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A SIMULATION APPROACH TO IN-HOUSE VERSUS CONTRACTED OUT COST COMPARISONS

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ABSTRACT. The purpose of this project was to compare the cost of transportation engineering design services provided by private contractors versus services provided by state transportation agency staff for the Louisiana Department of Transportation and Development (LaDOTD). Due to shrinking budgets, staff cuts, and a trend toward privatization, state transportation agencies now outsource the majority of the services they provide. The merits of doing so, however, have been difficult to discern for lack of "apples-to-apples" comparisons. For engineering design services, this problem is particularly acute due to the uniqueness of many projects (e.g., a bridge over the Mississippi river). A simulation approach was used in this study to make "apples-to-apples" comparisons for 39 design projects, 22 in-house projects and 17 consultant projects. For each in-house design project, the cost was estimated had the work been done by a consulting firm. Similarly, for each consultant design project, the cost was estimated had the work been done by in-house staff. The result of the study was that in-house design costs were cheaper by an average of 17 to 19 percent.

INTRODUCTION

Turning to private sector companies to provide goods and services to the public is commonplace. Although, a wide variety of services are

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contracted out, or privatized, the merits of doing so remains in dispute. In general, contracting out by governments generates interest in how the quality and the cost of the service or product are affected. While quality is understandably difficult to measure and compare, cost analysis is usually considered to be a straightforward process. The costs are what they are, it would seem. For a variety of reasons, however, that is not the case either. Certainly the price paid to contractors is known; but the costs to contract and to monitor the contractor are hidden. Moreover, most government accounting systems are not designed to provide product or service costs. Rather, the accounting system's main purpose is to keep track of line item budgets to ensure that the government stays within budget. So neither the full cost of public sector or private sector provision is readily known. If a government stops providing the service when it contracts out, the situation is complicated further. That is the case for State transportation agencies that commonly use consultant firms for a majority of the services and products they provide. The Louisiana Department of Transportation and Development (hereafter referred to as the "department" or "LaDOTD"), like many state Departments of Transportation (DOT), currently uses both consultants and in-house staff in designing state transportation facilities. The relative cost of doing so, however, is unknown. Is it less or more expensive to use consultants rather than in-house staff to provide these services? The answer to this question is the prime objective of this study.

Past studies in other states strongly suggest that consultants are more expensive than in-house staff in providing the design services needed by the DOTs (Wilmot, 1995). These studies also reveal the difficulty in comparing public sector costs to those in the private sector. This is particularly true for indirect costs. The public sector, for example, incurs costs of advertising for contract bids, consultant supervision, and general administration. Meanwhile, the private sector has taxation, marketing, and compliance costs. Moreover, costs incurred for office rental, utilities, senior administrative staff, and insurance are incurred differentially across private and public organizations. Moreover, as stated before, contracting out sometimes means that the government no longer performs that service, which complicates cost comparisons.

In this study, three simulation approaches were used to compare consultant and government agency costs. Given the real-world problems just identified, simulation approaches such as the one used here appear to be a fruitful methodology to conduct cost comparisons. The remainder of this study is organized as follows: the next section reviews other DOT cost comparison studies, the third section describes the cost comparison approaches used for this study followed by an explanation of the computation overhead cost rates. The fifth section presents the results from an analysis of samples of projects taken and is followed by conclusions.

LITERATURE REVIEW

Whether costs of in-house engineering work are lower than consulting engineering work is not a new question. Several state transportation agencies have commissioned studies to address this issue. The studies listed below were performed by independent consultants (Ashley, Ibbs, Ballard, Staneff, & Ho., 1992; Ernst & Whinney, 1987; Ward, Lee, & Bradley, 1987; Burke, Cavazos, Garcia-Diaz, & Tenah, 1987), by government agencies (Laffoon, Martin, Gupta, Spencer, Sfreddo, Sommerer, Hudson, Smith, Harris, Denkler, Kaiser & Bell, 1993; Bezruki, Saussen, & Sommerfeld, 1990) and by professional engineering groups (Fanning, 1992).

The University of California, Berkeley Study

The objective of this study was to compare the cost to the California Department of Transportation (CALTRANS) of employing in-house versus consulting engineering services staff for conducting designs for the department (Ashley et al., 1992). The analysis was conducted using 204 in-house projects and 32 consultant projects. The study collected actual costs incurred by CALTRANS to complete the designs for the in-house and consultant projects. The ratio of engineering design costs to completed construction costs was used as a measure of relative design cost. The ratio of average engineering design costs to final construction costs was 15.46 percent for the consultant project group and 17.76 percent for the in-house project group. The difference was not statistically significant. The projects were bundled and compared as groups rather than paired. Thus, differences in design project complexity, size and type were not considered in the study.

Texas State Department of Highways and Public Transportation

The Texas State Department of Highways and Public Transportation (SDHPT) commissioned three studies to answer the questions of how the cost and quality of pre-construction engineering services provided by consulting engineers compare with those provided by in-house staff. All three studies concluded that the cost of engineering services is lower when using in-house staff instead of consultants (Ernst & Whinney, 1987; Ward et al. 1987; Burke et. al., 1987).

Ernst and Whinney

The accounting firm of Ernst & Whinney (1987) compared the costs of ten pairs of project (each consisting of one consultant project and one similar in-house project). Three measures of design cost were used: the ratio of design costs over construction costs, design costs per plan sheet, and design cost per roadway mile. These three ratios were used to control for variations in the type of projects. The study found that in-house work costs less than consultant work. Since the sample was small, statistical tests were not performed.

Center for Transportation Research

The Center for Transportation Research (CTR) at the University of Texas at Austin examined accounting methods, global cost comparisons, and quality issues (Ward et al., 1987). CTR concluded that consultant overhead and indirect costs (as paid by SDHPT) were about 45% higher than similar overhead and indirect costs incurred by the department. In the study, overhead was expressed as the ratio of indirect costs to direct labor cost. In-house overhead rates ranged from 194 percent to 212 percent compared to 286 percent to 307 percent for consultant services. In addition, the study indicated that consultant salary rates were 5 percent to 22 percent higher than in-house rates. Similar to the Berkley study for CALTRANS, a "global" approach was used in that results were developed for the entire group of projects instead of for project pairs. The study concludes that the in-house pre-construction engineering services may be delivered for less cost than those of consultant's services.

Texas Transportation Institute

The study by the Texas Transportation Institute's (TTI) at Texas A & M University compared eighteen pairs of projects (Burke et al. 1987). The percentage of engineering costs to total construction costs was lower for in-house projects in 15 of the 18 pairs. The study relied extensively on interviews with various SDHPT officials to determine an overhead rate for in-house projects. Consequently, some overhead cost items may have been left out or estimated with error.

Legislative Audit Bureau of Wisconsin

A large increase in the use of engineering consultants between 1982 and 1989 led the state of Wisconsin to commission a study on the cost-effectiveness and impact on quality of contracting out design services. The Legislative Audit Bureau of the state of Wisconsin conducted the study (Bezruki et al., 1990). The ratio of design costs to total construction costs was the measure used for project comparison. Though the number of projects involved in the comparisons was not given, it is implied to be large given the history of consultant use. The study concludes that the use of consultants is no more costly than if the state had used in-house staff. Two reasons for this finding were offered. First, projects given to consultants were less complex, and second, in-house projects were not managed efficiently.

Study for the Missouri Highway and Transportation Department

Laffoon et al. (1993) compared preliminary engineering (PE) design costs for projects performed in-house with projects performed by consultants. Three methods of comparison were used. In Method 1, the total in-house PE design costs to total construction costs for a 19-year period were computed and compared to the total consulting PE design costs to total construction costs for the same time period. In Method 2, two samples of bridge and roadway design projects were selected for in-house and consultant projects, respectively. The ratios of PE costs to total construction awards were compared for the in-house and the consultant jobs. Method 3 compared the salary and associated costs for identical projects if they had been done in-house versus done by consultants. The results of Method 1 showed that in-house PE was on the average 7.34 percent of construction awards versus 9.62 percent for consultants. Methods 2 and 3 support these findings that in-house design work is more cost effective than consultant design work.

Professional Services Management Journal

Fanning (1992) reported a scale of economy effect from outsourcing. Using data collected by Federal Highways Administration (FHWA) from all fifty states for the period 1979-1989, he showed that states that contract out less than 20 percent of their engineering design work have the highest design costs in relation to construction spending. States that contract out between 50 percent and 70 percent of their engineering design work have achieved the lowest ratios of design to construction spending. Specifically, states that contracted out less than 10 percent of their design work had an average ratio of design cost to construction cost of 0.21 while states that contracted out between 50 percent and 70 percent of their design work had an average ratio of only 0.11. No relationship to topography, size of highway system, size of construction program or any other characteristic of the state, except proportion of engineering work conducted by consultants, could be established to explain the relationship.

The majority of the work in the field of engineering design cost comparisons between in-house and consultants has concentrated on samples of projects and used available accounting data to determine cost differences. This has usually taken the form of direct cost comparisons and overhead rate examinations. Table 1 summarizes the aforementioned studies. As shown in the table, most studies have found consultants to be more expensive than their in-house counterparts. While direct project charges have generally been taken straight from accounting databases, overhead rates have been more critically examined with regard to their composition. While in-house versus consultant costs have been compared on many criteria, the ratio of design costs to construction costs is the most popular approach.

TABLE 1
Summary of Past Study Findings

Study	Cost
Ward et al., 1987	Consultants more expensive.
Burke et al., 1987	Consultants more expensive
Ernst and Whinney, 1987	Consultants generally more expensive.
Fanning, 1992	Consultants cheaper than in-house staff.
Bezruki et al., 1990	No difference in cost.
Ashley et al., 1992.	No difference in cost
Laffoon et al., 1993	Consultants 31% more expensive. In survey of 10 states, eight said consultants more expensive and two said costs were the same.

COST COMPARISON METHODOLOGY

In general, previous studies have shown that it is difficult to measure design costs accurately. To add to these difficulties the type of projects and their complexity and size also affect any costs comparison. Some of the ways in which past studies attempted to establish more equitable conditions include:

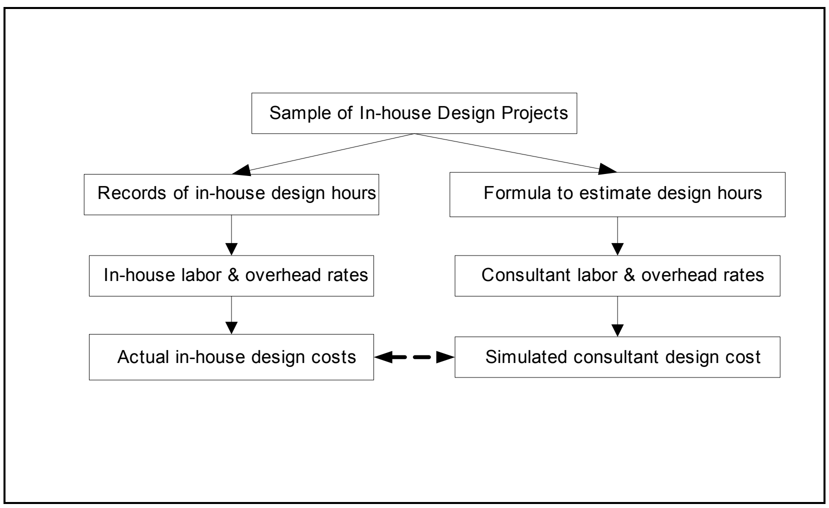
- Using the ratio of design cost over construction cost to eliminate the effect of the size of the project, and
- The pairing of projects to eliminate the effects of type of project, or
- Sampling to establish similar mixes of projects among those designed by in-house staff and consultants and to ensure that the results are representative.

Two interrelated problems can limit the usefulness of the approaches typically used to conduct the cost analysis. First, while the ratio of design cost over construction cost takes into account the influence that project size has on design cost, it is does not capture the impact of important factors such as the number of plan changes, unique environmental conditions where the facility is to be constructed, and design complexity. A measure which is capable of canceling out these additional factors is the ratio of design costs by in-house staff divided by the design cost by consultants for the similar projects. Finding similar projects, however, is difficult because it is commonplace to entirely outsource particular types of projects (e.g., waterway bridge designs) and retain others entirely in-house (e.g., interstate overpasses). Hence, pairing projects or drawing samples with a similar mix of projects is not possible.

A simulation approach was adopted by this study to overcome the lack of available comparable projects conducted by the public sector and a private sector counterpart. Three approaches were used to simulate the costs to either the public or private sector. The three approaches are as follows: (1) simulate consultant cost for projects done in house; (2) simulate in-house costs for projects done by consultants; and (3) simulate the cost of one "typical" hour of engineering design for each. Each approach is explained in turn.

In the first approach shown in Figure 1, only projects designed in-house are considered. The in-house design costs are determined from accounting records. Estimates of the consultant design costs of the same projects are simulated by using a formula to estimate consultant design hours for bidding purposes and then applying consultant labor and overhead rates as determined by average rates determined through audits of consultant records by the auditing division of the department. Comparisons then are made between the actual in-house costs and estimated consultant design costs by simulation of each project.

FIGURE 1
Methodology of Approach 1—Simulation of Consultant Costs

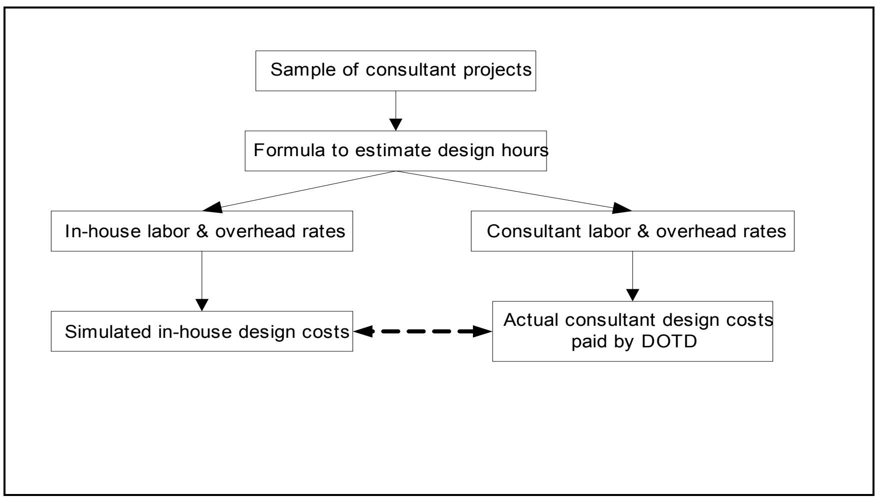


The design hours used in Approach 1 may be questioned on two counts. First, it is generally acknowledged by in-house staff that the record of in-house time may not be accurate. However, if there is a consistent bias to either under-report or over-report design time, the method used to incorporate "non-project" related time within the overhead will cause the overhead rate to be either inflated or deflated to compensate for the effect. Thus, while in-house recorded hours may be inaccurate, in-house total design costs should be accurate.

The second concern with the methodology of Approach 1 is more serious since there is no way in which it can be controlled. The concern centers on the fact that consultant design hours had to be specially estimated for these projects by in-house staff, and there is no guarantee that the design hours estimated were not consciously or unconsciously deflated to put in-house design times in a more favorable light. For this reason, the results of Approach 1 cannot be considered in isolation, and Approaches 2 and 3 were compiled to eliminate any bias introduced with Approach 1.

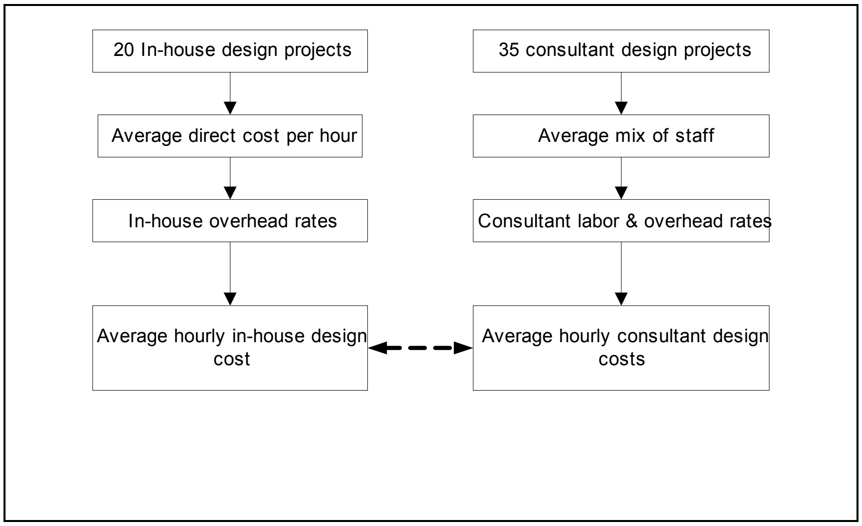
Approach 2 is described in Figure 2. In this approach, all the projects in the sample that were designed by consultants in the past are considered. However, contrary to Approach 1, the same design hours are used to estimate both in-house and consultant design costs. The design hours were extracted from the records of awarded consultant design contracts.

FIGURE 2
Methodology of Approach 2—Simulate In-House Costs



Approach 3 was developed to not depend on estimates of design hours for any particular project. Rather, for consultant projects, it considers the average mix of staff used on 35 randomly selected consultant projects and applies labor and overhead rates to determine the average cost of one design hour. For in-house projects, the recorded total cost and total time for 20 randomly selected projects is used together with overhead costs to estimate the average cost of one in-house design hour. The method is illustrated in Figure 3.

FIGURE 3
Methodology of Approach 3—Simulated Hourly Cost



Description of Project Sample

A sample of 20 preliminary or final designs from 14 in-house projects and 17 preliminary and/or final designs from nine consulting projects were selected. The projects chosen closely resemble a population of 73 projects with respect to bid estimate, engineering cost, and ratio of engineering cost to consultant cost. In addition, the projects also canvas all of the kinds of work done including river crossings, railroad overpasses, two-lane rural roads, intersections and four-lane rural roads. Only projects designed within the last five years were considered to avoid extensive adjustments of costs for time elapsed.

To generate the total cost of design projects, LaDOTD overhead is calculated at several levels of the organization and allocated step-by-step to finally reach the individual sections that work directly on the project. Step 1 is to determine the LaDOTD-wide support services' overhead rate and to assign this to each section in the department. Step 2 is to identify upper management supervision within the Directorate of Engineering and Program and Project Development and assign the cost to each section that it supervises. Step 3 is to determine supervision, clerical, and other indirect charges incurred in each section and add this to the cost estimates of the previous two steps to form actual indirect cost estimates for each section. An overhead rate is established by dividing total indirect costs for each section by the direct costs of that section. The end result is a single composite overhead rate for each section working directly on design projects that incorporates on LaDOTD-wide support services, upper level management, and the section's own indirect costs. The following tables (Tables 2, 3, and 4) show the overhead computation for three sections: (1) consultant contract services, (2) in-house road design, and (3) in-house bridge design.

TABLE 2
Overhead rate for Consultant Contract Services Section

Description	***Amount***
Section specific indirect costs	$217,056
Applied Overhead:	
Allocated In-house Supervision Costs	10,175
Insurance	25,489
Other Support Services	46,847
Total Non-Project Charges & Overhead	299,567
Divided by Project Charges	$91,151
Section Blended Overhead Rate	**329%**

TABLE 3
Overhead rate for Road Design Section

Description	***Amount***
Section specific indirect costs	$1,210,774
Applied Overhead:	
Allocated In-house Supervision Overhead Costs	77,869
Insurance	179,953
Other Support Services	330,748
Total Non-Project Charges & Overhead	1,799,344
Divided by Project Charges	$965,198
Section Blended Overhead Rate	**186 %**

TABLE 4
Overhead rates for Bridge Design Section

Description	***Amounts***
Section specific indirect costs	$1,408,574
Applied Overhead:	
Allocated In-house Supervision Costs	85,337
Insurance	196,525
Other Support Services	361,207
Total Non-Project Charges & Overhead	2,051,643
Divided by Project Charges	$967,786
Section Blended Overhead Rate	**212%**

LaDOTD conducts audits of consultant records as part of LaDOTD's oversight of consultant contracts. The 158% average overhead rate was found for 104 audits of projects completed by 37 consulting firms. The contracts also include a 13% profit factor. In addition, departmental supervision of the consultant contracts was found to add 15 percent to road design projects and 25 percent to bridge design projects. Table 5 illustrates how these additional factors affect the consultant overhead rate.

TABLE 5
Effective consultant overhead rates

Description	**Bridge Projects**	**Road Projects**
Average Consultant Overhead Rate	158%	158%
Net Effect of Other Factors on Overhead:		
13% Profit Factor	34%	34%
LaDOTD Supervision: 15% Road Design Section 25% Bridge Design Section	73%	44%
Effective Consultant Overhead Rates	265%	236%

Table 6 compares in-house road design and bridge design overhead rates to average and effective consultant overhead rates.

TABLE 6
Comparison of overhead rates

Description	**Overhead rates**
Road design section	186%
Bridge design section	212%
Average Consultant Overhead Rate	158%
Effective Consultant Overhead Rate: Road Projects Bridge Projects	 236% 265%

Two factors contribute to in-house overhead rates being higher than the average consultant overhead rate. First, LaDOTD's fringe benefit rate is nearly 58 percent compared to around 33 percent for consultants. Second, LaDOTD has a lower percent of labor time charged to projects. Consultants average 63 percent of labor costs charged to projects, while LaDOTD road and bridge design sections were substantially lower at 52 percent and 48 percent, respectively.

Salary Rate Comparisons

Although LaDOTD has higher fringe benefit rates, the base salary rates are lower than those of consultants. This is demonstrated in the next table.

TABLE 7
Comparison of base salary rates

Position Description	**Average Hourly In-house Base Salary Rate**	**Average Hourly Consultant Base Salary Rate**	**% Consultant/In-house Hourly Rate over/(under)**
Drafting	$10.55	$11.47	8.7%
Technician	12.64	15.45	22.2%
Pre-professional	13.94	16.35	17.3%
Engineer	22.32	26.14	17.1%
Supervisor	24.17	32.23	33.4%
Principal	34.53	40.18	16.4%

As shown in Table 8, salary rates with fringe benefits are nearly the same for three skilled positions (pre-professional, engineer, and principal); higher for consultants in two areas (technician and supervisor); and higher for in-house at another area (drafting). This suggests that, overall, total in-house labor costs are very similar to those of consultants on an hourly basis.

TABLE 8
Comparison of salary rates with fringe benefits

Position Description	Average Hourly In-house Salary Rate with Benefits	Average Hourly Consultant Salary Rate with Benefits	% Consultant/In-house Hourly Rate over/(under)
Drafting	$16.61	$15.30	(7.9%)
Technician	19.90	20.61	3.6%
Pre-professional	21.94	21.81	(0.6%)
Engineer	35.13	34.87	(0.8%)
Supervisor	38.05	42.99	13.0%
Principal	54.35	53.60	(1.4%)

ANALYSIS OF PROJECTS

To compare the cost of providing pre-construction engineering services by in-house staff or by consultants, two sets of project samples were analyzed using three separate analysis approaches. In each analysis, the costs of an actual sample of projects by one provider are compared with the estimated costs of the alternative provider. The following sections consider several cost features of the sampled projects. The additional costs incurred by LaDOTD in letting contracts to consultants are discussed. Costs related to the sample of in-house projects is discussed and analyzed. As applicable, the in-house and consultant overhead rates developed in this study are applied in the analysis of projects. In the first analytical approach the actual in-house costs are compared with estimated costs as if the project had been offered to consultants. The second analysis compares the costs of the sample of consulting projects to the estimated costs that would have occurred had the project been done in-house. The third analysis considers the average cost of one design hour for in-house and consultant staff. A summation [or summary] of the findings of the three approaches is included at the end of this section of the report.

Approach 1: Analysis of In-house Projects

Actual costs for 20 designs from 14 in-house projects were compared to the costs that would have been paid to consultants had LaDOTD contracted out the engineering design. Five preliminary plans and fifteen final plans were included in the sample. The sample has three types of waterway crossings (large, medium, and small), two-lane and four-lane rural highways, a railroad overpass, intersection improvements, and interstate rehabilitation. Since two of the projects include both bridge and road design, there are actually 22 comparisons made between in-house actual costs and simulated consultant costs. Nine bridge designs and thirteen road designs are included in the sample.

Cost comparisons and direct labor hour comparisons were made for the bridge and road sections. The in-house costs and hours are actual amounts charged to the projects. The consultant costs and hours are simulated by LaDOTD engineers according to the formula-based process used by LaDOTD to let contracts to consultants. It is important to realize, therefore, that the comparison being made is between actual in-house costs (and hours) to estimated consultant costs (and hours) that LaDOTD would have paid rather than costs (and hours) consultants might have incurred.

The audit division of LaDOTD periodically conducts man-hour studies to determine how the number of hours estimated by the formula compares to the actual hours incurred by consultants. Discussion with the audit manager in charge of these man-hour studies revealed that variances between estimated hours and actual hours was relatively small and did not suggest there was a systematic bias in the formula. Costs comparisons for both bridge and road projects appear in Table 9. The costs include labor, supervision, overhead, and direct costs for in-house and consultant projects.

In all cases, the in-house costs were less than costs that would have been paid to consultants. On average, in-house costs for bridge design were just under 76 percent of the simulated consultant costs. Among road projects, in-house costs were about 65 percent of those that would have been paid to consultants under the formula. Because of the large variation in project cost, a weighted average was used. The differences, in both cases, are statistically significant at the 0.1 percent level. The major conclusion of the cost comparison shown in Tables 6.2 is that in-house costs are significantly lower for both bridge and road projects. This result can be attributed to differences in the price of labor, indirect costs, or some combination thereof.

TABLE 9
In-house project cost compared to simulated consultant costs

Plan Type		***Bridge Design***			***Road Design***		
Prelim	***Final***	***Consultant***	***In-House***	***%.***	***Consultant***	***In-House***	***%***
	X	286,538	245,881	86%			
	X	387,191	206,798	53%			
	X	91,933	101,596	111%	126,035	80,930	64%
	X	165,992	172,682	104%	124,198	117,041	94%
	X	60,744	33,031	54%			
	X	98,356	80,310	82%			
	X	343,768	249,413	73%			
	X	142,240	133,744	94%			
	X				284,666	240,524	84%
X					57,352	13,567	24%
	X				55,420	20,967	38%
X					62,412	26,905	43%
	X				74,437	21,677	29%
	X	91,575	40,368	44%			
	X				271,589	226,127	83%
X					104,560	38,913	37%
	X				99,689	37,087	37%
X					146,177	83,951	57%
	X				133,397	99,552	75%

Approach 2: Analysis of Consultant Projects

A sample of nine bridge or road projects representing 17 preliminary and/or final designs by consultants was drawn for analysis. For each project, actual consultant costs were compared to simulated in-house costs using consultant labor hour amounts and current LaDOTD average salary rates for the same time period. This analysis results in significant differences in both bridge and road design as shown in Table 10.

TABLE 10
Consultant project cost comparison

Plan Type			***Consulting***		***In-House***		***% In-H./ Cons.***	
Prelim	***Final***	***Letting Cost***	***Bridge***	***Road***	***Bridge***	***Road***	***Bridge***	***Road***
X	X	$2,495,987	$80,721	$134,289	$66,757	$134,510	83%	100%
X	X	1,526,216	63,467	142,484	53,001	118,317	84%	83%
X	X	9,138,060	0	378,067	0	301,634		80%
X	X	993,616	0	80,805	0	55,008		68%
	X	3,167,176	0	96,808	0	62,091		64%
X	X	1,665,692	86,940	66,103	62,230	56,163	72%	85%
X	X	1,074,508	25,252	63,433	21,777	56,910	86%	90%
X	X	1,851,295	27,928	72,025	21,605	61,583	77%	86%
X	X	5,491,587	22,100	119,097	9,581	88,501	43%	74%

Simulated in-house costs average 83 percent of consultant costs for bridge design and about 81 percent for road design. Again, because of the large variation in project costs, the weighted average was used. Both of these differences are statistically significant at the 5 percent level.

Approach 3: Comparison of Average Design Hour Costs

The final approach focuses on effective hourly rates that consider the mix (or use) of staff. Table 11 shows the mix of staff for 35 randomly selected consultant projects. Based on this sample, a percentage mix of staff was computed for consultants.

Using the average of the consultant staff mix in Table 11, the cost per hour of a representative consultant project can be computed. A similar computation can be done for in-house projects. While the percentage of staff mix cannot be computed for in-house projects, an average hourly cost can be obtained by dividing total in-house direct cost of the projects by the total number of hours used for the projects. This average of $15.03 is considered the direct payroll cost per design hour at the LaDOTD. Table 12 shows the computations of the respective hourly salary rates. Adding the costs of overhead, profit, and consultant contract initiation and supervision provides a further comparison of in-house and consultant costs.

TABLE 11
Mix of staff for consultant projects

Type	***Hours***	***% Type***
Draftsman	13,689	30%
Technician	11,773	26%
Pre-Professional	8,934	19%
Engineer	7,963	17%
Supervisor	3,090	7%
Principal	370	1%
Total	45,819	100%

The upper section of rows in Table 12 gives the average salary rates for LaDOTD and consultants. The middle section of rows provides the overheads. The percentage of total payroll is then computed without and with the cost of LaDOTD supervision. The bottom section of rows shows the effect of the overheads on cost per hour. The average payroll cost per hour is $15.03 for the LaDOTD and $17.63 for consultants. Adding overhead, the average cost ranges from $43.07 to $47.04 at the LaDOTD and $48.47 for the consultants. This means that the cost per hour for in-house design is 89 percent that of consultants in road design and 97 percent in bridge design sections, respectively. However, adding LaDOTD contract initiation and supervision for projects results in 77 percent (road) and 77 percent (bridge) of consultant costs. Table 12 also shows clearly the main causes for the cost differences; namely, the LaDOTD has a lower base salary rate, and the overall salary additives for consultant projects including LaDOTD supervision are higher than LaDOTD overhead.

TABLE 12
Estimated cost per project hour

	LaDOTD		***Consultant***	
Type	***Road***	***Bridge***	***Road***	***Bridge***
Draftsman			11.47	11.47
Technician			15.45	15.45
Pre-Professional			16.35	16.35
Engineer			26.14	26.14
Supervisor			32.23	32.23
Principal			40.18	40.18
Overhead	186%	212%	143%	143%
Profit	0%	0%	13%	13%
Total Percent Payroll Overhead	186%	212%	175%	175%
Contract (Section 18,24,25)			5%	6%
Supervision (Section 24/25)			10%	19%
Total Percent Payroll Additive Incl. Contr.	186%	212%	188%	193%
Total Percent Payroll Additive Incl. Contr.&Superv.	186%	212%	216%	244%
Direct Payroll	$15.03	$15.03	$17.63	$17.63
Direct Payroll+Overh.	$43.06	$46.90	$48.47	$48.47
LaDOTD/Consult(%) without Contr.&Superv.			89%	97%
Direct Payroll+Overh. +Contract	$43.06	$46.90	$50.75	$51.60
LaDOTD/Consult(%) with Contr.			85%	91%
Direct Payroll+Overh. +Contract&Supervision	$43.06	$46.90	$55.65	$60.71
LaDOTD/Consult(%) with Contr.&Superv.			77%	77%

An overhead rate of 143 percent is used for consultants since this is the value that was established by the department from a statewide survey. This is different from the 158 percent overhead rate for consultants derived from the 37 audits conducted by the department. The 143 percent is the official value used by the department and is, therefore, used here. However, the difference between the statewide average and audited values is not large and would not influence the findings in Table 6.6 significantly.

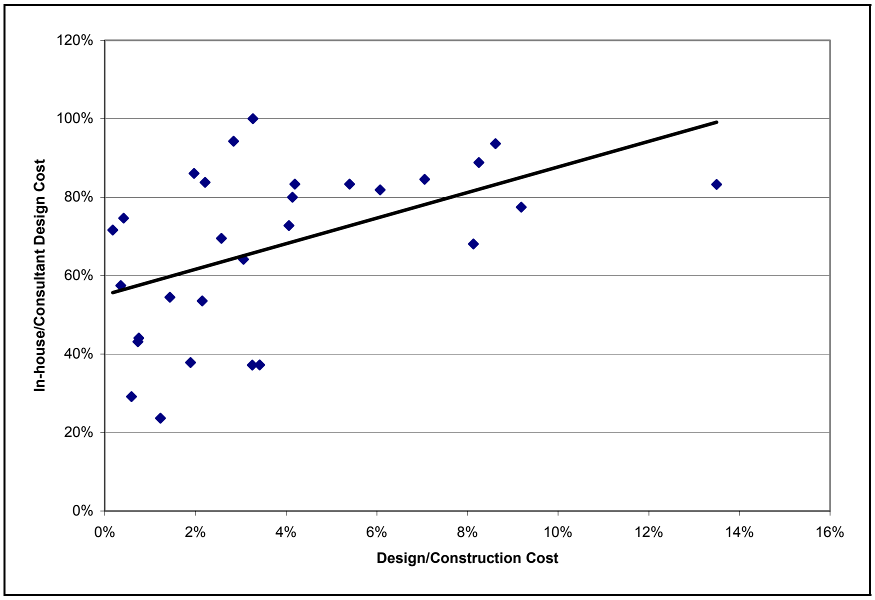
Table 13 summarizes the results of the three different approaches for comparing costs. Approach 1 comprises the analysis of actual in-house projects with simulated consultant costs, Approach 2 analyzes actual consultant projects with simulated in-house costs, and Approach 3 compares hypothetical hourly rates based on the mix of staff used by each. For bridge design, all three approaches give about the same result, namely, that in-house designs are about 80 percent of the cost of consultant designs. For road design, Approaches 2 and 3 give the same result. However, Approach 1 leads to a lower percentage for road design. Taken together, the results suggest that a collective interpretation could be that in-house designs are in the order of 80 percent of the cost of consultant designs.

TABLE 13
Comparison of approaches

Approach	***Sample***	***% In-house/Consultant***	
		Road Design Average	***Bridge Design Average***
1	In-House Projects—Simulate Consultant Costs	65%	76%
2	Consulting Projects—Simulate In-house Costs	81%	83%
3	Cost per Design Hour including mix of staff	77%	77%

The cost comparisons listed in Tables 9 and 10 show that there is substantial variation in the percentage of in-house cost over consultant cost. Figure 4 shows the percent of in-house over consultant cost plotted as a function of design cost divided by construction cost. The graph shows that as projects become more complex (i.e. the higher the percentages of design to construction cost) the consultant design costs become increasingly competitive with those of in-house designs.

FIGURE 4
Percent in-house/consultant cost by construction cost



POLICY FACTORS

The objective of this study was to compare the cost of providing pre-construction engineering services by in-house staff or consultants. In this section, factors other than cost are discussed that should be considered in deciding on an appropriate level of involvement of consultants.

The Transportation Research Board sponsored a study in 1984 of the use of contract services in state Departments of Transportation (Cook, 1985). The study included a survey among all state DOTs to establish current practice. Two-thirds of the respondents indicated that they do not use, or only occasionally use, cost as a factor in deciding whether to contract design work out to consultants or not. One of the common reasons quoted for using consultants is the need to accommodate fluctuating demand for services. The implicit assumption is that consultants can more easily accommodate fluctuating demand than a state department because of their more flexible hiring and firing policy. Closely associated with the issue of using consultants during periods of peak demand is the matter of meeting demands in a timely manner.

Consultants have a larger reservoir of manpower resources to draw upon and can be contractually induced to meet important deadlines. Consultants are also sensitive to meeting deadlines since their appointment to future projects depends in part on being able to deliver services on time.

Few state Departments of Transportation can afford to retain specialized design expertise on their staff for complex designs that arise infrequently. Such specialized expertise could involve the design of large bridges or complex freeway interchanges. In such cases, it is more cost-efficient to make use of consultants to provide such expertise. Allied to this issue is the matter of proficiency through experience. For example, if consultants are regularly used to perform certain types of designs, they are more likely to become more proficient in producing such designs. Similarly, in-house staff may, through custom, perform most of the designs of another type and, therefore, become more proficient in that area. Identifying such areas of distinct capabilities is an issue that administrators of the program should be mindful of in providing the most efficient delivery of designs for the department.

Qualifications-based selection of consultants not only serves to ensure quality of consultant design work, but it also serves to reduce the degree of departmental supervision needed. The Louisiana LaDOTD uses a rating system to evaluate the performance of its consultants, and this is used to identify those consultants who, in the opinion of the LaDOTD coordinators serving as contact persons between the consultants and the department, are the most efficient in performing their design tasks. In some states, consultants are handling the majority of the state's design activities. Can in-house staff retain the necessary design skills and experience to effectively check, evaluate, and approve designs without personal design experience? Indications are that a department can quickly lose (through resignations and transfers) the experience necessary to effectively supervise design activities in the department if there is not an ongoing design service being performed in the department (Lay, personal communication, 1997, October). Another factor is that in-house staff deserves the opportunity to develop their careers in the department in a meaningful way. Having no or little previous design experience adversely affects the ability of in-house staff to gain new experience for a career. If engineers are to be retained, career development opportunities must be maintained in the department.

CONCLUSIONS

The objectives of this study were: (1) to identify and compare the cost of providing pre-construction engineering services to LaDOTD when these services are provided by in-house staff or by consultants, and (2) list other factors that are relevant to establishing an optimum balance between the use of in-house staff and consultants in providing pre-construction engineering services. The cost of providing road and bridge designs to LaDOTD is, on the average, lower when provided by in-house staff than by consultants. The best estimate of the average cost for in-house designs is that it is 81 percent the cost of consultant designs for road projects and 83 percent the cost of consultant designs for bridge projects.

The factors other than design cost that are relevant to establishing an optimum balance between in-house and consultant design work include the need to accommodate fluctuating design demand, being able to meet deadlines, having access to specialized expertise, having flexibility in workforce size, supporting the state's consulting industry, maintaining a core of consultants who are experienced in departmental requirements and standards, maintaining in-house capability to effectively supervise consultants, and maintaining an environment in the Department which adequately serves the training and career development needs of in-house staff.

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