The cost of 'best value' construction

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Abstract
One of the major objectives of facility owners is to get the 'best value' in construction, renovation or maintenance of facilities. Owners are reluctant to pay more for best value if they do not understand what the value is. Research now proposes that the use of best value procurement can actually reduce the first costs of delivering the construction. The research looks at the transaction costs or the first costs of construction. The research uses the procurement of roofing in the State of Hawaii because of the availability of data on both the low-bid and best value procurements. The State of Hawaii used transaction cost analysis to identify the cost of best value construction. The costs considered were planning and programming, design, procurement, construction management and inspection costs. Owing to the number of projects and the access to budget figures, construction cost figures, design costs and construction times, the State was able to identify the relative transaction costs and performance for both processes. The first costs or transaction costs of the best value procurements were lower than the transaction costs of the traditional design–bid–build costs. The actual performances of the roofing systems procured, which included warranty period, performance of the contractor and performance of the roofing systems, were far superior. The result was an increase in value for a lower cost.

Keywords:
transaction cost, financial management, construction management

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INTRODUCTION

Theoretical analysis of the construction industry structure has identified the low-bid award, design–bid–build (DBB) process as one of the main reasons for construction industry non-performance (time delays, poor quality and being over budget with change orders). Awarding construction contracts to the lowest bidder has led to poor construction performance.[1] A movement away from the DBB process (design using a specification and award to the lowest bidder) to alternate delivery processes has verified this conclusion. A major issue in the movement from the traditional DBB process to an alternate delivery process is the issue of cost. Owners are still cost conscious, and many owners, including public-sector owners, are required to justify spending more money for best value procurement.

Does performance actually cost more?

The justification for best value has been that, although it costs more initially, the life-cycle costs will be lower over the life of the facility. Performance information (first costs, maintenance costs, documented service periods, performance of the manufacturers' systems and contractor performance) is needed for a valid life-cycle cost analysis. This information is not usually available. Life-cycle cost analyses are usually done with very subjective opinions of construction professionals. Owing to the lack of performance information, these analyses cannot factor in the performance of the contractors. Deductive logic identifies that performing contractors will construct facility systems which will last longer and require less maintenance.

This research proposes that the hypothesis that first cost of best value construction is higher has never been validated. Owners assume best value construction will cost more. This research proposes to identify whether the first cost of best value construction is higher than low-bid construction. Previous work[2] suggests that the requirement of performance may not mean an automatic increase in first cost if it is a performance-based process such as the Performance Information Procurement System (PIPS).

Owners have a constrained amount of resources to deliver a construction requirement. The total amount of resources used on the project, called the transaction costs, defines the first cost of the construction. This includes programming and planning, design, procurement, construction management and inspection costs. In many cases, these transaction costs are not available. Because of the large number of best value procurements roofing systems in the State of Hawaii, a transaction cost analysis using comparative data can be accomplished.

STATE OF HAWAII BEST VALUE RESULTS

The State of Hawaii attempted to increase the value of its procured construction owing to the low performance of the products they were procuring.[3] Based on the results at the State of Utah,[4] the State of Hawaii decided to use the PIPS. Roofing was the first

construction type they targeted to try to improve. The PIPS was implemented in 1998, and by 2002, 96 roofs had been procured using this method. It is important to note that over the four years, PIPS was modified to minimise management work, decision making and risk. Over the four years, the following results were documented:[5]

Best value results show high performance and efficiency

1. Out of 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. There are no current leaks on the 96 roofs.
2. An average post project rating of 9.6 (maximum of 10) on roof performance by facility users.
3. No specifications were required on any of the retrofit projects. Design costs were reduced from 11 per cent to 2.5 per cent.
4. Inspection on roofs were minimised to the start and end of construction.
5. Enforceable roof warranties increased from two years to a range of 10–20 years.
6. Project management was minimised by 80 per cent.
7. The cost of the installed roofing systems was 7 per cent over the low-bid cost.
8. The performance-based roofing construction was 35 per cent faster than low-bid construction.
9. The projects had fewer total change orders (including scope changes), and fewer punch list items (which were immediately handled by the contractors).

A contractor who had performance issues protested at this process. The protest went through an administrative hearing. The hearing concluded the best value process met the requirements of the State procurement law, the contractor was unable to prove that the system was unfair, and subjective performance information can be used to determine best value.[6]

The performance-based procurement process is a selection process based on performance and price. It is an outsourcing process. Building owners whose core competency is not construction outsource the construction requirements to those who can perform efficiently. The best value is a contractor who can deliver the best performance for the best price. Outsourcing construction is a 'zero sum game'. There are a limited number of resources to deliver construction. To deliver best value, the entire delivery process must be made efficient. This is optimised when a 'win-win' exists between all parties in the delivery process. If any component is inefficient, another component will pay for the inefficiency. A 'win-win' exists when the owner receives best value, and the performing contractor maximises their profit.

Efficiency is achieved when management and other overhead functions are minimised. Outsourcing is efficient because, by definition, outsourcing requires no management and direction. This

is difficult to understand because so many companies outsource and then manage the outsourced function. Outsourcing, however, is when a company gives another company the complete responsibility to perform a function. Outsourcing is where one company does not manage another company. In the outsourcing of roofing construction, the State of Hawaii gave the contractors and manufacturers a requirement to waterproof the roof of the building, but did not direct the contractor on how to do the waterproofing. In the roofing application, the delivery of roofing construction resembles a design–build process. A design–build process is a process where the owner hires one entity, a joint venture composed of a contractor and designer, who will design and build the project. It minimises the functions of the user's project management, design, construction management and inspection. Deductively, the only reason to manage the outsourced function is when the outsourced function does not meet the expectation of the owner. Companies who can perform will know what their performance is and will be able to provide the performance without management from their buyer.

Efficiency minimises management

The PIPS had the following features, which forced efficiency, motivated performance, and minimised management and direction:

PIPS forces efficiency

1. There is no directed technical design solution. The designer identifies the current condition of the roof and any special requirements.
2. The past performance of every contractor and manufacturer is documented. The documented performance numbers of the manufacturer and the contractor directly affect the competitiveness of the contractor. For example, a roofing manufacturer's system that has a performance barcode of 10 years' proven performance, 95 per cent customer satisfaction, and 98 per cent roofs not leaking will be more competitive than a manufacturer's system that has the following performance barcode: 3 years' proven performance, 90 per cent customer satisfaction and 80 per cent roofs not leaking. Unlike most prequalifying procurement systems, where roofing contractors are either considered as qualifying or not qualifying, each manufacturer and contractor must now compete based on their actual performance numbers and price.
3. The performance on the current project will affect both the manufacturer's and the contractor's future performance numbers by 25 per cent. If a contractor's past performance showed a leaking roof, the contractor and the manufacturer become non-competitive for future work.
4. The perceived value of each contractor's roofing warranty is identified by taking the smaller or more conservative number of the proven performance periods (in years), or warranty period length, minus a year for every major exclusion (exclusions minimise the risk of the manufacturer by passing it to the owner).

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

PIPS hires contractors to perform

The contractors were no longer bidding to install roofing materials but they were bidding to waterproof the building. They competed based on performance and price. Performance was being measured in terms of success of waterproofing, customer satisfaction, not having change orders and speed of installation. The PIPS allowed the owner to outsource construction, relying on the identification of a high-performing contractor, rather than the management of a poorly performing contractor. The PIPS was embraced by the building users, the project manager, the majority of contractors who participated, and industry organisations who were interested in improving construction performance. There were others, however, who were not as comfortable with PIPS owing to the following:

Performance-based environment makes non-performers nervous

1. Liability and risk: Manufacturers and contractors were hesitant to accept responsibility for performance if they could not perform. Non-performance is defined as customer dissatisfaction, leaking, not finishing on time or within budget. In their implementation of PIPS, the State of Hawaii identified that non-performance was minimised by the information environment.
2. High-performing systems have an advantage over unproven systems. Contractors were motivated to select the best-performing manufacturer's products. Contractors were also selecting manufacturers based on their support in terms of technical knowledge and promptness. Manufacturers with poor performance and service to the contractors were not being selected.
3. Not price based. The low bidder was not assured of the award.
4. Non-efficient functions are minimised. The efficiency of the process minimises functions (engineering, design and sales order taking) that were previously perceived as 'critical'.
5. Change. The PIPS changes the functions of the delivery process.

The discomfort with change and accountability resulted in accusations of high costs and technical incompetence. 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 DBB (low-bid) and the

performance-based design–build process (PIPS) as pertaining to the procuring of roofing systems.

Audit analysis was conservative, forcing PIPS to prove better value

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 first cost of the performance-based construction was higher, then a comparison of the value of both processes would be analysed. Owing to the lack of 'total information', when decisions have to be made in the analysis, the decisions would be made on the conservative side (in favour of the hypothesis that PIPS is not more economical than the low-bid).

TRANSACTION COST ANALYSIS

The objective of the analysis is to identify the relative first costs of PIPS delivered construction in relation to the standard DBB delivered construction. The methodology to be used is the transaction cost analysis of the two processes that procure construction. The transaction cost analysis will cover the relative first cost of owner's (State of Hawaii) delivery processes. The traditional drawbacks of doing transaction costs analysis in construction include:[7]

1. the lack of full information of all costs
2. the number of related functions that cannot be completely quantified
3. the uniqueness of every construction project requiring different levels of each function
4. difference in quality of the end product.

Transaction cost analysis has been used for two different purposes: first, to identify which costs are related to the delivery of construction,[8] and secondly to assist in identifying more efficient and economical processes.[9] Unlike Chang and Ive,[10] this transaction cost analysis uses actual cost data with conservative assumptions, to compare the two processes which are run by the same organisation, for a specific type of construction: retrofit roofing. This analysis will use the methodology of relativity and differential between processes to identify which process is more economical to the owner. Using relative costs will bypass proving every related function and cost. Since the same organisation did both processes, and the type of construction is the same, the only critical functions would be the functions that resulted in a difference in cost. The objective is to identify if the cost of PIPS is more than the DBB process costs.

Transaction costs study the relative first costs

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

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 identified no differential in the cost of planning and programming, bidding and award phases between the two processes. The remaining four functions were then analysed for differential.

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

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 per cent. The State then assumed that the overhead or management costs for all projects was about the same.

Project management of best value is minimised by 80 per cent

The State then estimated how much of the management effort was minimised by PIPS in the delivering of the projects. The sources for the estimates were the University of Hawaii (UH) test case. The UH test case[11] resulted in minimising the project and construction management and inspection by 80 per cent. The UH test case involved just one project manager, who followed the project from inception to completion. The State of Hawaii test case results were similar, however, owing to the larger number of project managers and inspectors, the percentage of minimised effort was more difficult to determine. The State took the 2.65 per cent management rate, multiplied it by 0.2 (minimised by 80 per cent) and then divided the result by 1/3 (because the project managers could perform from five to ten times as many projects as the project managers who were managing under the DBB process). The division by three was a conservative number (range of reduction by two to five times). The resulting management/inspection cost of PIPS was identified as 0.4 per cent.

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. All projects were being budgeted with a standard estimate based on previous low-bid awards. The low-bid roofs were 13 per cent below the budget. Upon closer analysis, however, it was identified that three of the roofing projects had large cost deviations between the budget and the awarded price. This usually signifies a mistake in budgeting. When the three roofs were taken out of the sample, the average cost was 8.4 per cent below the budget. Another factor that skewed the average price of roofing was the changing of some roofing

Low bid roofs were 2.3 per cent below budget

budgets for added insulation. Ten of the low-bid roofs were insulated roofs, which had increased budgets. Without the impact of the budget changes and errors, the average cost of the low-bid roofing systems was 2.3 per cent below the budget. The two factors, inaccurate budgets and the insulated roof budget increases were taken out to compare the prices for the same type of roof jobs. In the DBB process, a specification is used to direct the contractor exactly what to do, how to do it and when to do it. Huge differentiations should come only when the contractor is using another procedure. Therefore, it is rather easy to identify when the budget is wrong (30–50 per cent difference between the budget and the low-bid). The insulated roofs were taken out from both the low-bid and the PIPS projects owing to the inconsistency of the budgets for these projects.

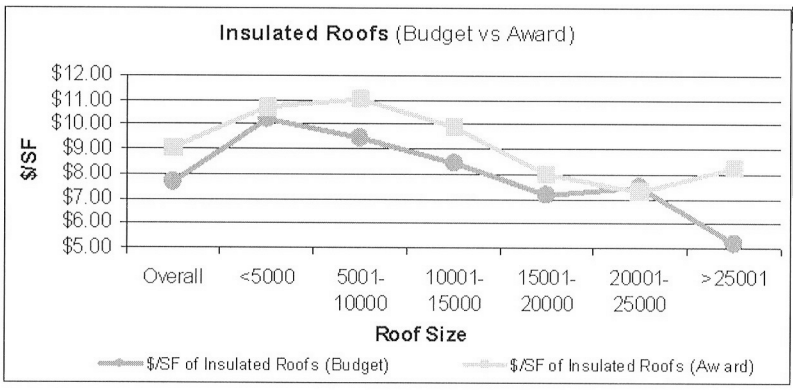

Figure 1: Insulated roof budgets underestimated

Performance-based roofs were 5.6 per cent below budget

The State had data from 96 of the PIPS projects. The average cost was 7 per cent over the budget. Upon closer analysis, however, 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 PIPS insulated roofing project costs were consistently above the budgets by an increment of 18 per cent. It was after this was identified that the low-bid procured roof budgets were increased in 2002 (owing to the protest of PIPS on the basis of costs, no roofing projects were procured using PIPS in 2002). The average cost of PIPS delivered roofs without insulation was 5.6 per cent below the budget (Table 1).

Table 1: State of Hawaii construction costs

Construction costs	PIPS (%)	LB (%)
Audit Report costs on all projects	7.0	–13.0
Average costs without projects with poor budget estimates		–8.4
Projects without insulated roofs and poor budgets	–5.6	–2.3

Cost of quality is the cost of redoing work

The last cost is the cost of quality or cost of non-performance.[12] Examples of construction non-performance within the last three years can be identified by three projects at the State of Hawaii. The first project, Kalanimoku Building, was a waterproofing project that was designed by the State and awarded to the lowest bidder. The project cost $575,000. After the contractor finished the project, the leaking continued. The State had to hire another contractor based on performance to stop the leaking temporarily.

The second project was the State of Hawaii capitol roof which, after being re-roofed, continued to leak. The estimated cost of fixing the leaks was $350,000. The State continued to do temporary repairs on the building. The third project 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 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 the leaking was stopped.

There are other low-bid projects that have also resulted in non-performance. The low-bid process was assessed a conservative 0.5 per cent cost of non-performance. The PIPS by definition has no cost of non-performance, because the contractors are paid to perform, not install construction materials. This definition is supported by the fact that none of the PIPS projects over four years had leaking problems.

Performance-based roofing had 13.8 per cent lower cost

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	

Performance-based roofing had much higher performance

Table 3: Performance results of PIPS and low-bid

No.	Criteria	Results
1	Percentage of Department of Education users that would rather use PIPS over low-bid	100
2	Percentage 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	Percentage increase in delivery schedule of PIPS compared with low-bid	35
7	Average PIPS ensured warranty	10–25 years
8	Average low-bid enforceable warranty	2 years
9	Percentage 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	No. of PIPS projects (with leaking roofs) repaired by the owner	0

A lack of information and rework can skew transaction costs

Table 2 shows the results of the transaction cost analysis. The PIPS delivery costs were 14 per cent better or 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, it is easy to identify the PIPS process as the better value process (Table 3). The PIPS has documented higher customer satisfaction, longer maintenance free performance, faster delivery of performing products and no leaking roofs.

CONCLUSIONS AND RECOMMENDATIONS

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

1. Roofing can be procured more economically by procuring with performance-based procurement rather than the traditional DBB process.
2. Retrofit roofing can be procured more economically by procuring the system solution with the best-documented performance instead of using an expert's design.
3. This case study suggests the difference in the construction first cost has less impact than other component costs in the delivery of roofing systems.
4. The value brought by performance-based procurement far exceeds the value of low-bid awards.
5. This case study suggests the value of high performance does not cost more. The results identify performers that 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.

Best value has lower first costs

This research proposes that the best value construction may have a lower first cost. It proposes that the traditional method of procuring construction is inefficient and has a higher overhead cost component. The higher overhead costs exceed the increase in construction first costs for performance-based construction. The efficiency of outsourcing construction, which is another term for performance-based construction or best value, minimises the overhead costs, uses the money to increase the quality and performance of the construction and results in an overall lower first cost to the owner.

Low bid procurement has higher first costs

The conclusions are that the traditional DBB 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 traditional delivery process, which does not use

performance information to differentiate, but uses management and control to deliver a commodity, may be the reason for construction non-performance. It proposes that the facility owner outsources construction by using performance-based procurement.

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