

A CASE STUDY OF THE TRANSACTION COST AND VALUE OF THE DELIVERING OF CONSTRUCTION

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The State of Hawaii was introduced to performance-based procurement in 1998. Four years later, the State of Hawaii used a transaction cost analysis of performance-based procurement to identify if the State was receiving the best value (construction performance and price). The transaction cost analysis used relative differences in the delivery component costs of the best value system and the low bid system. The study identified that the relative transaction costs of the performance-based procurement were lower than the transaction costs of the design-bid-build costs. The analysis was possible due to the same organization running both procurement systems, negating the need to identify every possible activity related to the transaction costs. Due to the number of projects, budget figures, construction cost figures, design costs, and construction times, the State was able to identify relative transaction costs and performance for both processes.

Keywords: financial management, transaction cost.

INTRODUCTION

The performance of the construction industry has been less than desirable in the past twenty years. The low bid award environment has been identified as one of the reasons for the poor performance of construction and the existing industry instability (Post, 2001.) This has resulted in a movement away from the low bid award, design-bid-build process to best value, alternate delivery processes in the United States (Sade, 2002.) A major issue in the movement from the traditional low bid award to the alternate delivery processes, which consider both price and performance, is the higher cost of performance. Owners are cost conscience, and the public sector requires the users to procure the best value or the lowest cost alternative.

The State of Hawaii attempted to increase the value of its procured construction through the implementation of a best value procurement process, the Performance Information Procurement System, or PIPS (Hawaii Report 2002). They selected roofing construction as the first test. PIPS was implemented in 1998, and by 2002, 96 roofs had been procured by this method. Over the four years, the following results were documented (Hawaii Report 2002):

Out of the 96 roofs, leaks were reported on two roofs. One leak was a flashing leak, which was quickly repaired by the contractor. The other leak was a leak through a mechanical fan, which was not the fault of the roofing contractor. However, the roofing contractor identified the source of the leak, and was paid to fix the leak. There are no current leaks on any of the 96 roofs. An average post project rating of 9.6

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(maximum of 10) was given to the contractors by facility users. No means, methods, or material specifications were required on any of the retrofit projects. Design costs were reduced from 11% to 2.5%. Inspection on roofs during construction was minimized to the start and end of the projects. Enforceable roof warranties increased from two years to 10 to 20 years. Project management was minimized by 80%. The cost of the roofs was 5.6% below the budget, 3.3% lower than the low bid roofs. The roofing construction was completed twice as fast as the low-bid construction. The projects had fewer change orders (including scope changes), and fewer punch list items (which were immediately handled by the contractors).

A contractor who had performance issues, protested the process. The protest went through an administrative hearing, and the result was that the contractor's claims of being singled out and treated unfairly had no merit (Marshall 2002). However, the efficiency of the PIPS process threatened some of the participants in the delivery of the roofing and other construction systems. The distrust of the system due to its seemingly lack of checks and balances, and perception that performance was too expensive, resulted in an audit of PIPS and the low bid award. Initial results of the audit showed that the low bid roofs were 19% below budget, and that the PIPS procured roofs were 7% over budget. However, upon closer examination of the awarded costs and budgets, the PIPS projects were less expensive.

The PIPS process is a selection process that bases award on performance and price. In roofing applications, it is a design-build process. PIPS minimized the functions of the user's project managers, designers, construction managers, and inspectors. This met with resistance from many of the participants. Others were pleased with the results, which allowed them to concentrate on the non-performing projects. After seeing the performance of the roofing contractors in the new best value environment, the State of Hawaii inspectors minimized their inspection to the start and finish of construction. The PIPS process has the following features, which motivated the contractors and manufacturers to increase their performance:

There is no design solution. The designer identifies the current condition of the roof, and any special requirements. Contractors are able to use their solutions to install the roof. Past performance of the contractor and manufacturer is documented. The performance numbers of the manufacturer and the contractor directly impact the competitiveness of the contractor.

The performance on any completed project, impacts both the manufacturer and contractor's performance numbers by 25%. If the information identifies a contractor with a leaking roof, the contractor and the manufacturer become non-competitive for future work.

The perceived value of each contractor's roofing warranty is identified by taking the smaller of the proven performance periods (in years or warranty period length), minus the exclusions that increase the risk to the owner.

The contractor and manufacturer are required to identify the risk to the owner in terms of cost, time, risk of leaking, their method of minimizing the risk, and how they would add value to the roof. This proposal is rated and becomes a major factor in the prioritization. The installation time of the roof affects the contractor's competitiveness. The relative price of the roofing system also affects competitiveness.

The contractors were no longer bidding to install roofing materials but they were bidding to waterproof the building's roof and surrounding surfaces. Performance was being measured in terms of success of waterproofing, customer satisfaction, the ability to minimize change orders, and the speed of installation. PIPS allows owners to outsource construction, relying on the identification and procurement of services of a high performing contractor rather than managing a poor performing contractor.

However, the PIPS was not embraced by delivery system participants (State of Hawaii personnel, designers, manufacturers, and contractors) for the following reasons:

Liability. Manufacturers and contractors were hesitant to accept responsibility for performance. Non-performance is customer dissatisfaction, leaking, not finishing on time or within budget. Non-performance for any reason in the new environment resulted in being non-competitive.

High performing systems had an advantage over unproven or non-performing systems. Contractors were motivated to select the best performing manufacturer's products. Contractors were also selecting manufacturers based on their support (technical knowledge and promptness.) Manufacturers with poor performance and service were not being selected. Not price based. The low-bidder is not assured of the award.

Non-efficient functions are minimized. The efficiency of the process minimizes delivery functions (engineering, design, and sales order taking) that were heretofore perceived as "critical." Change. The PIPS changes the functions of the delivery process.

The discomfort with change and accountability resulted in accusations of high costs, technical incompetence, and charges of fraud and misconduct. This resulted in an internal audit by the State of Hawaii to identify the true value of the roofing procured through the PIPS process. The two options being discussed were the standard design-bid-build (low-bid), and the performance based design-build process (PIPS) as pertaining to the procuring of roofing systems.

The State of Hawaii used the hypothesis that the PIPS process was less costly and provided higher performance for procuring the retrofitting of roofing systems. Based on this hypothesis, the State broke up the analysis into two parts, delivery cost and performance. If the cost of the performance based construction was higher, than a comparison of the value of both processes would have to be analysed. Due to the lack of "total information," when decisions have to be made in this analysis, they will be made on the conservative side (in favour of the null hypothesis that PIPS is not more economical than the low-bid system).

TRANSACTION COST ANALYSIS

The objective of this research is to identify the relative value of PIPS in relation to the standard design-bid-build (DBB) process. The methodology to be used is the transaction cost and value analysis of the two processes. The transaction cost analysis will cover the relative cost of the owner's (State of Hawaii) delivery processes. The traditional drawbacks of doing transaction costs analysis in construction include (Hughes 2003):

- The lack of full information of all functions that have transaction costs.
- The number of related functions that cannot be completely quantified.

- The uniqueness of every construction project requiring different levels of each function and thereby having different costs.
- Difference in quality of the end product.

Transaction cost analysis have been used for two different purposes: first, to identify which costs are related to the delivery of construction (Hughes 2003), and secondly to assist in identifying more efficient and economical processes (Leffler 1991). Unlike Chang and Ivie (2001), this transaction cost analysis uses actual cost data with conservative assumptions, to compare the two processes. The two processes being analysed are run by the same organization, for a specific type of construction: retrofit roofing. This allows the methodology of using relativity and differential between processes to identify which process is more economical to the owner, without having to accurately identify every cost associated to the processes. The objective is to identify if the value (higher performance, lower costs) of PIPS is more valuable than the design-bid-build process.

Delivery Process

The analysis first identified the major user functions or costs involved in the two delivery systems. They included:

1. Planning and programming.
2. Design and procurement.
3. Bidding and award.
4. User project / construction management and inspection.
5. Construction.
6. Rework: non-performance (lack of quality).

The State of Hawaii could identify no differential in costs in the planning and programming, and bidding and award phases between the two processes. This left design/procurement, construction management and inspection, construction, and the cost of rework to be analysed.

The design costs were taken from the cost records of the State. It was costing the State 11% of the project cost to create roofing designs (selection of materials, means, and methods). It was costing 2.5% for designers to identify the requirement for PIPS. The procurement functions were similar for both processes.

To identify the project management, construction management and inspection costs for the traditional process, the State took the delivered construction costs for the last three years, and divided them by the overhead costs. The State then used the most efficient rate, 2.65%. The State then made the assumption that the overhead or management costs for all projects were about the same.

The State then estimated how much of the management effort was minimized by PIPS in the delivering of the projects. The sources for the estimates were the University of Hawaii (UH) and State of Hawaii test results. The UH test case resulted in minimizing the project and construction management and inspection by 80% (Hawaii Report 2002). State of Hawaii results reinforced the UH results. The State took the 2.65% management rate, multiplied it by .2 (minimized by 80%), and then divided the result by 1/3 (because the project manager doing PIPS could perform from 5 to 10 times the number of projects as the project managers who were managing under the

design-bid-build process). The division by 3 was a conservative number (range of reduction by 2 to 5). The resulting management/inspection cost of PIPS was identified as .4%.

The State then identified the difference in construction costs of the low bid and the PIPS projects. The State identified 100 low bid projects, and 96 PIPS projects from 1998 to 2002 (see Table 1). All projects were being budgeted based on previous low bid awards. [a] The audit first identified that the low-bid roofs were 13% below the budget. However, upon closer analysis, when three of the roofs with large deviations were taken out of the sample, the average cost was reduced to 8.4% below the budget. When the over budgeted insulated roofs were deleted, the average cost of the remaining roofs was 2.3% below the budget.

The State had data from 96 of the PIPS projects. The audit identified that the average cost was 7% over the budget. However, upon closer analysis, 36 of the roofs were insulated roofs. Upon checking with the programmers, the roofs were not budgeted for the installation of insulation. After plotting the costs against the budgets, Figure 1 verifies that the insulated roofing project costs were consistently above the budgets by an increment of 18%. It was after this was identified, that the low-bid procured roof budgets were increased in 2002 (due to the protest of PIPS, no roofing projects were procured using PIPS in 2002). The average cost of PIPS delivered roofs without insulation was 5.6% below the budget.

Table 1: State of Hawaii Construction Costs

Construction Costs	PIPS	LB
Audit Report Costs	7.0%	-13.0%
Projects with no insulated roofs	-5.6%	-2.3%

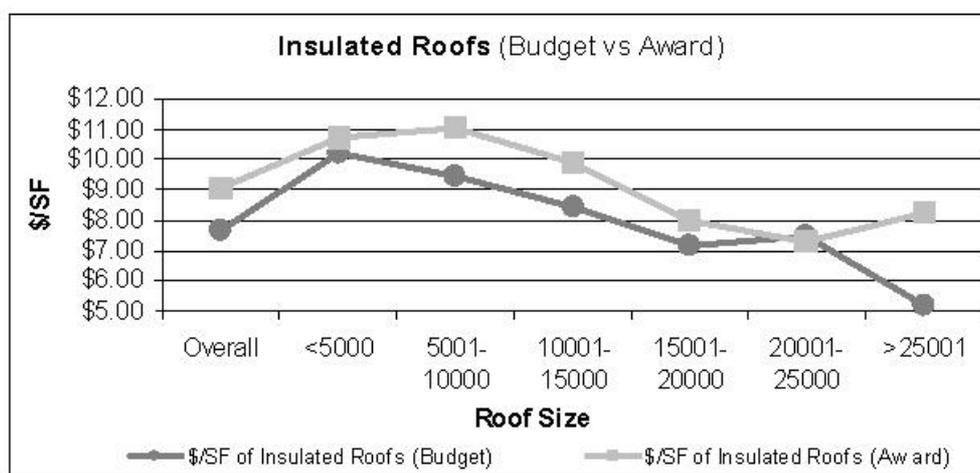


Figure 1: Insulated roof budgets underestimated

The last cost is the cost of quality or more popularly known as the cost of non-performance (Crosby 1980). Examples of construction non-performance within the last three years can be identified by three projects procured by the State of Hawaii. The first project, the waterproofing of the Kalanimoku Building, was designed and awarded to the lowest bidder. The project cost over \$575,000 and leaked from the day the construction was completed. The State had to hire another contractor to temporarily stop the leaking.

The Hawaii State capitol project was a re-roofing project to fix the existing leaking roof. It was re-roofed five years ago, however the leaking persisted. The repair of the roof was bid at \$350,000.

Another roof was re-roofed in 2001 (the UH Activity Center roof). The roof had been installed five years earlier and leaked from its inception. The State was unable to get the general contractor or the roofing contractor to fix the problem because no engineer could identify the source of the leaks. The result was non-performance. The owner re-bids the project under the PIPS process for a cost of \$400,000. The project was completed on time, without any change orders, and stopped the leaking.

There are other low bid projects that have also resulted in non-performance. The low bid process is assessed a conservative .5% cost of non-performance. The PIPS test results showed no cost of non-performance. Table 2 shows a conservative approach to the transaction cost analysis. The PIPS process is 14% more economical than the low bid process. The transaction costs analysis is comparing first costs, and not life cycle costs. If the performance of the two processes is compared, the PIPS process is the more efficient process (see Table 3). PIPS has documented higher customer satisfaction, longer maintenance free performance, faster delivery, and no leaking roofs.

Table 2: Transaction Cost Analysis

No	Item	PIPS	Low bid
1	Design Cost	2.5%	11.0%
2	Project Management Cost	0.4%	1.9%
3	Construction Cost	-5.6%	-2.3%
4	Cost of Quality	0.0%	0.5%
	Total	-2.7%	11.1%
	Savings due to PIPS	13.8%	

Table 3: Performance Results of PIPS and Low Bid

No	Criteria	Results
1	Percent of DOE users that would rather use PIPS over Low-Bid	100%
2	Percent of users that would use the PIPS contractor again	100%
3	Performance rating of PIPS (10 is maximum)	8.1
4	Performance rating of Low-Bid (10 is maximum)	5.6
5	Average PIPS post project contractor rating (10 is maximum)	9.6
6	Percent increase in delivery schedule of PIPS compared to Low-Bid	35%
7	Average PIPS ensured warranty	10-25 years
8	Average Low-Bid enforceable warranty	2 years
9	Percent of PIPS project completed on time	98%
10	Average PIPS production rate per day (\$/day)	\$4,500
11	Average Low Bid production rate per day (\$/day)	\$2,500
12	Number of PIPS projects (with leaking roofs) repaired by the owner	0

CONCLUSIONS AND RECOMMENDATIONS

The State of Hawaii case study of analysing the transaction costs of PIPS versus the traditional low-bid process led to the following preliminary conclusions:

1. Retrofit roofing can be procured more inexpensively by procuring the system solution with the best-documented performance instead of using an expert's design.

2. This case study results shows that the first cost of the performance based procurement is less than the transaction first cost of the low bid procured roof.
3. The difference in the construction first cost has very little impact on the transaction cost or real costs of delivering roofing systems.
4. The value brought by performance-based procurement far exceeds the value of low bid awards.
5. This case study suggests that the value of high performance does not cost more. The results identify that performers can make a profit while bringing owners a better value.
6. This case study suggests that the practice of awarding retrofit roofing projects to the lowest bidder is more expensive and does not bring value to the user.

The conclusions of this case study where transaction costs were used to compare the performance based approach to the low bid approach shows that the traditional design-bid-build process may be inefficient, offer relatively poor value, and cost building owners more. It is only because of the complexity of the construction process, and the lack of information that allows the current inefficient construction processes to continue. It confirms the concept that the delivery process, which does not use performance information to differentiate construction expertise, may be the reason for construction non-performance

REFERENCES

- Chang, C.Y. and Ive, G (2001) A comparison of two ways of applying a transaction cost approach: The case of construction procurement routes. *In: Bartlett Research Papers*, 13, 41.
- Crosby, P. B. (1980) *Quality is Free, The Art of Making Quality Certain*. New York: Penguin Group.
- Hughes, W. (2002) Developing a system for assessing the costs associated with different procurement routes in the construction industry. *In: Uwakweh, B. and Minkarah, I. (Eds.), CIB 2002 10th International Symposium, 9-10 September 2002, Cincinnati, OH, Vol. 2, 826-840.*
- Leffler, K.B., and Randal R. R. (1991) Transaction Costs and the Efficient Organization of Production: A Study of Timber-Harvesting Contracts. *Journal of Political Economy*, 99(5), 1060-1087. Url: http://faculty.washington.edu/~krumme/readings/transaction_cost.html
- Marshall, R. (2002, June 28) Hearing Officer's Findings of Fact, Conclusion of Law, and Decision. *Office of Administrative Hearings Department of Commerce and Consumer Affairs State of Hawaii*.
- Post, N.M. (2001) Bumpier Road to Finish Line. *Engineering News Record (ENR)*, 246(19), 56-63.
- Sade, M. and the Seven Steps Team (2002) Seven Steps to Performance-Based Services Acquisition. *Department of Commerce and Office of Federal Procurement Policy*. URL: <http://oamweb.osec.doc.gov/pbsc>
- State of Hawaii PIPS Advisory Committee (2002) Report for Senate Concurrent Resolution No. 39 Requesting a Review of the Performance Information Procurement System (PIPS).

USA Government (1997, December). White Paper Past Performance. *U.S. General Services Administration*. URL: <http://www.acqsolinc.com/pastperfdoc/pastperfw.html>