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Comparing transportation project development efficiencies: the California department of transportation and the California county sales tax agencies

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Abstract

Finding time and cost efficiencies associated with preliminary and final design of transportation projects has become increasingly difficult. Major new complexities present interesting and challenging project management issues and many agencies have incrementally adapted the project development process to improve efficiencies. Yet our understanding of the project development process is limited and the incremental changes in the process have not resulted in major modifications in the way in which transportation project development is approached for most agencies. A time honored method for elucidating problems with project development and potential solutions to them has been through the use of governmental audits. For example, over the past 30 years some 14 performance audits and evaluations have conducted of the California transportation project development process. These California audits have suggested that voter or legislatively approved projects, in terms of time, cost, or scope, significantly enhance project efficiencies. In this study, we examine time and cost project development efficiencies between voter or legislatively approved projects and projects with standard scopes. We find no significant evidence that state highway projects with highly defined, voter or legislatively approved project scopes, time, or costs are any more likely to have lower project development costs or times than projects with non-voter approved scopes.

Keywords: Transportation projects; California audits; Time and cost difficulties

1. Introduction

One of the most important problems facing transportation systems managers is the difficulty in developing major transportation projects on time and at reasonable costs. Among the complexities encountered in the development of transportation projects are issues associated with the presence of new and expanded permitting requirements (NCHRP Report 371, 1995) and the need for additional training and expertise for project management and staff (Deakin, 1991; Rutherford, 1993). In the US alone, new statutes and permitting requirements cover a range of project design features associated with the environment, historic preservation, endangered species, occupational health and safety, hazardous waste, right of way acquisition, park and farm land preservation, scenic resources, and public involvement; all of which can increase project development time and costs while making the process extraordinarily complex (SRI International, 1994).

Yet the time and cost difficulties associated with these changes have not resulted in any major modifications in the way in which transportation project development is approached. Most agencies rely on past project development activities to delineate major project tasks; these tasks are then incrementally modified over time to reflect changing conditions and requirements. A time honored method for elucidating problems with project development and potential solutions to them has been through the use of governmental audits. For example, over the past 30 years some 14 performance audits and evaluations have conducted of the California transportation project development process. As might be expected, the audits and evaluations have identified lengthy times and high costs as the most frequent problems encountered in project development.

Attempts at improving transportation project development have largely focused on such strategies as developing time and costs benchmarks for the performance of each specific task associated with project development (e.g. Reed, Luettich, and Lamm, 1993); examining the relationship between transportation expenditures and system performance (e.g. Hartgen, 1992), and passage of 'use or lose it' legislation. Several California audits have also suggested that developing more explicitly defined project

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scopes might serve to reduce time and cost of project development. In one recent audit several examples were given of transportation projects delivered in substantially less time, and at less cost than the norm (Californians for Better Transportation, 1994). Many of these projects were on the state highway system, but had been managed by organizations other than the California Department of Transportation (Caltrans). The projects had one important attribute in common: the project scope, cost, and delivery times were very specifically defined and approved by ballot measure. The effect of the ballot measure was to reduce the need for extensive alternative studies, thus reducing both project development time and cost.

The project examples cited in the Californians for Better Transportation audit were developed by the County Sales Tax Agencies (STA) of Santa Clara County Traffic, Contra Costa Transportation, Los Angeles MTA, and the Orange County Transportation Authorities. The STAs use sales tax funding to design and construct individually identified (and highly defined) transportation projects; the majority of the STA transportation projects to date have been projects on the state highway system, which has historically been the sole purvey of Caltrans. The STAs are created by election for a finite term and when the term expires, the STA is terminated unless county voters grant further sales tax authority. Out of 58 California counties there are currently 17 such county agencies. The Los Angeles County STA, the Metropolitan Transportation Authority, is the only agency without a termination date.

In one of the few studies of the STAs, Razo and Murry (1995) partially validated the advantages of having highly defined project development parameters. Based on their findings, they concluded that Santa Clara County STAs efficient completion of state highway transportation projects was due, at least in part, to a tightly defined scope of work that had to be completed within a specified time frame. The authors also attributed project success to aggressive project management by the agency. One important limitation to this study was it only addressed one (fairly unique) sales tax organization that may not have been representative of the other 16 STA organizations.

In this paper, we report on a recent evaluation of the project development processes used by Caltrans and the STAs. Specifically, we compare the development times and costs of voter approved, highly defined projects to those projects having more general scopes. We hypothesized that project managers of major transportation projects with clearly defined, voter approved project scopes, constrained cost parameters, and identified time limits tended to develop projects in shorter time, and at less cost. To evaluate this hypothesis, we draw upon 2 years of data collection of transportation project information, which includes interviews with 63 project managers from both Caltrans and the STAs. The study focuses exclusively on project development on the state highway system.

2. Empirical setting

Our data are based on interviews conducted with 44 Caltrans project managers and 19 STA project managers. The project managers selected for interviews were those most recently involved in the project development of large transportation projects (generally exceeding one million dollars in development costs). Access to these project managers within Caltrans and the STAs could not have been possible without agency cooperation. It is also important to note that projects developed on the state highway system are more or less similar in nature, and thus, by interviewing both Caltrans and the STA's we can readily compare project development differences between the two organizations.

During personal interviews we gathered information related to each individual project manager and their most recently completed, or almost completed major project. Three categories of data were collected: project manager demographics, project specific data, and organizational attributes. The demographic information included age, sex, licensing, years as a project manager, and the number and range of projects managed. Project managers were also asked to identify, from their perspective, the major project development barriers. Questions were directed toward several possible major barriers including political sensitivity, complexity of project development, difficulty in right-of-way acquisition, and regulatory permitting.

Finally, we asked 11 questions designed to gauge the level of delegation of authority given to the project manager for project development from the respective agency. These 11 questions queried information on such items as who had authority to increase the project budget, to increase project overall time in development, to deviate from design standards, to sign the project design plans, to control project cost and schedule, to sign and send letters on project matters without supervisory review, and to meet independently with politicians. It was assumed that each project manager perceived the importance of these items of delegation differently in the successful development of a project. It is also assumed that this difference in perception is partly based on each manager's experiences, the organizational norms, the specific project being contemplated, and the ability to receive timely decisions for those items not controlled by the project manager.

To explicitly weigh each survey response and compute a single measure of perceived delegation for each project manager, we obtained a team of 10 experts to evaluate and weight each question. The experts represented a total of over 243 years of experience in project management, specifically on transportation projects. The experts were directed to divide 100 points among the 11 delegation questions: the distribution indicated the importance of each question. The 10 expert scores for each question were then averaged to weight each question. We computed a composite (additive) score on perceived delegation of authority for each project

Table 1
Demographic characteristics

Description of survey question	Caltrans project managers ($N = 44$)	Sales tax agency project managers ($N = 19$)
Average time as a project manager (years)	3.5	7
Average age of the project manager (years)	38	38
Licensed as civil engineers in California (%)	95	74
Male (%)	89	100
Project managers that state project development time is important (%)	100	100

manager based on the survey response and the expert weighting.

Although the experts differed on many of the survey questions, all tended to weight two of the questions more heavily: the ability of project managers to control: (1) cost and (2) time. That is, the experts tended to agree that project managers perceiving greater levels of project development time/cost control would tend to have greater delegation of authority. While the other nine items in the questionnaire on delegation were of importance, the feedback from the experts was that the project manager's most important responsibility to control project scope, time, and cost, and in order for a project manager to perceive project ownership, the control of cost and time must be delegated to the project manager.

Project related information, on the project manager's most recently completed project, on project development time/cost was collected across four categories: environmental/preliminary design studies, final design, capital right-of-way, and construction. Construction costs included construction administration, oversight, inspection, and material testing of the construction project. Additional project related information included the type of environmental document, type of project (i.e. freeway, conventional highway, bridge, or other), degree of urbanization, surrounding terrain, source of funding, whether the project scope was voter approved, and whether or not litigation was served or filed on the project.

Finally, data were also collected on organizational attributes and included the number of projects currently managed by each project manager, the location of the project design, and the location of the project manager's supervisor. We also collected information on the number of project managers that had been assigned to each specific project, the number of management levels above the project manager, perceptions of the agency's willingness to deviate for cause from agency standards, the agency's concern for the time and cost of project development, and the expected agency reward for superior project management performance. We are happy to provide the survey upon request.

We interviewed project managers selected by Caltrans and STA management. These individuals were selected by each agency in accordance with our request to interview all available project managers with project management experience in all three phases of project development: environmental/preliminary design, final design, and construction. Each project manager was interviewed according to a pre-agreed schedule and format. The interview began with a general explanation of the research, including the purpose, overall goals, data to be collected, and possible results of the research. The typical interview lasted 50–55 min; the shortest interview was 45 min and the longest was 90 min.

For the purpose of our analysis, we have divided project development time into three phases: the environmental phase, which includes the preliminary design effort; the project final design phase; and the construction phase. Costs were divided into the same three categories with the addition of a fourth category for capital right-of-way. We have limited our analysis in this paper to the environmental/preliminary design and final design phases to be consistent with the audit review.

3. Results

3.1. Project manager demographics

Beginning with the basic demographics, from Table 1, it can be seen that Caltrans and STA tax managers are approximately same average age (38). The average (interviewed) STA project manager had about 7 years experience versus three and one-half for the Caltrans project manager. One implication of the difference in years of experience is that with twice the experience in project development, the STA managers should be more knowledgeable about the complex development process. While time alone does not indicate competence, greater experience aids the project manager in understanding the barriers and pitfalls in the development process. We would expect this knowledge to translate into more efficient project development.

As Table 1 reflects, of the Caltrans project managers we interviewed, 11% were female versus no females among the surveyed STA project managers. Caltrans offers training and staff development for newly hired staff that can lead toward project management positions, while sale tax project managers were typically brought into the STA as project managers. The STA, with small staffs, do not have the opportunity to train and develop new staff as easily as Caltrans with a larger more stable organization. This might be a partial explanation for the difference in gender.

Of those interviewed, 74% of the STA project managers

Table 2
Projects information from the interview survey

Description of survey question	Caltrans projects ($N = 44$)	Sales tax agency projects ($N = 19$)
Average time (mo) environmental/preliminary design phase	38.4	31.8
Average time (mo) final design phase	31.8	31.1
Average time (mo) project construction	21.0	30.9
Average total time (mo) for project development	91.2	93.8
Average cost ($) environmental/preliminary design	$1,946,200	$5,293,500
Average cost ($) final design	$5,949,200	$6,547,400
Average cost ($) for the construction	$47,979,200	$53,983,200
Average cost ($) right-of-way	$32,777,100	$14,794,100
Average cost ($) total project	$88,651,700	$80,618,200
Projects with EIR env. document (%)	36	32
Projects with negative declaration env. document (%)	23	63
Projects with categorical exceptions (%)	41	5
Freeway projects (%)	57	74
Road rehabilitation projects (%)	9	5
Conventional highway/other project types (%)	34	21
Projects in an urban area (%)	57	63
Projects in a suburban area (%)	7	16
Projects where terrain is flat (%)	48	58
Projects where terrain is rolling (%)	30	26
Projects where terrain is mountainous (%)	22	16
Projects with voter approved scope, cost, or time (%)	11	63
Projects with federal funding	80	57
Projects delayed by agency management (%)	43	21
Projects in which a litigation warning was made (%)	18	11
Projects in which litigation was actually filed (%)	16	16

had civil engineering licenses versus 95% for Caltrans. Caltrans typically requires a civil engineering license for its higher-level staff. In contrast, the STA have generally hired project managers from the private sector, some of whom are not licensed civil engineers. The two interviewed Caltrans project managers who were not licensed civil engineers were trained in landscape architecture and planning.

3.2. Project specific information

From Table 2 it can be seen that Caltrans projects took an average of 7 months longer in the environmental/preliminary design phase than STA projects and less time to complete construction. A breakdown by agency of the environmental/preliminary design phase for the differing environmental type documents shows the following times: for an EIR (Environmental Impact Report)/EIS(Environmental Impact Report) type of document, Caltrans took on average 47 months versus 41 for STA projects; negative declarations took Caltrans an average of 35 months versus 30 for STA projects; and categorical exemptions took an average for Caltrans of 10 months versus 8 for STA projects.

Differences in time for environmental/preliminary design phase might be partly explained by interview feedback from Caltrans project managers that cited delays when there were unusual or specialized environmental issues. The Caltrans project managers indicated that there was a required process for obtaining outside environmental consultants that was both rigid and lengthy.

The average project construction time was 21 months for Caltrans and almost 31 months for the STA projects. However, it is important to note that the type of project influences project construction times. Freeways comprised 74% of the STA projects versus 57% of Caltrans projects. Most freeway projects had several bridge structures, which added considerable time to construction.

The average cost for environmental/preliminary design for the surveyed Caltrans projects ($1.9 million) was much less than the average cost for STA projects ($5.3 million). One of the main reasons for this difference is that 41% of the Caltrans projects were categorically exempt from the environmental process versus only 5% of the STA. Many of the Caltrans projects included in the survey were maintenance-related, including a large number of seismic retrofits of existing structures; these projects were categorically exempt from the environmental process. Almost all of the STA projects required a negative declaration/FONSI (Finding of No Significant Impact) or an EIR/EIS environmental documentation.

The cost of the right-of-way for the surveyed Caltrans projects was over $32 million versus $15 million in cost for STA right-of-way. While this is a large difference, right-of-way costs depend mainly on the projects that each agency is developing. The STA projects often include widening within existing right-of-way and road closure gaps where the right-of-way already exists. Despite differences in right-of-way and environmental/preliminary design costs, the average total cost of projects, approximately $80 + million, were similar between the two agencies.

As noted earlier, the predominant types of environmental documentation undertaken by Caltrans and the STA were very different. For the surveyed projects, the full EIR/EIS documentation was undertaken 22 times (out of 63 projects); 16 times by Caltrans and six by STAs, roughly the same percentage of total projects (32% of Caltrans projects, 36% of STA projects). However, more negative declarations (63%) were found on the STA projects when compared to Caltrans projects (23%). Again, in part this is due to the types of projects undertaken by each agency. One interesting finding was that in some geographic areas the use of the categorical exemption is more frequently allowed than in other areas. For example, the categorical exemption tended to occur more often in rural areas, where there are fewer sales tax projects. It is somewhat counterintuitive that rural areas have more categorical exemptions since it could be assumed than rural projects would potentially have a greater probability of environmental impact. Our survey found that 8 out of 10 projects in far northern California were categorically exempt.

Of the STA projects included in our survey, 74% were freeways, 21% conventional highways, and 5% rehabilitation. In contrast, the surveyed Caltrans projects were 57% freeway, 34% conventional, and 9% rehabilitation. The difference in the project mix reflects a desire by the STAs to present more important projects to the public for a vote on sales tax funding. In general, it is assumed that the public is more likely to support additional tax dollars for a congestion relief project than a rehabilitation project. Most of the surveyed STA projects (63%) were within urban areas, with 16% in suburban areas and only 21% of the projects in rural areas. By comparison, of the Caltrans projects surveyed, 57% were urban, 7% suburban, and 36% rural.

The majority of surveyed STA projects (63%) were highly defined in terms of project scope and timing, and designated by the empowering sales tax vote. However, there were many projects, 37% of our survey sample, developed by the STA that were voter approved in scope or were new (non-voter approved) projects. The new projects were allowed as alternatives to the approved projects. By comparison, only 11% of Caltrans projects were voter approved and administratively assigned, sometimes by the legislature or by agreement with a STA. Seismic retrofit projects are an example of an administratively assigned project with a highly defined scope. Voter or legislatively assigned projects are generally assumed to be less costly to develop since they require fewer alternative design studies.

The majority of Caltrans projects we surveyed (80%) were financed in part by federal funding. This compares to 57% of STA projects that were at least partially funded by federal monies. When STA projects are funded with sales tax only, there are fewer constraints than for projects with federal funding. These constraints include, for example, the time consuming and complex process of requesting federal funding for each project phase. Until the federal funding is approved no development work on that requested phase can proceed. Caltrans relies on federal funding in order to perform their planned program, but with the federal funding comes a large number of regulatory requirements that add both time and cost to project development.

In our survey, a large number of both Caltrans (43%) and STA (23%) projects were delayed by management. The Caltrans project delays were mainly the result of changes in program priorities. In particular, in the period following the Northridge Earthquake, Caltrans shifted significant project funding to seismic retrofit projects. This shift resulted in delayed projects until new funding could be identified. STA management also delayed projects but to a lesser degree. Most of the delays were the result of unforeseen conditions and political decisions. For example Route 238 in Alameda County is an STA project funded by sales tax in 1988 that has been delayed over 12 years due to political and public opposition. Project delays increases project development costs and time due to a variety of circumstances such as changing conditions on adjacent properties, changing standards, inefficient use of resources, and personnel changes.

3.3. Organizational attributes

As seen in Table 3, the Caltrans project managers we surveyed were assigned to manage an average of 31 projects, while Sale Tax Agency project managers were assigned on average, 12 projects. The large difference in project management responsibility has important implications. During the interviews, Caltrans project managers noted there was little time to review plans, participate in planning for their future projects, perform project quality control, or anticipate and be proactive in problem solving. Under the current load, Caltrans project managers stated they have little time to do more than project reporting on schedule, cost, and scope.

Caltrans has seven centralized locations for project design within the state. The state is composed of 12 regions, or districts, with state highway miles and project managers located in each district. For the surveyed Caltrans projects, 23% of the design effort was performed in a different location than where the project and project manager were located. In 9% of the Caltrans projects, the project manager's supervisor was located in a different district than the project manager. This centralization of Caltrans design effort sometimes results in communication problems and increased travel for the project managers, project manager's supervisor, and project development staff. In the STA the project manager's supervisor is located in the same office as the project managers (for those we interviewed).

The majority of both Caltrans (77%) and STA (95%) project managers felt that their agency was very concerned about project development time and cost. However, only 9% of Caltrans project managers believed that their agency was

Table 3
Organizational attributes

Description of survey question	Caltrans	Sales tax agency
Average number of projects managed currently by the project manager	31	12
Percent of design effort located in different location than project	23	0
Percent of project manager's supervisor located in different location than the project manager	9	0
Average number of project managers on a project during development	1.9	2.0
Average number of levels of management to district director or executive officer	2.3	2.5
Percent of project managers that believed their agency is very concerned about time/cost of project development. (Possible responses: very concerned, concerned, not concerned)	77	95
Percent of project managers that felt their agency would be very willing to deviate from standard plans and procedures to save time and cost. (Possible responses: very willing, possibly willing, not willing)	9	74
Percent of project managers that believed the agency would usually reward a project manager for project development costs lower than anticipated. (Possible responses: very concerned, concerned, not concerned)	0	26
Percent of project managers that believed the agency would usually reward a project manager for project development times lower than anticipated. (Possible responses: usually, sometimes, never)	2	32
Weighted score for project delegation authority. (Out of 100)	35.4 ($\sigma = 18.0$)	48.9 ($\sigma = 21.0$)
Percent of project managers who believe they have the authority to control project development costs[a]	52	74
Percent of project managers who believe they have the authority to control project development time[a]	32	63

[a] These two questions represent two of the eleven questions used in determining the delegation score. Recall that the experts weighted these two questions most highly.

very interested in changing standard designs and procedures to save development time and cost. This contrasts to 74% of the STA project managers who indicated that their agency would be willing to deviate from standards to save time and cost. This important difference in perceptions about the respective organization's willingness to change from adopted standards has several implications.

First, it is apparent that Caltrans project managers have been trained to avoid deviation from the standards, or believe their superiors unwilling to deviate from the standards. Alternatively, STA project managers seem to be more willing to deviate from standards and procedures that are unwieldy. Even though Caltrans project managers perceive that management wants lower costs and quicker delivery times, deviation from standards is usually not the accepted method for achieving these goals. This organizational mindset can perpetuate use of outdated standards and procedures, and inhibit innovation.

One example is Caltrans procedure for the public bidding of a project for construction on a state highway. After the final design is completed in the Caltrans district, the project is sent to Caltrans headquarters to be rechecked. Contra Costa County STA has instituted a recent change in this standard procedure that eliminates this extra step, and check of final plans and specifications. This modification of procedure on a state highway project can result in a reduction of up to 6 months in overall project development time. Another example is the early projects in Santa Clara County STA where the Caltrans project development staff were moved to the project site under the control of the STA. This further decentralization is believed by Santa Clara STA to have been one reason that many of the early Santa Clara projects were completed in short time periods.

Our survey indicated that less than 2% of Caltrans and approximately 30% of the STA project managers felt their agencies would be likely to offer a reward for reduction of time or cost of project development. That is, there appeared to be little organizational recognition for project success from either organization, but particularly from Caltrans. This includes even simple rewards such as recognition.

STA project managers believed they were delegated more overall authority than Caltrans project managers for project development. A majority of STA managers (74%) felt they could control project development costs versus 52% of the surveyed Caltrans project managers. Overall, fewer project managers in both agencies felt they could control project development time: 63% of STA project managers versus 32% for Caltrans. The project manager's perception that they are unable to control project development time or cost results has consequences, the most serious of which is a lack of motivation to control a project time or cost. From both the SRI International and Californians for Better Transportation audits, lack of real project management authority can lead to dispirited staff, high turnover of qualified personnel, and poor project management.

3.4. Relationship of voter approved project scopes to project development time/cost

Recall that one of the purposes of our research was to analyze two basic relationships:

- the relationship between project development time for the environmental/preliminary design phase and the final design phase, and factors related to project scope (i.e.

Table 4
Model variables

Project Manager Demographics
Age of the project manager (yes = 1; 0 otherwise)
Time as a project manager
Licensed as a Civil Engineer (yes = 1; 0 otherwise)
Sex (F = 1; 0 otherwise)
Importance of time to the project manager (Very Concerned, Concerned, Not Concerned)[a]
Project specific details
Time/Cost by development phase
Cost for capital right-of-way
Type of environmental document (Exempt, FONSI, EIR/EIS)[a]
Difficulty with the environmental process (Considerable, Moderate, Little)[a]
Sensitivity of project (political) (High, Medium, Low)[a]
Difficulty with right-of-way acquisition (Severe, Moderate, Minor)[a]
Difficulty obtaining regulatory permits (Severe, Moderate, Minor)[a]
Project complexity (Very Complex, Moderate, Easy)[a]
Type of project (Freeway, Arterial, County Road, Bridge)[a]
Location of project (Urban, Suburban, Rural)[a]
Project terrain (Mountainous, Rolling, Flat)[a]
Type of funding (Federal = 1; 0 otherwise)
Project with voter approved scope, cost, or time (yes = 1; 0 otherwise)
Delay of project by agency action (yes = 1; 0 otherwise)
Litigation filed or served on the project (yes = 1; 0 otherwise)
Organizational aspects
Agency developing the projects (1 Caltrans; 0 otherwise)
Design effort in a different location from the project manager (yes = 1; 0 otherwise)
PM supervisor in a different location than the project manager (yes = 1; 0 otherwise)
Average number of project managers assigned to a project
Levels of management above the project manager to the District Director
Perceived agency concern about time or cost of project development (Very Concerned, Concerned, Not Concerned)[a]
Perceived agency concern about deviation from standard plans and specifications (Very Concerned, Concerned, Not Concerned)[a]
Perceived agency's reward for lower/time or cost of project development (Usually, Sometimes, Never)[a]
Agencies delegation of authority to project managers
Number of projects currently managed by the project manger

[a] $(N-1)$ variables are coded in the standard fashion.

voter approved or not), the controlling agency, and organizational management and

- the relationship between project development cost for the environmental/preliminary design phase and the final design phase, and factors related to project scope, the controlling agency, and organizational management.

Mathematically, we can specify a model

$$Y = B_0 + \sum_{i=1}^{p} B_i X_i \quad (1)$$

where Y represents time/cost variables for the environmental/preliminary design phase and time/cost variables for the final design phase. The Bs are estimatable coefficients and the Xs represent a vector of independent variables. We specified four models, one for each of the time/cost phases.

It is important to also recognize that transportation projects are complex. Our research attempted to collect variables that, we believed, most impacted time and cost of project development. In the collection process we discovered that a few of the projects (three) had variable conditions that were so unique to that project that they were not 'typical' by any measure. We chose to exclude these projects from our analysis, as all had construction costs in excess of $200,000,000 and/or a very long time in either the environmental/preliminary design stage or the final design phase for project development. Table 4 presents the variables used in our research by categories. The information for the many variables in our analysis came directly from the personal interviews with the project managers. The standard tests for multicollinearity and heterogeneity were also conducted.

3.4.1. Project development time models

Table 5 presents the results for the environmental/preliminary design model. Before reviewing our findings, we should note that since there was a relatively small sample of projects and transportation projects are, in general, complex, we applied a statistical significance level of 0.10 rather than the traditional 0.05. Given the complexity of factors that might impact project development, we did not want to overlook individual variables that might have a relationship with project development time/cost because of insufficient power.

Turning to Table 5 (top half), the model indicates that voter approved project scopes do not significantly reduce preliminary design development time. Recall that this variable is coded 1/0 and is used to indicate those projects in which a ballot measure was approved and the project scope was very well defined. Although the variable is not statistically significant, the positive coefficient is somewhat counterintuitive; the coefficient indicates that the project environmental/preliminary design time is higher for projects with greater project scope specificity than for those projects that did not require voter approval. One possible explanation for this may be related to our project sample. We noticed that our surveyed voter approved projects had higher construction costs than the non-approved projects. The higher costs suggest greater complexity and scope than the less costly projects.

The time of the environmental/preliminary design phase is significantly and positively related to the type of environmental document prepared. Preparation time for an EIR (coded as EIR = 1), is considerably longer than either a negative declaration or a categorically exempt type document. The EIR type of environmental clearance requires additional studies with greater levels of detail.

Litigation served on a project will delay final environmental certification and can significantly delay projects. Litigation is usually served with intent to delay, modify, or stop a project from continued development. Litigation can result in additional studies and additional design alternatives

Table 5
Time models

Independent variable	Beta Coef.	t-value	Sig.
Preliminary/environmental design ($N = 53$, $R^2 = 0.50$)			
Constant	0.9	−0.105	0.917
Voter approved project scope	20.8	1.408	0.166
EIR type of environmental doc.	31.5	2.008	0.051
Litigation served on project	72.7	3.344	0.002
Location in suburban area	45.2	2.087	0.042
Dev. in different district/location	44.7	2.705	0.010
Final design ($N = 53$, $R^2 = 0.51$)			
Constant	6.3	1.365	0.178
Voter approved project scope	7.4	1.489	0.143
Very difficult right-of-way acquisition	10.8	2.109	0.040
Project delayed by agency	16.4	3.162	0.003
Number of project managers	6.6	2.744	0.009

Table 6
Cost models

Independent variable	Beta Coef.	t-value	Sig.
Preliminary/environmental design ($N = 53$, $R^2 = 0.52$)			
Constant	282,534	2.907	0.006
Voter approved project scope	96,486	0.573	0.570
EIR environmental document	852,617	4.614	0.000
Project located in suburban area	746,769	2.981	0.005
Project delayed by agency action	374,392	2.359	0.023
Final design ($N = 53$, $R^2 = 0.58$)			
Constant	−1211,211	−2.131	0.038
Voter approved project scope	913,475	1.587	0.119
Severe difficulty with permits	1585,206	2.678	0.010
Freeway project	851,386	1.692	0.097
EIR required for project	2611,305	4.275	0.001
No. project managers assigned	769,748	2.986	0.004

can, in turn, significantly extend the time to complete the environmental/preliminary design phase.

The project location variable was significant and positive. This indicates that projects located in suburban areas have a longer environmental/preliminary design phase than projects located elsewhere. Feedback from surveyed project managers indicated that suburban projects often had increased citizen participation. This resulted in additional alternatives that had to be studied, more public hearings, and increased political sensitivity.

The results also shows a significant increase in time for the environmental/preliminary phase for projects that are developed in a different locations that where the project manager is located. This variable is a result of the centralization of design effort in the Caltrans organization and the relocation of the project development process for some projects. When the project manager lacked day-to-day contact with the staff performing the work, there was a significant increase in this phase's development time for the projects we studied.

The results for the final design time model are shown in Table 5 (bottom half). As can be seen final design time is affected by difficulty with right-of-way acquisition, delay caused by the agency, and number of project managers assigned to the project. The time of final design is not significantly affected by project scope specificity (i.e. voter or legislatively approved projects tend to have more highly defined project scopes).

Difficulties with right-of-way acquisition can significantly extend final design time while the project property is obtained. Federal and state requirements do not allow proceeding with the construction of a project until all rights-of-way have been acquired or are under the control of the contracting agency.

Agency delay had significant and positive impact of the time of final design. These delays are created by factors such as shifting priorities, lack of funding, or lack of availability of qualified staff. Examples of these delays include the shift from prioritized projects in the late 1990s to seismic upgrading of bridges throughout California.

The number of project managers assigned to a project can also significantly and positively impact the time of final design. Assigning a new project manager to a complex project can extend the final design time while the manager is gaining project understanding. While this project understanding is taking place, the new project manager can order redundant or unnecessary work. The results of poor management direction can result in extended project delivery time. In addition, multiple project managers on a project may well indicate a lack of upper management commitment to a project. When a project manager can be assigned to a project for its duration, more efficient project development should result.

3.4.2. Project development cost models

Table 6 (top half) presents the results for the environmental/preliminary design cost model. The final model indicated three statistically significant variables affecting the cost of this phase: the type of environmental document, delay by the agency, and the location of the project. Again, the project scope specificity (i.e. voter or legislatively approved) was not significant

Having to complete an EIR or an EIS, significantly increases the cost of environmental/preliminary design when compared to projects with a negative declaration or a categorical exemption. In some projects in our survey, the cost and complexity of the EIR rivals the cost of the total final design cost.

The location of the project significantly and positively impacts the environmental/preliminary design costs. In this phase, projects in the suburban area were more costly to develop than projects located elsewhere. Surveyed project managers indicated that the degree of involvement by affected suburban residents increased costs. When transportation projects are through or near suburban neighborhoods the number of alternatives studied and the public participation process grows. In short, increasing the number of additional alternatives studied as well as increased public participation significantly increases project development costs.

Finally, as shown in Table 6 agency delays are significant and positive in their effect on environmental/preliminary design costs. When projects are delayed, standards change, studies need to be redone, start up time is costly, reeducation of the project team is required, and new regulations may be enacted negating some past work. Once started it is most efficient to continue this phase of project development until completion.

The results for the final design costs are shown in Table 6 (bottom half). The final model indicates three variables are significantly related to final design cost. These are: difficulty with regulatory permits, type of project, and the number of project managers assigned to the project. Project scope specificity (i.e. voter or legislative approval) was not significant in the final design cost.

The model indicates that difficulty with regulatory permits significantly and positively affects the final design costs. Difficulty with regulatory permits can result in delay, redesign of portions of the project, added design features, an increase in specification requirements, extensive field reviews, and protracted negotiations. Surveyed project managers indicated that many regulatory agencies appear relatively unconcerned about project development time/costs. Until permits can be obtained for a transportation project, work cannot proceed. Project delay and redesign can add significantly to a project's final design costs.

Freeway projects significantly and positively affect project final design costs. Freeways often have greater scope and greater construction costs since separation of roadways usually requires elevated structures that are more costly than at-grade intersections. It is reasonably intuitive that projects with greater scope would require more design effort and greater final design costs.

When a project has an EIR type of environmental document, final design cost are significantly and positively affected. A project in which this type of document has been required will generally be more complex, be more politically sensitive, have increased requirements for regulatory permits, and have more extensive and sensitive right-of-way to acquire. All of these characteristics and requirements require more engineering and staff costs to complete the final design.

The number of project managers assigned to the project adds significantly to final design costs. Changes in management direction on a complex project can result in redundant and unnecessary effort, lack of understanding the project purpose, lack of knowledge to schedule work efficiently, rereview of past work, and perceived lack of upper management support for the project.

4. Conclusions

This research investigated project development efficiencies for state highway transportation projects. In an effort to determine the effect of differing organizations with different funding sources on project development, our research compared the California Department of Transportation, Caltrans, with County STA, involved in the development of state highway projects. We further made an effort to determine if projects that were highly defined, voter or legislatively approved in scope, cost, and schedule were more efficiently developed than generally scoped projects.

We found no evidence that projects with highly defined, voter or legislatively approved scopes tended to reduce project design development time and costs. In the projects we surveyed, the project development performance of the two organizations was not significantly different. The lack of differences in the time and cost of project development can, in part, be explained since the two organizations are using the same (required) development process, a process that described in detail in Caltrans manuals and required for all projects with federal funding. The process requires adherence to a rigid task sequence, lengthy review and approvals, use of rigid procedures, and required audits that extend project delivery.

In the beginning of our research effort, we hypothesized that the STAs would be able to more efficiently develop state highway projects, a notion grounded in the audit literature about STAs. The presumption was that STAs had more highly defined, voter or legislatively approved projects that would preclude multiple alternative studies; their organizations were smaller, less structured, and presumably more innovative, and they were developing projects supported by the vote of the people.

The projects we surveyed in many cases showed no greater efficiencies in project development than those managed by Caltrans. Had we been aware of the research results apriori, we would have collected additional information in an attempt to determine an explanation of this lack of difference. Having not collected this data we can only speculate on some of the reasons that the current projects by the STA are not more efficient than Caltrans.

The causes may be as follows: the projects now being developed by the STA are more difficult projects than included in past audits, or conversely the easier projects are already completed; the rigid process itself has caused all projects to be developed in much the same time frame and at the same cost; many of the STA projects are being developed in part by Caltrans thus making less of a difference between the two organizations; and finally the STAs are now using more federal funding making the total requirements of the development process equal to Caltrans.

Our study has some limitations in our ability to fully compare the efficiencies of project development by project scope and by organization. As time passes, the project development process changes constantly with differing regulations and requirements. Therefore, our research was aimed at current project development and it is recognized that project development in the future will be different. The data were collected at the project manager level. While this input is desirable for project manager perspective, it may or may not reflect the agencies actual policies and positions. The time of the survey reflected a number of seismic retrofit projects in development. As a different mix of projects is produced, the resulting data will likewise be differences. The project costs are dependent on accurate accounting. Sometimes the phases of development can overlap and not clearly differentiate between such items as preliminary design and final design. However, given the limitations, we believe that with the cooperation of Caltrans and the STA our research adequately addresses the project development experiences by the most experienced project managers in California.

There were several issues that came to light in the data collection that warrant further research. These included the following: the lack of uniformity of the allowance of categorical exemptions was surprising since it occurred more often in the rural north areas of the state; the perceived lack of delegated authority to control cost and time by the project manager; the number of active projects managed by Caltrans project managers; the longer time for the environmental/preliminary design phase by Caltrans than the STA; and the difference in experience as a project manager by Caltrans versus the STA.

Past audits of the transportation development process appeared to neglect the process itself and to focus on the project manager's behavior and the project specificity. The project manager in either organization appears to be unable to significantly accelerate project development time given the rigid process and the lack of authority to deviate from the process. A critical independent review of the project development process should be undertaken if substantial reduction in project development time is desired.

Additional research needs to address the reasons that the STA are not currently developing projects as they have done in the past when compared with Caltrans projects. Our research did not address the amount of work for the STA done by Caltrans and the differences when work was wholly done by the STA.

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