TRADITIONAL LOW-BID PROCUREMENT SYSTEM VERSUS PERFORMANCE INFORMATION PROCUREMENT SYSTEM (PIPS) IN CONSTRUCTION INDUSTRY

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The past decade has brought about a lot of changes in the construction industry. But the low bid system has remained the most popular procurement system. Many users have documented the poor performance and poor quality of contractors that have been procured using the low-bid. The low bid process is a price-based environment. Research testing has shown that performance may be increased in moving to a performance based environment. A survey was conducted to collect data on delivery systems falling under both the price-based environment and the performance based environment from testers of a performance based system named PIPS. This data was used to statistically compare the performance of both these systems, namely PIPS, a performance based system, and low bid, a price based system. Results from the two-sample t-test gave indications of better results for the performance-based system than the price based system.

Keywords: price-based, non-performance, performance-based, minimize risk.

INTRODUCTION

The Past decade has brought about many changes in the construction industry. Numerous project delivery systems have been proposed. These systems include low-bid, design-bid-build, CM@risk, etc. A comparison of U.S project delivery systems can be found in the "Comparison of U.S. Project Delivery Systems" (Konchar and Sanvido 1998). The low-bid system has remained the most popular procurement system. Many users have documented the poor performance and poor quality of contractors that have been procured using the low-bid process (Illia 2001, ENR Staff Writer 2003, Post 1998). Owner education has always been an issue, and the owner's low bid mentality and lack of education are perceived to be problems in the construction industry (Post 2000). The low bid process may have created a large number of problems in terms of projects not being on time and within budget (Illia 2001). Project delivery systems such as construction management-at-risk and various forms of design-build, have solved some problems and created others (Post 2001). But the fact of the matter remains that the problems for owners in terms of projects not being on-time, within budget, and not meeting quality expectations of the owners, have persisted.

A contractor's past performance record is a key indicator for predicting future performance (Steyaert 1997). The U.S. Federal Government establishes past

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performance information, along with price/cost, as one of the two mandatory evaluation factors in any source selection over a set dollar threshold (Steyaert 1997). It is the policy of the Federal Government that agencies use performance-based contracting methods to the highest extent practical when acquiring services (Seven Steps 2002).

The Performance Information Procurement System (PIPS) is the latest among construction procurement systems. It was developed essentially to address the problem of non-performance in the construction industry. As the name indicates, PIPS uses performance information to evaluate the participating contractors. Rather than procuring construction subjectively or based solely on price, PIPS lends objectivity by adopting a risk minimization approach using past performance information along with price for selecting contractors. Our prior work provides a detailed explanation of PIPS (Kashiwagi and Byfield 2002, Kashiwagi, Parmar, and Savicky 2003, Kashiwagi 2004). PIPS is based on the understanding that the problem in construction procurement lies with the process and not with the project. In other words, rather than adopting a "Problem solving approach," PIPS adopts a "Process approach." Consider Figure 1 below.

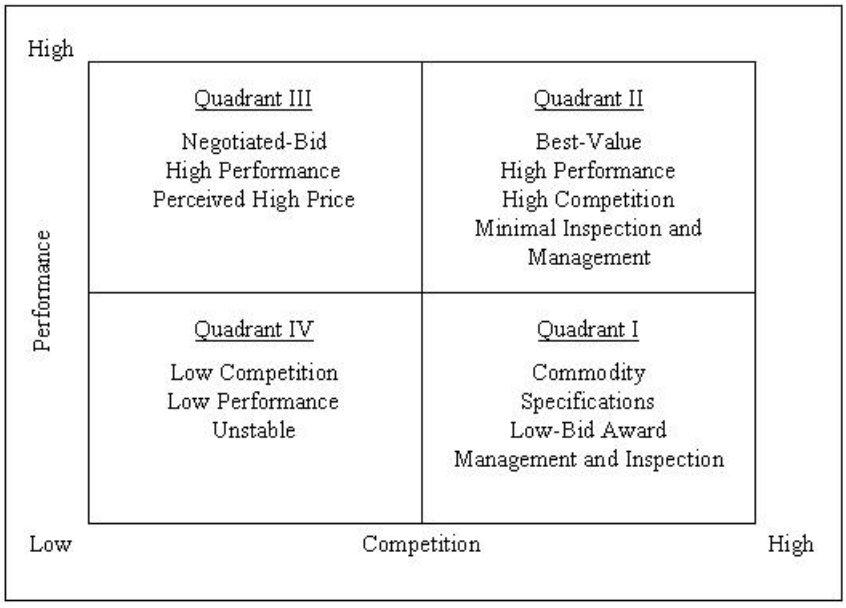

Figure 1: Construction Industry Stability

Construction started as a performance based industry (Quadrant III in Figure 1). It was common practice for owners to pre-qualify contractors, have the contractors compete, and select and negotiate with the best value contractor. Price pressure moved the industry to increase the amount of competition. However, there was no information based processes available to compete the contractors based on both performance and price. This resulted in an industry shift where the construction professionals deliver construction more as a price based commodity (Quadrant I).

The design-bid-build low bid award is the largest delivery process of construction. Many of the alternate delivery processes that are supposedly best value awards still use prequalification and low-bid awarding. This is due to the inability to identify and compete performance as well as price. One solution is to move from a Quadrant I environment to a Quadrant II environment. Quadrant II is a process-based quadrant. The difference in performance between Quadrant I and II is shown in Figure 2.

Figure 2: Performance Results

The 98% performance number for Quadrant II was obtained from the preliminary results of 380 tests of the performance-based procurement. The 60% performance number for Quadrant I has come from the Report for the 2000 Annual Consultative Conferences (Vickers 2000) and Nadine Post's *Building Teams Get High Marks* (1998). Quadrant I is price based and Quadrant II is performance based (on time, no contractor generated cost change orders, and meets the client's expectations). Quadrant II minimizes the subjectivity of experts and uses performance numbers, while Quadrant I uses the subjectivity of experts to manage and control low performing contractors.

A Quadrant II process is defined by the following characteristics:

1. Risk is transferred to the contractor. The validation of this concept is that either contractors minimize the risk or withdraw from the project.
2. Selection is done through performance: past performance ratings of key components; and the contractor's ability to identify, prioritise, and minimize risk in terms of money, time, and expectations.
3. Contractors are selected by their performance numbers.
4. The contractor is allowed to clarify unknowns, use their expertise to minimize risk, and maximize their profit.
5. The designer designs, and the constructor constructs.
6. All technical decision making of the client and their representatives are minimized.

The low performance of the price-based environment (Quadrant I) can be verified by the following performance information:

1. 42% of the projects surveyed finished late, 33% were over budget, 13% had pending claims, and only 53% of the owners would ever use the same contractors again (Post 1998).
2. From 1990-1997, over 80,000 contractors failed, leaving behind over $21B in liabilities (Why do Contractors Fail 2003).

3. European construction performance has had similar results (Egan 1998, CIB 2000).

The PIPS results (Quadrant II) in Utah, Hawaii, California, Arizona, and Georgia are as follows:

1. 350 tests of $240M in construction.
2. 96% of projects completed on time, with no contractor generated cost change orders, and 98% meeting the expectation of the owners.
3. Projects include maintenance and repair, renovation, and new construction.
4. The majority of projects were in the public sector.

HYPOTHESIS

The hypothesis is that by moving to Quadrant II, performance can be improved. This hypothesis is based on the characteristics of Quadrant II (mentioned earlier). To investigate, the hypothesis of higher performance in Quadrant II over performance in Quadrant I was tested. A statistical comparison was done between PIPS, a Quadrant II process, and low bid, a Quadrant I process. The data was collected through the surveying of facility owners who had implemented both the low bid and the PIPS processes.

METHODOLOGY

The general procedure for hypothesis testing mentioned in *Engineering Statistics* and reproduced below was adopted (Montgomery, Runger, and Hubele 1997).

1. From the problem context, identify the parameter of interest.
2. State the null hypothesis, H_0
3. Specify an appropriate alternative hypothesis, H_1
4. Choose a significance level α
5. State an appropriate test statistic.
6. State the rejection region for the statistic.
7. Compute any necessary sample quantities, substitute these into the equation for the test statistic, and compute that value.
8. Decide whether or not H_0 should be rejected and report that in the problem context.

These eight steps were performed for each performance criterion (Items 2-5 in table 1 shown in next section), and the two processes, PIPS and low bid, were statistically compared.

SURVEY DESCRIPTION

Data was collected by conducting surveys and collecting feedback from owners who had implemented both the PIPS and the low bid process. The relevant questions from the survey questionnaire are as shown in table 1 below.

Table 1: Relevant criteria from survey questionnaire

No.	Criteria	Unit	Low Bid	PIPS
1	Rate your overall satisfaction with the process. (10 is very satisfied, 1 is very unsatisfied)	(1-10)		
2	Approximately what percent of the projects were completed late or behind schedule for any reason whatsoever?	%		
3	Approximately what percent of the projects were not completed within the budget?	%		
4	Approximately what percent of the projects were completed with no cost generated change orders?	%		
5	Approximately what percent of the projects met all of the requirements of the user?	%		

RESULTS AND ANALYSIS

There were 30 responses received to our survey from owners who had implemented both PIPS and the low bid projects in the past. Two sample t-tests were performed on a sample size of 30. A significant level $\alpha = 0.01$ was used. This means that the risk of coming to a wrong conclusion is 1 %. The two sample t-test results for the PIPS and the low bid process on different performance criteria are summarized in the table below. The subscript 1 on the mean values indicates the low bid process and the subscript 2 on the mean values indicates the PIPS process.

Table 2: Results of two sample t-test on 4 performance criteria

Criteria or parameter of interest	**Null Hypothesis** H_0	**Alternate Hypothesis** H_1	**P – Value**	**Conclusion**	**99% Confidence Interval**
Percentage of projects completed late or behind schedule for any reasons whatsoever	$\mu_1 - \mu_2 = 0$	$\mu_1 - \mu_2 > 0$	*0.0000*	Since P-value < 0.01, null hypothesis is rejected.	(27.5, 60.4)
Percentage of project not completed within budget.	$\mu_1 - \mu_2 = 0$	$\mu_1 - \mu_2 > 0$	*0.0000*	Since P-value < 0.01, null hypothesis is rejected.	(22.9, 57.0)
Percentage of projects completed with no cost generated change orders.	$\mu_1 - \mu_2 = 0$	$\mu_1 - \mu_2 < 0$	*0.0000*	Since P-value < 0.01, null hypothesis is rejected.	(-68.1, -19.4)
Percentage of projects that met all the requirements of the user	$\mu_1 - \mu_2 = 0$	$\mu_1 - \mu_2 < 0$	*0.0000*	Since P-value < 0.01, null hypothesis is rejected.	(-56.3, -18.4)

The results indicate that statistically, based on the responses obtained from 30 owners (sample size 30), the performance obtained from the PIPS process is superior to that of the low bid process. The 99% confidence interval (last column in above table) states that if this analysis was performed 100 times using different samples, then 99 out of 100 times, we would expect the value of $\mu_1 - \mu_2$ to fall in this interval. Since 0 is not included in this interval, it indicates that 99 out of 100 times, $\mu_1 - \mu_2 > 0$ for the first two criteria and $\mu_1 - \mu_2 < 0$ for the last two criteria. Thus, statistically, the two samples are different, indicating difference in performance - PIPS demonstrating higher performance than the low bid process. Although a sample size of 30 is slightly small, considering the nature of the low bid, the PIPS processes, and the theoretical basis of the PIPS process, it is highly unlikely that a larger sample size would change the conclusion that PIPS, Quadrant II process, is better than low bid, a Quadrant I process.

CONCLUSION

Based on the analysis conducted, it appears that statistically, the performance obtained in construction industry using the PIPS process is greater than that obtained using the low bid process. Thus it appears that the PIPS process outperforms the low bid process. In other words, a Quadrant II process outperforms a Quadrant I process, justifying the hypothesis that there is a need to move from Quadrant I to Quadrant II. This analysis justifies the need to adopt a process approach rather than a project specific approach in the construction industry. The PIPS environment might be the alternative that owners have been looking for to address the problem of construction non-performance.

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