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16. Abstract Increased use of professional services firms for engineering and related services created the need for tools and methods that can support and improve TxDOT negotiation of contracts and management of professional services firms. A data availability and applicability analysis identified a wide variety of types and sources of historical data that might be useful for developing and populating database tools. However, the lack of information on the specific interactions among existing data prevented full development of tools based on historical data. Work to develop tools for structuring cost proposals of professional services firms that can also facilitate proposal analysis by TxDOT personnel produced two prototype spreadsheet tools. Initial feedback and testing at a TxDOT district indicate that the tools can improve negotiations and provide the basis for the development of database tools. Additional development and training in tool use are recommended.					
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CONTRACT NEGOTIATION TOOLS FOR PROFESSIONAL SERVICES ON HIGHWAY PROJECTS

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CHAPTER 1: INTRODUCTION

This chapter provides an overview of contracted professional consultant services based on the literature to establish a context for the current work, followed by a description of the general circumstances that led TxDOT to initiate the project, within a wider context described by the literature.

CONTRACTING WITH PROFESSIONAL CONSULTANTS

A professional consultant is an individual or firm with special knowledge, skills, and talent who makes needed expertise available to a client for a fee, rendering advice and often helping to successfully implement that advice with and for the client (Shenson 1990). Research has identified effective professional design services as a critical component of project success. Chua, Kog, and Loh (1999) identified critical success factors (CSFs) for construction projects based on the knowledge and judgment of experts (20 years of experience) in the construction industry. They identified and assessed 67 CSFs in four categories (project characteristics, contractual arrangements, project participants, and interactive process) for performance in three dimensions (budget, schedule, and quality). On the basis of the studies Chua, Kog, and Loh found that (1) adequacy of plans and specifications and (2) constructability emerge prominently as the two most critical success factors, regardless of the project objective.

Professional services consulting firms are engaged for one or more of several reasons. The following list of possible client needs that can be filled by professional services firms is derived from those developed by Shenson (1990) and McGonagle (1981):

- a limited or one-time use of specialized skills;
- unique areas of expertise;
- access to services that are only available by paying persons more than is allowed within the client's organization;
- specific skills that are not available in the current labor market;
- rapid access to the latest technology and experience in its application;
- multiple exposures to alternative solutions to new problems;
- an independent, unbiased, frank opinion;

- temporary technical assistance;
- services that are unavailable due to political and/or organizational problems;
- response to problematic regulations;
- services that can be provided internally but that capacity is needed on other work;
and
- help with training programs.

In response, firms may provide a variety of services and activities; common ones according to [Shenson \(1990\)](#) are listed in [Table 1](#).

Table 1. Services and Activities Commonly Provided by Professional Services Firms (Shenson 1990).

Areas	Services/Activities
Research	Find suppliers
	Find target markets for ideas or products
	Find talent
	Find experts
	Find commercial possibilities for abstract ideas or concepts
	Assess public mood
	Assess political realities
	Trace problems, ideas, etc., to their source
Analyze	Classify data
	Perceive and define cause-and-effect relationships
Invent	Design educational events
	Improve on others' ideas
	Update others' ideas
	Adapt others' ideas
	Create commercial possibilities for abstract ideas or concepts
Synthesize	Summarize
	Assess people's needs
	Extract the essence from large quantities of data
Predict	Plan financial matters
	Predict obsolescence
Recommend	Recommend experts
	Recommend suppliers
	Allocate scarce resources

Table 1. Services and Activities Commonly Provided by Professional Services Firms (continued).

Areas	Services/Activities
Communicate	Arbitrate disputes
	Negotiate agreements
	Terminate people/projects/process
	Translate jargon
	Help others express their views
	Help others clarify their goals and values
	Handle difficult people
	Interview
Motivate	Sell an idea, program, or course of action to decision makers
	Raise money for nonprofit institutions
	Raise money for business ventures
	Recruit leadership
	Direct creative talent
Evaluate	Appraise monetary value
	Judge people's effectiveness
	Identify and assess others' potential
	Analyze communication situations

The use of contracted professional service firms is a process that can be described as a set of steps. [Bell and Nadler \(1985\)](#) developed a relatively simple standardized consultation process model with five steps: entry, diagnosis, response or action, disengagement, and closure or termination of consultation. In organizations such as TxDOT that repeatedly contract with many professional services firms, some of these steps have been standardized to improve uniformity of treatment, transparency, facilitate the process, and to exploit economies of scale. Professionals within TxDOT perform portions of some steps (e.g., identification and description of the need). However, in general, during the entry phase the consultant is contacted and the problems are explored with the client. Details regarding the relationship and the role and goals of the consultant are formulated. Also, the resource parameters are identified, final clarifications of the methodology are clarified, and, finally, the contract is negotiated.

During the diagnosis phase the consultant investigates the cause and nature of the problem (e.g., traffic congestion or structural damage). The consultant also identifies the subsystem(s) in which the problem is perceived to be located and the interrelationships between that subsystem and other parts of the system.

The response or action phase includes the course of action, redefinition of consultative goals, and identification of appropriate objectives, strategies, and roles. This could include the

preparation of plans and specifications for a TxDOT construction project. This phase also includes planning and engaging structured activities or interventions employed to correct the problem or improve the state of affairs, which was specified in the contract.

The disengagement phase includes evaluation of results to determine how successful the response has been, to determine whether the project is progressing as per the plan, and to analyze whether there is a need for response revision or additional resources. Based on the evaluation, planning for continuous process maintenance is conducted to ensure permanent integration and lasting change.

In the closure phase the consultant prepares for a mutually satisfying termination of the working relationship.

Shenson (1990) provides a more detailed model with nine steps that reflects the perspective of the professional services firm, as shown in Figure 1.

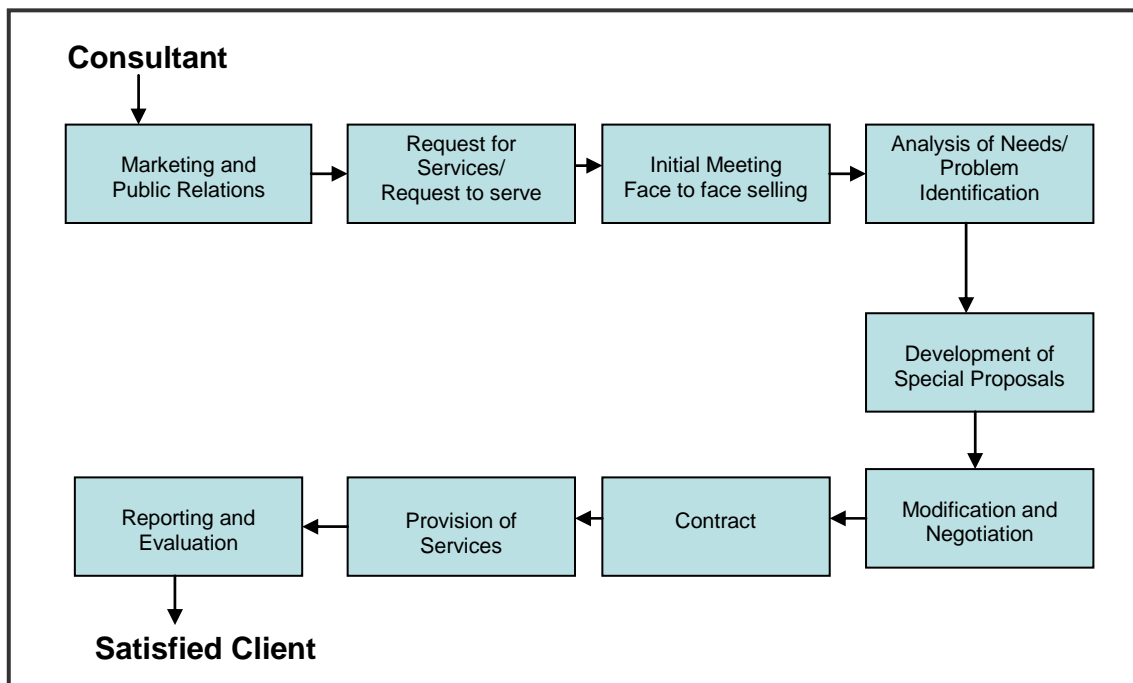


Figure 1. Nine-Step Model for Using Consulting Firms (Shenson 1990).

More detailed descriptions of the current state of the art as described in the literature are included in other sections of this report.

CONTEXT FOR THE TXDOT PROJECT

TxDOT initiated this project in the context of large and potentially increasing design work being contracted to professional services firms. The TxDOT experience is not unique. Historically, consultants have been used to provide certain operational activities or to solve a specific problem. However, consultancy has expanded to include improving leanness, speed to market, efficiency, and competitiveness of organizations (Worth 2001). These changes are mostly caused by the impact of information technology, technical sophistication of business, and increases in customer expectations, deregulation, and political stability. Industrial and public organizations have been forced to meet the requirements of new technologies and other changes. This adaptation is achieved by using expertise provided by consultants. Within this context of increasing use of consultants in general, TxDOT has, over several years, increased the fraction of design and related work for TxDOT construction projects that are performed by contracted professional services firms. Poor management of professional engineering consultants leads to a decline in the quality of the service provided and failure to meet project objectives. Therefore, successful TxDOT projects require effective and efficient management of contracted professional engineering consultants.

A second factor that has contributed to the need for the current project is increased complexity of contracting professional services due to increased subcontracting within consultant teams. Consultants frequently outsource a portion of the scope of consulting services they provide to owners because of increased competition, to reduce their engineering staff to complete services faster, or to meet Historically Underutilized Businesses (HUB) and Disadvantaged Business Enterprises (DBE) goals. Professional services firms used by TxDOT commonly subcontract surveying, geotechnical investigations, and design and traffic studies. This subcontracting increases the number and role of third parties to the primary consultant-client relationship. Berggren, Soderlund, and Anderson (2001) studied issues related to increased outsourcing and fragmentation in large engineering projects. Their study emphasized increasing organizational complexity and the role of third parties in large-scale engineering projects. Berggren, Soderlund, and Anderson identified three major problematic consequences of increased fragmentation in nonrecurring projects. Although some consequences apply more to the construction phase of projects, several aspects also apply to contracting professional services such as the design of construction projects:

- **Increased need for coordination:** Despite contractual innovations, many interdependencies and much uncertainty cannot be resolved by sophisticated contract language and require the need for other forms of coordination.
- **Potentially absent customer, operator, or user:** When end customers, operators, or both delegate all responsibilities to engineering and management consultants, suppliers lose opportunities to reach tradeoffs between project cost and operation benefits.
- **Increased need and challenges for organizational learning:** When suppliers outsource onsite project management to external consultants, the learning cycle is fragmented, resulting in the weakening or breakdown of crucial feedback loops, making the process more complicated.

[Berggren, Soderlund, and Anderson \(2001\)](#) suggest developing new forms of contracting and introducing new organizational forms that proactively address the observed problems. They also recommend that firms involved in these kinds of projects have a strong track record in building temporary problem-solving and conflict-resolution arrangements in situ and have strong technical and contractual skills. Tools for implementing these suggestions can include joint management committees for solving problems quickly and informally, rapid approval processes, fair compensation for changes, emerging dispute resolution and imbalance offsetting without recourse to legal measures.

TxDOT has developed and currently applies tools to address some of these issues. For example, TxDOT pre-certifies consulting professional services firms in a process that documents and updates the skills and abilities of firms.

THE NEED FOR IMPROVEMENT IN TXDOT MANAGEMENT OF CONSULTANTS

The volume of TxDOT work requiring design services continues to increase. The evolution of design work for TxDOT construction projects toward increasing use of contracted professional services firms creates a need for improvements in TxDOT's ability to manage professional services (including selection, procurement, etc.). At the initiation of the current project, some consultant management processes were specific to individual districts, and expertise and capacity of districts to manage professional services firms varied widely. The lack

of experienced consultant negotiators and managers within TxDOT districts and challenges in hiring and retaining those experienced personnel were of particular concern because failure to meet these challenges could allow the inadvertent imperfect management of TxDOT resources in contracting with professional services firms through inadequate scoping of services, unclear expectations of services, and resulting inappropriate costs of services. In addition, the amount, quality, and usefulness of the existing data on TxDOT's 10-20 years of experience contracting with professional services firms was largely unknown. The impacts of previous efforts to improve TxDOT's management (described in the [next chapter](#)) were unclear, as was how to proceed with improvement.

Therefore, the products of work to address these needs were not completely and specifically described at the onset of the project, and this description became the first order of business for the research team and TxDOT project director and advisors. The first project meeting (August 24, 2001) developed preliminary descriptions of possible products, including a literature review of consultant management (provided as part of this report), conceptual design of possible contract incentives for use in managing consultant schedule and quality performance, and a knowledge management tool (database tool) for use by knowledgeable TxDOT managers of consultants. At the suggestion of the project director, the initial emphasis of the project was on the development of a database that would provide knowledgeable TxDOT managers of consultants with access to useful historical TxDOT data and information on consultant contracts. In a subsequent meeting (September 12, 2001), the primary objective of this tool was defined to assist district personnel in estimating man-hours, costs of design work, and consultant costs as fractions of estimated construction costs (depending on circumstances) in preparation for negotiating contracts with consultants by providing historical data at the function code level or above (i.e., not at the object code level). As will be discussed, the availability and usefulness of the historical data to develop this tool are critical.

CHAPTER SUMMARY

This chapter established a context of contracting professional services as one of expanding services and use. The circumstances within TxDOT that created the need for the current project were described as an increase over several years in the volume of design work

contracted to professional services firms. Those needs are described as the basis for initial project objectives.

CHAPTER 2: RELEVANT HISTORICAL AND CONCURRENT EFFORTS

In response to the need to develop and improve management of contracted professional services, TxDOT has developed and applied many tools, methods, and organizational schemes. These include but are not limited to the Consultant Contracting Office in the Design Division, consultant contracting capabilities within districts, standardized processes for selecting consultants, standardized contract types (project specific, indefinite delivery, surveying, etc.), and standardized invoicing and payment processes. These initiatives have been successful in managing the large volume of consultant contracting work outsourced by TxDOT and will not be specifically addressed further in this report except as they relate to the current project. However, the previously mentioned variety in the experience of district consultant negotiators and managers remains an area that needs improvement.

A requirement for the effective progress of the project was establishing a shared understanding of the relevant historical and concurrent efforts to improve TxDOT consultant management. Those efforts are described in this chapter, along with their relationships to the current work.

RELEVANT PREVIOUS EFFORTS TO IMPROVE CONSULTANT MANAGEMENT

Several years prior to the current project Khali Persad, Ph.D., led a significant effort to develop numerical estimates of reasonable consultant services resource requirements (man-hours) and costs for projects that had not yet been designed. These estimates were based on the relationship between relatively few characteristics of the services provided (e.g., plans, specifications, and estimates) and products (e.g., estimated cost of the constructed facility being designed) and the historical costs on many projects. The relationships were generated by regression analysis between project characteristics and professional services costs. As such, the estimates did not (and could not) take into account the specific features and characteristics of individual projects or services.

A tool was developed based on the estimating equations and made available within TxDOT. The tool was considered potentially useful in helping identify large mismatches between consultant cost proposals and TxDOT estimates of costs, and thereby a means of identifying potential misunderstandings about scope, expected design products, and other

negotiation issues. The goal of the tool developers and TxDOT was that experienced TxDOT consultant negotiators would use this tool as a guide, as one of many indicators, and deeply and carefully consider all special and unique project features during its use. However, several TxDOT participants in the contracting of professional consultants became concerned that these estimates might be used as a recommendation of cost or as a rule to prescribe compensation amounts for contracted professional services firms. This use is very different than the tool's intended use as a guideline and could prevent the inclusion of project-specific characteristics in negotiations. These concerns contributed to the tool not being used widely within TxDOT and eventually being withdrawn.

The work described above had two primary impacts on the current work. First, it was agreed (September 12, 2001) that the tool developed in the current project would report historical data, but it would make no recommendations, projections, or predictions of appropriate cost values. Second, in the investigation of the prior work, it was learned that the raw data (project characteristics and costs for specific projects) upon which that work was based were not available.

THE TXDOT NEGOTIATION TASK FORCE

Throughout the current project TxDOT worked with the Texas Consulting Engineering Council on a Negotiation Task Force to improve interactions between TxDOT and firms that provide contracted professional services to TxDOT. The Task Force identified issues of concern to TxDOT, professional services firms, or both, and discussed potential changes for improvement. The tools developed as part of the current project are considered a part of this effort, although the project is separate from the Task Force. The Principal Investigator of the current project attended several Task Force meetings, presented prototype versions of tools, received valuable feedback from Task Force members, and incorporated that feedback into tool improvements. Throughout these interactions the members of the Task Force from professional services firms consistently and sincerely supported improvements in their interactions with TxDOT and the role that the current project played in those efforts.

SUMMARY OF EFFECTS ON THE PROJECT

Prior and concurrent efforts impacted the current project by clearly establishing the roles, priorities, and preferences of TxDOT and the professional services firms in their interactions and focusing the work by effectively eliminating some unfeasible aspects of the issues being addressed.

CHAPTER 3: A LITERATURE REVIEW OF THE MANAGEMENT OF OUTSOURCED CONSULTING SERVICES

A literature review provided background information on the management of outsourced consultant engineering services (Jeyapandian 2003). The particular focus for the purpose of the project was knowledge or lessons available from outside TxDOT (versus TxDOT processes, requirements, etc.). Therefore, the report focuses on published literature. Significant portions of the background material provided in the [Introduction chapter](#) are excerpts from that report. This chapter focuses on the procurement of professional services.

PROCURING CONSULTING SERVICES

Government agencies have established procedures for the selection of professional engineering consultant services to procure the professional engineering services (Avila 1997). The first stage of this process is the request for qualification (RFQ), in which consultants submit information on their qualifications and ability to perform the work associated with a proposed project. Consultants are typically requested to submit this information in a statement of qualifications (SOQ) that meets the local agency's standardized form and format. TxDOT facilitates this step in the procurement process through pre-certification of professional services firms to perform a wide variety of types of work. The second stage in the process is the proposal stage, in which the firms that submitted the best SOQs submit proposals that discuss their proposed performance of the work. The third stage of the process is the interview stage, when the "short list" (typically 3-5) of consultants that submitted the best proposals make presentations to demonstrate their ability to successfully complete the project. Presentations typically address their approach to work, specialized project team experience, project team organization, and quality assurance. The interview stage tests a consultant's ability to effectively communicate with the agency. Avila (1997) identified desired characteristics in consultants during the interview process:

- The consultant's presentation is well orchestrated and practiced.
- The interview and presentations are primarily with and by consultant team members who have the highest hourly commitment to the project and the firm's principal(s). This includes the consultant's project manager and engineer.

- The consultant project manager and engineer have good communication skills, speak clearly and correctly, and listen well.
- The consultant is able to provide proper, detailed, and effective responses to formal and follow-up interview questions.

The final firm is selected based on SOQ, proposal, presentation, and responses to formal and follow-up interview questions.

[Avila \(1997\)](#) identified keys for successful procurement by consultants that can be used as a guide for agencies in providing information that will improve consultant selection:

- knowledge of the agency’s project management team for fostering professional relationships;
- identifying how the agency defines success at the local (e.g., district) and more global (headquarters) levels;
- knowledge of agency policies and procedures which will govern project activities, including consultant procurement;
- knowledge of why the agency is hiring a consultant for tailoring their SOQ, proposal, and interview to meet those needs; and
- building a highly qualified team to execute the project, potentially including sub-consultants for special types of services.

A PHASED PROCUREMENT STRATEGY

Traditionally, contracts for professional services included the entire scope of the client’s specific project. However, this can cause problems in large, long, or complex projects as firms, personnel, and project conditions change. [Chang and Ibbs \(1998\)](#) describe an alternative procurement model that they call “on-call” contracting. TxDOT currently implements a version of on-call contracting through the use of individual work authorizations in indefinite delivery contracts. Although it is a procurement strategy as used by TxDOT, [Chang and Ibbs'](#) term (on-call contracting) will be used here. In on-call contracting the owner/agency selects the consultant and signs a master contract for the entire project. The prime contractor then divides the project into task orders (work authorizations), which they later release to the consultant as the project progresses. By doing this, the owner/agency has the opportunity to assess the consultant based on

the performance of the first task and retains options to continue with the consultant. On-call contract management involves three steps: task order planning, owner/consultant interaction, and consultant performance evaluation. The most critical management process in this approach is task order planning, which is done in parallel with the design process. Task order planning involves five steps, as shown in [Table 2](#): (1) dividing the overall work, (2) dividing the group tasks into task orders, (3) defining task orders, and (4) issuing task orders. The fifth step is the actual design phase. The first four steps in the contracting strategy are carried out continuously throughout the project until the last task order is issued.

Table 2. Task Orders Planning (Chang and Ibbs 1998).

Step (1)	Principle (2)	Guidelines (3)	Owner's Role (4)	Consultant's Role (5)
1. Divide overall work	Complete planning Overlapping Design Management	A well-prepared CPM, overall plan, and reimbursable first TO to execute it	Cooperate	Lead
2. Group tasks into TOs	Complete planning Overlapping Design Management	TO packages to be studied, detailed to a sufficient level	Lead	Cooperate
3. Define TOs	Complete planning Overlapping Design Management	Well-defined TOs, smaller scopes, incentives for TO definition effort, fixed price TOs	Cooperate	Lead
4. Issue TOs	Complete planning Overlapping Design Management	Check TO interface, check work-load, avoid issuing TOs out of meetings	Lead	Cooperate
5. Design	Overlapping Design Management	Provide experience and results for follow-on TO planning	Cooperate	Lead

CPM = Critical Path Method schedule
TO = Task Order

Although on-call contracting has advantages over the traditional process, it also has limitations that must be overcome for its successful implementation. These include the complete and clear definition of the roles and responsibilities of both parties and potentially high administrative costs associated with applying an on-call contracting strategy.

MANAGING CONSULTANTS EFFECTIVELY

[Shenson \(1990\)](#) identified factors that facilitate good working relationships between clients and consultants, including precise objectives, observable milestones, intermediate submittals, written contracts, open communication, client-staff liaisons, supportive environment, and quick feedback.

Evaluation of the performance of professional engineering consultants during project execution helps manage the consultants. Performance evaluation at appropriate intervals during the project provides the client/owner a clear picture of how the work is progressing and how well the consultant is furnishing services. Moreover, evaluation during the execution stages acts as a check on consultants. Consultant evaluations can be carried out by measuring the critical project factors. These measurements also help keep track of performance for the purpose of qualifying the consultants for future assignments.

Although important, the effective measurement of consultant performance providing design, procurement, and construction services is difficult. This is partially due to the challenges in designing performance metrics ([Sternbach 1998](#)). [Chang and Ibbs \(1999\)](#) identified performance measures for design projects based on their study of California Department of Transportation (Caltrans) projects and previous literature on performance measures. They divided performance measurements into two categories, deliverables and work processes. In each of these categories, a hierarchy of goals, criteria, and measures are included ([Chang and Ibbs 1999](#)). Based on the three goals of cost, quality, and time, they developed a framework of 42 measures, as shown in the [Appendix](#). In the deliverables category, they identified six criteria. Design cost and economy are cost criteria. Accuracy, usability, and constructability are quality criteria. Schedule is the time criteria. The process category also uses cost, quality, and time as goals but develops slightly different criteria. Performance metrics are recommended for each criterion.

[Chang and Ibbs](#) also suggested a five-step process for evaluating consultant performance. The process was tested on eight pages: four ongoing projects ranging from \$2.5 million to \$5.5 million (consultant costs) and durations of about 18 months and on four other structural design projects. Performance evaluations included levels on individual criteria and trending as an indicator of performance over longer periods of time.

Hoxley developed an alternative method of evaluation to measure the service quality of contracted professional services (Hoxley 2000, 2001). He analyzed results from 189 clients across the United Kingdom who anonymously assessed consulting using SURVEQUAL, a tool he developed. Service quality is measured across the five dimensions of tangibles, reliability, responsiveness, assurance, and empathy. The tool has 25 items upon which the client/owners rate consultants using a balanced Likert seven-point scale. Although (unlike the Chang and Ibbs method) this tool cannot help clients track progress and therefore provide control over consultants, it can help track performance for qualifying consultants for future assignments.

BENCHMARKING FOR BETTER MANAGEMENT OF CONSULTANTS

Benchmarking is a process of continuous improvement based on comparison of an organization's processes or products with those identified as best practice (McGeorge and Palmer 1997). The best practice comparison is used as a means of establishing achievable goals aimed at obtaining organizational superiority. Benchmarking can help managers improve their effectiveness and efficiency. Benchmarking the performance of professional engineering consultants by clients can help assess the quality of services provided and set standards and expectations for services from consultants. Such assessments are an important part of continuous improvement. Fong, Shen, and Cheng (2001) review benchmarking approaches and propose a unified process in eight stages:

1. Decide what to benchmark (i.e., select a product, service, or process).
2. Understand successful performance characteristics, including critical success factors and key performance metrics.
3. Identify the best performers for comparison.
4. Collect and analyze data.
5. Determine current performance gaps and project future performance levels.
6. Gain acceptance of the results and establish functional goals.
7. Develop action plans and implement the best practices.
8. Monitor progress and recalibrate benchmarking measures.

CHAPTER SUMMARY

This chapter reviewed the literature on management of contracted consultants.

CHAPTER 4: A DATABASE TOOL BASED ON HISTORICAL DATA

INTRODUCTION

Initial efforts in the current project focused on the development of a database tool to be populated with existing data on historical TxDOT projects. This portion of the project consisted of four phases: data analysis, data collection, prototype tool development, and prototype tool assessment.

DATA AVAILABILITY AND APPLICABILITY

A study of data availability and applicability was performed, resulting in a report to TxDOT (December 19, 2001) that identified eight distinct sources of potentially useful data. Data available from TxDOT are dispersed across TxDOT and vary widely in content, format, and usefulness for the tool development. Pertinent data and some of their characteristics are summarized in [Table 3](#) (from the 2001 report).

Table 3. Partial Results of Data Availability and Applicability Study.

Source Document	Location	Format	Data Fields...	No. of Entries	Useful Period
FIMMS Spreadsheet	TxDOT Research Team	Excel spreadsheet	Project total contracted \$ Project in-house \$		
NOTE: The data describing consultant work in the accounting database are in dollars, not hours. According to the TxDOT accounting department, data about consultant hours is not available from the FIMMS system.					
FIMMS Database	TxDOT accounting department	Access database	No data on contracted work in hours or dollars		
NOTE: See note above.					
Consultant Contract	District offices	Paper	Scope of services provided by state and consultant Time to complete tasks Maximum \$ amount allowed Breakdown of engineering and design tasks by function codes and personnel type Hours est. to complete work by function codes Hourly rates for different levels of personnel Est. schedule by function code	1 project/contract	1993

Table 3. Partial Results of Data Availability and Applicability Study (continued).

Source Document	Location	Format	Data Fields...	No. of Entries	Useful Period
NOTE: Can contribute estimated hours and durations and rates data. Useful dates based on adoption of uniform scoping definition by TxDOT in 1993. Earlier contracts are available.					
Consultant Monthly Invoice	District office	Paper	Monthly hours used by function code by personnel type Personnel type hourly rates Miscellaneous reimbursable expenses per month	1 per month of contract duration	
NOTE: Can contribute actual hours and duration data. To aggregate these data into the total actual hours used on a project, the monthly invoices must be inspected individually.					
Consultant-Designed Projects	Research team from contracting office	Spreadsheet	CSJ (County Section Job) project number District and county information Highway number Project category Construction cost Type of work Layman description Letting date TxDOT manager # Project class	469	1990-present
NOTE: Can contribute project-level descriptive data. No consultant hours data.					
Persad results	Research team	Reports (electronic) dissertation (hard copy)	None - see note below	One per project type	
NOTE: Persad reported that no raw data used in his work are available and that the only potentially pertinent portions of his work are the equations that he developed from the raw data to predict required hours and durations.					
Ernst and Young report	Research team	Paper	Consultant fees by project types	Many/project type	
NOTE: Focuses on consultant fees, not hours. Five project types. May contribute context but no raw data.					
Project cost estimate (“E&O”)	PS&E district offices	Electronic spreadsheet	Items of work Standard item number Item quantity Unit price	Many/project	All projects
NOTE: This is construction (not design) data.					
Project flow charts	Design department	Paper	Design activities with function codes for each activity Precedence of activities	One/project type	(14±)
NOTE: Can contribute descriptions of activities that can be included in each function code and therefore valuable context information.					

The available data were assessed to be capable of providing the basis for meeting several of the TxDOT objectives, including:

- focus on consultant hours (versus dollars);
- focus on contracting conditions to facilitate negotiations, while providing a basis for understanding the relationship between work as estimated at contracting time and actual work;
- describe projects at the level of functional codes, not at a more disaggregated level; and
- provide information that can assist knowledgeable TxDOT negotiators who are familiar with the project, design process, and scope of work to be contracted (versus predicting “appropriate” man-hours or durations).

The data available were also assessed to be capable of providing the basis for a tool that could describe TxDOT’s aggregate (across projects) experience with man-hour and duration estimates of consulting work, actual consulting work in the same dimensions (man-hours and durations), pay rates, and contextual data such as project size and location. It was planned that such a tool could assist TxDOT personnel in evaluating consultant proposals for work on specific projects and negotiating those contracts. When combined with the data that describe TxDOT’s aggregate experience with actual consultant hours and durations, it was hoped that the tool could be developed further into one that could assist TxDOT personnel in assessing the progress of projects.

Consulting man-hours and durations at the function code level for individual projects are only available on a project-by-project basis in paper documents (consultant contracts and invoices). It is difficult to collect data from these documents, as they are typically difficult to locate and are sometimes available only through district personnel. Therefore, data collection from these paper documents would have to be manual and relatively slow. At the time of the data report, these barriers were identified as limiting factors on the total volume of data that could reasonably be collected. Therefore, it was deemed prudent to develop the most valuable or easily collectable data first.

For several project types it was discovered that more than one activity used the same function code. In many cases, all or none of the work in a given function code (e.g., drainage

design) was contracted. This distinction could be incorporated into a tool. However, since activities are the basis for establishing the scope of contracted services, the data concerning function code hours in different contracts may reflect different scopes of work. Data are not available to separate hours for these function codes based on the specific activities included in different contracts. However, the tool could be designed to provide TxDOT with information on the design activities that can utilize each function code for direct and easy comparison with the scope of services planned for the project being negotiated. Knowledgeable TxDOT negotiators can then assess the consultant's resource and duration proposal.

One TxDOT objective was assessed as being particularly problematic, given the nature of the available data. TxDOT wanted the tool to be updated with data from the TxDOT financial management information system (FIMMS) on a regular basis. This requires that FIMMS contain data about consultant hours or durations. However, this is not the case. According to TxDOT personnel familiar with FIMMS, the data needed for the tool are not currently captured by FIMMS. Recommendations for an alternate means of updating the tool and future data collection would be needed for final implementation.

DATA COLLECTION

Based on the results of the data availability and applicability study, the research team recommended that data collection initially focus on projects with the following characteristics:

- project type that TxDOT considers particularly important (e.g., intersections) or projects that have particular characteristics (e.g., large, urban, etc.);
- projects for which data are relatively easy to collect (to increase basis of tool descriptions; this could include projects located in large districts); and
- consultant service contracts that have been completed (to prevent errors from mixing partial-project-data with complete-project-data in descriptions of actual performance). Estimated requirements can still be collected on incomplete projects.

Data were collected by graduate students, who made copies of consultant contracts at the Houston, Dallas, Fort Worth, San Antonio, and Austin District offices. Several hundred contracts were copied. An Excel[®] spreadsheet was developed for standardized data entry, and all relevant project and consultant identification, man-hour, and cost data were collected from contracts into

spreadsheets. Data collection proceeded over several months in parallel with prototype tool development.

PROTOTYPE TOOL DEVELOPMENT

Based on the results of the data availability and applicability study, the research team recommended that it develop a tool based on the data available in consultant contracts and monthly invoices and existing electronic project data. At the meeting to address data availability and applicability (December 19, 2001) it was agreed that the tool would need to give TxDOT negotiators an idea of general (whole project) ranges of fees and hours (“Is the consultant proposing a scope several times the average for this work, or about in the normal range?”). In addition, TxDOT wanted consultant hours to be related to a few project scope parameters for each project type (e.g., lane miles) so that TxDOT negotiators could calculate these ratios (e.g., man-hours per unit parameter) for the project being negotiated and compare with information from the tool on TxDOT experience in same ratios. The research team would focus on project-specific projects (not preliminary engineering, seal coat work, or preventative maintenance) and attempt to use TxDOT’s 14 project types. Categories for labor were discussed, and it was agreed that the following four categories of consultant project participants would be used:

1. project managers,
2. engineers,
3. technical (not engineers), and
4. administrative.

Tool development in Access[®] (the Microsoft Windows database development tool) began on the basis described above in parallel with data collection. Tool development in Microsoft Access began in parallel with data collection. Two typical users and uses were developed based on: 1) specific projects in which the products are typically plans, specifications, and estimates (PS&E) for an entire project in a project-specific contract or work authorizations in indefinite delivery contracts, or 2) rates for indefinite delivery contracts. The former user would enter a few project characteristics and access individual records of historical projects meeting the selection criteria and aggregate data across those historical projects. A second Excel spreadsheet was developed to transfer data from the data collection spreadsheet into the PS&E database. Over

several months, several versions of the PS&E tool were developed, presented to TxDOT and Task Force personnel to receive feedback, and improved. A preliminary tool for use with indefinite delivery projects was also developed.

PROTOTYPE TOOL ASSESSMENT

The PS&E prototype was tested in many ways (ability to aggregate data across projects, ease of use, portability across platforms, etc.) and performed well. However, despite the large number of projects in the database prototype, the number of projects identified by construction project selection criteria remained very low. Repeated attempts to link construction project components and characteristics to consultant contract data in large numbers failed, even using data from different sources. This forced the research team to delve deeply into the specific structure of the available data. To be useful as envisioned, the tool had to link the design of a constructed component (e.g., man-hours to design a bridge) to the characteristics of the construction of the same component (e.g., estimated construction cost of the bridge). This could only be done by specifying three links among four information structures:

1. The component design had to link to the consultant contract that procured the design service.
2. The consultant contract that procured the design service had to link to the construction project that built the component.
3. The construction project that built the component had to link to data on the construction of the component itself.

The research team discovered that each of the three required links could split work into two or more information structures closer to actual construction or could join work from two or more information structures. This precluded the use of TxDOT identifiers for any of the four information structures to uniquely identify components. Therefore, prototype development focused on tagging information pieces with a unique identifier for each component. When the complexity of the data structure required became clear, the research team returned to central members of the TxDOT project team to verify the data structure requirements and seek access to the required data that would link components from design through construction. TxDOT personnel confirmed the data requirements and reported that the needed data do not exist. The

research team and TxDOT members of the project team reluctantly concluded that a useful tool based on historical data could not be developed. The effort to develop such a tool proved helpful to the project despite the infeasibility of developing the tool as originally planned. First, initial prototype development efforts tested whether the vast amounts of TxDOT data developed for other purposes could be applied to the issues investigated by the project. In addition, development efforts clarified existing data needs and structures that became useful in subsequent tool development work.

CHAPTER 5: TOOLS FOR STRUCTURING CONSULTANT COST PROPOSALS

OBJECTIVES AND FOCUS

The focus of the development effort changed based on the work done to develop tools based on historical data (described in the [previous chapter](#)). The revised focus took a forward-looking perspective by seeking to develop two tools that could assist knowledgeable TxDOT negotiators immediately upon adoption and could collect data for a future database tool. One tool for use with PS&E work in the project-specific contract or work-authorization stage and another for indefinite delivery contracts at contract-negotiation stage prior to work-authorization stage were envisioned. Both tools were envisioned and intended to be transparent so that consultants and TxDOT negotiators would develop confidence in their use.

A TOOL FOR PLANS, SPECIFICATIONS, AND ESTIMATE WORK

The tool for PS&E work is a self-contained spreadsheet intended for interactive use by TxDOT and consultants in the preparation and negotiation of costs for professional services. It can be applied to projects that are contracted in one piece (in project specific contracts), for individual work authorizations on larger projects (in project-specific contracts), or for individual work authorizations in indefinite delivery contracts. The tool captures information at the project level on project, consultant team members, and Disadvantaged Business Enterprise Program and Historically Underutilized Business Enterprise Program participation. At the consultant team member (firm) level, the tool captures information on manpower loading by function code, hourly rates of project participants, overhead and fee information, and direct reimbursable quantities and costs. The tool has 17 pages as follows:

1. Title Page
2. Instructions and Notes
3. Definitions
4. Relevant Contract Information
5. Cost Summary
6. Prime Consultant
7. Subconsultants #1-8 (8 pages),

8. Geotechnical Consultant
9. Surveying Consultant
10. Printing

The tool can be better understood through direct inspection of the spreadsheet, which is a separate deliverable product of this project.

A TOOL FOR CONSULTANT CONTRACT RATES (INDEFINITE DELIVERY CONTRACTS)

A tool for indefinite delivery projects was developed in parallel with the development of a tool for PS&E projects. This tool is also a self-contained spreadsheet intended for interactive use by TxDOT and consultants in the preparation and negotiation of costs for professional services, in this case for indefinite delivery projects. The tool captures information concerning the project and consultant team members. At the consultant team member (firm) level, the tool captures information on escalation rates, hourly rates of project participants, overhead and fee information, and direct reimbursable unit costs. The tool has 15 pages as follows:

1. Title Page
2. Instructions and Notes
3. Definitions
4. Relevant Contract Information
5. Prime Consultant
6. Subconsultants #1-8 (8 pages)
7. Geotechnical Consultant
8. Surveying Consultant

The tool for indefinite delivery projects can be better understood through direct inspection of the spreadsheet, which is a separate deliverable product of this project.

TOOL TESTING AND IMPROVEMENT

The PS&E tool was tested by the San Antonio District during a negotiation with a consultant. The principal investigator and representatives of the TxDOT Consultant Contracting

Office met with San Antonio District personnel before and after the application for instruction in tool use and feedback on tool structure and use.

The tools were also presented to TxDOT personnel and consultants at the TxDOT Design and Bridge Conference in Houston in June of 2004. Both tools were generally well accepted and perceived as valuable contributions to improving TxDOT's interactions with consulting professional services firms. Feedback on the tools for improvement was gathered.

CHAPTER SUMMARY

This chapter described the development and initial testing of two tools for use in TxDOT/consultant cost preparation and negotiation.

CHAPTER 6: SUMMARY, RECOMMENDATIONS, AND FUTURE WORK

SUMMARY

This report describes the role of consultants in providing professional services and the circumstances that generated the need for the current project. Relevant historical and concurrent efforts to improve interactions between TxDOT and contracted professional services firms are described with their impacts on the current work. A literature review of management of outsourced consulting services provides a context for a description of the current efforts. Initial efforts focused on the development of a historical database. The data study, development, and analysis of that effort is followed by a description of two tools for structuring consultant cost proposals. This chapter recommends future work to complete these development efforts and implement those tools for improved interactions between TxDOT and contracted consulting professional services firms.

RECOMMENDATIONS

TxDOT can significantly improve its interactions with contracted consulting professional service firms through development and use of tools that structure and standardize consultant cost proposals. Doing so will improve TxDOT's management of consultants. These tools should have two primary objectives: (1) improve contract negotiations between TxDOT and consultants by structuring cost data and facilitating its analysis, and (2) collect data for the development of a database on consultant costs. TxDOT can also significantly improve its negotiations with contracted consultants by developing database tools that assist knowledgeable TxDOT personnel in estimating and analyzing consultant costs. Such tools should be planned and preliminarily designed and developed in conjunction with tools to collect the data that would populate these tools.

FUTURE WORK

Future work can continue the development and testing of prototype PS&E and contract rates cost proposal tools. This work can provide and explain tools to districts that have volunteered to use and report on the tools, debrief participating TxDOT personnel and

consultants concerning use of tools, and improve tools as indicated by the testing. Additional improvement may be available by integrating these tools with other tools being developed by TxDOT, such as professional services scoping aids. Training can be developed in the use of these tools, including training process design and training aids, testing of training, and provision of training for TxDOT district personnel. Future work can also focus on database system design and prototype database tool development for PS&E and indefinite delivery consultant work that can utilize data collected with the tools currently under development for use during negotiations.

In conclusion, continuing the development, testing, and implementation of tools for contracting with consultants for engineering services on highway projects can significantly improve interactions between TxDOT and contracted professional services firms, the management of those firms in providing engineering services, and TxDOT effectiveness and efficiency.

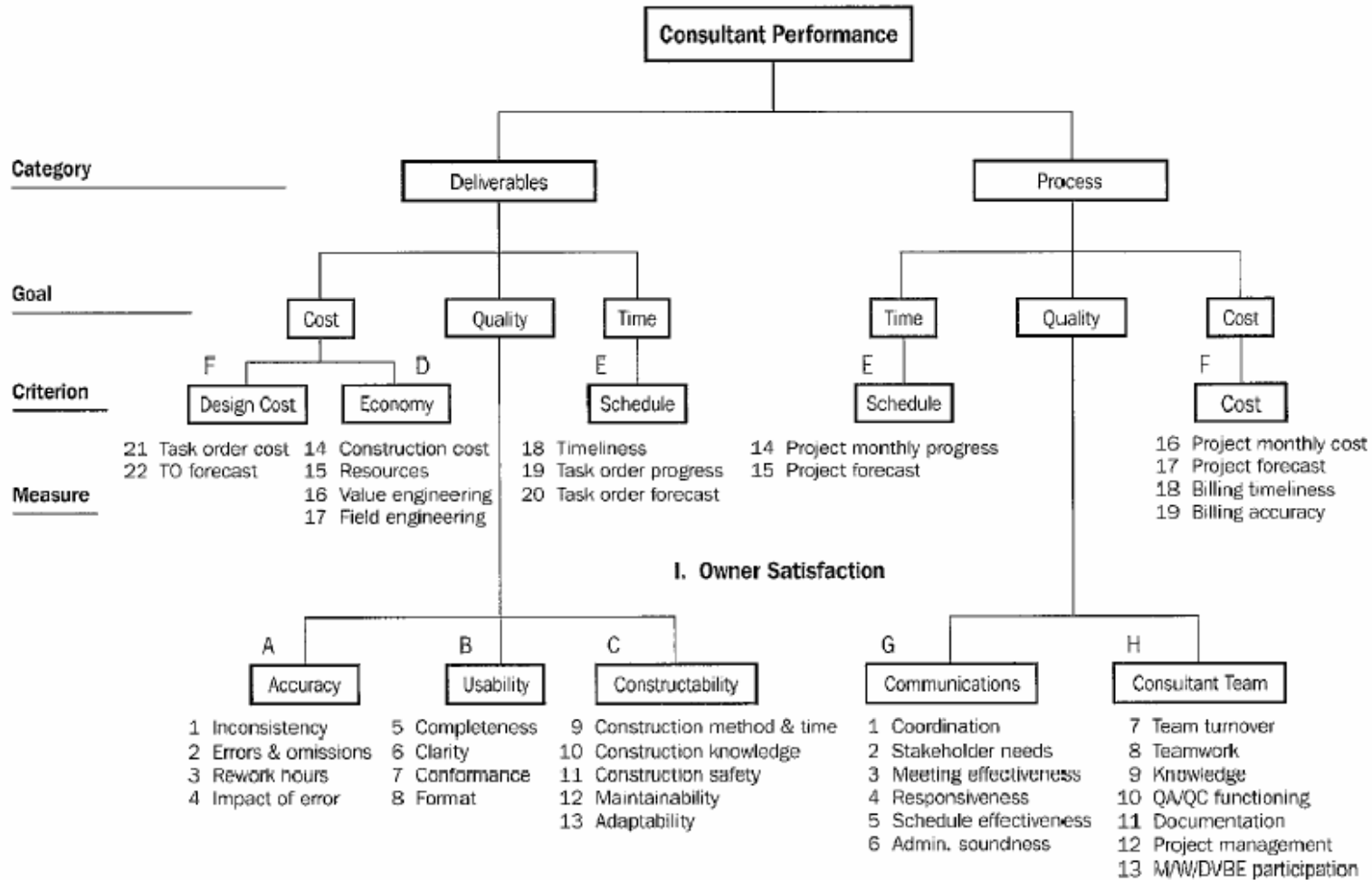
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APPENDIX

CONSULTANT PERFORMANCE MEASUREMENT FRAMEWORK



Consultant Performance Measurement Framework (Chang & Ibbs, 1999).