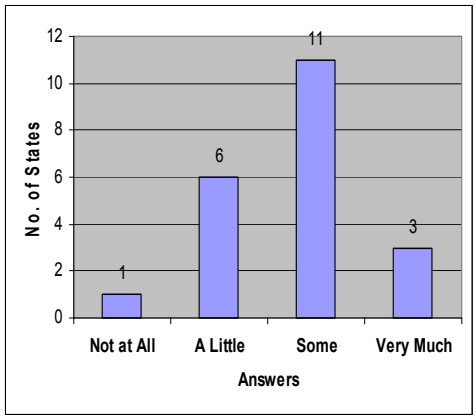

Figure 4.3: Outsourcing right-of-way

Outsourcing Design

How much has your agency investigated or practiced outsourcing of project design?

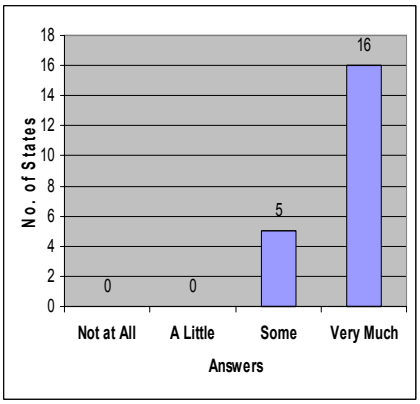

Figure 4.4: Outsourcing design

Outsourcing Permits

How much has your agency investigated or practiced outsourcing of obtaining required permits?

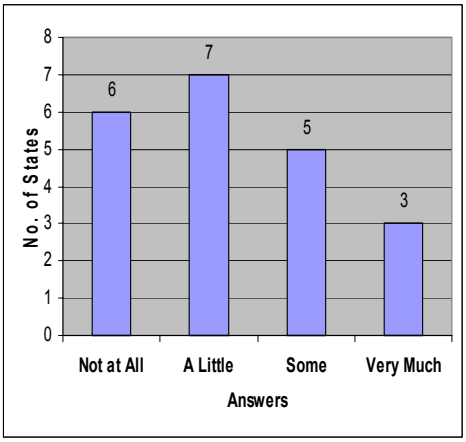

Figure 4.5: Outsourcing obtaining permits

Outsourcing Surveying

How much has your agency investigated or practiced outsourcing of surveying?

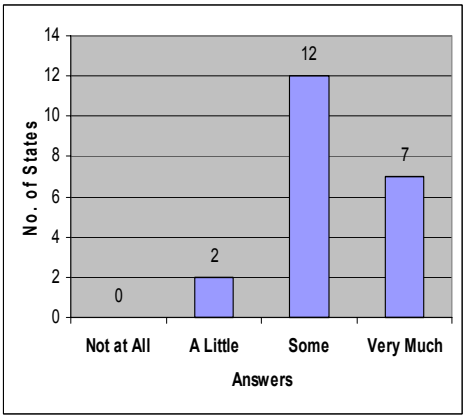

Figure 4.6: Outsourcing surveying

Outsourcing CE

- How much has your agency investigated or practiced outsourcing of construction engineering (or construction contract administration)?

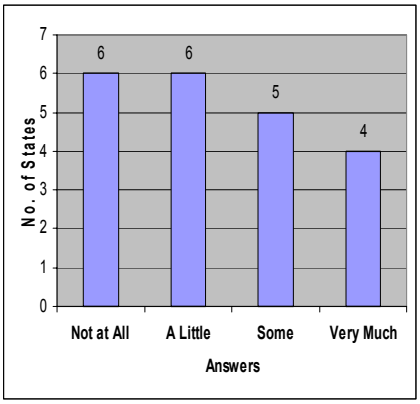

Figure 4.7: Outsourcing CE

Outsourcing Inspection

- How much has your agency investigated or practiced outsourcing of construction inspection?

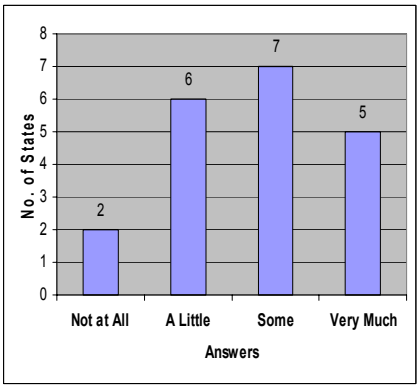

Figure 4.8: Outsourcing inspection

Outsourcing Program Mgmt

- Program management is defined as oversight of project delivery of agency projects. Has your agency outsourced program management to deliver part or all of your capital improvement program?

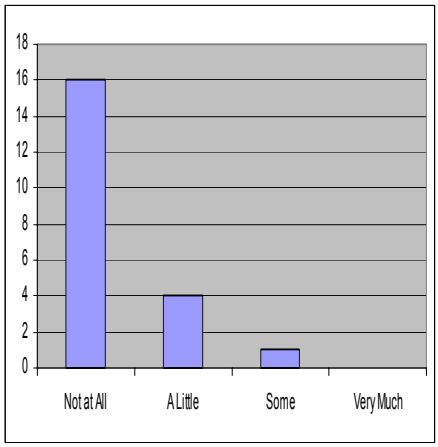

Figure 4.9: Outsourcing program management

Outsourcing Unit?

- Do you have an organizational unit specifically responsible for investigation of, or practices for, effective use of outsourcing agency functions?

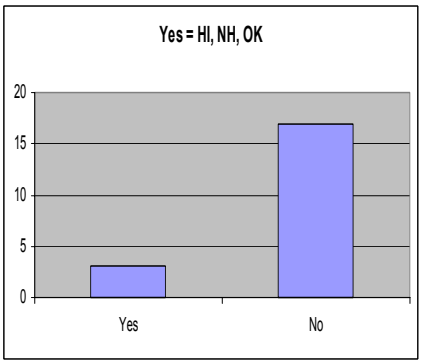

Figure 4.10: Special organizational unit for outsourcing

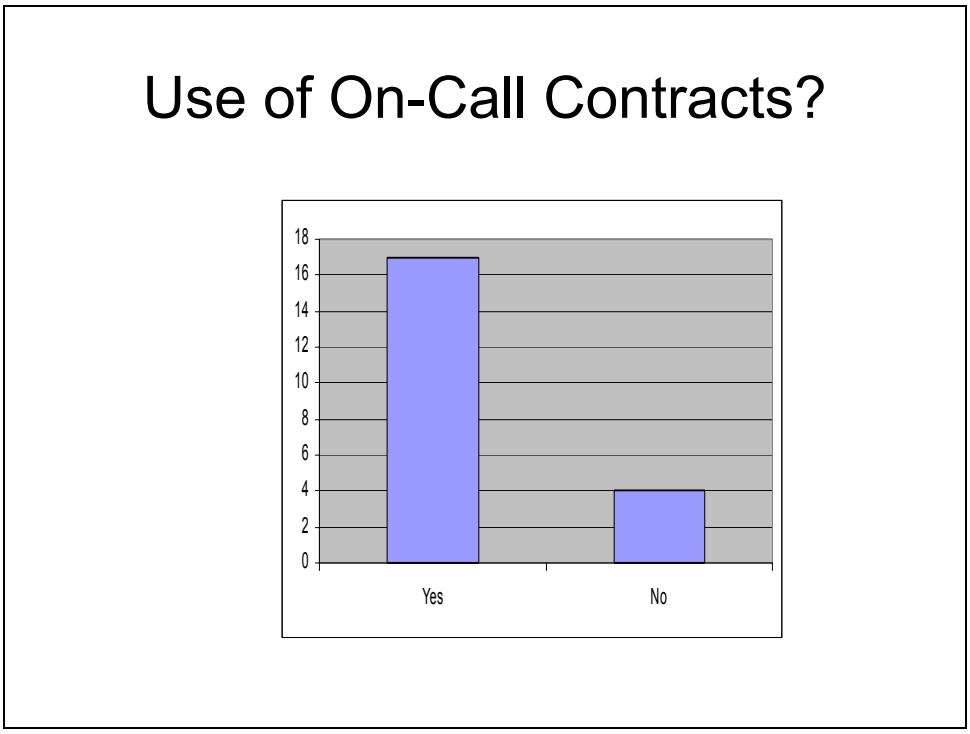

Figure 4.11: Use of on-call contracts

4.2 STAGE 2 SURVEY

Based on the response to the Stage 1 survey and information obtained from the literature review, particularly the FHWA FLH study on outsourcing (*Calderon 2000*), 22 states were targeted for further information gathering. From the Stage 1 survey responses, the following states were selected: Alaska, Colorado, Georgia, Hawaii, Idaho, Louisiana, Maryland, Nevada, New York, North Carolina, Oklahoma, South Carolina, and Texas. In addition, Arizona, Connecticut, Florida, Illinois, Indiana, Kansas, Kentucky, New Mexico, and Tennessee were targeted from the FHWA FLH study.

The Stage 2 questionnaire was developed to target outsourcing practices of the DOTs, rather than collect quantitative data regarding their outsourcing experience. This decision was made to reduce the time needed to respond, and because one very recent study (*Warne 2003*) was available that had gathered quantitative data. The Stage 2 questionnaire was developed for completion and submission by e-mail, fax, internet, or mail, at the respondent's preference. In practice, the majority of the information was obtained through telephone interviews, scheduled and conducted by the principal investigator. The survey and interviews were conducted between April and June, 2003.

Appendix B provides the Stage 2 survey questions and a compilation of responses by state. The survey includes questions for: outsourced design-bid-build, including outsourced PE and/or CE; design-build delivery; performance measurement; and general

questions about outsourcing project delivery. From the 22 states receiving the stage 2 survey, responses were obtained from only fourteen states. The information obtained from the states reinforced the information from the literature review.

Eight states, contacted in the Stage 2 survey, were also interviewed in the 2000 FHWA FLH study (*Calderon 2000*). When possible, the information from the study and the survey were verified. No significant changes from the study were found.

The first four questions of the Stage 2 survey (see Appendix B) were designed to determine how state DOTs are using consultants to facilitate project delivery. Options explored ranged from using consultants for PE or CE, to a full program management approach. Question 34 asks a similar question for the DB approach to project delivery. Table 3.6 summarizes the information obtained on outsourcing project delivery functions to consultants.

Table 3.6: Outsourcing of project delivery functions

Responding States	PE	CE	Program Management	DB
AZ	High	Mid		Yes
CT	High	High	Yes	No
FL		High	No	Yes
GA	Mid	Low		
ID	High	High	No	No
IN	High	Low	No	Yes
KS	High	High	No	No
LA	High	Low	Yes	No
MD	High	Low	No	Yes
NV			Yes	No
NM	Mid	Low		Yes
NY	Mid	Mid	No	No
OK	Mid	Low	Yes	No
SC	Mid	Low	Yes	Yes

4.2.1 Outsourced Design-Bid-Build

The most commonly reported use of consultants to facilitate project delivery was the outsourcing of PE. This is the practice with which the states have the greatest length of experience and, consequently, the greatest comfort level. Responsibility for PE is generally more centralized, within the DOT, than for CE which is generally decentralized. The responding states definitely have less experience and working knowledge with outsourcing CE than with outsourcing PE.

Five of the responding states reported the use of program management. These were: South Carolina, Louisiana, Oklahoma, Connecticut, and Nevada. The seven-year program of South Carolina and the rapidly completing five year program of Oklahoma appear to be the most ambitious and successful examples.

Connecticut, Indiana, Idaho, Kansas, and New York have more than 30 years of experience outsourcing PE to consultants. Connecticut, Oklahoma, and South Carolina have more than five years of experience with program management. Maryland has worked with general engineering consultants for more than five years.

Estimates of the percent of capital programs delivered using outsourcing, for at least PE, are summarized in Table 3.7.

Table 3.7: Percent of capital programs utilizing outsourcing to consultants

Percent Outsourced	States Responding
41%-50%	LA, NY
51%-60%	NM, OK
61%-70%	MD, SC
71%-80%	FL, ID, KS
81%-90%	CT, IN

When asked why the agency chose to outsource, the virtual universal response was, "That the size of the capital program exceeded the resources available with state DOT staffing." This was either a temporary condition, due to a sudden and temporary increase in program level, or a long-term condition resulting from a political climate, limiting the size of the permanent DOT staffing level.

4.2.1.1 Consultant Selection

All of states reported using some type of qualifications-based selection procedure for consultants performing, PE, CE, or program management. About half of the responding states issue requests for proposals for each contract. Some states have procedures to qualify consultants for a one-, two-, or three-year period. As projects emerge, consultants from the qualified pool are assigned to them. Some states use both approaches. Where program managers were selected, the selection process included extensive interviews and panel selection.

4.2.1.2 Consultant Payment

All responding states to consultant payment questions, (9 of 9) use contracts providing for payment based on hourly costs plus a fixed fee. These provisions generally include a "not to exceed" amount. Three states reported extensive use of provisions for payment for PE by phase or task. Connecticut reported using primarily lump sum payments for PE work. In the three cases where CE work was addressed, payment was cost plus fixed fee.

Connecticut, New Mexico, Idaho, and Kansas have provisions for retainage in consultant contracts. Indiana, Maryland, Oklahoma, and South Carolina do not. Connecticut retains 2.5% on lump sum contracts, and 10% of the profit for on-

time and material contracts. New Mexico retains 5%, by phase, of the lump sum for PE contracts. Kansas retains 5% until the scope of work is completed, when 4% is returned. The remaining 1% is released after successful completion of an audit.

4.2.1.3 Consultant Authority

Responses to questions regarding decision-making authority of consultants produced similar answers. In general, state DOTs view consultants as extensions of DOT staff; not as DOT managers and supervisors. Consultants are expected to make engineering decisions within the defined scope of work. When scope, budget, and schedule issues arise, DOT managers must become involved. This should also be true for environmental and community relations issues.

4.2.1.4 Insurance Requirements

A majority of the individuals responding to the survey were not intimately familiar with DOT insurance requirements of consultant contracts. It is not likely that the responses include all of the required insurance coverages. Nine respondents (all except Kansas) require errors and omissions insurance from their consultants. General liability and workers' compensation were other commonly reported insurance requirements. Oklahoma mentioned "valuable paper" insurance.

4.2.1.5 Training

No states responded that they provide training for agency personnel about dealing with consultants. Some touch on the subject in their project management training. Of the ten states responding to the training questions, four indicated that consultants are invited to participate in DOT training programs at their own expense. Four of the states offer construction inspection training for their consultants.

4.2.1.6 Evaluation of Consultant Performance

Ten states responded with information on performance evaluations of consultants. Minimal approaches included annual evaluations, or end of project evaluations. South Carolina uses a quarterly review, tied to small incentives. Indiana includes agency construction personnel and their contractors in the review process, along with design personnel. Idaho and the Consulting Engineers Association of Idaho have developed a program that evaluates a variety of measures, including constructability. Kansas uses a project evaluation team composed of KDOT and consultant personnel to conduct an office check, field check, and post-construction check for each project. Maryland's standard annual rating form for consultants scores them on timeliness, technical ability, public involvement, and errors. Florida conducts a quarterly evaluation of their contractors that may be used to terminate work, or to extend the scope of services.

4.2.1.7 Consultant/DOT Interface

Consultants report to agency personnel with a variety of titles. Consultants responsible for PE, report to project development engineers, project managers, department project managers, design development section managers, road squad leaders, and consultant managers. Consultants responsible for CE, report to district construction engineers and engineers-in-charge. Consultants retained as program managers report to a very high level in the agency organization.

In general, DOT employees do not work under the direction of consultants serving as program managers. Maryland did report successful experience with agency designers being coordinated by a general engineering consultant, as part of the work for a major corridor program.

Outsourcing of PE and CE does not affect the way that construction contract change orders are handled. Procedures for outsourcing PE and CE are the same as for projects with insourced PE and CE, with the consultant acting as a DOT employee. Changes in scope to the consultant's contract for PE or CE services are negotiated with the DOT. When a program manager has sub-consultants, changes to the scope of the sub-consultants' contracts are the responsibility of the program manager.

4.2.1.8 DOT Staffing for Consultant Oversight

Responses to Question 21, about the need for agencies to add additional personnel to provide oversight of consultants, indicate confusion about the question. Responses to this question were difficult to interpret. However, most commonly, DOTs could not add additional staff to handle the increased project workloads. Outsourcing provided a manageable solution. Therefore, if they thought that additional DOT staff would be needed to oversee the consultants, DOT staff would have to be reassigned and the work of reassigned people outsourced to consultants. In general, the states attempt to rely heavily on the skills and professionalism of the consultants to manage themselves as much as possible.

The two states responding that they had added new positions (Oklahoma and Idaho) indicated that the job descriptions were not new and that the individuals were blended into existing administrative units. They were just adding more individuals to that category.

Question 27 asked if states could quantify the need for additional agency personnel, with respect to added project workload. Idaho indicated that they used a-rule-of-thumb, establishing that a project manager could manage approximately $8 million of projects. This determined the required increase in project managers due to the added TEA-21 funding.

The FHWA FLH study is the best attempt found in this research that addresses issues of supervising consultant contracts (*Smith 2000*). The computer model,

developed as part of that study, does show additional agency staff to manage the consultants. The LADOTD study (*Wilmot et. al. 1999*) also attributes costs to preparing and administering the contracts for the consultants.

4.2.1.9 Lessons Learned/Best Practices

Connecticut believes that consultants really hit the mark on specialty projects. For example, for major bridges with caissons, they were able to bring in consultants who were very familiar with caisson construction. A vertical lift bridge provides another example. They employ consultants for bridge rehabilitation painting because of the environmental health complexities. Although they outsource the majority of their PE, they still maintain in-house expertise to provide checks and balances on consultants.

Several states stressed the importance of proper scoping of the project, prior to finalizing negotiations with the consultants. New York has found it helpful to get all assumptions out on the table during the initial meeting with consultants. Kansas has found it helpful to break the PE contract into four phases beginning with a "discovery" phase. The other phases are: design, delay (if applicable), and construction. Each phase is closed out before moving onto the next phase.

Several states stressed the importance of spending more time up front, defining the roles and responsibilities of consultants and agency personnel. If this is not well done there is a risk of important elements of work not being done, or work being done twice (once by the agency and once by the consultant). In Kansas, partnering was identified as an effective procedure to help define the roles and responsibilities and to make sure that there is agreement on the scope of work.

Idaho has found the ability to pre-qualify consultants using term agreements very helpful. This speeds the selection process when work is outsourced to consultants.

New Mexico warns that if outsourcing forces consultants to increase their staff significantly, then costs will rise. Spreading the work among qualified consultants may help minimize this effect.

Connecticut sees efficiencies in utilizing the same consultants for PE and CE; other states avoid this. Oklahoma is allowed to use the same consultant for both, but it would happen only if separate solicitations produced that result.

Kansas has seen benefits from grouping similar projects into a single consultant contract. This is due to the continuity between projects, and the reduced interviewing and contracting time for new consultants. Kansas has also found joint training of KDOT and consultant personnel to be beneficial.

The respondent from the Florida DOT indicated that Florida is "very satisfied" with outsourced project delivery. The other ten responding states indicated that they were "satisfied".

Miscellaneous comments include a belief that it is easier to terminate a consultant than an employee. DOTs may put demands on consultants that they would not put on their own employees. Another respondent stressed the importance of having a clear career path for young engineers to aid in the recruitment and retention of them. In New York, because of the lengthy consultant contract approval process, if a project needs to be done in a hurry, they have to do it in-house.

4.2.2 Outsourced Design-Build

Information relevant to the DB section of the questionnaire was obtained from twelve states. Although a response to the survey from the Colorado DOT was not received, the principal investigator had a telephone conversation with the FHWA's Colorado office (*Bennett 2003*) and received an on-site briefing and written materials from the DB contractor for the TREX project in Denver. Therefore, information about TREX is included in this section of the report.

Connecticut, South Carolina, Arizona, Indiana, Maryland, New Mexico, Colorado, and Florida use DB for project delivery. Idaho, Kansas, Nevada, and Oklahoma do not. Statutes prevent Oklahoma from using it. Arizona, Florida, Indiana, Maryland, South Carolina, and Utah have more than four years of experience with DB. Arizona, Indiana, Maryland, and New Mexico use it to deliver less than 10% of their capital projects budget. Maryland has a goal of about 5%, while Florida has the most aggressive use of DB. Indiana, South Carolina, and Utah have each delivered over $1.5 billion in projects with DB.

Speed of project delivery was the most commonly cited reason for the use of DB. Indiana, Maryland, and South Carolina clearly stated faster delivery as the primary driver in the decision to deliver projects using DB. Florida reported an accelerated use of DB for economic stimulus after the national economic downturn following the New York Trade Center destruction. This implies a belief that the stimulus would occur faster if DB delivery was used. Florida also reports a belief that efficiencies result from combining design, construction, and in some cases CEI into one contract. Maryland cites additional benefit of reduced cost growth (1% versus 5-10%) on a very small sample of projects.

South Carolina takes care of environmental approvals and permits prior to bidding, but right-of-way may or may not be finalized prior to bidding. If DB contractor is to have the responsibility for right-of-way acquisition, then the contract caps the contractor's risk. In this arrangement the contractor acts as an agent for the DOT for right-of-way. The DOT makes the ultimate decision if imminent domain is required.

4.2.2.1 DB Contractor Selection

Selection of the DB contractor is most commonly a two-step process. Based in response to an initial request for a statement of qualifications (SOQ); interested parties are reduced to a short-list based on the DOT's evaluation of their ability to execute a DB contract for the specific project. Three to six short-listed entities would be common. The short-listed firms are invited to submit project-specific proposals, including design concept and price. Selection is based on a combination of technical and price criteria. The example provided by Arizona uses evaluation of low bid based on, A+B, divided by technical score. "A" is the contract amount. The "B" dollar value is computed based on, scheduling with a daily cost based on road user costs. The technical score is computed by rating the proposal against specified criteria. Indiana uses a one-step process where only the price proposals of those with a minimum score (80) on technical criteria are opened.

South Carolina has used DB where the amount of the contract was specified and the bidders bid on scope to be provided. Each bidder determines what would be done for a fixed budget.

Stipends may or may not be paid. Maryland reports using a $25,000 stipend for firms short-listed, but not awarded. Colorado's TREX project paid a $1 million stipend to the short-listed, but not awarded bidders. South Carolina has only paid a stipend for one project.

4.2.2.2 DB Contractor Payment

Payment for DB contracts is usually a lump sum. This is the case for South Carolina, Indiana, Maryland, New Mexico, and Colorado. New Mexico requests unit prices for anticipated changes (if needed). Colorado on the TREX project, and South Carolina make progress payments based on cost-loaded schedules.

4.2.2.3 DB Contractor Authority

For DB to work, performance specifications must be used, and the DB contractor must be held accountable for meeting those specifications. The DOT must allow the DB contractor freedom to meet those requirements with any sound engineering solution. Decisions within the specified scope of work of the contract are made by the DB contractor. Changes in the scope must be approved by the DOT.

4.2.2.4 DB Contractor Insurance Requirements

Insurance coverage and knowledge of insurance varied amongst the respondents. Indiana presented a picture of coverage similar to any of their construction contracts; with the additional requirement that their designer have errors and omissions insurance. Arizona's experience is similar to Indiana's on most

projects. However, one yet-to-be-completed project used an owner controlled insurance program (OCIP) where ADOT provided most of the insurance, except for automobile insurance and insurance for off-site activities. A decision regarding usage on future projects has not yet been made in Arizona. New Mexico requires complete "wrap-up" insurance.

4.2.2.5 Training

Training for DB was not common. New Mexico sent project engineers for DB training provided by the Design Build Institute of America (DBIA). Florida has the same training requirements for QC personnel on DB projects as they do on other projects with contractor QC. Maryland does not have formal training, but semi-annually agency managers meet with their counterparts from contractors and the consulting engineers' council to discuss what works well, and what needs improvement.

4.2.2.6 Performance Evaluation

Little noteworthy information regarding performance evaluation of the DB team resulted from the survey. It does not appear to be an item that has been stressed. However, Florida responded that they separately evaluate the performance of designers and contractors on a monthly basis.

4.2.2.7 DB/DOT Interface

DB contractors report to agency personnel similar to what would happen with a DBB approach. For example, in Arizona their primary contact is a project manager for technical issues, and the resident construction engineer for construction activities.

Indiana's response of, "no difference from traditional" provides a good summary of the way that changes and claims are processed on DB projects. South Carolina notes that more negotiation is required because of the absence of unit price bids. Both Maryland and South Carolina noted that most changes have been owner-driven scope changes. Arizona notes that so far, with an effective partnering program, no claims have arisen.

4.2.2.8 Lessons Learned/Best Practices

Similar to outsourced DBB, the importance of quality scope definition is stressed. In the words of the Arizona DOT respondent, "It is important to define a good scope of work that clearly details the final product. Include specific criteria that must be adhered to and even more importantly, define what is not acceptable if the agency has a history of a failed system or one that has not performed to expectations."

The Arizona DOT respondent makes these additional recommendations, "If you have outside agencies and stakeholders, especially utility companies, railroads, Native American communities, cities, etc., get them involved during the development of the scope of work to ensure that they are aware of the project and know what to expect. One of the first meetings that needs to take place between the owner and the DB contractor is to discuss their interpretation of the scope of work and try to identify any difference in their approach to the project and the owner's expectation of the finished project. If this can be done before design progresses too far it will save a lot of stress and tension for the whole team."

Both Arizona and Colorado strongly endorse co-locating the entire DB contractor, designer, and general consultant (if applicable) team on site. In the words of the Arizona DOT respondent, "Co-locating the whole team, to include owner, DB contractor, designer, and general consultant is critical to timely and accurate coordination."

Challenges presented by environmental permits were noted by New Mexico and South Carolina. The challenges presented by subsurface utilities were noted by New Mexico and the Colorado TREX project. Maryland agrees on both counts. Probably the biggest schedule risk for TREX resulted from the design and construction of utilities that had to be done; but which were not in the scope of work of the DB contractor.

South Carolina says that right-of-way acquisition may be included in the DB contract if the contractor's risk is limited. They are advocates of the use of formal partnering and recommend requesting a warranty.

Colorado TREX, Florida, New Mexico, and Arizona have experience with oversight consultants to oversee DB contracts. There were no negatives noted regarding this practice.

4.2.2.9 Satisfaction with DB

Florida, South Carolina, and Indiana expressed satisfaction with DB. No dissatisfaction was expressed from the respondent states.

4.2.3 Project Delivery Performance Measures

Cost and schedule measures are the most commonly used performance measures. Florida also tracks performance and quality, but provided no details. South Carolina checks scope creep on a monthly basis. They track it project by project, and on an overall program basis. Maryland tracks change orders and claims.

Since project cost is not the driver behind increased use of outsourcing for project delivery, cost comparisons are not common. Maryland informally compares savings in construction, attributable to design. Maryland has also determined that their "detail-build" projects have less cost growth than similar traditional projects. Maryland would

like to expand “detail-build” to smaller safety and resurfacing projects of $1 million or less because percentage overruns have been high when delivered by traditional DBB. Maryland is interested in pavement warranties and would like to investigate best value procurement.

Indiana believes that their experience with outsourcing CE shows that CE costs are twice as much when outsourced.

Information compiled by Kansas for the past ten years indicates that change orders run about 4-4.5%, whether insourced or outsourced. Kansas reports that many problems have been solved through partnering and that outsourcing has improved the relationships between KDOT and consultants.

5.0 DISCUSSION

5.1 OVERALL TRENDS

Outsourcing of various services by transportation agencies has grown rapidly through the 1990's and into the current century. Outsourcing project delivery has followed the same trend. This has been a worldwide phenomenon, as highlighted in the discussion of the paper from Finland (*Pakkala 2002*). In the United States increases in funding from TEA-21, bonding programs, and the prevention of agency growth by legislatures, has left DOTs with no choice but to increase outsourcing of project delivery. They have done so either within the traditional design-bid-build project delivery system, or through the use of design-build contracting.

5.2 OUTSOURCING DESIGN-BID-BUILD

Increased use of outsourcing in the traditional design-bid-build delivery has taken on several forms. The use of specialized skills of consulting engineering firms to augment DOT engineering capabilities, while still maintaining direct control of PE and project delivery, has increased. DOTs have also expanded the practice of turning over the PE function, for entire projects, to engineering consultants.

Contracting with consulting engineers to take responsibility for PE (culminating in delivery of plans, specifications, and estimates for projects) has been practiced for over 30 years by the Indiana DOT, Connecticut DOT, and other states. Outsourcing of PE may reach proportions as high as 90%. States practicing such high levels of outsourcing for long periods of time simply accept this approach as the way that they do business. Still, they share the universally-expressed concern that high levels of outsourcing will lead to the loss of DOT technical expertise and the ability to effectively oversee consultant delivery of engineering functions. After interviewing eleven states and developing a computer-based staffing model, the FHWA FLH contracting out study (*Smith 2000*) recommended that, "to avoid loss of technical expertise and provide a training ground for future contract overseers, outsourcing should not exceed 80%."

There is general consensus that outsourcing PE, costs more in the short term than performing PE in-house. Although there are few published cost studies, a study by Wilmot and others (*1999*) supports this opinion. Consultant pay scales are higher than those of DOTs. The use of consultants entails extra DOT oversight and effort for consultant selection and contracting. Consultants must earn a profit to survive. As a result, consultants would have to be more efficient in their practice of engineering just to break even with DOT PE costs. In many cases the same engineers would have to be more efficient, because it is common for consulting firms with contracts for PE services to hire DOT employees as part of their workforce.

Those suggesting a cost justification for outsourcing PE argue a long-term cost savings because fixed costs of permanent DOT staff and infrastructure are minimized. Permanent agency employees are not hired for increased project load and retained for the possibility of another increase in project workload.

Outsourcing CE functions to consultants is practiced much less than outsourcing of PE. CE is usually administered at a local, decentralized level in the DOT. CE services are delivered at the jobsites, frequently at remote locations. Bringing consulting engineers to remote locations may be difficult and expensive. When CE services have been outsourced, it has been common practice for consulting firms to hire DOT employees to deliver the services. As outsourcing is practiced more extensively, the pipeline of former DOT employees may run dry.

Cost comparisons of insourced and outsourced CE are also scarce. The most comprehensive comparative study of insourced and outsourced CE (*Ellis, et. al. 2000*) shows outsourced CE to be more expensive than insourced. Survey responses from 38 states showed a possible 2.5% cost advantage for insourcing (8.6% versus 11.1%). The analysis of five years of Florida DOT cost data for projects with insourced and outsourced CE showed a 5.5% cost advantage for insourcing (9.2% versus 14.7%). Again, those arguing cost advantages for outsourcing would say that the long-term minimization of permanent DOT staff and infrastructure will more than offset any immediate higher costs. They might also argue that as outsourcing of CE services becomes a reliable market for consulting engineering services, more consulting firms will enter the marketplace and competitive pressures may improve productivity and reduce costs.

Consultants for both PE and CE services are chosen through a qualifications based selection process. For PE contracts, selection may be on a project by project basis, or for on-call contracts for fixed terms. These may range from renewable one-year contracts to contracts for six or more years. Contracts for PE services are predominantly some form of reimbursable cost plus fixed fee contract. However, there is increased interest in improved scope definitions to allow lump sum contracting, or lump sum by milestone payment. There is also an increased interest in the use of incentives, primarily to reward timely delivery of PSE with more work.

Contracts for CE services are generally on a project by project basis. Arizona uses temporary employees, for inspection services, as an alternate to contracting for full CE services from a consulting firm.

States have the most experience with separate contracting for PE services and for CE services. In recent years, it has become more common to have both PE and CE outsourced for a project. Opinions differ on how to go about this. Connecticut advocates a “cradle to grave” approach. This approach uses one consulting firm to follow the project through PE and CE. This is the approach that the Oregon DOT has chosen for projects delivered by outsourced DBB. Other states prefer to maintain checks and balances on consulting firms by, mandating that consulting firms performing PE services for a project may not perform CE services on the same project. At least one state

(Oklahoma) would allow the outcomes of separate solicitations for PE and CE on a project to determine whether the same or different consulting firms supplied both of the services. One consulting firm for both PE and CE is likely to provide the most efficiencies and the timeliest response during the execution of construction.

The most comprehensive approach to outsourcing DBB is the use of a program manager. The largest application of this approach has been South Carolina's "seven in twenty-seven" program. The state has been split in half geographically with one program manger assigned responsibility for the eastern half of the state and the other assigned responsibility for the western half. This approach goes beyond Oregon DOT's ODBB in that South Carolina DOT looks to the program managers for financial reporting systems and overall control of budget and schedule for the entire program. They are not just supplying PE and CE on a project by project basis. The program managers are assigning PE and CE either internally or to sub-consultants as they manage the entire program.

Regardless of the approach to ODBB, states retain the responsibility and control of bidding and awarding of construction contracts. Bid documents produced by the PE consultant or under the direction of the program manager are delivered to the DOT for the normal bid and award process. When the construction contractor has been brought under contract, the CE consultant or program manager assumes responsibility for its administration.

5.3 OUTSOURCING DESIGN-BUILD

One of the most dramatic trends in the outsourcing of project delivery has been the increased use, and the use on high profile projects, of DB. DB is being advocated primarily for reasons of scheduling. Many times it is seen as the fastest way to get the project into service. Although there are theoretical arguments for cost savings for DB delivery, it is difficult to find clearly documented evidence of cost savings. On the other hand, there is almost universal agreement that schedules are accelerated by the use of DB.

In at least one state (Oklahoma) statutes preclude the use of DB.

Use of DB for transportation projects is evolving into two categories of usage. Mega-projects use DB to deliver the project as quickly as possible to either bring on a revenue stream as soon as possible (toll-roads), or to minimize inconvenience to the motoring public (Utah's I-15 and Colorado's TREX). Potential DB contractors are short-listed based on qualifications. Short-listed DB teams prepare preliminary designs and submit cost and schedule proposals. Proposals are evaluated on technical merit, schedule, and cost. Cost may or may not be determined through a best-and-final-offer approach. Florida DOT's DB guidelines (*Prasad 2002*) provide procedures for what they call, adjusted score design build (ASDB).

The other use of DB is really a "detail-build" approach. Routine projects are competitively bid with selection based on price. The awarded contractor must do whatever design is required to allow them to deliver the constructed end product

consistent with the performance specification provided. On an overlay project for example, the DOT may provide the type and thickness of overlay required and leave it to the detail-build contractor to develop the design details and traffic control plans to provide the desired section of overlaid highway, consistent with state and federal standards. The Florida DOT guidelines (*Prasad 2002*) provide procedures for what they call, low bid design build (LBDB).

5.4 PERFORMANCE MEASURES

The quality movement of the late 1980's and early 1990's had a profound effect on North American industry and institutions. The value of establishing and tracking measures of effectiveness gained widespread acceptance. In this context, the Oregon Benchmarks for performance measurement at the highest levels of state government gained acclaim. The 1997 NCHRP synthesis (*Poister 1997*) also provided recognition to ODOT performance measurement practices.

For effective performance measurement and improvement, lower level performance measures and targets must effectively feed into higher level measures. Since ODOT's major impact on higher level performance measures, such as Oregon Benchmarks, is dependent on successful completion of projects, it is important that effective performance measures be established and monitored at the project level.

The ODOT Office of Project Delivery (OPD) has chosen three performance measures to aid in the continuous improvement of project delivery functions. Percent PE and percent CE are measures tracked by most DOTs nationwide. Thus, not only may trends over time be compared, but comparisons may be made with other states. PE and CE are relatively small percentages of construction costs, however, there is always the danger that too narrow of a focus on these measures could lead to increases in the cost of construction. Even relatively minor (1%-5%) increases in construction costs resulting from poor quality design, could more than offset the perceived benefits from reduction in PE and CE percentages. ODOT OPD's other measure of "STIP delivery" is intended to provide motivation for timely completion of PE, bid, and award processes. Emphasis on maintaining or accelerating the bid letting schedule also presents the potential for reducing PE costs that might increase through increased expenditures of work hours if schedules slip.

The current and developing performance measures for the construction phase of projects appear to be comprehensive and fit well within the matrix derived from CII's Benchmarking and Metrics report (*Thomas 1998*). The crucial areas of quality, safety, cost, and scheduling are all being addressed.

6.0 CONCLUSIONS

This section summarizes key findings from the literature review, DOT survey, and DOT interviews. The information will be used by ODOT to assure that all relevant information from outside sources is available as ODOT moves forward with its significant change in project delivery for recently authorized major construction programs. The next phase of this research project will be to gather and analyze performance measures for ODOT projects delivered by: insourced design-bid-build, outsourced design-bid-build, and design-build.

The following conclusions result from analysis of the information gathered for this interim report:

- Outsourcing and alternate project delivery methods are seeing increased usage.
- The spectrum of activities outsourced by the different DOTs throughout the United States is very wide. Activities vary from, basic maintenance functions, such as litter removal and landscaping, to the most complex and specialized high technology engineering services available in the industry.
- Outsourcing delivery of capital projects by state DOTs has been increasing because:
    - TEA-21 has increased the federal funding almost 50% since 1998.
    - The workforce has either stayed the same or decreased in 80% of DOTs.
- Cost (immediate) is not the driving force behind outsourcing project delivery.
- Perceived benefits from outsourcing work to the private sector are:
    - The ability of DOTs to provide projects for the general public, while experiencing resource constraints.
    - Costs are incurred only when services are used.
    - A smaller permanent DOT workforce is required, with peak demands handled by outsourcing.
    - Potential for cost savings to DOTs because costs of permanent staff and facilities are reduced.
    - Access to special private sector skills on an as-needed basis.
- Potential concerns with outsourcing project delivery are:
    - DOTs may have less control on quality, schedule, and budget.
    - DOTs may lose essential in-house expertise.
    - Conflict with DOT's workforce.
    - Requires new management skills for DOTs.

- Loss of specialized skilled people and in-house production capabilities are significant consequences of the downsizing phenomenon, and a possible consequence of the outsourcing process.
- There are no studies about the outsourcing impact on human resources in DOTs.The literature search did not find established methodologies, guidelines, or decision models for determining which projects to outsource; except for a proposed computer-aided model for decisions regarding outsourcing of specific maintenance activities (*Wilmot et. al. 2002*).
- Outsourcing program management is one of the approaches for outsourcing project delivery that is gaining popularity among DOTs.
- Program management has been shown to be an effective method for delivering large capital programs in Oklahoma and South Carolina.
- Maintaining technical expertise within the DOT becomes more difficult as the percent of outsourced projects increases.
- It is important to keep interesting and challenging projects in-house, to maintain some level of expertise in the DOT.For states that have outsourced the majority of their design for long periods of time, outsourcing is simply accepted as the way they do business.
- No DOT expressed dissatisfaction with outsourcing PE, CE (more limited experience), or program management (very limited experience).
- An, FHWA Federal Lands Highway Division report has recommended best practices for various aspects of outsourcing project delivery functions. Among them are (*Smith 2000*):
    - Work repeatedly with specific A/E firms.
    - Keep the design team on board through construction.
    - Combine training for project management, construction and other in-house and consultants' personnel.
    - Require construction inspector training and certification.
    - Hold frequent status meetings and employ good scheduling methods.
    - Hold contract retainage for task order work.
    - Use a consultant evaluation process.
    - Develop a design matrix to determine which projects go to A/E.
    - Establish post contract reviews to learn what went well and what did not.
    - Bundle small or similar projects into more manageable and economic sizes.
    - Limit the outsource work to no more than 80% of the agency project load.
    - Use Lump Sum design for more efficient and timely deliveries.
    - Use partnering during contract work and continuous periodic partnering with contractor industry, prior to contracting the work.
    - Review consultant designs for scope and guidelines, not for technical accuracy.
    - Use a standard clause for consultant liability in all contracts.

    - Have consultant prepare statement of work (SOW) for task order work at no charge to the DOT.
    - Use constructability reviews or VE (value engineering) studies during project development.
    - Use A + B bidding to reduce contract time and oversight time.
    - Perform preliminary design and environmental scoping before contract task order work. The entire cross-functional team should participate.
    - Categorize contract change orders to identify trends.
    - Include a disincentive clause on A/E contracts for contracts not completed on time.

- The computer-based staffing model used in the FHWA FLH study (*Smith 2000*) projects the need to add significant numbers of additional contract management staff to properly administer significantly increased volumes of outsourced work (see Figure 3.1).

- A University of Florida report (*Ellis et al. 2000*) has recommended the best practices for various aspects of outsourcing CEI. These include:

    - Assign to the CEI consultant only those tasks that can be efficiently performed by the consultant. (Scope of services should be developed for each project, based upon the project requirements and the availability of alternative sources.)
    - Insure that the outcome of the CEI consultant negotiation will be a staffing plan, which is appropriate for the specific project, at an appropriate cost.
    - When possible, use multi-project consultant contracts for CEI. Establish guidelines for the formation of multi-project CEI consultant contracts.
    - Maintain a continually updated analysis of project costs, including CEI costs. Allocate CEI responsibility on the basis of cost effectiveness.
    - Attention should be given to delay-avoidance and mitigation. Utilities and plan errors remain frequent causes for delays. Increasing the project duration directly increases CEI costs.

- Representation of accurate state agency overhead costs is a major concern for cost comparisons between insourcing and outsourcing.Accounting methods and systems, and cost categorizations are different between public and private entities.Overhead cost categorizations often are very subjective.Contract supervision and overhead costs account for the most significant cost differences between projects designed in-house, and those designed by an external consultant (*Wilmot, et al. 1999*).

- Measuring the performance of programs and services has become a very important tool in the effective management strategies of DOTs. Appropriate performance measurement is essential to monitor and enhance performance in the future.

- Wisconsin DOT has developed a group of outcome-oriented measures of performance for the design and engineering activities, both at the corporate and functional levels. These performance measures are indicators of productivity,

quality, and effectiveness within the project delivery process, both for pre-construction and construction phases.

- ODOT's performance measures for project delivery are rapidly evolving. When fully developed, measures will cover the critical areas of cost, time, quality, safety, environment, community relations, contractor relations, and contract administration.
- Schedule is the primary driver for DB delivery. For some projects, cost savings may be difficult to document, however, schedule improvement is generally achieved.
- The Florida DOT's guidelines for DB include the discussion of project delivery for:
    - Routine projects where innovation and alternatives are not sought. These are referred to as low bid design projects (LBDB).
    - Highly challenging projects where potential gains from innovation are great. These are referred to as adjusted score design build (ASDB) projects.
- ODOT's two, 1999, DB pilot projects successfully accomplished their primary objective of providing low-risk projects where ODOT and the Oregon consulting and general contracting communities could develop procedures to successfully deliver DB projects. Both showed schedule benefits. Cost savings for the surface preservation and guardrail project were estimated at 3%. For the bridge rehabilitation project, ODOT probably paid a small premium (about 10%) for a higher quality bridge deck and a dramatic savings in user cost provided by the construction of a detour bridge.
- ODOT's approach to outsourced DBB is viable.

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