

1. REPORT NUMBER CA10-1582	2. GOVERNMENT ASSOCIATION NUMBER	3. RECIPIENT'S CATALOG NUMBER
4. TITLE AND SUBTITLE Capital Outlay Support: Percentage Baseline and Benchmark	5. REPORT DATE June 2011	
7. AUTHOR Professor Deb Niemeier, P.E., Ph.D.	6. PERFORMING ORGANIZATION CODE	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Regents of UC Davis Department of Civil and Environmental Engineering University of California 1 Shields Avenue Davis, CA 95616	8. PERFORMING ORGANIZATION REPORT NO.	
12. SPONSORING AGENCY AND ADDRESS	10. WORK UNIT NUMBER	
15. SUPPLEMENTARY NOTES	11. CONTRACT OR GRANT NUMBER 65A0263	
16. ABSTRACT The California Department of Transportation (Caltrans) uses a performance measure for the Capital Outlay Support (COS) program, the ratio between COS and capital outlay costs. Caltrans was looking for an independent study of this ratio. The results of the research showed that the productivity could be equated to the hours of labor that were inputted for capital outlay projects. Productivity could also be measured from the conception stage when projects are nested within programs within Caltrans districts, which would provide accountability for project development. Measures of quality should be developed for both labor inputs and outputs. For inputs, quality should be reflected on the workforce labor composition and the outputs should measure the project complexity.	13. TYPE OF REPORT AND PERIOD COVERED March 2008-January 2011	
17. KEY WORDS performance measures, productivity, labor, quality	14. SPONSORING AGENCY CODE	
19. SECURITY CLASSIFICATION (of this report) Unclassified	20. NUMBER OF PAGES 55	21. COST OF REPORT CHARGED

A framework for measuring productivity the California Dept. of Transportation

Prepared by

Professor Deb Niemeier, P.E., P.D.
Dept. of Civil and Environmental Engineering
University of California
One Shields Ave.
Davis CA 95616

Prepared for

The California Department of Transportation

June 2011

Table of Contents

Table of Contents	i
Introduction.....	2
Background on Public Agency Productivity	2
Caltrans and Productivity	5
Capital Support to Capital Outlay.....	7
State Transportation Agencies: A Comparison of the COS/CO Ratio and Productivity Approaches.....	11
Comparing COS/CO Ratios Using Federally Reported Information.....	15
General Productivity Index.....	18
Measuring Inputs.....	19
Measuring Outputs.....	21
Measures of Caltrans Productivity.....	24
Institutional Setting.....	24
Outputs.....	25
Labor Inputs.....	28
Productivity Index.....	29
Discussion.....	30
Basic Trends.....	30
Conclusions and Recommendations.....	34
References	37
Appendices.....	40
APPENDIX 1: LAO Request Material.....	41
APPENDIX 2: Additional SHOPP Analysis	43
APPENDIX 3: Response to Review Comments	47

Introduction

Defining and measuring government sector productivity, while important, is also very difficult. Ideally, prices and quantities of inputs and outputs are measured over time and from this, a productivity measure calculated. It is fairly straightforward to measure input prices and quantities; it is measuring public sector output prices and occasionally quantities that pose a more significant problem. Public sector outputs do not usually compete in the marketplace; thus the price, or the value assigned to these goods cannot be readily measured (Diewert 2010).

The California Department of Transportation (Caltrans) has been using the ratio of capital support to capital outlay (COS/CO) for about 15 years as an aggregate measure of productivity. Capital support includes the design and construction engineering and the right of way acquisition support costs accrued to deliver projects included in the capital program (which is referred to as capital outlay). The purpose of this report is to present the findings of an independent review of the applicability of the COS/CO ratio for measuring agency productivity. The report includes a summary of the issues and ways in which government productivity has traditionally been measured and a comparative analysis to other state departments of transportation (DOTs). Finally, a recommended measure of productivity is presented and two examples are derived using Caltrans project delivery information.

Background on Public Agency Productivity

It is common to associate improvements in public sector productivity with cost savings (Danker and Dohrmann 2007). While cost savings are important, particularly as government budgets become increasingly constrained, productivity is more appropriately characterized as a measure of output, including both quality and quantity, given resource inputs. That is, while increased productivity should result in cost savings relative to positive changes in output, increased cost savings do not necessarily connote improved productivity. There is also the conundrum that society might prefer certain goods and/or changes in the quality of services provided even if productivity declined (Simpson 2009).

These and other more fundamental issues make measuring public sector productivity very complex, from both public policy and accounting perspectives. The US government began a

program to measure public sector productivity in the 1970s, even publishing a number of productivity indices. Unfortunately, as part of reducing governmental expenditures, the program was terminated in the early 1990s (Danker, Dohrmann et al. 2006). However, the effort did highlight two of the key issues associated with measuring the productivity of many public sector activities: 1) there is often no discrete, quantifiable output and 2) even for those sectors in which outputs can be quantified, it is difficult to place a price or value on that output and to monitor how that value changes over time.

Total productivity is usually defined as the ratio of a volume output measure (goods and/or services) to a volume input measure (labor and capital) (Simpson 2009). Because many public sector agencies produce multiple outputs, the output volume indices are also usually cost-weighted; that is, outputs reflect the quantity of a good multiplied by the price of the good or service, where price represents the value assigned to the good or service by the end user or consumer. Outputs are differentiated because production costs associated with different outputs will vary. In contrast, private sector weights are commonly derived using revenue for each type of output (Fisk and Greiner 1998).

For public sector outcomes, this is a more difficult approach since revenues, if they even exist, are usually set by policy. When price weights are unavailable, it is technically correct to use unit costs, but these are also not often available for public sector outcomes and so unit labor inputs are frequently used as proxies. Because public sector activities don't usually have market prices, the outputs are sometimes measured by the costs incurred in output production (Lehtoranta and Niemi 1997). This translates to output being measured by input and productivity essentially remains unchanged (in real terms) over time. These kinds of measures are at best inadequate, and at worst meaningless for understanding variations in public sector productivity over time.

The final key element in estimating productivity for public agencies is the need to reflect quality (Fisk and Greiner 1998). That is, output quantity and output quality are both determinants of how effectively outputs are produced (Rosen, 1993). In fact, increases in public sector expenditures often hinge on arguments of quality improvements (e.g., service is delivered faster or better). Just recently, Peter Orszag, Director of the Office of Management and Budget, argued that the single most important factor driving the expanding gap between government sector productivity and private sector productivity was technology; that is, modernization of IT would result in a significant quality shift in government service provision (Orszag, 2010).

It is difficult to measure quality for public sector outputs, but nonetheless characterizing the impact of quality is generally regarded as very important (e.g., see Hatry and Fisk, 1971), particularly with the emergence of strong public dissatisfaction with government (Rosen 1993). Moreover, if improvements in quality (e.g., changes in labor force composition) are not accounted for, productivity estimates can be under- or over-estimated. Because price changes don't reflect quality changes, one technique sometimes used to infuse productivity measures with quality is to apply hedonic equations¹ to adjust prices. Most often though quality indicators are developed for public sector outputs; for example, distinguishing high quality train service from poor quality train service might elicit a range of indicators such as fast, reliable, comfortable and accessible (Rosen, 1993). Once a list of indicators has been compiled, weights can be assigned and any requisite indices be computed.

The Bureau of Labor Statistics has suggested a five-step approach toward developing and implementing quality indicators in the measurement of public sector productivity: 1) identify service output; 2) identify quality indicators for the output measure; 3) identify how each quality indicator can potential impact resources required; 4) create a quality index, and 5) adjust the productivity index by the quality indicator. The adjustment of the productivity indicator has traditionally been accomplished through three general approaches (Rosen, 1993): 1) segregating quality assessments from productivity assessments; 2) using quality measures as a way of screening out unacceptable outputs, and finally, 3) discounting outputs that fall below a specified quality measure. Caltrans current policy-based efficiency measures (i.e., COS/CO) and quality performance measures are calculated and presented independent of one another and the relationship of quality to productivity is unspecified.

One final caveat to assessing productivity is that although measures of total productivity are desirable, frequently it is only labor productivity that is measured in the public sector. The one difficulty in measuring only labor productivity is that any gains or losses in productivity are interpreted through one factor even though, for example, increased production may actually be due to other factors (Lehtoranta and Niemi 1997).

¹ Hedonic models are used to estimate demand or prices by decomposing the item into various characteristics thought to provide value.

Caltrans and Productivity

In 1994, SRI completed a study for the Legislative Analyst's Office (LAO) which reported Caltrans faced challenging issues regarding managing project expenditures and scheduling performance (SRI 1994). In response, Caltrans initiated a number of activities across the project management spectrum, including implementation of a new work and resource breakdown structure, along with various agency-wide project management support activities (e.g., see Caltrans 2007). During this time period, the legislature also passed Senate Bill 45, which delegated decision-making funding authority to the regional governments and among other changes, required the development of transportation system performance measures.

Beginning in FY1995-96 and continuing until 2001-02, Caltrans reported on a number of capital outlay support measures. Initially a three-tiered system cataloging overall transportation system performance, the performance of individual Department programs, and the operational effectiveness at the point of delivery was used to characterize the effectiveness of capital support (Caltrans 1995). The long-term intent at the time was to create a suite of performance measures that could be linked to, among other activities, strategic planning, budget development and legislative initiatives. Twelve specific capital support measures were initially proposed (Table 1); the 1996/97 Performance Report issued by Caltrans was the first to attempt to document performance across most of the twelve measures.

Table 1. Capital Support Measures

Measure	Target
1. Capital Support in Context	None
2. Capital Support to Capital Outlay	<33%
3. Quality	TBD
4. Number of Programmed Projects Ready to List ²	>92%
5. \$ Value of Programmed Projects Ready to List	>100%
6. Days Worked/Days Allotted	<110%
7. Awarded\$/Programmed\$	<100%
8. PFE\$/Award\$	<100%
9. FE\$/Award\$	<103%
10. Capital Delivery	Not available
11. Act.PjD Supp\$/Prog PjD Supp\$	Not available
12. Act.PjC Supp\$/Prog PjC Supp\$	Not available

Briefly, *capital support in context* is intended to convey a sense of how funds are being spent relative to other Caltrans programs. The *capital support to capital outlay* measure is the ratio of the summation of support costs associated with: 1) project approval and environmental clearance (the beginning of this phase is referred to as PA&ED or phase 0); 2) project design (the beginning of this phase is referred to as PS&E or phase 1; at the end of this phase the project should soon be eligible for ready to list (RTL) status), 3) right-of-way acquisition (ROW or phase 2, at the end of this phase ROW certification has met delivered), and 4) construction engineering (CONSTR or phase 3; at the end of this phase, the project is eligible for construction contract acceptance (CCA)), all of which is divided by capital outlay.

The *quality* indicator was never fully developed; it was originally intended to reflect a comparison between the final product and deficiencies noted in the original scoping document and the maintainability and the operational effectiveness of the product. In the 1996-97 performance report, the department indicated that *quality* would be measured in the future using a customer satisfaction approach. Performance measures 4 and 5, *number of programmed projects ready to list* and *equivalent dollar value of programmed projects*, were proposed as a means of measuring the department’s success in completing the programmed project design within or ahead of schedule. As an outcome measure, this is only partially effective for use in assessing productivity since for any

² Ready to list (RTL) indicates that projects are ready for advertising status. Beginning in FY 2005-06, district offices were required to commit to project delivery goals; projects are considered delivered when a project has achieved ready to list status

given budget cycle there may be more projects programmed than funding available (e.g., in 1994-95). This would reduce the performance measure, yet have very little to do with how efficiently the department produces those projects for which there is funding available.

The *Days Worked to Days Allotted* performance measure reflects the time spent in construction, adjusted for weather, versus the time allocated at contract award. This performance measure basically measures the ability of the department to accurately predict (absent weather effects) the time spent in construction activities. Performance measures 7, 8, and 9 are aimed at measuring the increased cost of capital support during project development and construction. *Awarded \$/Programmed \$* reflects the contract award value to the programmed amount (estimate). The *PFE\$/Award\$* measures the proposed final estimate prepared by the department to the contract award amount. Likewise, the *FE\$/PFE\$* measures the final estimate to the proposed final estimate.

The *Capital Delivery* measure was eliminated fairly early on as a yearly performance measure. Performance Measures 11, *Act.PjD Supp\$/Prog PjD Supp\$*, and 12, *Act.PjC Supp\$/Prog PjC Supp*, measure total support cost for programmed projects during project development and construction, respectively. The *Act.PjD Supp\$/Prog PjD Supp\$* measure reflects support costs for project development and right of way work (Phases 0, 1 & 2) for awarded projects as a percentage of the estimated total project development support costs. *Act.PjC Supp\$/Prog PjC Supp* is the ratio of support costs (Phase 3) for projects with a proposed final estimate (PFE) in the fiscal year to the total estimated construction support costs.

Caltrans has tracked some of these measures (Figure 1) and made the performance reports publically accessible through 2001-02.³ As can be seen, some measures were never fully developed, while others were tracked in every fiscal year. Targets (the number in the lower half of each circle) were modified over time; in some cases, the rationale behind the modification was explained, in other cases, it was not. In the 2003 Budget Analysis conducted by the Legislative Analyst's Office (LAO), it was noted that many targets, in particular three thought to be critical to understanding capital support outlay were missing, or had not been met (LAO, 2003). But more importantly, the LAO also noted that the measures outlined by Caltrans were inadequate for understanding annual project support costs requests. Fundamentally, the LAO was then identifying what has continued to

³ The reports are available at: <http://www.dot.ca.gov/hq/projmgmt/reports.htm>

be a problem: using the current performance measures, the Legislature does not have the ability to evaluate the relationship between yearly budget requests and yearly expenditures.

To address this gap, the LAO recommended adoption of three measures; the first is an existing measure for which the referring terminology is slightly changed and the remaining two are new measures. The first, the COS/CO ratio is a key measure that has been tracked since at least the late 1980s. The ratio is currently calculated for projects that receive CCA in a given year. Thus, for any given year, the COS/CO ratio represents the ratio of the cumulative support and outlay costs accrued through the life of the project; the costs embedded in the ratio will not be related to the budget request for support costs during the same given year since the ratio is calculated for projects at CCA. The COS/CO ratio represents a policy-based measure designed to keep capital operating support costs to a specified percentage of capital outlay costs (e.g., 33% is a frequently referred to target). As the LAO correctly identifies, the ratio reflects the historical capability with which Caltrans has been able to deliver projects and still meet this policy-based performance measure.⁴ One limitation of this measure is that it does not provide a way to assess current expenditures.

For this, the LAO recommended a new measure, *estimated current efficiency*, which is the ratio of actual project COS that began construction in the prior year⁵ to total projected capital outlay. According to the LAO report, this ratio averaged around 16% during the 1999-00 to 2001-02 period; by law, the ratio must be 20% or lower for any given three-year period. The second new measure is designed to capture on-going support expenses for the current budget year by showing project expenditures organized by estimated construction contract award year.

Together, these three measures recommended by the LAO were designed to increase the transparency of budgetary details related to the State Transportation Improvement Program (STIP)/State Highway Operation and Protection Program (SHOPP) program expenditures.⁶ In addition, the LAO also recommended tracking these measures by the 2004-05 budget year. Caltrans has implemented a number of new reporting tools since the 2003 LAO report. Among them include the Contract for Delivery, the Performance Measures report, and a revamped CTC quarterly report.

⁴ The LAO also refers to this measure as an efficiency measure, however, it is somewhat unclear as to how the COS/CO ratio serves as an efficiency measure.

⁵ Presumably this timing refers to the construction contract award date.

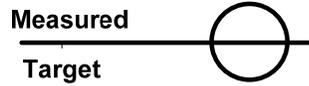
⁶ The STIP is a multi-year capital improvement funding program for projects on state and federal roadways. The SHOPP program provides funding for safety and maintenance projects on state highways.

The Contract for Delivery reports are available online⁷ for the years 2006-07 through 2008-09 and summarize the number of projects delivered by district and the total construction capital value. The Performance Measures Report, also available online,⁸ provides quarterly updates on 56 performance measures across five goals: safety, mobility, delivery, stewardship, and service. While comprehensive, the report provides little to no integration with business practices and does not include either of the two 2003 LAO recommended budget performance measures.⁹

⁷ <http://www.dot.ca.gov/hq/projmgmt/cfd.htm>

⁸ <http://www.dot.ca.gov/perf/>

⁹ The standard COS/CS ratio is summarized; in addition, the 2010 reports indicate a target ratio of 32% is desired.



	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
Cap. Support to Cap. Outlay	34% <33%	30% <33%	30% <33%	43% Trend	44% Trend	46% Trend	46% Trend
Quality	NA TBD	NA TBD	NA TBD	NA TBD	NA TBD	NA TBD	NA TBD
No. Projects	NA >92%	93% >92%	93% >92%	91% >90%	95% >90%	95% >90%	91% >90%
\$ Value Projects	NA >100%	111% >100%	111% >100%	117% >100%	104% >100%	109% >100%	119% >100%
Days Worked/ Days Allotted	NA <110%	113% <110%	113% <110%	122% <110%	123% <112%	121% <112%	121% <112%
Awarded \$/Programmed \$	NA <100%	NA <100%	NA <100%	82% 85-100%	80% 85-100%	89% 85-100%	89% 85-100%
PFE\$/Award\$	NA <100%	97% <100%	97% <100%	101% <100%	99% <100%	97% <100%	96% <100%
FE\$/Award\$	NA <103%	103% <103%	103% <103%	101% <103%	103% <103%	102% <103%	104% <103%
Capital Delivery	NA NA	Elim NA	Elim NA	Elim NA	Elim NA	Elim NA	Elim NA
Act.PjD Supp\$/Prog PjD Supp\$	NA NA	NA NA	NA NA	71% TBD	83% TBD	79% TBD	82% TBD
	NA NA	NA NA	NA NA	101% TBD	81% TBD	87% TBD	87% TBD

Figure 1. Summary of Performance Measures and Targets
 (Source: <http://www.dot.ca.gov/hq/projmgmt/reports.htm>)

Capital Support to Capital Outlay

While all of the measures described in Figure 1 have been generally referred to as indicators of productivity or performance, this report focuses specifically on the *Capital Support to Capital Outlay* ratio. This ratio has served as the key indicator of the department's aggregate project level productivity to policymakers and the general public, and has been the subject of a number of internal reviews by Caltrans staff. The COS/CO ratio has also been the focus of a number of LAO reports, which has long been consistent in its recommendation that Caltrans better justify its budget and control support costs. In its 1997 budget analysis (LAO 1997), the LAO noted that the justification for increased project support costs was vague and the legislature had directed Caltrans the previous year to improve the link between its budgetary request for capital outlay support and project delivery. In nearly every budget analysis since the 1997 review, the LAO has stressed the need for linking capital support requests to capital outlay costs and improving department efficiency.

In March, 2010, the LAO issued its review and analysis of the 2010-11 Caltrans budget request (LAO 2010). Chief among the LAO's criticisms was the lack of a workplan that "*provide[s] the Legislature the information it needs to determine how efficient the department has been in delivering capital projects (p. TR-12).*" Although the LAO refers to efficiency in this statement, much of its report is focused on issues that are more directly related to the concept of productivity.¹⁰ In this review, the LAO suggested that other transportation agencies had lower COS costs than Caltrans because they accomplished project delivery with "*fewer staff and more efficient procedures (p. TR-13).*" To better understand the basis for the LAO recommendation and to integrate these recommendations into future productivity measures, an informal request for data supporting the report recommendations was sent to the LAO in March, 2010.¹¹ The LAO responded formally, citing the Legislative Open Records Act, in June, 2010.¹²

¹⁰ It is common to confuse productivity and efficiency. Productivity is measured as input/output; efficiency is 100%*actual output/standard output. Efficiency may also be used to refer decreasing input costs relative to output value. Throughout the 2010 analysis, the LAO intermixes the concepts of efficiency and productivity making it somewhat difficult to ascertain the primary intent of their recommendations. For the purposes of this study, it is assumed that the LAO is primarily referring to issues of productivity.

¹¹ Included in Appendix 1

¹² Following the initial request to the LAO, several reminder requests were also made. The LAO noted that such requests for supporting data had not been previously made and that internal communications to determine delivery options were underway. When little progress was made, Sen. Wolk's (Davis) office was enlisted to facilitate the request and the LAO provided hard copies of the material supporting the report findings, noting that all material was being provided under the Legislative Open Records Act, which excluded

In their formal response, the LAO provided four sets of material, which have been summarized in Table 2. The LAO did not identify which material supported which LAO report recommendation (see Appendix 1 for the request letter), and in fact, after reviewing the information sent by the LAO, it is unclear how any of the material supports the LAO recommendations. Table 2 summarizes the information provided by the LAO and was used to establish how the substance of the recommendations relates to, or are supportive of an emphasis on productivity.

Table 2. Supporting Material for 2010-11 LAO Budget Analysis (Provided by the LAO)

Set 1	<p>Material Description. <i>See Note</i> This material is a set of summary slides that appears to be for a presentation. The slides are not dated and authorship is not identified. The material includes 9 slides with various COS/CO comparisons across 4 different soundwall projects: SR-134 soundwall from Louise to Harvey (Glendale, completed 3/09); SR-170 (City of Los Angeles, completed 7/07), SR-210 from Vernon to Azusa Ave (Azusa, to be completed 10/10), and SR-210 (Arcadia, awarded 4/08)</p> <p>Summary. This material argues for a design-build approach to constructing soundwalls based on the experience of constructing the SR-134 soundwall. In this project, METRO had requested that Caltrans execute the SR-134 project as a design-build project with METRO handling the project management.¹³ Administratively, Caltrans was precluded from allowing a design-build process, and suggested instead a combined METRO/Caltrans team approach with METRO as the project manager and Caltrans providing oversight. The slides compare the capital outlay support (unaudited) for the team approach (a COS/CS ratio of 30%) to three other soundwall projects constructed under the traditional Caltrans managed design-bid-construct process (with COS/CO ratio's ranging from 50% to 69%).</p> <p>Relationship to Productivity. Soundwalls represent a very small proportion of the Caltrans overall capital program. The LAO appears to have used a single soundwall testing a new project management paradigm as the basis for evaluating (or comparing) differences in agency level COS/CO ratios. The LAO statements to this effect appear to be insufficiently justified by the material provided. The productivity impact of reducing agency COS/CO on the basis of the success of this single project is unknown.</p>
<p>Note: The material description section was developed with the assistance of Brian Lin, Transportation Planner, METRO; Adel Girgis, P.E., Project Manager, Caltrans; Second Quarter Report FY 2007-08 Project Delivery Report, <i>Quarterly Report to the California Transportation Commission</i></p>	

from “mandatory disclosure ‘[p]reliminary drafts, notes, legislative memoranda, ...’[c]orrespondence of and to Individual Members of the Legislature’, and ‘[c]ommunications from private citizens to the Legislature.” The LAO response further notes that “Records described by these exceptions, therefore, have been withheld.”¹³ Typically design-build refers to a project delivery system in one entity (the design-builder) working under a single contract provides both architectural/engineering (A/E) design services and construction services.

Table 2 (con't). Supporting Material for 2010-11 LAO Budget Analysis (Provided by the LAO)

<p>Set 2</p>	<p>Material Description. This material is a monthly status report, issued Oct 2009, on the Interstate 405 Sepulveda Pass Widening Project.</p> <p>Summary. This is a monthly update on the status of the project.</p> <p>Relationship to Productivity. The Notice to Proceed was issued for this project in June 2009. The project was let as a design-build team effort with METRO and Caltrans. The relationship between productivity and the information presented in the monthly project report, which contains no cost or labor data, and was issued only 4 months after the project was initiated, cannot be ascertained based on this information.</p>
<p>Set 3</p>	<p>Material Description. This is a one page breakdown of hard and soft cost percentages of total project costs for the METRO Gold Line Eastside Extension. The source of the material is unknown and is dated June 2007.</p> <p>Summary. The material presents a piechart divided into sections identified as soft and hard costs, with so-called soft costs (identified as <i>agency, designer, construction manager, and other professional services</i>) approximately 15.1% of the total project costs.</p> <p>Relationship to Productivity. The information provided on the slide is not applicable to the LAO's discussion of COS/CO. Caltrans has not in recent history been responsible for construction of light rail infrastructure. The most recent transit project undertaken by Caltrans was for Sacramento Rapid Transit in the early 1980s.¹⁴ There is also conflicting information on the slide. On the slide legend, '<i>Interest cost</i>' comprises 81% of the total costs and capital costs are not identified. Thus, it's not clear if the slide information is even accurate.</p>
<p>Set 4</p>	<p>Material Description. This material comprised six pages, five of which detail project programming costs and expenditures for 5-6 projects currently under construction from each of districts 4, 6, 7, 8, and 11. The remaining page listed project programming and expenditures for 5 projects that have been completed in district 3. The source of the material was not specified by the LAO, but was provided by Caltrans upon LAO request; the material is dated May and June 2009.</p> <p>Summary. The six pages of projects for each district that are currently under construction represent a single snapshot of project progress. The district 3 project list, for which construction had been completed, are suitable for use in assessing trends in CS/CO, however, because of a very small sample size, both over time and projects, conclusions drawn from this material should be considered exploratory at best.</p> <p>Relationship to Productivity. The use of on-going project to analyze Caltrans productivity is limited; productivity is measured over time. It would not be unusual to see individual projects with very low or high COS/CO ratios depending on the project phase/status or delivery timeline. The single page of district 3 completed projects constitutes too small a sample (n=5) from which to draw conclusions.¹⁵</p>

¹⁴ Personal Communication (2010). Caltrans Staff. Davis, CA.

¹⁵ The LAO report itself appears to rely on the additional project data provided by Caltrans to the LAO, but these data were not included in the LAO response to the UC Davis request for information. (See Appendix 1).

In sum, the supporting material provided by the LAO does not provide support for the recommendations contained within the report as they relate to improving agency effectiveness for project delivery. It should be noted, however, that the LAO provided their supporting material under the Legislative Open Records Act, and indicated that they did not transmit notes, legislative material and communications from private citizens. It is possible that excluded material better supports the analysis provided in the report.

Some of the more recent LAO analyses have conflated the effects of reducing support costs with increasing productivity or at least being productivity neutral; this is particularly true for the March budget analysis (LAO, 2010). For example, the recommendation to reduce capital outlay support (i.e., reducing staff) by 15% because productivity has not been affected by the furloughs is nonsensical. At the extreme, this would imply 100% productivity could be achieved by completely eliminating capital outlay support. Measuring the impact of the furloughs on productivity requires multiple years of comparison. That is, productivity gains or losses due to staff furloughs cannot be fully understood without a (trend-based) comparison to output.

Recommendations for support reductions without implicating the impact of these reductions on agency productivity could prove to be problematic in terms of agency output. It is important that changes in support costs be evaluated in terms of potential impacts on productivity. This does not appear to have been assessed by the LAO. However, to some degree the LAO has been constrained in conducting this type of evaluation because of a lack of consensus around an appropriate productivity indicator, coupled with overemphasis on COS/CO as an agency efficiency measure; as noted earlier the COS/CO ratio is more appropriately characterized as a policy-decision performance measure.

State Transportation Agencies: A Comparison of the COS/CO Ratio and Productivity Approaches

As part of this study effort, four state transportation agencies: Washington, Florida, Michigan, and Oregon, were also reviewed with respect to their approach to measuring productivity and to determine whether a comparison of COS/CO ratios could be formulated. From this review, it is clear that each of the agencies have taken different approaches (and used different expenditure categories) to measure accountability (but not necessarily agency productivity). Even general comparisons of capital support to outlay ratios among the four agencies would be complicated. Among the many difficulties include, but are not limited to appropriation and program categories that vary between agencies, significantly different work breakdown schedules, and even how individual projects are classified within established programs. Despite these differences, comparisons across state transportation agencies is not impossible, but must be interpreted carefully. To show how comparisons of the ratio could be conducted consistently over time, the COS/CO ratios are constructed using data reported annually by the state DOTs for use in FHWA's *Highway Statistics*. The advantage of using these data for comparisons is that state agencies have set reporting requirements that they respond to over time; that is, if there are differences between agencies, once the ratio is normalized to a base year, the trend effect of these differences should be relatively minor.¹⁶

Washington State Department of Transportation (WSDOT). WSDOT uses the Government Management, Accountability, and Performance system (GMAP) established under Gov. Gregoire to track accountability measures associated with performance. For example, under stewardship, project delivery times and rates are continuously tracked every quarter (e.g., see WSDOT 2009). In FY 2009, on-time delivery and on-budget performance across 194 Nickel and Transportation Partnership Account projects were 90% and 88%, respectively.¹⁷ Although staff levels and training performance measures are reported, costs are not linked to staffing levels or time spent at the project level.

¹⁶ One way in which calculated ratios might change is if a state agency changes its reporting protocol, but the federal agency has not implemented a request for change. Under this circumstance, the state agency's calculated ratio would not be consistent with prior reported data. In general, it is reasonable to assume that state agencies, once reporting data requirements have been set by FHWA, are unlikely on their own initiative to dramatically change reporting protocol.

¹⁷ The 2003 (Nickel) Account and the 2005 Transportation Partnership Account provide significant funding for highway preservation and improvement projects in the State of Washington.

Development on a new project management system, the Project Management and Reporting System, was begun several years ago and will allow tracking at the project level. This system combines 11 other internal systems that support management and delivery of the capital program¹⁸; the system came online in June, 2010. The system was developed primarily to manage on-time delivery, costs for bonding purposes¹⁹, and construction scheduling, and although workforce analysis was not a motivating factor in the development of the system, the system does have the capacity to do these analyses and may well be used in this manner in the future.²⁰

Florida State Department of Transportation (FDOT). FDOT produces a set of annual performance measures as well. A subset of the 20 primary measures reported by FDOT are similar to those reported each year by the California Transportation Commission and include, for example, the number of construction contracts executed versus planned, the percentage of construction contracts completed within 20% of the original contract time and within 10% of the original contract cost, and the number of lane miles of capacity improvement projects let compared to planned. A ratio of capital support to outlay is not included in the performance measures. However, an agency level ratio can be computed using basic information contained in the annual reports and the program and resource management documents ([Table 3](#)).

Oregon Department of Transportation (ODOT). ODOT reports the legislatively adopted program budget each year. ODOT tracks the “Percent PE” by project for each its programs. *Percent PE* is calculated as the ratio of preliminary engineering costs²¹ to the summation of construction plus construction engineering costs. This ratio is tracked across modernization, bridge, safety, operations, and preservation programs. As presented in the ODOT program budget, the ratio is not directly comparable to Caltrans COS/CO ratio since construction engineering costs are included in the denominator. Upon request, ODOT provided cost data for projects between 2002 and 2010 and a ratio of preliminary and construction engineering costs to capital outlay was calculated for each year ([Table 3](#)). It is important to note that even with the addition of

¹⁸ WSDOT (2008). Chapter 5, Information Technology Systems. Project Control and Reporting Manual, M 3026.01. Olympia, Washington State Department of Transportation.

¹⁹ In 2008, WSDOT was audited; the audit found that the agency was over-bonded and over a 5-year period the over-bonding resulted in a loss approximating \$20m Moore, S. W. (June 2010). Personal communication.

²⁰ Ibid.

²¹ Not including right of way or utility relocation costs

construction engineering costs to the numerator, this ratio is still not directly comparable to the Caltrans COS/CO ratio since the ROW and utility costs are not included. Finally, ODOT has had a significant increase in outsourcing, due largely to a shortage of in-house resources (Casavant, Jessup et al. 2007). During this period, preliminary engineering costs have increased and there is some evidence of a decline in overall quality. In reviewing ODOT’s standard ratio of preliminary engineering cost to the sum of construction engineering and construction costs it is clear, in fact, that the ratios tend to be larger for projects in which design and project management has been outsourced to a private firm.

Table 3. Support to Capital ratio for Florida, Oregon, and California DOTs³

Year	Florida¹	Oregon²	California
2000-01	0.39	--	0.46
2001-02	0.30	--	0.46
2002-03	0.43	0.17	0.33
2003-04	0.34	0.16	0.37
2004-05	0.33	0.19	0.37
2005-06	0.31	0.19	0.34
2006-07	0.31	0.28	0.37
2007-08	0.36	0.36	0.35
2008-09	0.36	--	--

¹ The product support costs reported by Florida do not break down costs by capital outlay program area. Thus, the numerator reflects all support costs for all programs in the denominator (highway, other arterials, ROW, safety, resurfacing, and bridge programs).

² Support (numerator) includes preliminary and construction engineering; outlay (denominator) includes bridge, modernization, and consultant managed projects. ROW and utility relocation costs are not included. ODOT also provided these data using a standard calendar year; the end of each first calendar year is used to record data (e.g., 2002 is recorded in 2002-03 FY).

³ WSDOT does not compute these measures.

⁴ Combined STIP/SHOPP (source FY02-03-FY05-06: *Caltrans Draft Efficiency Study*, provided by M. Bailey (3/25/08); source FY06-07: Support to Capital Performance, provided by M. Bailey (3/25/08); source FY07-08: Caltrans Performance Measures Report)

Michigan Department of Transportation (MDOT). Each year Michigan DOT produces both a financial report as well as a series of performance reports for the legislature. The information provided is very extensive and profiles many of MDOT activities as well as many of the program balances. However, financial data is organized by fund type with no project specific breakdown of labor costs. Therefore, it is very difficult, if not impossible based on public information, to create a comparable statistic to the capital support to capital outlay ratio used by Caltrans. The MDOT does track total labor force by employment category (MDOT 2010), suggesting that if Caltrans were to develop a measure of labor force productivity, it might be possible to derive comparable information using Michigan’s published data.

In general, there are a number of caveats that are important to take note of when comparing ratios across state transportation agencies. First, embedded in the ratios are often policies and decisions that are not easily tracked. For example, one of the most difficult issues is ensuring that capital outlay for a specified project has been defined consistently between state agencies. Caltrans defines a capital outlay as one that “produces a unique physical improvement to the transportation system in California” (Caltrans 2007, p.10). Other agencies may not even refer to capital outlay directly as capital outlay. Projects may also be classified differently. For example, Oregon funds a modernization program which in theory should be aimed at projects relatively similar to California’s STIP programs, but ODOT’s modernization program has somewhat greater latitude in identifying which projects can be considered under this program.

Finally, it’s important to recognize that state DOTs also use different methods to track expenditures (Hendren 2001); these can vary widely in form and function. For example, product support for FDOT includes preliminary engineering, construction engineering and inspection, right-of-way support, environmental mitigation, materials, applied research, planning and environment, and support for public transportation. In each of these categories, the support costs include salaries and benefits, professional fees, and certain administrative costs (FDOT 2010). Alternatively, some DOTs will allocate administrative costs to projects and exclude them from administrative overhead cost reports.

Project related phases may also be defined slightly differently. For example, MDOT generally uses four phases for project development: early preliminary engineering; preliminary engineering, ROW acquisition, and construction. The early preliminary phase typically includes environmental clearance; however, the department may elect to complete a feasibility analysis prior to environmental documentation and this effort may include some portion of the preliminary design.²² In contrast, Caltrans uses the four phases described earlier for tracking project costs: (1) PA&ED; 2) PS&E; 3) ROW, and 4) CONSTR. Despite these caveats, comparing agencies is not impossible; however, comparisons must be carefully conducted.

²² For example, *Section 376-Reinstated Projects Report* (2010), FY2010 Legislative Reports, Michigan Department of Transportation, Bureau of Finance and Administration, Budgets and Reports Unit

Comparing COS/CO Ratios Using Federally Reported Information

Another approach for comparing the staffing costs and capital outlay expenditures across agencies is to use data reported annually by the state DOTs for FHWA's *Highway Statistics*. Using Table SF-4C from the annual Highway Statistics report, a support to capital ratio can be derived with information reported on forms FHWA-531 and 532 (FHWA 2008). The numerator includes preliminary and construction engineering,²³ and administrative costs directly related to projects.²⁴ The denominator includes the cost of construction for roads and structures and installation of traffic facilities.²⁵ Because this ratio is based on annual expenditures, it is not directly comparable to the COS/CO ratio currently calculated by Caltrans, but is useful in comparing performance over time across state agencies.

The state ratios are summarized using boxplots (see Figure 2). Boxplots are useful for visualizing the distribution of quantity of interest. The rectangle identifies the interquartile range (IQR), which is defined by the first quartile (the 25th percentile) and the third quartile (the 75th percentile). The range of the upper and lower whiskers is defined by the maximum or minimum values, unless these values are larger (smaller) than 1.5 times the IQR. Values outside the IQR are referred to as outliers.

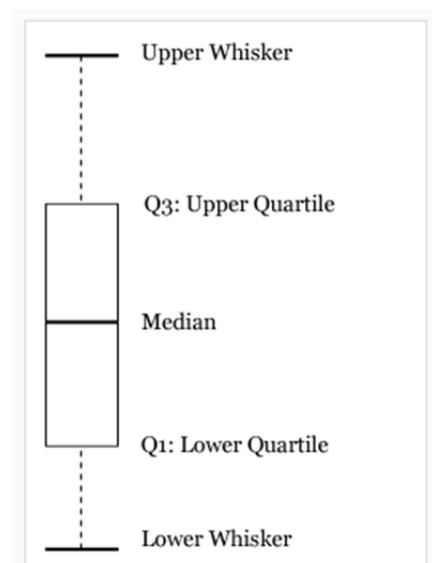


Figure 2. Boxplot Description

Figure 3 presents the boxplots for the calculated support to outlay ratio over time using the Highway Statistics data. The boxplots are defined using the calculated ratios for all 50 states. Under this derivation (i.e., using the annual reported data for *Highway Statistics*), the ratio only includes the preliminary engineering and construction support costs. These are a subset of the capital support costs that Caltrans has typically reported.

²³ Includes field engineering and inspections, surveys, preparation of PS&E and traffic and related studies.

²⁴ Right-of-way acquisition cost data is available, but has not been included in this comparison due to differential land acquisition costs.

²⁵ Includes all expenditures for construction, relocation, resurfacing, restoration, rehabilitation, and reconstruction, widening, safety and capacity improvements, and road bridge improvements. Capital outlay for toll facilities and for mass transit improvements is not included; maintenance costs are also reported elsewhere.

Using the data from *Highway Statistics*, California (Caltrans) ratio of reported support to capital costs has tended to fall into the 4th quartile (above the 75th percentile) of the distribution of ratios calculated for other states, suggesting that support costs are, in general, higher than most other states. However, this should be viewed cautiously. Other factors may play a role in the ratio such as how states parse and submit data to FHWA. Prior research has shown that states do not always report consistently across categories (Hendren 2001).²⁶

To better understand why and how differences in support costs arise, and how much of the differences might be attributable to reporting conventions, the data reported to FHWA would have to be reviewed in-depth and additional interviews with state transportation agencies would need to be conducted. Nonetheless, these data do provide an important picture of Caltrans preliminary and construction engineering and project-specific administrative costs as a function of capital outlay relative to other states. Figure 3 suggests that California's reported yearly support cost expenditures as a ratio to capital outlay are typically in the top quartile when compared to other state DOTs. Regardless, it is important to keep in mind that the COS/CO ratio as designed is not a productivity measure, but rather a policy goal. In summary, the COS/CO ratio, as it is currently derived and implemented, reflects a policy decision: to maintain supports costs at or below a specified percentage; as will be discussed in the next section, the COS/CO ratio should not be considered a productivity measure.

²⁶ There has also been research in characterizing peer states for such comparisons (e.g., see Hendren, P., D. Niemeier (2008). "Identifying peer states for transportation system evaluation & policy analysis." *Transportation* 35(4): 445-465.

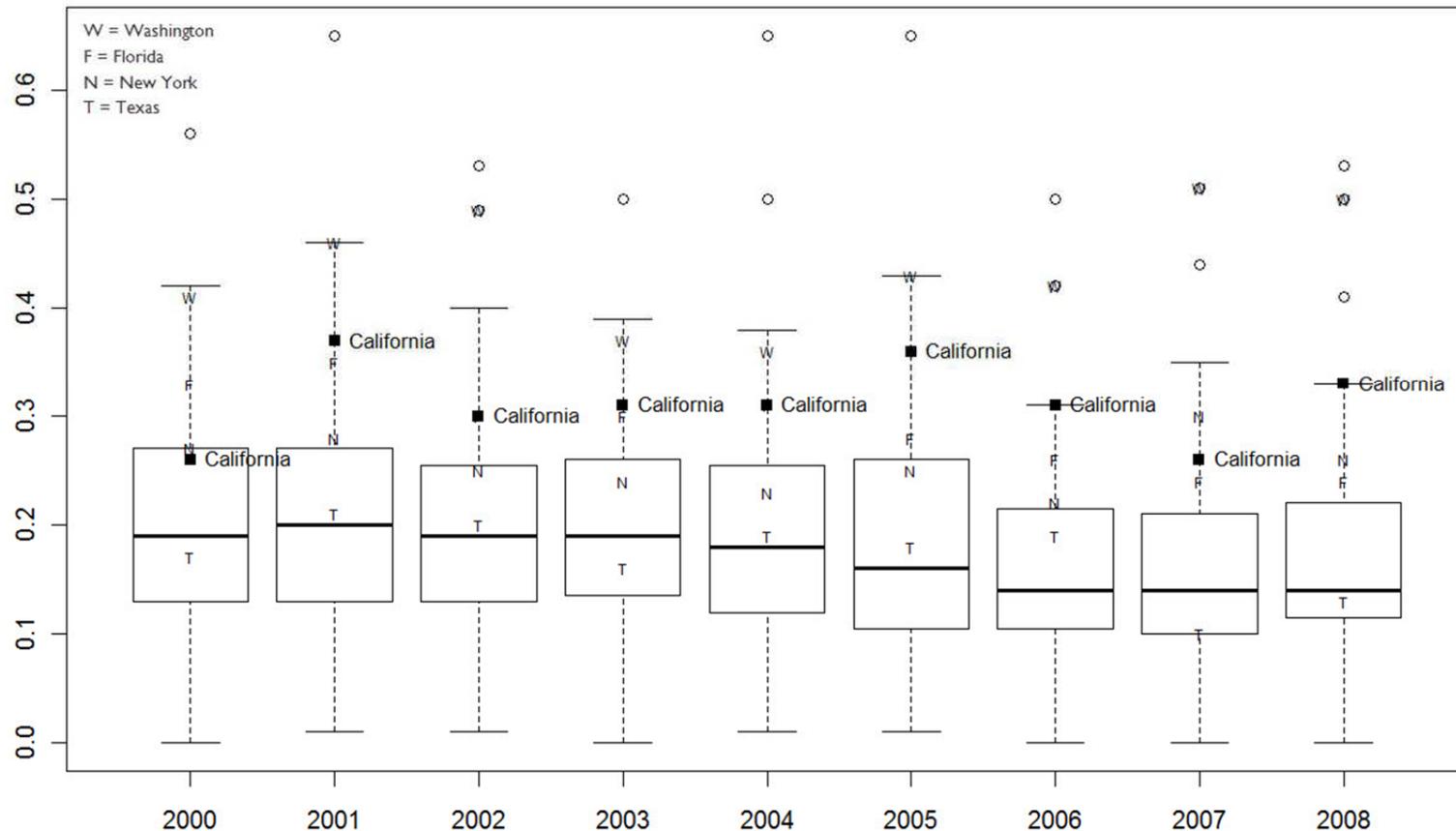


Figure 3. Ratio of reported annual preliminary and construction engineering expenditures to capital outlay expenditures (Source: Highway Statistics)

Notes: **Preliminary and construction engineering** includes field engineering and inspections, surveys, preparation of plans, specifications, and estimates and traffic and related studies. **Capital outlay** includes all expenditures for construction, relocation, resurfacing, restoration, rehabilitation, and reconstruction, widening, safety and capacity improvements, and road bridge improvements. Capital outlay for toll facilities and for mass transit improvements is not included; maintenance costs are also reported elsewhere. Right-of-way acquisition cost data is available, but has not been included in this comparison due to differential land acquisition costs.

General Productivity Index

Although many forms of productivity indices have been used, the most common is a base year (sometimes labor weighted) productivity index,

$$P_i = \frac{Q_i}{Q_0} \div \frac{H_i}{H_0}$$

where P_i is the index of productivity or output per unit input in year i ; Q_i is the output quantity in year i ; Q_0 is the output quantity in year 0 (the reference year); H_i represents the input in year i , and finally H_0 represents the input in year 0.

This index has been well vetted within the U.S. (Fisk 1998) and in general, the use of productivity indices is well established (e.g., see Rosen 1993). Some form of this basic index has been used in the UK, Finland and a number of other countries who have undertaken recent measurements of public productivity. Its use, however, in public sector enterprises is not without difficulty. For example, under circumstances of low productivity indicators, the private sector often restructures – that is, firms enter, expand or exit the marketplace – and productivity gains are achieved. But in the case of public agencies, the exit of a public agency that is providing services can have important implications for society even if low productivity is observed (Simpson 2009).

The Bureau of Labor Statistics organizes public agency productivity measures into three general categories (Fisk and Greiner 1998): 1) operational (activities); 2) direct outputs (outputs) and, 3) organizational or program consequences (outcomes). The operational productivity measures usually include measures associated with efficiency. These kinds of indicators are generally easy to measure but unlikely to capture the full range of public sector productivity (Simpson 2009). For example, if technology improves healthcare treatment delivery, a count of treatments might be measured, with a reduction suggesting decreasing output over time. It is important to understand that even straightforward direct output productivity measures do not address the issue of whether the service can be provided at a lower cost, or even whether it should be provided at all. The direct measures also have the greatest similarity to the range of technical production productivity measures that are most often used in the private sector.

The most commonly used productivity indicator tends to be one reflecting consequences or outcomes rather than a direct output (e.g., focusing on patient outcomes instead of counting treatments) (Fisk and Greiner 1998). The direct output productivity is usually calculated as an organizational or program output divided by the resources used to produce the output (e.g., “tons of solid waste collected per employee hour”, *pg. 9*). The third category captures the societal consequences of a program or organizational output. This captures what are in effect indirect productivity gains: lives saved through accident prevention, hours of delay reduced, etc. Outcomes are not generally included in productivity analyses, primarily because flawed policy assumptions, not the way in which the policy is implemented, can result in unsuccessful outcomes (Rosen 1993).

For the purposes of measuring productivity the organization is treated like a black box: what goes in the black box is irrelevant to measurement (Rosen 1993). That is, however the process being measured unfolds; productivity is concerned only with the relationship between resources (inputs) and services (outputs). There are some basic guidelines to measuring inputs and outputs and then constructing the productivity index.

Measuring Inputs

In general, measuring inputs is not difficult because they are usually priced (e.g., number of employees, hours worked, cost of employees to firm). The most common measure of productivity for public sector activities is labor productivity (Fisk 1998). Using labor productivity to measure the productivity of government activities does not strictly form a direct relationship to resources (inputs). Rather labor productivity measures the relationship of labor with the co-mingled effects of technology, management and government policy and regulations, to output.

Two of the most typical input labor measures are hours and number of employees, with hours as the preferred measure. The two measures can reflect very different trends so in the later examples productivity measures are derived to show both types of input. With respect to number of employees, two types of data are usually collected: number of employees and full-time equivalents (FTE). Counting the number of employees is simple and straightforward, but does not capture differences in, for example, part-time and full-time workers – both are counted as one. Using the number of employees typically understates changes in labor inputs if the person-time worked increases and overstates labor inputs if person-time worked decreases (Fisk 1998). In contrast, one FTE represents 2080 work hours and includes all paid time (e.g., overtime, sick leave, and holidays). In this measure, part-time workers are usually converted to full or partial FTEs. One of the practical

problems that arises when using FTEs is how to handle standby employees, employees paid by task, and those that work, but are not paid. Conceptually, most of these should be counted as well (otherwise productivity is over- or understated). The selection of FTE versus worker counts depends mostly on the proportion of seasonal or part-time workers.

One element of using labor inputs is the need to reflect composition. Ideally, labor inputs would be differentiated by skill level. For example, in theory, over time you might expect that productivity or quality would decline with decreasing proportions of skilled project managers or engineers. But this decrease in productivity is not a direct productivity loss, but rather a shift in labor composition. The usual method for capturing adjustments in labor force composition is to differentiate labor hours by pay scales or skills (e.g., educational levels). However, these data tend to be more difficult to collect in public agencies and often are neglected in productivity calculations. There are five basic criteria, and some suggestions for characterizing inputs available from the literature (Rosen 1993; Fisk 1998; Simpson 2009),

- *Inputs should reflect resources required to produce outputs*

There are several aspects to matching that should be attended to in selecting inputs. First, the inputs should reflect the production (resources) used to deliver outputs. For example, if a design productivity index were desired, only that labor used to produce the design should be used in the input. For an organization like Caltrans, where there are multiple outputs (e.g., technical assistance to MPOs), it is critical to ensure that inputs directly match outputs. That is, labor hours used to provide technical assistance to MPOs would not be appropriately used in a productivity measure reflecting design productivity.

- *Inputs should be measureable*
- *Inputs should accurate and comparable*

Data collected on public sector activities is often spotty and in some cases, does not reflect absolute conditions. It is critically important to be able to compare trends over time. Thus, whatever input measures are used, data should be consistently collected on them over time.

- *Inputs should use existing data*

It is expensive and time-consuming to collect new data. As much as possible, existing data should be used to capture trends over time. Adjustments in data may be necessary to capture changes, particularly any type of quality change.

- *Inputs should be easily understood*

Inputs that are not easily understood will make public acceptance more difficult.

Construction of inputs should be transparent and straightforward.

In general, straightforward labor inputs like fulltime equivalent employees, hours, etc., provides an accessible, practical link between services produced and resources used. Labor hours has the added feature of providing a means for measuring the effectiveness of a variety of indirect interventions such as new training programs, new computer systems, many of which Caltrans has implemented, but from which productivity gains have been difficult to measure. But there are some important caveats to recognize in constructing labor inputs (Simpson 2009).

First, it is important to recognize that organizations produce a wide range of goods and services; for example, Caltrans produces goods and services across planning, project development, technical assistance, maintenance and preservation. There are quality dimensions to the labor inputs reflecting the production of these goods and services that can vary over time. Simple measures of labor input should be adjusted to reflect quality or human capital (e.g., engineers might be weighted more heavily than clerical workers). In addition, when inputs (e.g., employee hours) cross different outputs within the organization, then the appropriate fraction of time has to be attributed to the appropriate output. If labor input is only reflected at the organizational level, inefficiencies will almost certainly be masked (e.g., output in one sector can be very high, while output in another is very low). The last major point that is very clear from the literature is that in measuring inputs, dollars should not be used as a proxy for labor input. Managers in state agencies rarely control negotiations that are part of setting labor costs. For example, managers don't directly negotiate with labor unions or adjust civil service categories. Using dollars to measure productivity implies that managers can control these negotiations, which is simply not the case for public agencies.

Measuring Outputs

Appropriately specifying the output being measured is both the most difficult part of measuring productivity, and perhaps the most critical, particularly for public sector activities (Fisk 1998). Output measures should ideally capture the full range of services offered, but will usually be

restricted to those main services produced by an agency; that is, those that constitute, or consume major portions of the resources provided (Simpson 2009). There are broadly speaking two types of outputs commonly recognized in public sector services: end use and collective use. For example, police investigate specific crimes, but also prevent crime by their presence. In the first case, there is an end use and in the second, a collective benefit (Rosen 1993). For Caltrans, the end product are projects, the collective benefit is improved travel.

In selecting outputs, the basic measure should be homogenous: projects delivered, and must be related to the resources provided (Fisk 1998). In the private sector, productivity can be measured using revenue generated; in the public sector, as noted earlier, market prices are usually not available. Without prices, estimating output in real terms is difficult and often physical measures that can be quantified are acceptable (e.g., number of projects delivered). Within a multi-service agency defining outputs translates to taking one of two possible approaches: either independently specifying each output (e.g., projects delivered, MPO technical assistance provided, etc) or focusing on the dominant service delivered (e.g., projects delivered). Deciding between the two approaches is premised mostly on what matters to policymakers, and what is most critical or visible in terms of how resources are allocated. If the dominant product approach is applied, output measures can be adjusted to reflect workload difficult by creating discrete output groups (e.g., different types of projects within programs) and then weighting each group appropriately. Thus, even single product labor outputs can be adjusted to reflect the degree of complexity underlying delivery of the product.

In the BLS study, seven criteria were provided, the first four critical and the last three desirable for identifying and selecting output measures (Fisk 1998),

- *Outputs must reflect the final organizational product*

Outputs should reflect the final product leaving the organization. It is often tempting to identify intermediate steps as producing key outputs, but these are not appropriate for measuring organizational productivity and are rarely the basis of resource allocations. It is also important that outputs not reflect an outcome, or consequence of a product. That is, if projects delivered are the primary product provided by Caltrans, an outcome such as improved travel flow should not be used to measure agency productivity. This is not to say that outcomes are not important, they not just not directly connected to resource inputs.

- *Outputs must be measureable*

The argument that government services cannot be quantified is often put forth as a reason not to measure productivity. For example, it's true that mobility has value even if the full range of mobility options that are available are never used. But many of these arguments do not appropriately distinguish between activities, output, and outcomes. It is critical to define direct outputs on a function by function basis.

- *Outputs should be repetitive*

Understanding trends over time requires that the same product is measured over time. The quality of inputs (e.g., labor composition) and outputs can be adjusted to reflect changes in quality of time, but the basic product should be the same.

- *Inputs should accurate and comparable*

Data collected on public sector activities is often spotty and in some cases, does not reflect absolute conditions. It is critically important to be able to compare trends over time. Thus, whatever input measures are used, data should be consistently collected on them over time.

- *Outputs should use existing data*

It is expensive and time-consuming to collect new data. As much as possible, existing data should be used to capture trends over time. Adjustments in data may be necessary to capture changes, particularly any type of quality change.

- *Outputs should be easily understood*

Outputs that are not easily understood will make public acceptance more difficult. Construction of outputs should be transparent and straightforward.

- *Outputs should reflect the resources spent in their production*

- *Output units should reflect the resources spent in their production.*

Regardless of how outputs are specified, costs should not be used (Rosen 1993; Simpson 2009). Using costs implicitly weights certain costs higher (e.g., seismic retrofit of a large bridge versus rehabilitation) and if the output mix is changed to relatively cheaper outputs (e.g., maintenance and preservation), then the aggregate output will be incorrectly reduced. One last aspect of output

measures that is worth mentioning is that frequently government services have been valued at the cost of the resource input, a resource input equals output approach (Lehtoranta and Niemi 1997; Simpson 2009). By definition, this restricts productivity gains (or losses) that can be shown.

Measures of Caltrans Productivity

In this section, two productivity measures are constructed as examples of how the framework can be applied.

Institutional Setting

Caltrans constructs, maintains and operates the highway system in California. The agency is divided into 12 districts, many of which encompass several counties. In the past decade, Caltrans capital outlay budget has ranged from \$7b (FY2000-01) to nearly \$14b (FY2010-11); over roughly a 20 year period, the transportation share of the budget increased from 3.5% to about 6.2% (CBP 2006), averaging about 4% per year. Caltrans total staffing levels are also among the highest across state agencies ranging from 18,000 regular positions to around 20,000 in the last few fiscal years (Figure 4). At least some of the staffing change has been associated with passage of legislation and Proposition 1B.

Despite more than 10 years of examining various types of performance measures, Caltrans has experienced difficulty in developing consensus around acceptable performance measures (Larson 2004). In responding to the demands of various constituents, a plethora of efficiency and productivity indicators have been developed. For example, in the latest Performance Measures report (Caltrans (2010)), more than 56

different performance measures are presented, with little to no identified

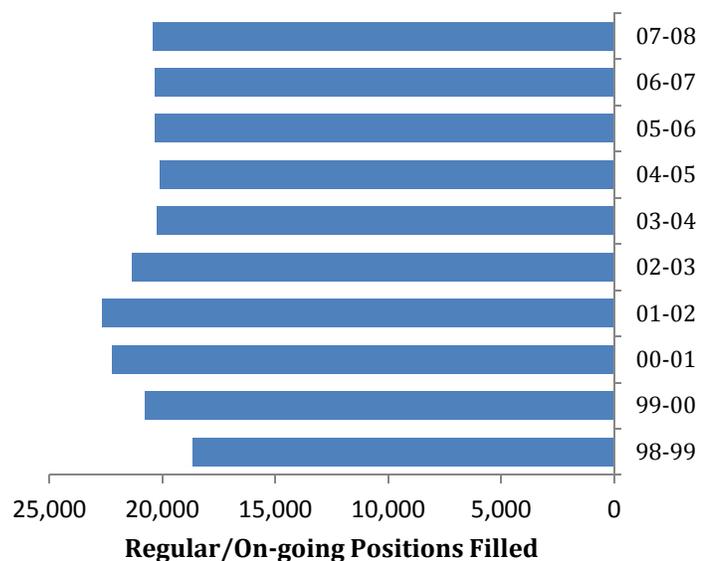


Figure 4. Caltrans Staffing by FY
 (Source: Dept. of Finance, Salaries and Wages)

importance in hierarchy or priority. Nonetheless, one consistent emphasis has been on the number of projects delivered annually. In response to a request by the Governor in 2004, districts now submit annual performance reports that align district project delivery objectives and goals with Caltrans overall strategic vision. Project delivery measures are also reported to the California Transportation Commission, which in turn, submits an annual report to the legislature. As will be discussed in the next section, project delivery, while not perfect, is a reasonable indicator of output.

Outputs

As noted earlier, in recent history Caltrans has relied on the ratio of capital outlay support ratio to capital outlay as its primary measure of productivity. By definition, the use of the COS/CO ratio in assessing productivity (or efficiency) is not appropriate. Recall from the earlier discussion that defining productivity outputs by authorized expenditures does not measure productivity; simply put, spending what you have been authorized to spend does not necessarily imply anything about the productivity associated with that expenditure.

Private sector engineering firms tend to measure productivity outputs by revenue generation, profitability and even by factors such as number of plan sheets produced (e.g., see Chang 2006). As discussed earlier, most of the research on productivity of engineering design firms has focused on evaluating productivity at the activity level. Construction in particular has been well studied at the activity and project level. Here, the focus is on developing a productivity index with an output measure that captures the project delivery process. In addition, the measure should be consistent from the lowest to the highest level at which output measures are derived (or tracked).

The department has typically assigned a high priority to project delivery, most recently moving toward design-build concepts and private-public partnerships (Kelly 2007). The number of projects delivered is also closely aligned with LAO and legislative productivity objectives. Since at least the early 2000s,²⁷ Caltrans has delivered performance reports to the CTC on project delivery, who in turn has used these data to report annually to the legislature; the number of projects delivered is an output measure that can be evaluated consistently over time. Using these data as output measures is also coherent with the productivity index framework and the public accountability context described most recently in SB 45. However, it should be noted that not every program or activity category is consistently reported each year in the CTC annual report. Reported project delivery

²⁷ See <http://www.dot.ca.gov/hq/projmgmt/reports.htm>

statistics by various groupings, as documented in the annual CTC report to the legislation, are identified in Table 4.

Table 4. Project Delivery (Source: *CTC annual reports*)²⁸

	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08
STIP Projects	•	•	•	•	•	•	•	•	•
SHOPP Projects	•	•	•	•	•	•	•	•	•
Minor Projects	•	•	•	•	•	•	•		
ROW Allocation	•								
STIP Env Doc.	•	•	•	•	•	•	•		
SHOPP Env Doc.	•	•	•	•	•	•	•		

Separate output indexes were calculated for STIP/SHOPP project delivery. As noted earlier, the data for these outputs were taken directly from CTC annual reports. Caltrans has noted that together, these categories cover a substantial majority of the department’s capital outlay (40-60% in any given year). The output indices are referenced to the 1999-00 fiscal year. Table 5 suggests that, over time, the rate at which STIP projects have been delivered has largely stayed steady with the exception of the 1999-00 base year, which had an extremely high number of projects, and the 2003-04 and 2004-05 fiscal years, which saw a dip in the number of delivered projects (Figure). The number of projects delivered is of course a function of the number of projects programmed. During both of these periods, the number of STIP projects programmed was exceptionally high (1999-00) and relatively low (2003-04 and 2004-05). In contrast, the SHOPP program has stayed reasonably steady in terms of both projects delivered and projects programmed. However, it is very clear that during the period in which programmed STIP projects declined, the number of SHOPP projects delivered increased. Note also that productivity cannot be determined from this information alone.

²⁸ Although not large, there are sometimes discrepancies in the number of project reported as delivered between the 4th quarter reports filed by Caltrans and the annual reports produced by the CTC. Caltrans has indicated that CTC’s practice is to report delivery based on programmed projects, whereas Caltrans follows Commission Resolution G-92 (Bailey, May 27, 2010). In reviewing the CTC “G” Resolutions (1992, G-92: 1-22), I was unable to confirm which reporting protocol applied. Therefore, for the purposes of this study, annual project delivery statistics reported by CTC. Caltrans provided a comparison to Table 5, which can be found in Appendix 2.

Table 5. Output indices (1999-00=100)

Year	STIP (inc. advanced projects)		SHOPP (inc. advanced projects)		STIP + SHOPP Combined	
	Index	Completed ¹	Index	Completed ¹	Index	Completed ¹
1999-00	100.0	112	100.0	258	100.0	370
2000-01	36.6	41	93.8	242	76.5	283
2001-02	46.4	52	74.0	191	65.7	243
2002-03	35.7	40	57.8	149	51.1	189
2003-04	25.9	29	77.5	200	61.9	229
2004-05	21.4	24	120.9	312	90.8	336
2005-06	55.4	62	119.8	309	100.3	371
2006-07	51.8	58	100.0	258	85.4	316
2007-08	42.0	47	102.7	265	84.3	312

One important caveat to using the CTC reports is that project delivery numbers that are reported in any given year sometimes change in a subsequent annual report. For example, in both the 1999-00 and 2000-01 annual reports (CTC 2000; CTC 2001), the number of programmed STIP projects is reported as 131. In the 2001-02 annual report (CTC 2002), the number of STIP projects

programmed is reported as 123.

As noted by CTC staff, this is the result of a change in the information reported. In 2001, project delivery information included a category for projects delivered in a prior fiscal year; this category was deleted in the 2002 report (Boutros, 2010). The

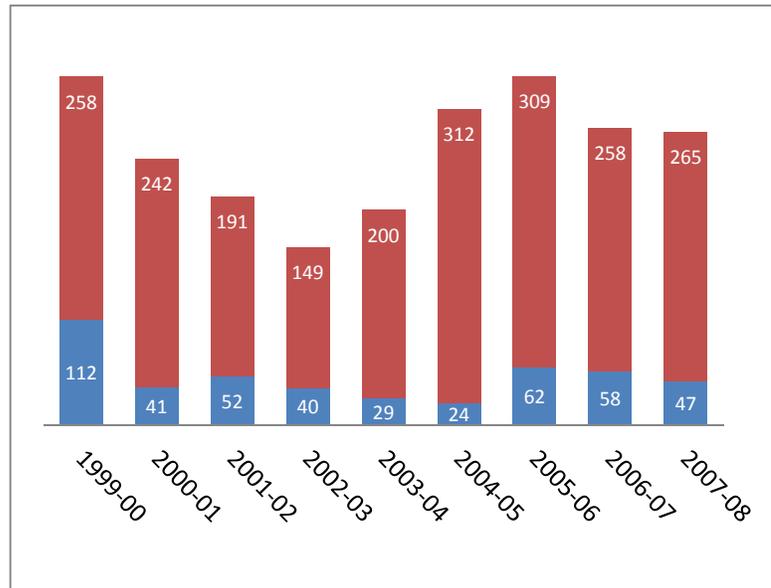


Figure 5. STIP (blue), SHOPP (red) Delivered Projects

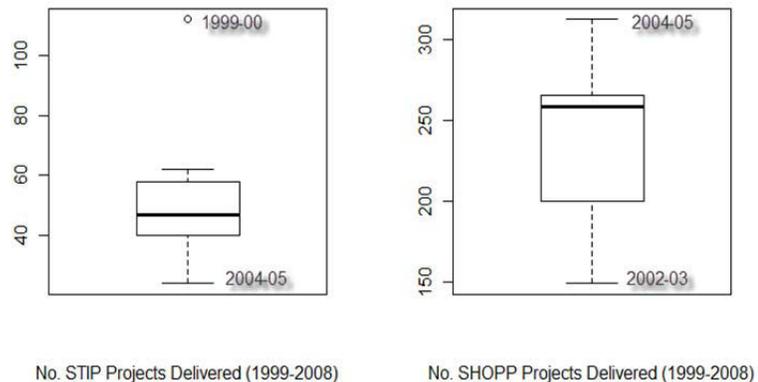


Figure 6. Project Delivery (STIP, SHOPP Programs)

convention used in the CTC reports to calculate the number of projects completed in a fiscal year is to subtract the time extended and lapsed projects from the number of programmed projects, explaining why the numbers may not match from year to year for the number of programmed projects. The CTC tracks project delivery for all projects programmed and funded through the STIP/SHOPP (CTC, 2009).²⁹

Labor Inputs

Labor inputs are usually expressed in terms of hours or full-time-equivalent. Hours are typically used in measuring private sector productivity, primarily due to their availability, while full-time-equivalent and total employment are used in deriving measures of government productivity (Fisk 1998). These indices tend to track in concert. Caltrans tracks hours at the project level, which can be converted to FTE at CCA for both the STIP/SHOPP programs (Table 6). STIP/SHOPP staff have ranged from 45% to nearly 70% of Caltrans total staff FTE, excluding overtime and contracted labor.³⁰ It should be noted that Caltrans has long been interested in the relative benefits of in-house staffing versus contracting out;³¹ this type of issue can be evaluated through a consistently defined and measured productivity index. Labor input measures for both STIP and SHOPP FTE have been calculated and are shown in Table 7. Labor indices (1999-00=100)

Table 6. Caltrans FTE History (Source: ____, 2008)

	STIP¹	SHOPP¹	Staff	Overtime	Contract Out	Total
1999-00	2095	2434	9854	546	592	10992
2000-01	2994	2909	10565	822	1159	12546
2001-02	2667	3154	11072	650	1646	13368
2002-03	2981	3073	10803	650	1382	12835
2003-04	2756	2749	10245	303	500	11048
2004-05	2398	3428	10651	699	1070	12420
2005-06	2716	4018	11200	710	1568	13478
2006-07	3016	3995	10638	636	1410	12684
2007-08	3011	4495	11069	668	1393	13130

¹ Caltrans provided STIP/SHOPP FTE (expended) converting hours to FTE using a conversion ratio of 1758 hours/FTE for state staff, overtime, or A&E consulting. The total capital outlay support program includes approximately 10% consulting (Rodriguez, 2010)

²⁹ The CTC also tracks RSTP and CMAQ projects; a project is considered delivered when federal funds are obligated by the local agency (CTC, 2009).

³⁰ The STIP/SHOPP staffing includes contracted labor estimated at approximately 10% (Rodriguez, 2010).

³¹ A recent Sacramento Bee study cited an Institute of Transportation Studies, University of California, Berkeley, UCB-ITS-RR-92-8 report which compared the ratio of capital outlay support to total construction cost for contracted versus in-house projects, and found no statistically significant difference.

Table 7. Labor indices (1999-00=100)

	STIP FTE	SHOPP FTE
1999-00	100.0	100.0
2000-01	142.9	119.5
2001-02	127.3	129.6
2002-03	142.3	126.3
2003-04	131.6	112.9
2004-05	114.5	140.8
2005-06	129.6	165.1
2006-07	144.0	164.1
2007-08	143.7	184.7

Productivity Index

Using the productivity formula given earlier, the productivity index can be calculated using both staff FTE and total FTE (staff plus contract out) as input. The results are shown in Table 8; both productivity indices are anchored at the 1999-00 fiscal year. The basic trends can be organized into three broadly defined periods Figure 5. In the early 2000's, despite increases in staff numbers, fewer projects were delivered, and productivity declined. Between 2003 and 2006, overall productivity increased. During this period, the number of staff FTE remained fairly constant, even declining slightly, while the total number of projects delivered grew significantly. Finally, during the third period productivity slightly declines accompanied by slight declines in staff levels; the number of projects delivered has remained steady since FY2004-05. These trends are suggestive of having reached a plateau in which further reductions in STIP/SHOPP staff may negatively impact productivity unless fewer projects are programmed (and delivered). Finally, the differences between staff and total FTE productivity are very small throughout the analyzed time period and unlikely to be statistically significant given the much greater variability exhibited over the analyzed years.

Table 8. Productivity Indices (100=FY1999-00)

	Program	
	STIP	SHOPP
1999-00	100.0	100.0
2000-01	53.5	64.0
2001-02	51.6	50.7
2002-03	35.9	40.5
2003-04	47.0	54.8
2004-05	79.3	64.5
2005-06	77.3	60.7
2006-07	59.3	52.0
2007-08	58.7	45.7

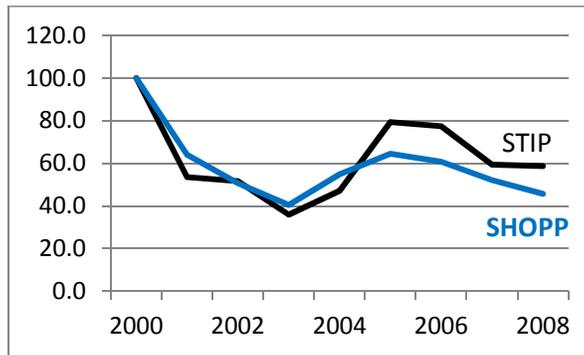


Figure 5. Productivity (100=FY1999-00)

Early in the study Caltrans also provided raw labor hours (at the project level) for the SHOPP program. Using the raw labor hours aggregated to construction completion year, labor productivity for the SHOPP was estimated. The results of this analysis are included in Appendix 2, and as can be seen, the productivity indices differ between the two analyses. When the annual aggregated project level hours are converted to FTE, the resulting FTE is substantially lower than the FTE figures provided by Caltrans in Table 6. This, in turn, results in a higher productivity index. It's not clear why there is such a marked difference in the computed FTE between the two approaches, but because of this, the productivity indices shown in Table 8 should be viewed as an exploratory lower bound for the SHOPP program. That is, productivity may actually be higher for the SHOPP.

Discussion

Productivity measures offer a means for improving insight on trends in labor performance over time, as well as helping to identify drivers behind changes. Two examples, one using the STIP/SHOPP programs and total FTE and one using the SHOPP program alone and reported hours were developed. From these examples, there are some obvious trends that can be highlighted by applying the productivity measure and the analysis helps to make clear the kinds of decisions that must be made to develop a robust and consistently applied productivity index.

Basic Trends

Since FY1999-00, capital program workforce levels have almost doubled for the SHOPP program and grown by more than one-third for the STIP, while the number of projects delivered (as well as the number of projects programmed) has generally held steady. Figure 6 clearly suggests that, in

addition to workforce inputs, productivity may be strongly influenced by other factors. That is, the input labor indices reflect less variability over time than programmatic trends over the same period. Hiring practices and changes in project composition and type may be strong influences on the final productivity measured. To really understand what these basic patterns might signify requires greater refinement of the input and output measures. This includes both developing a firm consensus around the final outputs and establishing quality factors associated with the inputs.

For example, although project delivery is obviously a key output measure, the complexity or compositional nature the projects delivered over time may have also changed; this is partially seen in the fluctuations in the dollar value of the programs delivered (Figure 7). This aspect to project delivery is not captured in the productivity measures calculated in this report. It could also be argued that smoothing out and generally increasing productivity over time would need to be prefaced with infrastructure programming that is less volatile than has historically been exhibited in California. There are basic problems of allocation that are out of control of the department and impact future years. For example, in 2002-03, 40 STIP projects were delivered for which there were no funds available for allocation. This, in turn, impacts subsequent year budgets and in this case resulted in significant 2003-04 budget constraints and lower project delivery.

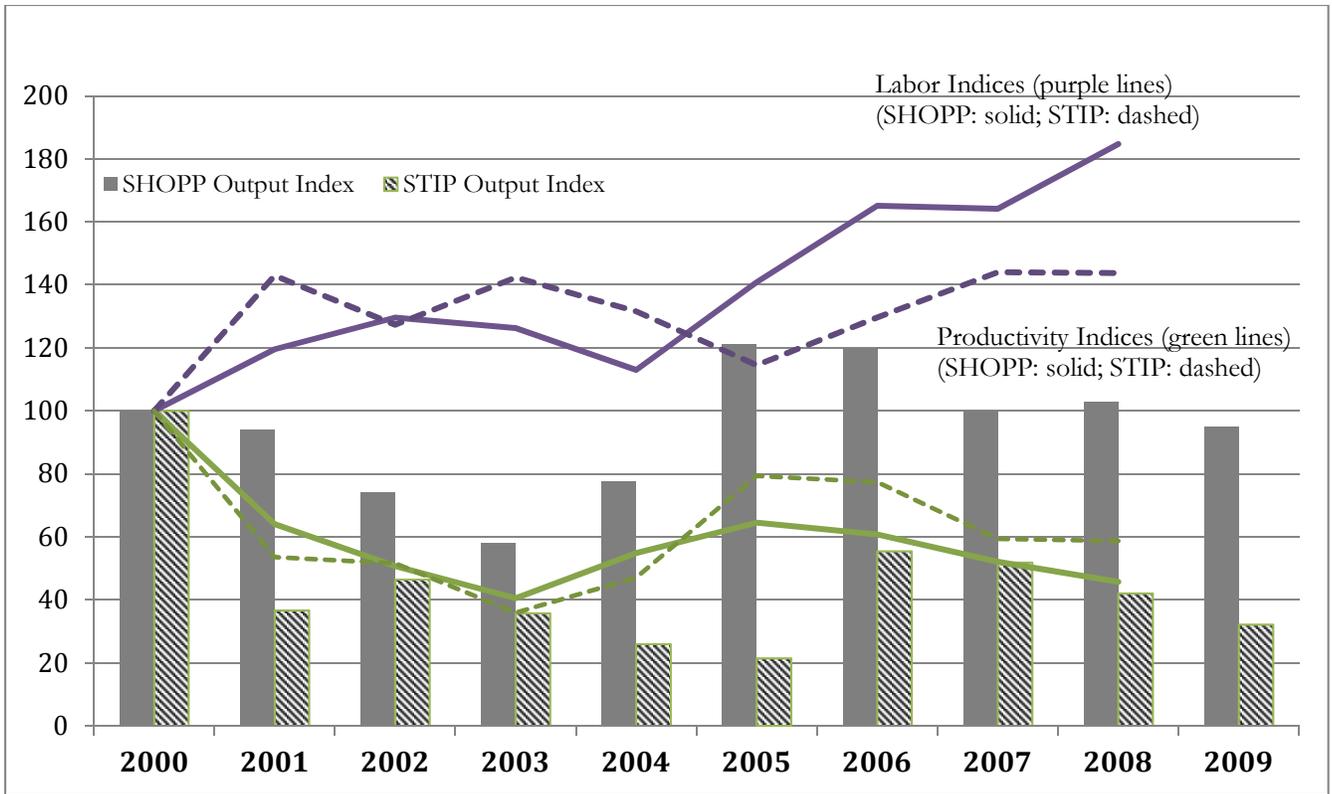


Figure 6. Input (Program FTE), output (no. STIP/SHOPP projects delivered), and productivity indices

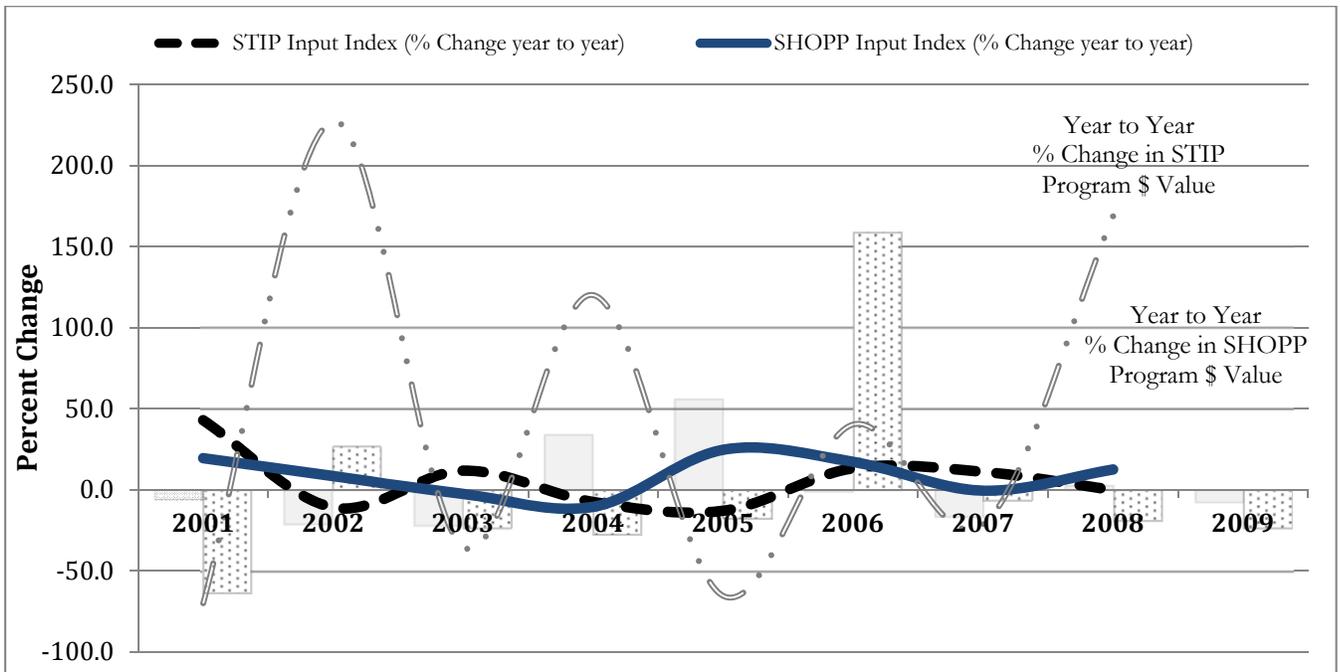


Figure 7. Year to year percent change in STIP/SHOPP labor input index (heavy dashed/solid line), no. of STIP/SHOPP projects delivered (shaded/dotted bars), STIP/SHOPP program value (open dash line/solid dash)

Likewise, improvements in labor input measures to better reflect quality should also ideally capture heterogeneity within the workforce. This is particularly critical for an agency like Caltrans, where the workforce composition includes highly trained personnel (e.g., engineers, surveyors, and construction and project managers) possessing skills that should ideally be treated as a separate and distinct labor input. Labor inputs are also limited in the sense that they do not capture the combined effects of a number of interrelated factors leading up and through the project delivery process that very likely impact productivity.

These factors might include changes in technology, investments in worker training, the effects of labor inputs on intermediate products, changes in the regulatory environment, and labor relationships (e.g., with unions or management). One of the most important elements in implementing a productivity measure is to ensure that its discrete parts can be summed at the program level. Program and agency productivity should be measured across phases and districts, but not at the individual project level. The LAO has frequently cited individual project COS/CO as a concern. However, any individual project may be higher or lower than any particular policy level that has been specified. This conceptually shifts the way in which measures should be derived from thinking about individual projects at the agency level to one in which projects are nested within programs which are nested within districts³² (Figure 9). This would allow the agency to better identify where productivity gains can and should be achieved, as well as improving accountability where projects are actually developed and managed.

³² This generalized structure could also be modified slightly to accommodate the use of functional units.

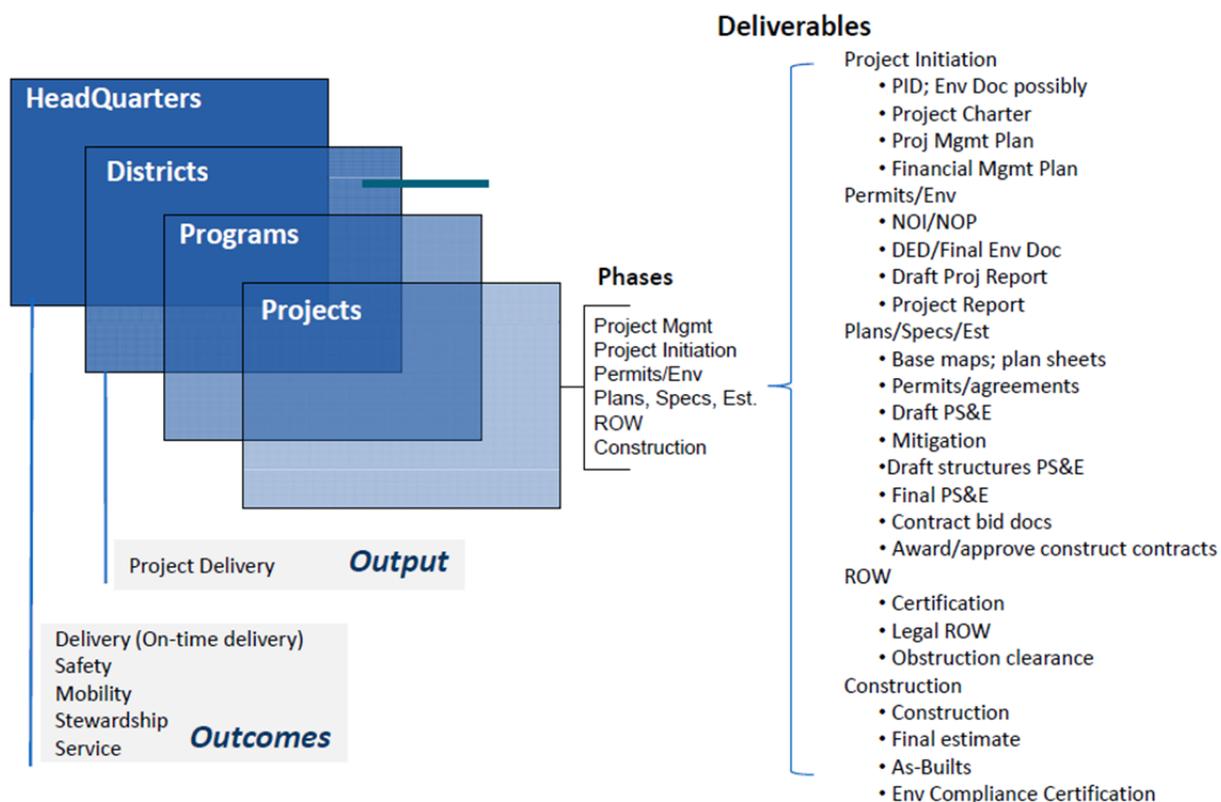


Figure 8. Conceptual application of the new framework

Conclusions and Recommendations

The purpose of this study was to demonstrate how labor productivity could be established for Caltrans. The study presented a framework for measuring changes in productivity over time. Specifically, a labor productivity indicator would replace the COS/CO ratio that is frequently, but inappropriately, relied upon to annually assess Caltrans support efficiency. As was shown, the COS/CO ratio of support to capital does not reflect agency productivity or efficiency. The ratio is a policy instrument designed to reflect certain policy decisions regarding support cost constraints. Since the unit rates of support costs are not entirely under Caltrans management control, a policy to constrain support costs may also affect productivity.

This report should not be considered a productivity analysis *per se*. Its primary purpose was rather to introduce and demonstrate a new framework for measuring productivity as well as to outline next steps that should be taken to fully implement the productivity framework for capital programs. There are a number of important elements to consider going forward. These include identifying the main policy objectives and deliverables for which Caltrans will measure

productivity, defining the scope and level of the implementing structure, and possibly even piloting a partial implementation to ensure a smooth rollout (e.g., at the district levels for one program).

Broadly speaking, Caltrans should begin to undertake the following efforts,

- Adopt the labor productivity approach along the lines of that described in this study. Ideally, this would entail developing broad acceptance of the need and appropriateness of this approach within the department and possibly the legislature and the LAO;
- Define the scope and boundaries of the inputs and outputs. The attributes of both inputs and outputs have been discussed at length and those ultimately selected by the department should meet these standards. In addition, the project development process should be examined with the purpose of identifying where labor inputs and produced outputs should be measured (e.g., at the discrete project phases).

Also as part of this effort, Caltrans should identify the levels within Caltrans at which the productivity index will be aggregated (e.g., at the District, functional unit or department-wide). Based on the information known at this time, productivity should be tracked in the conceptual form presented in Figure 10, where projects are nested within programs within districts. This would allow Caltrans to identify where productivity gains can be realized and to better specify actual accountability for project development;

- Caltrans has noted that the base year of FY1999-2000 was selected in part because it reflects when data became available due to passage of SB 45,³³ yet the fiscal year was clearly exceptional in terms of the numbers of projects programmed and delivered. Regardless of the final selected base year, productivity should be calculated for whatever period of time data are available;
- Caltrans should work with respective staff to define categories (e.g., programs, types of projects, etc.) for which the productivity indices will be derived;

³³ Some performance measures were sporadically reported on prior to FY1999-2000.

- Caltrans must define quality measures. Measures of quality should be developed for both inputs and outputs. For inputs, quality should, at the minimum, reflect workforce labor composition. For outputs, some measure of project complexity would be useful (if the project delivery output measure were retained). Potential elements that can add to the complexity of a project include, for example, the type of project, any difficulty that might be expected in acquiring right-of-way, and possible environmental impacts. For a productivity measure to be useful, it must be able to protect quality while increasing productivity.
- Derive the productivity indices at each stage and level defined above. This effort should determine the best method for handling the fractional portions of outputs and labor inputs of developing projects for each budget year.

One possible implementation strategy for Caltrans to consider would be the development of pilot application using one or districts and one or more programs. This would allow data processes to be defined consistently from the project-level aggregated to the program level, and would provide a mechanism for engaging staff in defining resources, products and the quality aspects of each.

This study has shown how a labor productivity measure should be defined and demonstrated the potential application of a productivity indicator that would provide a regular and reliable measure of the department's labor efficiency. Managing resources for productivity requires quantitative measures that identify the amount and quality of the resources used and the services delivered. The proposed measure is simple, straightforward and can be tracked over time.

References

- ___(2008). Senate Budget and Fiscal Review. Subcommittee No. 4, Pt. 2 2008 Agendas. Sacramento, California Senate: 455.
- Boutros, A (2010). Personal communication
- Caltrans (1995). 1995 Performance Report, Capital Support Measures. Sacramento, California Department of Transportation.
- Caltrans (2005). Ten Year State Highway Operation and Protection Plan. Sacramento, California Department of Transportation: 36.
- Caltrans (2007). Caltrans Project Management Handbook. Sacramento, California Department of Transportation: 77.
- Caltrans. (2007). "Chronology of Project Management in Caltrans, 1994." Retrieved June, 2009, from http://www.dot.ca.gov/hq/projmgmt/chron_1994.htm.
- Caltrans ((2010)). Performance Measures for the Quarter Ending March 31, 2010. The Office of Strategic Planning and Performance Measurement. Sacramento, California Department of Transportation: 41.
- Casavant, K., E. Jessup, et al. (2007). Program Scoping, State of the Practice, *Prepared for* Washington State Department of Transportation, Research Office, WA-RD 680.1.
- CBP (2006). Budget Backgrounder: Making dollars make sense. Sacramento, California Budget Project: 15.
- Chang, A., Ibbs, W. (2006). "System Model for Analyzing Design Productivity." Journal of Management in Engineering **22**(1): 27-34.
- CTC (2000). 1999 Annual Report to the California Legislature. Volume 1, 2000 Issues. Sacramento, California Transportation Commission: 151.
- CTC (2001). 2001 Annual Report to the California Legislature. Volume II, 2001 Activities and Accomplishments. Sacramento, California Transportation Commission: 151.
- CTC (2002). 2002 Annual Report to the California Legislature. Sacramento, California Transportation Commission: 136.
- CTC (2009). 2009 Annual Report to the California Legislature. Sacramento, California Transportation Commission
- Danker, T. and T. Dohrmann (2007). What is public sector productivity? Washington DC, McKinsey and Company.

Danker, T., T. Dohrmann, et al. (2006). How can American government meet its productivity challenge? Washington DC, McKinsey and Company.

Diewert, E. (2010). "Measuring productivity in the public sector: Some conceptual problems." http://ideas.repec.org/p/ubc/bricol/erwin_diewert-2010-6.html.

FDOT (2010). Section II - Product Support. Program and Resource Plan. O. o. F. Development, Florida Department of Transportation.

FHWA (2008). Chapter 8, Reports Identifying Highway Income and Expenditures of State Governments. Highway Statistics. Washington DC, Federal Highway Administration.

Fisk, D. and M. Greiner (1998). Measuring Productivity in State and Local Government: Examples from Eleven Services. Bulletin 2495. Washington DC, U.S. Dept. of Labor, Bureau of Labor Statistics: 204.

Fisk, D., M. Greiner (1998). Measuring state and local government labor productivity: Examples from eleven services. Bureau of Labor Statistics. Washington DC, U.S. Department of Labor.

Hendren, P., D. Niemeier (2001). "State Transportation Expenditure Reporting: Questions for the 21st Century." Public Works Management and Policy 5(3): 179-197.

Hendren, P., D. Niemeier (2008). "Identifying peer states for transportation system evaluation & policy analysis." Transportation 35(4): 445-465.

Kelly, J. (2007). Caltrans will ramp-up innovative project delivery methods. Engineering News Record, McGraw-Hill Construction.

LAO (1997). Department of Transportation (2660). Analysis of the 1997-98 Budget Bill, Transportation Departmental Issues, Part 1. Sacramento, Legislative Analysts Office.

LAO (2003). Department of Transportation (2660). Analysis of the 2003-04 Budget Bill. Sacramento, Legislative Analysts Office.

LAO (2010). Transportation. The 2010-11 Budget. Sacramento, Legislative Analyst's Office: 32.

Larson, M. (2004). Organizing for Performance Management. 2nd Annual Conference on Performance Measures, Irvine, California, Transportation Research Board.

Lehtoranta, O. and M. Niemi (1997). Measuring public sector productivity in Finland. Statistics Finland, Economic Statistics. **FIN 00022**.

MDOT (2010). Section 358, Total MDOT Employees. Legislative Reports, Bureau of Finance and Administration, Budgets and Reports Unit, Michigan Department of Transportation.

Moore, S. W. (June 2010). Personal communication.

Orszag, P. (June 8, 2010). Remarks by Peter Orszag, Center for American Progress.

Personal Communication (2010). Caltrans Staff. Davis, CA.

Rodriguez, B. (2010). Personal communication

Rosen, E. D. (1993). Improving Public Sector Productivity, Concepts and Practices. London, Sage Publications.

Simpson, H. (2009). "Productivity in Public Services." Journal of Economic Surveys **23**(2): 250-276.

SRI (1994). Evaluation of the Organizational Structure and Management Practices of the California Department of Transportation. Final Report Volume II (Detailed Findings, Options, and Recommendations). Stanford Research Institute (SRI). Sacramento, California Legislature, Legislative Analyst's Office.

WSDOT (2008). Chapter 5, Information Technology Systems. Project Control and Reporting Manual, M 3026.01. Olympia, Washington State Department of Transportation.

WSDOT (2009). The Gray Notebook, Washington State Department of Transportation, GNB-33.

Appendices

APPENDIX 1: LAO Request Material

Referring text in LAO report	UC Davis Request	Supporting material provided
"This information included reviewing reports published by Departments of Transportation in other states regarding their support costs" (TR-13)	List of reports that were reviewed	None
"We discussed these issues with state officials from other states." (TR-13)	List of state officials contacted	None
"We also surveyed local transportation agencies on their support costs for projects and compared them to Caltrans for comparable projects." (TR-13)	List of the local transportation agencies contacted; List of the projects compared.	None; See Table 2 (Main Report)
"We also discussed these issues with other transportation program experts." (TR-13)	List of the transportation program experts contacted.	None
"...also examined the support costs that are incurred for capital outlay activities in California other than transportation projects." (TR-13)	Please provide a description of the projects used in comparison.	None
"However, our analysis further indicates these differences alone do not fully explain Caltrans comparatively higher costs. Rather, it appears that Caltrans higher program costs are likely due to the comparatively greater staffing levels used to deliver the projects." (TR-13)	Please provide a description of the analysis/methods used to support this conclusion.	None
"..costs being reported by other transportation agencies for performing certain types of support work...are much lower than Caltrans." (TR-13)	Please provide the data used to support this conclusion.	See Table 2 (Main Report)
"Our review indicates that the costs for other transportation agencies were lower for these functions because they accomplished them with fewer staff and more efficient procedures." (TR-13)	Please provide the data and analysis used to support this conclusion.	See Table 2 (Main Report)
"High support costs seen on a sample of projects....Our review of the data indicates that support costs on some of the sample projects are unreasonably high." (TR-17)	Please provide the data and analysis used to support this conclusion.	See Table 2 (Main Report)

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
916-752-0586
916-752-7872(FAX)

DAVIS, CALIFORNIA 95616

April 11, 2010

Jessica Digiambattista
Legislative Analysts Office
925 L Street
Suite 1000
Sacramento, CA 95814

Re: Request for information

Dear Ms. Digiambattista,

I am following up on my email of March 5th in which I requested information, including data, that was used to support your report of March 2, 2010 on the 2010-11 state budget for transportation. I have now also taken the time to clearly outline those sections of the report in which I am requesting the backup information and/or the supporting data used to underpin the report conclusions. This summary list is provided below.

Thank you in advance. If you have any questions, please feel free to contact me. I appreciate your attention in this matter.

Regards,

A handwritten signature in black ink, appearing to read "Debbie".

Sincerely Yours,

Debbie A. Niemeier, Ph.D., P.E.
Professor
Editor-in-Chief, Transportation Research, Part A

APPENDIX 2: Additional SHOPP Analysis

The Caltrans State Highway Operation and Protection Program (SHOPP) provides funding for safety and maintenance projects on state highways. The state highway system includes approximately 50,000 lane-miles, more than 12,000 bridges, 200,000 culverts and drainage facilities, 53 truck weight and inspection stations, and more than 25,000 acres of landscaped area and 88 roadside safety rests (Caltrans 2005). Much of the system was constructed pre-1970 and is expected to serve state travel needs of around 251 billion vehicle miles of travel by 2020.

For this analysis, total hours charged to the projects and number of projects delivered were used to calculate the input and output indices (Table 9), respectively. Total hours worked is typically considered a much stronger labor input measure than FTE and provides a closer relationship to actual productivity; however, as is discussed in the next section, this measure would also be improved upon by adjusting hours by labor workforce quality.

Table 9. SHOPP Program Input, Output Indices (1999-00=100)

	Labor Hours (Input Index)	Projects Delivered (Output Index)	Productivity Index
1999-00	100.0	100.0	100.0
2000-01	142.1	113.6	79.9
2001-02	179.2	123.9	69.1
2002-03	161.7	95.1	58.8
2003-04	150.1	83.7	55.8
2004-05	153.9	82.1	53.3
2005-06	131.1	117.4	89.6
2006-07	266.3	215.2	80.8
2007-08	215.0	177.7	82.6
2008-09	190.3	123.4	64.8

In general, the number of SHOPP projects delivered over time has varied quite a bit. This is evident by discrete jumps (e.g., more than 100% in a single year) in the computed output index.

Nonetheless, it is clear that SHOPP project delivery productivity has generally declined over time. This is to say that the number of projects being delivered has been slower to rise than the total hours charged to deliver those projects. While there may certainly be some loss in individual worker productivity, it is also likely that there are multiple underlying reasons for declines in productivity. For example, costs may have risen through spending on project delivery elements that improve outcome, but do not contribute to output.

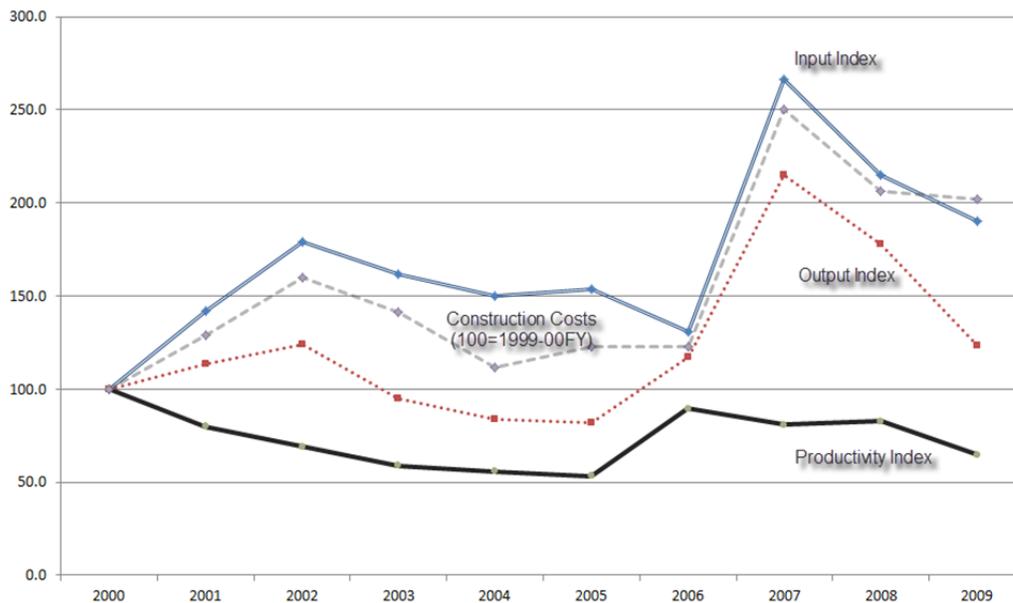


Figure 9. Cost, input, output and productivity indices (1999-00=100)

The process by which projects are delivered has many facets to it and there will be multiple underlying issues that affect can affect the rate at which projects are delivered. For example, in reviewing cost trends over time, there are years in which very high capital cost projects are included in the SHOPP program, and moreover, these years also associated with greater variability in support costs (e.g., 2005, 2009 in Figure 9). As projects with much greater capital costs than the typical distribution of costs are added to the program (e.g., the outliers above the upper whisker of the total capital cost boxplot), the percent of support costs will go down, but because the projects included in the program may be more complex, total support costs may increase.

Another factor contributing to declines in productivity may also be associated with how projects are budgeted and increases in unit support costs over time. Average support costs, total hours reported and capital costs for each fiscal year are shown (each is indexed at the 1999-2000 fiscal year). From this diagram, it is easily seen that average capital costs and average hours charged to projects have largely tracked each other. However, average support costs have dramatically increased over time. The department would have very little control over increases in unit costs. This figure also highlights why use of the COS/CO ratio is problematic. The relationship between productivity and the ratio of support costs to total costs is indirect, and further illustrates why

suggesting an arbitrary reduction in support costs without evaluating the potential impact on productivity is problematic. This figure also may indicate that there may be problems with budgeting. The close tracking of average capital costs and average reported hours suggest that projects may be estimated in a more or less routine fashion as a percentage of total estimated costs. However, this would require a more detailed analysis. Nonetheless, what this analysis has shown is that by using a consistent measure of productivity, additional factors impacting productivity can be more deeply explored.

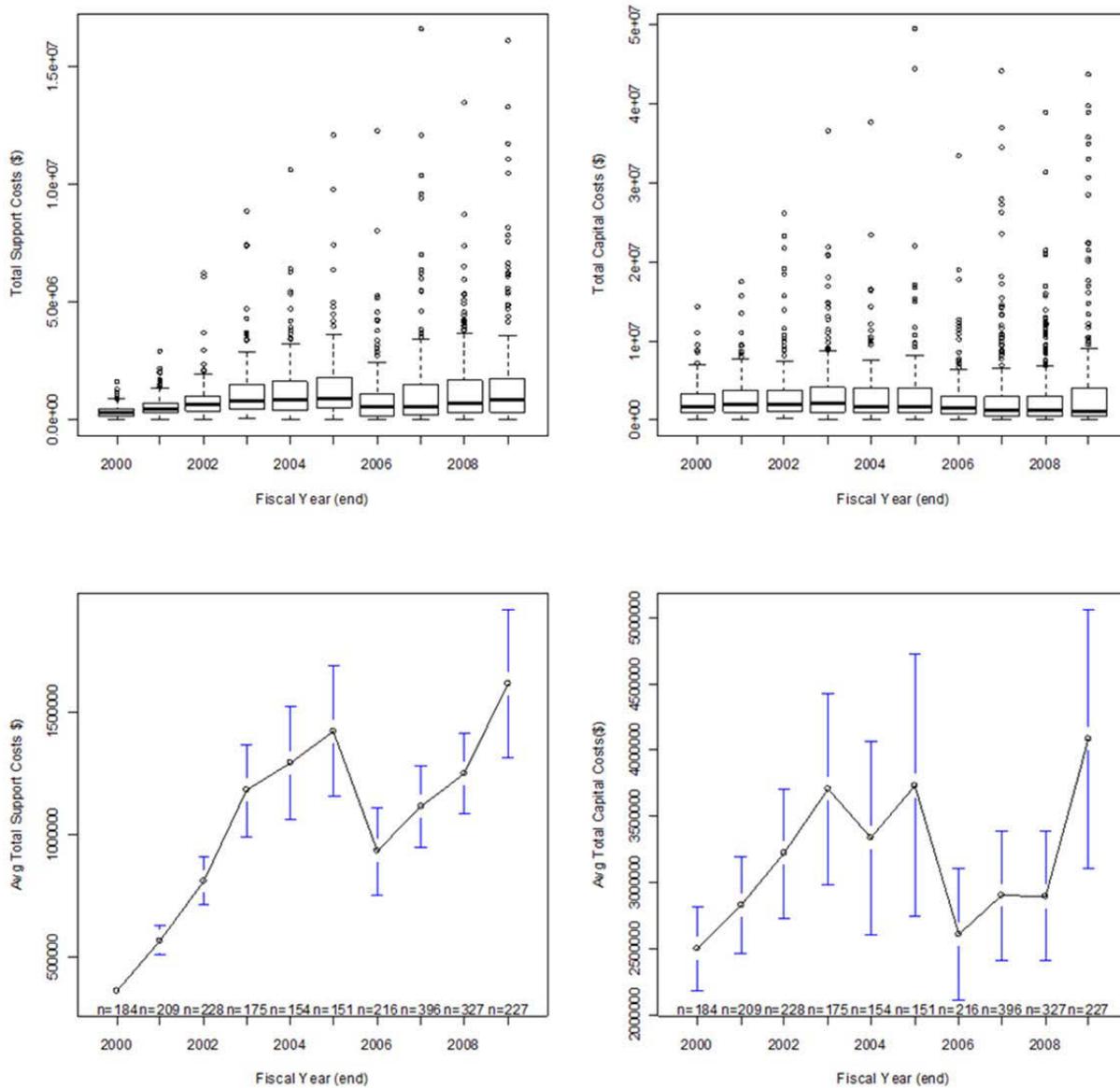


Figure 10. (a) Distribution of support and construction costs; (b) average support and average capital costs

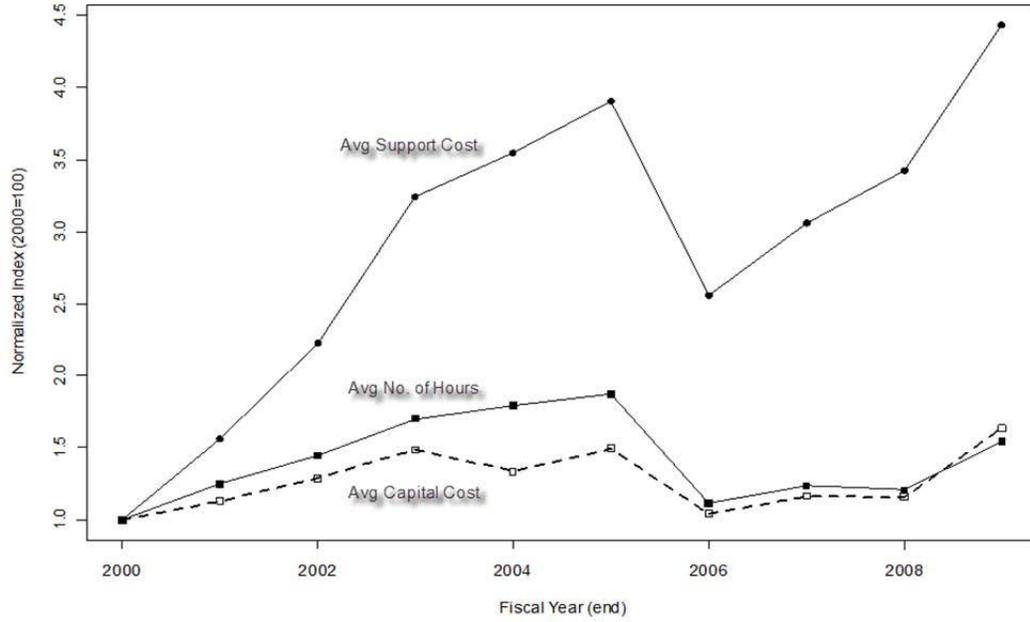


Figure 11. Average support, totals hours and capital costs

APPENDIX 3: Response to Review Comments

Caltrans, the LAO and CTC were provided a draft of the report for review; below is compilation of the comments received. In addition, a brief description has been provided for any changes or revisions that were undertaken in response to specific comments. Please note that all page numbers refer to the original draft.

Caltrans General Comments:

- ***“Demonstrates complexity of the topic”***
- ***“Differentiates between productivity and efficiency”***
- ***“Provides new model to evaluate productivity”***
- ***“Task 4 details lacking. Task 4 was to provide a multi-year evaluation framework. The framework also details the business processes that would impact each measure of productivity selected to examine over time.”***

Response: The discussion of how to establish a multi-year evaluation process has been expanded. Because the choice of outputs impacts the final productivity measure, business processes cannot yet be specified. However, if Caltrans elects to maintain and extend the example productivity measure (labor hours, projects delivered), then the business processes are self-evident, and the inputs and outputs should be refined to better reflect the range of programmatic efforts currently maintained by Caltrans.

Caltrans: ***There are two “page 1’s”***

Response: Corrected.

Caltrans: ***Replace ‘COS’ with ‘C/S’***

Response: To be consistent with past reports, the words “COS ratio” have been replaced with COS/CO.

Caltrans, pg 2: ***Missing “a”***

Response: Corrected.

Caltrans, pg 3 (referring to ‘fewer personnel-years’): ***“Is this true? Sometimes more studies can save significant dollars in capital costs.”***

Response: This section of text (the impact of quality on output) has been re-written to better clarify the distinctions being drawn.

Caltrans, pg 3 (referring to the text in which it is noted that frequently it is only labor productivity being measured for public sector outputs and that other factors may contribute to productivity gains and losses): ***“Labor costs have an impact on capital costs. If labor is reduced to eliminate reviews, etc, projects may be delivered cheaper and faster, but at a higher capital cost.”***

Response: Factors critical to the output should obviously be carefully considered before eliminating them.

Caltrans, pg 3: ***“[Replace] Since the mid-1990s with Starting in 1995-96 till 2001-02 and add capital outlay support before ‘performance’ (same sentence)”***

Response: The text has been modified to “Beginning in FY1995-96 and continuing until 2001-02, Caltrans reported on a number of capital outlay support measures.”

Caltrans, pg 3: ***“Add ‘funding to ‘decision-making authority’”***

Response: The text has been modified to “...which delegated decision-making funding authority to the regional governments...”

Caltrans, pg 4: ***“Should this section be in the report? It’s 1) old measures; 2) not produced anymore, and 3) LAO found it to be inadequate (see the 2003 Budget Analysis).”***

Response: The material is historical and important for establishing the context for the present study. In response to the third comment, regarding the LAO’s position, it should be noted that the LAO’s recommendation was more considered than simply identifying the measures as

inadequate. Nonetheless, it is important to reflect the content of the referred to LAO report in the historical review. Thus, a short discussion outlining the relevant LAO analysis has been added to the section.

Caltrans, pg 5: "...The Department is seeking the development of new measures [to replace the measures the LAO (2005) found inadequate]. Recent management measures that supersede previous measures include Directors Contracts for Deliveries, Performance Measures report, and the new version [of the] CTC quarterly reports." [confirmed by Matt Bailey].

Response: The section has been expanded (see above) and now includes reference to these materials.

Caltrans, pg 7: "This section of the report should be given to the LAO for review and comment prior to finalizing report."

Response: The LAO was provided an opportunity to review and comment.

Caltrans, pg 10: "Why these states and not others? Expand on why you used them."

Response: These were the states agreed upon with Caltrans at the beginning of the project.

Caltrans, pg 11: "Washington, Florida, and CA in top 10 in terms of support expenditures. Oregon is not, should it be included? A review of Michigan Hwy statistics data seemed to show a data error, so should it be included? New York and Texas were the other top two support states, should they be evaluated?"

Response: The states included (and the level of evaluation) was agreed upon at project initiation. Without additional information on Michigan, it is difficult to ascertain how to respond (e.g., what is the data error? In what material?). However, as noted Michigan DOT reports by fund type, not project specific categories and it is impossible to construct comparable ratios to COS/CO.

Caltrans, pg 11: "Report doesn't provide enough details or samples of other DOTs efforts in measuring productivity."

Response: These were the states agreed upon with Caltrans at the beginning of the project.

Caltrans, pg 12 "So why [is the ratio] included in next page table?"

Response: The text has been clarified as,

"The As presented in the ODOT program budget, the ratio is not directly comparable to Caltrans COS/CO ratio since construction engineering costs are included in the denominator."

The remainder of the paragraph also notes that ODOT provided additional data and more comparable ratios were calculated for the table.

Caltrans, pg 12: "Need to expand narrative in the state comparisons. Why are these states different, what do they have that are similar. It would be useful to have a table that shows common data and/or measures between the states."

Response: The purpose of the comparison was to highlight productivity or productivity-like measures between the states. There is not enough time to undertake a separate effort comparing state performance measures more broadly. However, there is a study (Hendren and Niemeier, 2008)³⁴ that provides peer groupings for state DOTs and comparative data.

Caltrans, pg 13: "[Note CA's] performance measures: contracts for delivery; performance measures report and CTC quarterly report."

Response: These are now referred to in the previous LAO section and highlighted as responses to the LAO recommendations.

Caltrans, pg 14: "What common factors (if any) were found [in the DOT comparisons]? If none, this should be stated. Are there any recommendations in terms of what other states do that

³⁴ Hendren, P., D. Niemeier (2008). "Identifying peer states for transportation system evaluation & policy analysis." *Transportation* 35(4): 445-465.

Caltrans should also do, or other measures that Caltrans & other states should attempt to benchmark?”

Response: These are important questions, but not within the scope of this report. Moreover, Caltrans has many performance indicators – it’s not clear more will help. What *is* needed is a systematic method for measuring labor productivity. The purpose of this report was to layout one possible framework for accomplishing this objective. If implemented, Caltrans will be a front runner in this area.

Caltrans, pg 15: Note that Highway Statistics is based on annual expenditures

Response: Done.

Caltrans, pg 15: In response to this sentence: “To better understand why and how differences in support costs arise...” “[Note there are differences] in field conditions. Meaning CA typically has higher traffic conditions. So factors such as night work, lane closures, rural/urban freeways, all can have an impact on support costs.”

Response: While it is correct that these factors can increase support costs, it is not clear that Caltrans support costs are significantly higher than other states *because* of these factors. The remainder of the referenced sentence notes that isolating these kinds of influences would require a much more detailed investigation at the state level.

Caltrans, pg 16: Expand/clarify: “Nonetheless, these data do provide an important picture of Caltrans preliminary and construction engineering and project-specific administrative costs as a function of capital outlay relative to other states.”

Response: Additional text has been added.

Caltrans, pg 17: Figure 3. Include annual and expenditure in title. Explain how low COS/CO ratios for other states are achieved. Include Florida, New York, Texas, Washington on graph. Possibly only include peer states?

Response: The title has been revised. On the basis of this study, it is not possible to comment on low COS/CO states. It may be that, similar to Oregon, these states contract out all project-related programming and development activities. All 50 states are presented and Texas, Washington, New York and Florida have been added to the graph.

Caltrans, pg 18: Expand on index use; minor edits

Response: The text was confusing and has been rewritten. Minor edits corrected.

Caltrans, pg 19: Minor edits

Response: Minor edits corrected.

Caltrans, pg 20: Clarify “Inputs must match outputs”

Response: Rewritten as: *Inputs should reflect resources required to produce outputs*

Caltrans, pg 22: Caltrans [outputs] should include environmental documents, construction contracts accepted

Response: The purpose of this study was to demonstrate a way of thinking about productivity, and showing how it could be applied. Caltrans should identify the appropriate outputs if the productivity framework is implemented; for every output labor hours should be matched to the production of this output.

Caltrans, pg 24: Note that capital outlay includes subventions

Response: This does not materially add to the discussion.

Caltrans, pg 24: Note that some staffing increase has been associated with passage of SB 45, AB 144, SB 66 and Proposition 1B.

Response: Agreed for Prop 1B (text added); changes in staffing as a direct result of legislative initiatives is not clearly documented.

Caltrans, pg 27: Note that 2000 should be changed to 1992 in this sentence: “Since at least the early 2000s, Caltrans has delivered performance reports to the CTC on project delivery...”

Response: This change was not made primarily because it was prior to SB 45.

Caltrans, pg 26: Note that “STIP/SHOPP is approximately 40-60% of total projects delivered in a year.”

Response: Added to the text.

Caltrans, pg 26: Should use Caltrans project delivery reports, not CTC, in Table 4

Response: The main difference between the formats is that STIP/SHOPP environmental documents would be collapsed to one category. Since we are not working with the environment documents in this study, it would make little difference.

Caltrans, pg 27: Please note that outputs also include DEDs, PAEDs, CCAs, Table 5, Figure 6

Response: In this example, we are concerned with STIP/SHOPP projects delivered only. If Caltrans decides to implement the framework to include intermediate outputs, labor hours should match these outputs.

Caltrans, pg 27: Share this section of the report with CTC staff

Response: The CTC staff was provided an opportunity to review and comment.

Caltrans, pg 28: Recalculate measures with STIP/SHOPP staff FTE.

Response: The analysis was recomputed using the provided FTE counts.

Caltrans, pg 29: “Model is yearly based, however, projects tend to follow program cycles and take years to implement.”

Response: This comment is somewhat confusing. The productivity measures given as examples in the report are clearly not yearly – the measures are based on completed projects. The only relationship to years they have is that the projects are anchored in the year in which they are completed. That is, the yearly variations within projects are not captured in this measure. As noted in the report, productivity measures can and should be calculated yearly (for those projects with CCA in a given fiscal year) and fractionally (for those projects partially completed in a given fiscal year).

Caltrans, pg 31: “Need to drop the following projects from this analysis...The data are skewed by the inclusion of large toll bridges in the sample.” Note also that hours are provided for recomputing productivity measures.

Caltrans, pg 32: “remove toll bridges from data.”

Response: No projects were dropped; Caltrans did not provide the hours allocated to these specific projects so that labor indices could be recomputed. If Caltrans elects to implement a productivity measure, then labor hours should be matched to the specified output (i.e., if the toll bridge projects are removed from project delivery numbers, the hours should also be removed from labor inputs).

Caltrans, pg 35: “It appears...that [number] of projects is not going up as fast as capital and hours. Dept puts out many \$100m projects these days. 10 years ago they were rare. Capital sizes may be driven by TCRP and Bond programs (policy decisions) which on a project count basis gives the impression of productivity decline.”

Response: The comment is confusing the COS/CO ratio with the productivity index. Labor productivity should not decline just because projects are more expensive; if the projects are more complex or require design elements that are unusual, this could impact overall productivity.

Caltrans, pg 38: Change effectiveness to support efficiency.

Response: Agreed.

Caltrans, pg 38: Change legislature to “transportation partners.”

Response: Appropriations are made by the legislature.

Caltrans, pg 40: “Potential complexity measures could include project type, right of way issues, and environmental documentation.”

Response: Excellent point; added to the text.