QUANTITATIVE ANALYSIS OF PARTNERED PROJECT PERFORMANCE

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ABSTRACT: Partnering is a technique that has become the construction industry's application of total quality management and enjoys widespread use throughout the industry. This paper details the results of a statistical analysis of over 400 Texas Department of Transportation construction projects worth a total investment of nearly $2.1 billion. Half the projects were completed under partnering agreements. After comparing the two groups of projects, the paper concludes that partnering promises to furnish a means to control the two prime project performance indicators—cost growth and time growth. Additionally, in a large construction program the continuous application of partnering will result in improved project performance across the entire program.

INTRODUCTION

Partnering construction contracts are popular throughout the United States and in certain countries overseas. The term partnering evokes different meanings to different sectors of the engineering and construction industry. Among the designers and builders of privately financed projects, partnering is a strategic relationship that is developed for relatively long periods and for multiple projects. These strategic partnerships garner many advantages to their members. The main one is the development of a thorough understanding of the partners' motivations, trustworthiness, and means of communication. This understanding allows one partner to gauge the other partner's potential reactions to impending crisis. It also encourages the honest sharing of bad news in a timely manner that permits joint action to avert or minimize the impact of the crisis on the successful completion of the project in question.

Private strategic partnerships have an advantage over their counterparts in the public sector in that private entities are relatively free of regulation on the form and substance of their internal operational activities and contractual relationships. Public agencies must answer to lawmakers, regulators, and the public alike. Thus, the freedom for public agencies to develop longstanding, strategic partnerships with private organizations is greatly diminished if not eliminated altogether. As a result, agencies like the Texas Department of Transportation (TxDOT), have focused their partnering activities on single project, team-building seminars.

The literature shows that the growth of partnering is directly related to the growth in claims and litigation regarding construction contracts throughout the nation (Kubal 1994). In the late 1980s, the U.S. Army Corp of Engineers (USACE) led the way for public agencies to begin using this new business practice as a means to avoid disputes and, consequently, reduce the ultimate cost of delivering public facilities. To verify the success of partnering, projects must be measured. One pitfall in past efforts to measure partnering performance involves the collection and interpretation of statistics regarding partnering. In public agencies, there is a tendency to credit partnering for project successes even when there was no tangible evidence of any improvement over the status quo. This was caused by the intense personal investment public project managers and contractors make during partnering sessions. There is no doubt that enhanced communication greatly improves a project's management/dispute resolution environment. However, most serious studies of the process have failed to identify significant benefits that can be directly attributed to partnering programs. An earlier study done on TxDOT (Grajek 1995) found that partnering (on 65 TxDOT projects) did not have a statistically significant impact on cost growth, change order cost, or net change cost. The same study found that partnered projects finished an average of 13.73% ahead of schedule as compared with nonpartnered projects that only finished 9.68% ahead of schedule. Although this appears to show some impact, the fact that most projects finish ahead of the contract completion date indicates that TxDOT is generally conservative in establishing contract duration. Even though there is nothing fundamentally wrong with this policy, it makes interpretation of actual performance data difficult with regard to schedule. A study of the Ohio DOT's partnering program (Chapin 1994) addressed only cost growth and found that 20 partnered projects had a 1.00% cost growth as compared to 123 nonpartnered projects that averaged a 4.03% growth. Although the partnered sample size is small, it does seem to promise potential benefits for partnering transportation projects.

USACE found that partnering is most valuable on projects with tight schedules where techniques such as issue escalation and open communication tend to enhance the efficiency of critical decision making. Thus, the contractor is allowed the maximum amount of time to react to scope changes and retain satisfactory progress. Additionally, change order time extensions are much more important to a contractor on a project with a tight schedule than on one that has greater schedule flexibility (Kubal 1994). Thus, the contractor will be more likely to formalize a dispute over a time extension on the former than on the latter (Kane 1992). This fact further blurs the validity of the apparent schedule improvement on partnered TxDOT projects.

The above discussion is not meant to cast doubts on the validity of the partnering process but rather to indicate the importance of understanding the dynamics of the process that produces the contract performance data. Studies done on USACE and Naval Facilities Command projects confined themselves to competitively bid, firm fixed price projects (Pina 1993; Weston and Gibson 1993; Schamder and von Rosenvinge 1994). Since the date of those studies, best value selection has been implemented on a broad scale by USACE and to a limited degree by Naval Facilities Command. Best value selection removes the requirement to award to the low bidder and has changed the dynamic under which partnering was developed in the federal government (Ellicott and Gransberg 1997). This approach shows much promise in that strategic relationships that produce positive outcomes for both parties are able to reap benefits from the synergy of repetition.

In September of 1996, TxDOT, through their Continuous

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Note. Discussion open until November 1, 1999. To extend the closing date one month, a written request must be filed with the ASCE Manager of Journals. The manuscript for this paper was submitted for review and possible publication on April 16, 1998. This paper is part of the ***Journal of Construction Engineering and Management***, Vol. 125, No. 3, May/June, 1999. ©ASCE, ISSN 0733-9634/99/0003-0161–0166/$8.00 + $.50 per page. Paper No. 18124.

Improvement Office, awarded a research contract to Texas Tech University to identify and quantify the impacts of their partnering effort. The purpose of this paper is to document the collection and analysis of the data. The discoveries, conclusions, and recommendations of this report are based on trends of the emerging data using parametric statistical analysis techniques.

DATA COLLECTION AND REDUCTION

To complete the required tasks, the researchers were required to interact with several departments within the TxDOT. These include the Continuous Improvement Office, Construction and Maintenance Division, and the Information Systems Division. The goal of the study was to attempt to identify benefits specifically accrued due to partnering. Therefore, the study population for each group was selected in a ''before and after'' mode with a time period that did not overlap the date ranges of the partnered and nonpartnered projects. The data collection effort started with the identification of 204 completed partnered projects during the period of January 1992 to November 1996 and then proceeded to an equal number of nonpartnered projects in the 5-year period (February 1987 to December 1991) immediately preceding the implementation of partnering. The control group of 204 nonpartnered projects was selected from a list of 255 projects that actually started before partnering was an option. All of these projects were of a nature that would have made them candidates for partnering if the program had been in existence. The database contains data from 408 completed projects worth $2.1 billion, which is three times as many projects as any of the other studies found in the literature search.

In addition to the collection of quantitative project performance data, surveys of over 500 TxDOT and contractor personnel were conducted to develop qualitative data regarding the perceived costs and benefits of partnering. The focus of the questionnaires was on identifying those features of a project that make it a good candidate for partnering. The results of the surveys can also be used to help explain the results of the quantitative data as well as to assist in appropriately grouping the project performance data for analysis. Complete results of the surveys can be found in Gransberg et al. (1998).

DATA ANALYSIS

Analysis of the data collected permitted the calculation of thirteen separate project performance parameters. Each of these parameters mathematically describes some performance measure, which can be compared between partnered and nonpartnered projects. The intent of this effort is to identify trends, which will help develop a method for partnering decision-making.

Cost Growth

Cost growth (CG) is a standard measure of project performance. In essence, cost growth is defined as the change in contract amount with respect to the original contract amount. This can be described by the following equation:

$$\text{CG} = \frac{\text{Final Contract Amount} - \text{Original Contract Amount}}{\text{Original Contract Amount}} \tag{1}$$

This number can then be converted to a percentage of growth over original contract amount. The comparison of this parameter between partnered and nonpartnered projects should permit the determination of whether partnering has any impact on subsequent cost growth within a project.

Average Cost per Change Order

Average cost per change order (AC/CO) is merely the arithmetic average cost of the actual changes on each project. This parameter allows the researcher to develop an idea of the order of magnitude of changes that occur on typical projects. This parameter is described by the following equation:

$$\text{AC/CO} = \frac{\text{Final Contract Amount} - \text{Original Contract Amount}}{\text{Number of Change Orders}} \tag{2}$$

Average Percent Increase per Change Order

Average percent increase per change order (A%/CO) is a measure of incremental cost growth. A contract with no change orders would be the perfect situation and have no cost growth. A large average percent increase per change order would indicate that cost growth occurs as a step function and provides a means of assessing the quality of the contract documents. The larger the average percent increase per change order the higher the probability that some errors of design were contained in the project. This would indicate that regardless of the quality of the relationship due to partnering a flawed design will require change orders and encourage cost growth. This parameter is described by the following equation:

$$\text{A\%/CO} = \frac{\text{Cost Growth (\%)}}{\text{Number of Change Orders}} \tag{3}$$

Average Total Change Orders per Project

Average total change orders per project are merely the arithmetic total of the number of change orders per project. This ratio further defines the impact of original contract quality on project performance. This parameter quantifies the number of times the owner and the contractor had to reach an agreement. The number used in this analysis is an adjusted total after removing ''administrative'' change orders that had nothing to do with the design/construction process itself. Examples are such things as on-the-job training costs, contractor reimbursement for the partnering workshop, etc. It should also be noted that the writers recognize that a single change order might correct several design deficiencies. No effort was made to determine the number of contract modifications made in each change order as this information was not available in digital form.

Time Growth

Time growth (TG) is the change in time with respect to the original contract completion date. Time growth is generally a result of changes in scope of the project. Time growth can be either positive (when the project is completed later than the original completion date) or negative (when the project is completed earlier than the original completion). In TxDOT contracts, time growth is a function of allowable working days. These contracts typically have a given number of days associated with the project. Things such as poor weather require field personnel to determine whether to charge a working day to the contract period. This system promotes the accurate interpretation of project time performance by making it unnecessary to cull out time growth due to circumstances beyond the contractor's control. Time growth is calculated using the following formula:

$$\text{TG} = \frac{\text{Days Charged} - (\text{Total Days Allowed} + \text{Additional Days Granted})}{\text{Total Days Allowed} + \text{Additional Days Granted}} \tag{4}$$

where Days Charged = actual contract duration; Total Days

Allowed = original contract duration; and Additional Days Granted = number of days added by change order.

Average Percentage of Additional Days Granted

The average percentage of additional days (AD%) granted is an indicator of the owner's willingness to reduce time pressure on the contractor

$$\text{AD\%} = \frac{\text{Additional Days Granted}}{\text{Total Days Allowed}} \tag{5}$$

Average Liquidated Damages as Percent of Total Cost

Average liquidated damages as a percent of total cost (ALD) is included as a means to measure the impact of partnering on those projects that have some problems as indicated by the imposition of liquidated damages (LDs). When new performance enhancing programs are introduced, focus tends to be on those projects that go well. If a program is to become totally institutionalized, it must also produce positive results in those projects that have problems. Measuring LDs on those projects, which finish late, is an objective metric with which to compare partnered projects to nonpartnered projects. This parameter can be calculated with the following formula:

$$\text{ALD} = \frac{\text{LDs Cost}}{\text{Total Contract Cost}} \tag{6}$$

Average Liquidated Damage Days as Percentage of Total Time

Average liquidated damage days as a percentage of total time (LDD) is a metric designed to measure the effect of LD days on the overall contract period. Again, comparing this parameter between the two types of projects should give us the ability to quantify the impact of partnering on project performance. This parameter is computed as follows:

$$\text{LDD} = \frac{\text{Number of Days of LDs}}{\text{Total Days Allowed} + \text{Additional Days Granted}} \tag{7}$$

Percent of Projects with Liquidated Damages

The percentage of projects with LDs (%LD) is a direct measure of the TxDOT's willingness to assess LDs. Additionally, it provides an indicator of the contractor's ability to prosecute the projects as they were originally planned and bid. A difference in this indicator between partnered and nonpartnered projects will provide a means to explain the value of partnering on projects that do not finish as expected. This metric is calculated by the following formula:

$$\text{\%LD} = \frac{\text{Number of Projects with LDs}}{\text{Total Number of Projects}} \tag{8}$$

Percentage of Projects with Deducts

A deduct is defined as a change order that reduces the contract amount. This parameter was developed to provide a measure of contractor willingness to keep total project costs as low as possible. Generally, contractors are reluctant to agree to deductive change orders because they throw off the balance achieved by spreading overhead and profit margin across bid items and possibly put a contractor in the position of not being able to recover anticipated markups. Thus, the percentage of projects with deducts is a good indicator of the success of the partnering charter. This parameter is calculated by dividing the number of projects that had negative cost growth by the total number of projects.

Claims Cost as Percentage of Original Cost

Claims are requested by contractors for compensation for work performed that the contractor believes is outside the scope of the contract. Generally, claims begin as contractor requests for a change order and become claims when the owner rejects the change order request. Negotiations ensue and if a settlement is reached, the contract is increased by the amount of the settlement. For purposes of this study, claims are defined as contract disputes that are settled above District level. TxDOT's primary purpose for instituting partnering is to avoid claims cost (*Partnering* 1996). Theoretically, a partnered contract should have no claims. Typical output of the partnering workshop is an issue escalation ladder to deal with disagreements and to attempt to keep them from becoming claims (*Partnering* 1996). An issue escalation ladder is the process of agreeing to move the settlement of an issue in disagreement up both the owner's and the contractor's chain of command to seek resolution without the need to resort to a claim. In essence, it relieves project personnel of the responsibility to settle and permits them to focus their efforts on project completion without wasting management energy promulgating and defending claims. Therefore, analysis of project performance in relation to this indicator is an important point. Claims cost (CC) is determined as follows:

$$\text{CC} = \frac{\text{Total Cost of Claims}}{\text{Original Contract Cost}} \tag{9}$$

Dispute Cost as Percentage of Original Cost

Disputes, for purposes of this study, are claims that are settled at or below District level. Again, the establishment and use of an issue escalation system in a partnered project would lead one to believe that partnered projects should have a significantly lower level of disputes than nonpartnered projects. This is also an important parameter because it speaks directly to the most highly touted benefit of partnering—dispute resolution. Dispute cost as a percentage of original cost (DC) is calculated as follows:

$$\text{DC} = \frac{\text{Total Cost of Disputes}}{\text{Original Contract Cost}} \tag{10}$$

Award Price

Award price is merely the original contract amount for each project and provides a method to separate and discriminate between projects based on their relative financial size. This parameter is important because the size of a project may influence the amount of benefit it can actually accrue from partnering. For example, a small project that has a $20,000 change order will experience a larger percentage of cost growth than a large project with the same size change order. Thus it is important to look at similar sized projects as measured by award price to accurately assess the impact of partnering on the TxDOT construction program.

ANALYSIS OF STATISTICS

Table 1 shows a breakdown of the aforementioned parameters for the 204 partnered projects and 204 nonpartnered projects. These groupings were selected as they represent the typical ordering of project size in use in TxDOT. The total sample population of projects was equal, but it can be seen that when the projects are grouped according to size that the significant grouping for partnered projects was in the $1,000,000–$5,000,000 range, and the significant grouping for nonpartnered projects was in the $1,000,000 or less range. Because of this disparity in subgroup population sizes, the

TABLE 1. Project Groupings by Award Price

Project parameter (1)	AWARD PRICE RANGE							
	$0–$1,000,000		$1,000,000–$5,000,000		$5,000,000–$15,000,000		$15,000,000–$40,000,000	
	Partnered (2)	Nonpartnered (3)	Partnered (4)	Nonpartnered (5)	Partnered (6)	Nonpartnered (7)	Partnered (8)	Nonpartnered (9)
Number of projects	35	100	110	46	45	35	14	23
Award price (dollars)	667,572	429,912	2,643,916	2,413,961	8,557,678	8,552,594	22,240,253	24,281,065

TABLE 2. Statistical Breakdown of Project Parameters by Award Price Range and Total Population

Project parameter (1)	AWARD PRICE RANGE					
	$0–$5,000,000		$5,000,000–$40,000,000		$0–$40,000,000	
	Partnered (2)	Nonpartnered (3)	Partnered (4)	Nonpartnered (5)	Partnered (6)	Nonpartnered (7)
Number of projects	145	146	59	58	204	204
Award price (dollars)	2,170,135	1,055,024	11,860,368	14,789,745	4,925,201	4,959,994
Cost growth	5.22	2.39	1.87	3.94	2.93	3.70
Number of change orders	11	6	28	29	16	10
Average cost growth per change order (dollars)	10,485	9,309	7,946	21,032	9,198	18,713
Average percent cost growth/change order	0.48	0.88	0.07	0.14	0.19	0.38
Percent of projects with deducts	17.16	31.86	5.39	3.92	23.53	36.27
Time growth	−0.32	−9.16	−14.97	36.62	−4.70	10.04
Percent additional days granted	28.15	22.57	15.62	25.52	8.32	12.49
Percent of projects with LDs	11.76	11.27	1.96	12.25	21.08	23.53
LD percent of total contract days	3.09	5.14	0.91	14.85	5.04	14.56
LD cost as percent of total cost	0.32	0.34	0.07	0.93	0.07	0.21
Claims cost percent of original cost	13.04	5.61	0.00	1.15	0.33	0.61
Dispute cost percent of original cost	0.13	13.84	0.00	0.71	0.04	0.93

projects were assembled into two subgroups of virtually equal populations of partnered and nonpartnered projects by breaking them at the $5,000,000 award price. Additionally, the surveys of field personnel further reinforced this decision when 67% of TxDOT and contractor personnel indicated that projects above $5,000,000 should be formally partnered (Gransberg et al. 1998). Thus, as shown in Table 2, there are equal groups of projects less than $5,000,000 and projects greater than $5,000,000 that enhance the value of the inferences that can be made from the statistics. The individual dynamic found in large and small projects is germane to the focus of this study in determining which projects to formally partner. The intuitive solution is to spend the time and resources required to formally partner those projects that are large and complex. Analyzing this data should provide the answer to that question.

Partnering's Impact on Cost Growth

This parameter is the classic metric for project performance. Table 2 shows that partnered projects outperformed nonpartnered projects in the upper award price range and overall for the total population. It appears that the change from adversary relationships brought on through partnering positively impacts cost growth. This conclusion is confirmed by the survey data where 67% of TxDOT personnel and 71% of contractor personnel stated that partnering improved working relationships (Gransberg et al. 1998). When the entire population is considered, partnered projects have a slightly less cost growth. This leads to the conclusion that implementing partnering generally improves cost growth performance with the greatest impact being felt in projects that are larger than $5,000,000.

Partnering's Impact on Change Orders

Change orders are the major source of cost growth. There were three parameters developed to evaluate partnering's effect on project change orders. The first concern that needs to be looked at is the feeling by field personnel that partnering makes the owner's representative more likely to accept contractor-initiated change requests (Gransberg et al. 1998). Table 2 shows that partnered projects have more change orders than nonpartnered projects. This would seem to confirm that suspicion. Partnering may make the owner's personnel more willing to consider contractor-initiated change requests. It should be noted that the researchers have no way of differentiating between contractor-initiated and other types of change orders. Next, the idea that the contractors ''return the favor'' by keeping change order costs down needs to be tested. Table 2 indicates that across the entire population mean partnered project change order cost was roughly half the average cost of the average nonpartnered change order. In the lower price range, partnered change order cost was slightly larger than the nonpartnered group. In the $5,000,000 and larger range, the partnered average change order cost was less than half that of nonpartnered. This reinforces the field survey data conclusion that projects over $5,000,000 will accrue more benefits from partnering than smaller projects (Gransberg et al. 1998). When viewed as a percentage of contract amount, the amount of each partnered change order is about half of nonpartnered change across the entire population and in both price ranges.

If contractor willingness to minimize overall project costs is measured by looking at the percentage of projects with negative cost growth (percent of projects with deducts in Table 2), the percentage of deducts is roughly twice that in nonpartnered projects for partnered projects in the less than $5,000,000 range. This trend reverses itself in the largest projects. However, considering the entire population, nonpartnered projects again outperform partnered projects. Therefore, partnering seems to create a desirable effect with regard to deducts only in the $5,000,000 and above range.

Partnering's Impact on Time Growth

The other objective measure of project performance is time growth. Two parameters were designed to provide trend in-

formation with regard to partnering. The first is a mean percentage time growth. Table 2 shows the most vivid difference in the entire study. For the three project groups, time growth was negative in partnered projects. It is positive in the large nonpartnered projects and the population as a whole. For the entire population, the average partnered project finished 4.7% earlier than originally planned and the average nonpartnered finished 10.04% later than originally planned.

The second metric is the number of additional days granted, expressed as a percentage of total days allowed. The parameter was meant to test the owner's willingness to grant time extensions because of a partnering relationship. Table 2 shows this is true only for the lower grouping of partnered projects.

Partnering's Impact on LDs

This analysis may be the acid test for partnering. It is easy to grant accolades for innovative approaches that were tried on projects that went well. The real test of a partnering relationship comes from those projects that do not proceed according to plan. The data showed that there were LDs assessed on partnered projects. That means that some partnered projects finished late in spite of the investment in team building and relationships. Table 2 shows that for partnered projects greater than $5,000,000 only 2% have LDs compared with over 12% on nonpartnered projects in the same category. Whereas, for those under $5,000,000, the two types of projects are roughly equal. The $5,000,000 breakpoint seems to have some significance.

Table 2 also shows the impact of LDs with respect to the total project cost. Partnered projects outperformed nonpartnered projects in every grouping. Finally, looking only at LDs in terms of time, partnered projects had a fewer number of LD days than nonpartnered projects in all categories. Thus, the conclusion can be drawn that partnering does work on projects with time problems by reducing the number of days that a project finishes late.

Partnering's Impact of Disputes and Claims

Remembering that disputes are defined as issues that are settled at District level or below and that claims are issues that are settled above District level (*Partnering* 1996), studying the potential impact of partnering on these two parameters is extremely important. The data show that partnering seems to virtually eliminate the cost allocated to disputes and has the same effect on claims for projects greater than $5,000,000. The only significant costs that remain in these two parameters are for claims on projects that are less than $5,000,000. For the upper range, there are no costs associated with disputes and claims on partnered projects. The total percentage of dispute and claims costs on nonpartnered projects is relatively low, whereas in the lower half of the projects, there are significant dispute and claims costs associated with both types of projects. This disparity is hard to explain. The survey data show that 71% of TxDOT personnel and 90% of contractor personnel believe that partnering greatly facilitates the resolution of disputes and claims (Gransberg et al. 1998).

CONCLUSIONS

The above discussion springs from the statistical analysis of the data collected for this project. Significant trends have been identified and conclusions can be made as follows:

- Partnered projects outperformed nonpartnered projects in virtually every category if they were awarded at a price above $5,000,000.
- Partnered projects have slightly less cost growth when the entire population is considered.
- Partnered projects have more change orders than nonpartnered projects.
- Across the entire population, mean partnered project change order cost was roughly one half the average cost of the average nonpartnered change order.
- Partnering seems to create a desirable effect with regard to deducts on projects greater than $5,000,000.
- For the entire population, the average partnered project finished 4.7% earlier than originally planned and the average nonpartnered finished 10.04% later than originally planned.
- Partnered projects have a fewer number of LD days than nonpartnered projects in all categories. Thus, partnering seems to have a positive effect on projects with time problems by reducing the number of days that a project finishes late.
- For the $5,000,000–$40,000,000 range, there are no costs associated with disputes and claims on partnered projects.

In summary, instituting partnering in a large public construction program such as the TxDOT's program seems to be worth the effort. It would be tempting to take the data collected and use it to quantify the savings ''due to partnering.'' That approach would be to allocate the 1% less cost growth across about $1 billion worth of partnered projects and say that partnering saved TxDOT nearly $10,000,000 over the 5-year study period. This would be a misstatement.

Partnering is a change in business behavior and not a technical change to a contract. For it to have a positive influence, the people on both sides of the construction contract must be willing to accept a higher level of trust than that which has traditionally been found in public construction contractual relationships. Therefore, to ascribe a specific amount of savings is to try to use the past to predict the future. The database contained many examples of partnered projects that did not conform to the desired goal. Some partnered projects finished late and some partner projects had higher cost growth than similar nonpartnered projects.

What the data does show is that partnering promises to furnish a means to control the two project performance indicators—cost growth and time growth. The field survey showed that 60% of TxDOT personnel and 85% of contractor personnel felt that implementing partnering improved the quality of the project as well (Gransberg et al. 1998). Additionally, in a large construction program, the continuous application of partnering will result in improved project performance across the entire program. Therefore, it can be recommended that partnering be implemented on a program-wide basis and that particular emphasis be placed on those projects which exceed $5,000,000. Over time, a public agency such as the TxDOT can expect to benefit due to increased project performance.

ACKNOWLEDGMENTS

The writers would like to gratefully acknowledge both the professional assistance and the financial support of the TxDOT Research Management Committee who commissioned this study.

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APPENDIX II. NOTATION

The following symbols are used in this paper:

AC/CO = average cost per change order;
AD% = average percentage of additional days;
ALD = average liquidated damages as percent of total cost;
A%/CO = average percent increase per change order;
CC = claims cost;
CG = cost growth;
DC = disputes cost as percentage of total cost;
LDD = average liquidated damages days as percentage of total time;
TG = time growth; and
%LD = percentage of projects with liquidated damages.