State of Utah Performance Information Procurement System Tests

Dean Kashiwagi, P.E.,[1] and Richard Byfield[2]

Abstract: The state of Utah has experienced problems in the procurement of construction. Similar to other states using low-bid, Utah historically has not had construction projects delivered on time and within budget. Faced with critical projects to prepare for the 2002 Olympics, overworked construction project managers, and construction litigation caused by low-bidding contractors, the Division of Facilities Construction and Management tested the Performance Information Procurement System (PIPS) in the fall of 1998 on the University of Utah Housing Project Phase II for the 2002 Olympic Housing. Five other tests were conducted. This article analyzes the differences between the PIPS and the Utah low-bid procurement system, the results of the state of Utah tests, problems, and modifications to the PIPS, and recommendations to future users of the PIPS. Major contributions of this article include the PIPS, Kashiwagi's Information Measurement Theory, and Zeleny's Displaced Ideal Model. The objective of this article is to use an information-based business process to procure contractors who deliver on time and on budget and meet quality expectations.

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Introduction

The standard construction delivery mechanism during the last 50 years has been the design/bid/build process. The following factors have forced construction managers to scrutinize the process and look for alternative delivery systems:

1. Poor performance of the ''low-bid'' design/bid/build construction process, communicated by the facilities groups in the states of Wyoming, Hawaii, Utah, Georgia, Kentucky, and Kansas and also documented by federal agencies. (Kashiwagi and Al-Sharamani 1997);
2. The worldwide competitive marketplace, resulting in an effort to minimize costs;
3. Change of construction design from the identification and communication of the requirements to contract documents that direct the contractor on ''how to do construction'';
4. Differences in construction system performances;
5. Increase in complexity of constructed facility systems; and
6. Lack of training programs and a decreasing number of trained craftspeople.

The design/bid/build process has not worked well. It has resulted overall in lower-quality construction, has created a new area of construction management, and has led to an increase in practices such as arbitration and partnering, increased change orders and construction cost, and construction litigation (Gransberg 1997).

The worldwide competitive marketplace has placed an emphasis on reducing costs. Architects, manufacturers of construction systems, and contractors are forced to reduce their prices. To reduce prices, participants are increasing their volume, reducing quality and training, and limiting liability to meet minimum standards. In the low-bid system, contractors are not credited with high performance. Large-facility owners who attempt to lower their prices by buying in volume compound the problems (Wright 1996).

In this increasingly complex construction world it has become more difficult for designers to perform. Their job initially was to identify and communicate project requirements to contractors. The evolution of the low-bid method has resulted in ever-increasing litigation to compensate contractors for the too-low price bid to obtain the project. To minimize change orders and to establish minimum quality standards, designers are forced to create regulatory contract documents replete with detailed construction instructions. However, with pressures from ever-reduced fees coupled with increasing internal costs, designers struggle to achieve complete contract documents.

These factors have resulted in a decline in overall designer performance. In an environment of avoidance of liability, low-bid construction, and minimal designer pay, designers do not have the motivation to identify their performance in terms of construction quality, price, and schedule. This reluctance is readily identifiable by the design community's continued encouragement of owners to use a qualification-based selection process. Unfortunately, under a qualification-based system, emphasis is too often placed on minimal qualifications, fees are based on a rate table, and subjective selection is based on relationships.

Manufacturers are competing in the same environment. The objective of every successful manufacturer of construction products is to make a profit. To make a profit in a low-bid environment, manufacturers must reduce performance and quality to

[1]Associate Professor, Del E. Webb School of Construction, P.O. Box 85207-0204, Arizona State Univ., Tempe, AZ 85287.

[2]Director, Division of Facilities Construction and Management, 4130 State Office Building, Salt Lake City, UT 84114–1002.

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meet minimum specification requirements, which are designed to accommodate the lowest performing systems and products. Technology continues to increase in construction because mechanical and electrical systems continue to become more sophisticated and integrated. This dichotomy—increasing complexity while demanding a bidding system promoting ''minimal'' and threshold solutions to obtain the project—creates a no-win environment. With increased risk, less-qualified constructors, lower performance designs, emphasis on price, and a lack of performance information and liability, the low-bid construction environment cannot produce ''best value.'' Additionally, low-bid competition-only considers the lowest price. It never considers the difference between contractors, that is, how long they have been in business, prior similar experience, and personnel with qualifications to perform the project successfully.

State of Utah Construction Environment

The State of Utah Division of Facilities Construction and Management (DFCM) was facing one of its most critical projects in the fall of 1998: the construction of Univ. of Utah Housing Phase II, which would provide the housing and beds for the 2002 Winter Olympics. The $131 million project was divided into two phases: Phase I, which included a portion of the housing and utility installations and hardscape for Phase II, and Phase II, the balance of the housing. The designer of the project performed the programming, design, and construction management and was hired to administer overall delivery of the entire design and construction program.

Unfortunately, the state of Utah construction environment exhibited the following characteristics of the low-bid environment:

1. Change orders other than scope and unforeseen site conditions at 5.7% (1.2% over the contingency construction budget measured over a 10-year period);
2. Construction not completed on time;
3. Construction problems leading to litigation or to the state of Utah paying the contractor for construction delays or changes. One of the contractors, who were very effective at low bidding, emphasized that their competitive advantage was based on finding errors in the specifications and drawings. The contractor also told the writers that this advantage would be nullified by the Performance, Information Procurement System (PIPS). He stated, ''We can no longer learn at the state's expense'' (personal conversation with Richard Byfield, February 1999);
4. Ineffective use of the DFCM's construction managers' time due to low-bid problems;
5. Low-bid contractors extremely successful at getting contracts, making it difficult for performing contractors (no contractor-generated cost change orders) to be competitive;
6. Subcontractors selected by price only; and
7. Lack of liability of designers due to confusion over design/construction problems.

The following was the situation facing the DFCM in November 1998:

1. Phase I was 3 months behind schedule. The only contractor on schedule was a design-build contractor who had been given control over the design;
2. Design services for Phase II were 3 months behind schedule;
3. The deadline for Phase II construction completion of May 2000 would be very difficult to meet using the low-bid procurement delivery system;
4. The facility manager (owner) needed a system that minimized subjectivity or the perception of biased selection when not awarding to the low bidder;

Performance Information Procurement System (PIPS)

The PIPS reduces risk, subjective decision making, and the need for minimal design requirements. It is different from other procurements in the following ways:

1. Past performance of the contractors is determined by prior customers (40);
2. Contractors identify the performance criteria, and prior users rate the past performance of the contractors based on those criteria;
3. No prequalification steps are required;
4. The PIPS identifies a relative value for the relative level of performance of each contractor;
5. Subjectivity in selection is minimized by the use of a mathematical model that considers both subjective and objective data and an associated risk factor;
6. The owner's subjectivity is minimized by the contractors' submitting realistic information that differentiates each of them from the other contractors;
7. The PIPS identifies which criteria will reduce the risk of the owner. This identification of risk-minimizing criteria is known as the ''information factor'';
8. Minimal requirements, that are subjective and prone to protests and make performing contractors ineligible are minimized;
9. The information factor does not allow a contractor with a performance deficiency in a critical area to get the job. Deficiency is measured in relative terms;
10. The PIPS model uses a requirement (weighting of criteria), distances away from optimal values, and the information factor to differentiate options;
11. The PIPS encourages the continuous improvement and education of contractors; and
12. The PIPS encourages partnering because all the participants' ratings affect their bids. The contractor's current project performance impacts the contractor's future performance line by 25%, which influences the contractor's current level of effort.

Dean Kashiwagi designed the PIPS in 1991. Testing of the system began in 1994 at Arizona State Univ. at the Performance Based Studies Research Group. At the time of the Utah project, the system had been tested 60 times on smaller construction procurements. Currently the PIPS has been tested more than 300 times on projects of all types and sizes. It is composed of the following components (Kashiwagi 1999):

1. Artificial intelligent decision maker: Modified Displaced Ideal Model (MDIM);
2. Theoretical foundation: Information Measurement Theory (IMT);
3. Legal process: Request for proposal (RFP) procurement requirements;
4. Requirement: Design and specifications;
5. Procedure: PIPS process;
6. Contractor identifiers: Contractor and key personnel performance lines;
7. Information sources: Past performance, management plans, bid amount, and interviews; and
8. Management plan and interview rating committee.

The DFCM decided to use the PIPS, which only two states, Wyoming and Hawaii, previously had. The state of Utah's implementation was different from the previous implementations for the following reasons (Kashiwagi and Al-Sharmani 1997).

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1. Project size. The construction budget was $53 million. The PIPS's largest project before this time was a $500,000 renovation project;
2. Project complexity. The project involved an incomplete design (at time of award), a prepatory Phase I, which was not complete, multiple designers, and a need for performing subcontractors in the electrical, mechanical, plumbing, roofing, framing, drywall, and landscaping areas;
3. Inexperienced staff and industry. The PIPS was a new program to the state of Utah and the construction environment and design community; and
4. Speed of procurement. From start to finish, the procurement period was only 2.5 months. This time span included the first information presentation.

The PIPS makes its decision by considering many factors (past, present, and future), and measuring differences in the performance of the factors. Because the PIPS uses a math process that is logical and nonbiased and measures differences between competitors, the resulting identification of the level of performance and its value is easily defendable. The PIPS asks the contractors to submit the following:

1. The contractor's proposed construction time;
2. A cost breakout by general areas;
3. Identification of risk, minimization of risk, and a general plan on ''how the project will be accomplished''; and
4. Project manager and site superintendent names on the job.

Many owners think they are doing performance-based procurement when in fact they are really running a modified low-bid system. The more subjective the decision becomes, the more impossible it is to defend paying for value. The result will be a return to the low-bid system in which the best value is determined only by the lowest bid. There are many users who use systems which are called ''best value'' but which use prequalification to reduce the number of competitors and awarding to the then low-bidder. This system may quickly root out nonperformers but will not improve the overall construction quality, because responsibility for performance was not established, and the system will return to the low-bid method of delivery (Fullmer 2000).

The majority of contractors (educated in the existing construction industry structure), if given the opportunity, will design a system in which they can get work with the least amount of effort or change. This mentality is responsible for the construction industry environment, which includes the following:

1. One of the lowest ''self-esteem'' industries;
2. Lowest net worth industry based on equity;
3. Lowest education and training rates among major industries;
4. One of the lowest profit margin industries;
5. The highest risk of bankruptcy among major industries; and
6. Success and performance determined by how much work is done, which encourages contractors to do more work for less profit and with less quality because the industry is attempting to work in a commodity delivery strategy.

Many contractors and construction industry people deny that the industry has the above characteristics. However, in a comparison of industry numbers, the above becomes apparent. This environment is leading to ''roll-ups'' and owners treating construction as a commodity, minimizing the characteristics of quality work and craftsmanship (traits of small contractors). Not all construction companies are lowering their quality and performance. However, it is becoming increasingly difficult for these companies to make a profit, train their people, do quality work, and get jobs in which they can perform quality work (Schleifer 2000).

The PIPS, as used by the Univ. of Utah, was composed of the following steps (dates in parentheses):

1. Education meeting (December 22, 1998);
2. Performance criteria review;
3. Registry meeting (January 7, 1999);
4. Collection of performance data (started January 14, 1999);
5. Design and specifications established for bidding, including an allowance for the Village Center because its design was incomplete (January 18, 1999);
6. Weighting of criteria;
7. Preproposal/site visit meeting (February 2, 1999);
8. Bid/management plan submittal;
9. A ''blind'' management plan review;
10. Interview of key personnel (February 17–18, 1999);
11. Prioritization of contractors;
12. Notice to proceed (March 9, 1999); and
13. Partnering meeting.

The management plan and interviews for the PIPS are different from the traditional processes. It is important for the owner's selection committee to understand Information Measurement Theory (IMT). One of the weaknesses of the current design/build RFP processes is the inability of owners' representatives to predict the level of performance of the contractor and key personnel. The objectives of the management plan review and the interview include

1. Ensuring that the contractor can identify the ''risks (not on time, on budget, or meeting quality expectations) to the owner'';
2. Determining if the contractor has a plan to minimize the risks;
3. Determining if the contractor understands how the project will be done;
4. Determining if the contractor understands the user's constraints;
5. Identifying what makes the contractor different in terms of performance; and
6. Determining if the key personnel can predict problems before they occur.

The contractors were encouraged to minimize their management plan (maximum of 30 pages) and to include information without marketing data. The management plans are reviewed ''blind.'' The raters were not able to identify the contractor from the management plans. The key individuals of the construction teams were then interviewed and rated on the following:

1. Response time to questions;
2. Construction knowledge;
3. Ability to predict future events;
4. Logical thinking; and
5. Problem-solving ability.

The contractors viewed the management plan and interview as the most expensive part of the PIPS as it requires more preparation than the low-bid system. PIPS forces contractors to

1. Assess the project;
2. Identify the risk and have a plan to minimize it before it happens;
3. Know how the project fits together and what it will take to minimize risk;
4. Know and take control of the project (from the government); and
5. Select key subcontractors and identify a common strategy to create a successful project.

The state of Utah realized that the PIPS was not a perfected system. However, the PIPS seemed to have far more potential

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than any other existing procurement system to deliver quality construction at a competitive price over a prolonged period of time while minimizing the risk of nonperformance. The PIPS process is a flexible process that is constantly evolving. Changes were made by the state of Utah to make the process fit their procurement process.

Information Measurement Theory

IMT is the most important component of the PIPS. It structures the PIPS: decisions are minimized first by the PIPS, then by the IMT when there is not enough information. Past implementations with private sector facility teams indicate that it is difficult to maintain a PIPS program without an understanding of IMT. IMT has the following strengths:

1. Minimizes direct owner management by creating an information environment;
2. Identifies and defines ''information'';
3. Minimizes the need for inspection of construction;
4. Reduces risk of the unknown; and
5. Uses logic relationships to reduce decision making, even when there is a lack of information.

IMT includes the following theories:

1. Everything is relative and related;
2. There is no true randomness, discontinuity, or chance events;
3. If all information is available, the future outcome can be accurately predicted;
4. Every event is constrained and can happen only one way;
5. The optimal performance is a win-win event;
6. The more participants who win, the more optimal the performance;
7. Minimal control should be used on other participants. The more control that has to be used by one party over another, the more costly and risky the venture;
8. The optimal environment is one in which information controls the event;
9. An effective person minimizes the amount of data and decision making; and
10. All persons do the best they can do and are described by their performance.

Managers who understand IMT will be successful at the PIPS because they

1. Possess a strategic vision of minimizing control and decision making, trusting performers, and encouraging everyone to use all information;
2. Incorporate the principles of IMT in their business and personal life;
3. Minimize the use of their personal bias or experience in their decision making;
4. Continuously change and use measurements of the change; and
5. Minimize the confusion and risk by using information systems.

Requirements of University of Utah Housing Project

The performance of the PIPS would be determined by the following criteria:

1. Awarding the project to a performing contractor in a competitive environment and meeting the legal constraints of the state of Utah procurement system;
2. Having performing contractors who do not bid state of Utah work bid on the project;
3. Selecting an innovative contractor with a clear plan of success;
4. Having the construction finished on time and on budget (minimizing contractor-generated change orders);
5. Having a satisfied owner and facility manager;
6. Minimizing the chances of awarding to nonperforming contractors; and
7. Having the state of Utah run the system again with the participation of top contractors.

There were unique pressures on the PIPS test. The Univ. of Utah housing project was a substantial project ($53 million). Due to the lack of a similar performance-based system, the magnitude of the project, and the radical change that the PIPS brought to the state of Utah construction procurement philosophy, the following occurred:

1. Successful contractors who did not bid government work participated in the bid.
2. Successful contractors were attempting to define ''performance'' for the state of Utah. This resulted in these contractors having a difficult time understanding the simple PIPS and IMT concepts taught in the educational seminars. Some of the contractors took a personal approach that if they did not win, the system was flawed. All the contractors agreed that performance was the basis on which to award the project, but no one was willing to lose the bid based on another's definition of performance.
3. The openness of the PIPS allowed the participating contractors to set the performance criteria and show their performance capability. The opportunity seemed to stun the contractors, who were used to marketing themselves and not differentiating by performance. A few of the contractors made obvious errors in their proposals, supporting the above idea of not being ready for a performance-based approach.

Performance Data Collection

The PIPS collects performance data in the following areas:

1. General contractors' past performances (from both users and subcontractors);
2. Critical subcontractors' past performances;
3. Project managers and site superintendents' past performances;
4. Management plans submittal;
5. Interviews with key personnel; and
6. Price.

Performance data were collected on the following (number of contractors in parentheses):

1. General contractors (9);
2. Electrical contractors (15);
3. Mechanical/plumbing contractors (18);
4. Drywall contractors (3);
5. Framing contractors (10);
6. Landscaping contractors (10);
7. Masonry contractors (14); and
8. Paving contractors (7).

Contractors submitted references from previous jobs. They were instructed to give only their best references for the following reasons:

1. Previous experience with the PIPS resulted in the contractors sending their best personnel. If they did not, they were not as competitive; a risk-oriented project would require the best

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managing personnel and the best company performance. The performance data should identify the level of performance that will be provided.
2. If the references are bad, the contractor cannot blame the criteria or the user for being unfair as each contractor participates in setting the criteria and in selecting the references. Such a process gives the contractor total liability for their own performance indicator.

Contractors are also told to contact their references to inform them how important the references' feedback is. Despite these instructions, some contractor references resulted in poor numbers, revealing that some contractors do not understand performance.

The following data describe an unusual level of success of the data collection process:
1. Number of surveys: 1,931;
2. Total number of contractors surveyed: 86;
3. Percentage of surveys returned: 69%; and
4. Average number of criteria per survey: 42.

Normal returns on reference surveys would be 15 to 20%. The average return on PIPS surveys is 65 to 70%.

Multiple Criteria Decision Making Modified Displaced Ideal Model

The PIPS uses a modified Displaced Ideal Model (DIM), a multicriteria model developed and published by Milan Zeleny (1984). The model
1. Identifies the best numbers in each criteria area;
2. Identifies the relative distance of each number to the best number;
3. Allows the user to set the requirement by assigning a set of weights to the criteria;
4. Uses the natural log function to create an information factor for each criterion. Instead of a consultant picking out which criteria are important, the artificial intelligence model selects the most important criteria by the relative ranges of values. If there is no relative range, the criteria are not important, the values are all the same, and the model does not factor the criteria as being important;
5. Multiplies the relative distance of an alternative's value by the information factor and the weighting factor;
6. Sums the distances of all the criteria for each alternative; and
7. Selects the best option as that which has the smallest overall relative distance (closest to the optimum solution relative to their competition).

Due to the length of the paper, the mathematics of the DIM is not included. However, a simple example of the DIM is found in Zeleny's *Multiple Decision Analysis Criteria* (Zeleny 1984).

The positive characteristics of the MDIM include the following:
1. The decision is based on information. Therefore, the model does not use personal bias in ranking the alternatives, allowing the job to be awarded on price and performance;
2. Risk is minimized by use of the information;
3. Objective criteria such as number of days to respond, number of surveys, number of different people giving references, number of safety violations, and so on are considered along with subjective (1–10) ratings;
4. A contractor is not allowed to have a nonperforming characteristic in a critical area. If the contractor is deficient in a critical area, the system eliminates the contractor even though the contractor may be strong in other areas;
5. Every factor is considered relative and related. The MDIM allows the performance data from the job references of contractors to be compared even though the jobs are different in nature. The MDIM also allows the use of mathematically dependent performance criteria, allowing the owner to state the requirement with his or her own unique perception. The model also allows contractors with a different number of references to compete with each other;
6. The owner is allowed to set his requirements and identify the contractor who best fits the requirement. This is done before the project is sent out to bid;
7. Subjective and objective ratings allowed. While the objective is to minimize subjectivity by using the most valid data (from people who have the most information) whenever possible, subjective ratings can be used in parts of the process; and
8. No minimum sample size required. The MDIM uses any and all available information.

The major benefit of using the PIPS MDIM is that it is a mathematical solution that mimics a ''perfect'' human mind, which measures performance and risk using subjective and objective data. Performance can be compared on a relative basis. Contractors can know in what areas changes will increase the value to the user and the contractor. A change in the contractor's performance may get the contractor the job, but it may not add value for the user.

The following are disadvantages of using the MDIM:
1. The math in the MDIM is straightforward but more complex to the average contractor;
2. Personnel need knowledge of IMT to effectively weight the MDIM;
3. Contractors who are used to using marketing data to show performance have a difficult time understanding what it means to compete on performance;
4. Contractors are used to winning the bid with the low price. Competing on a performance basis is much more difficult than identifying the low price; and
5. The model does not override a weakness in a critical area with strength in another area—the information factor will not allow a contractor with a large weakness in a critical area to win the bid.

Subjective Ratings in Performance Information Procurement System

The following are subjective elements in the PIPS:
1. Weighting of the performance criteria to express the project requirement;
2. Rating of the management plan; and
3. Rating of the interview.

The PIPS model then takes the price, past performance data, management plan rating, and interview rating and prioritizes the alternatives based on
1. Distance away from the best values;
2. Information factor or relative spread of values; and
3. Weighting factors.

The weights for the performance criteria are set by the user and stated in the RFP. The criteria weights represent the user's subjective perception of the requirement. The criteria weights measure the relative importance of the different components of the contractor's bid. The perception of the requirement is subjective (what the owner wants). The PIPS minimizes the bias in the selection by quantifying the subjective requirement of the owner

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Table 1. Criteria Weights

Number	Category	Weight
1	Price	20
2	Management plan	10
3	Contractor interview	10
4	Site superintendent performance	5
5	Site superintendent interview	5
6	General	20
7	Electrical	5
8	Mechanical	6
9	Framing	4
10	Plumbing	4
11	Masonry	3
12	Drywall	3
13	Roads	3
14	Landscaping	2

as clearly as possible before the bid submittals; it then finds the contractor that most closely meets the owner's requirement (Table 1).

Each subcomponent is also rated; the ratings are totaled, and the various rating committee members' scores are averaged. The interview rating is done in a similar manner. Committee members are rating the relative ability to understand the project before it happens. This quality represents experience, minimized decision making when something goes wrong, and minimized risk for the contractor and owner.

Minimization of Risk

Risk is defined as not getting what is expected. It can be quantified in most cases as the contractor not finishing on time, on budget, and meeting the owner's quality expectation. On time and on budget are more clearly defined than meeting the owner's quality expectations. Risk is minimized when the owner knows what will happen before it happens. Risk is different from poor-quality construction. Owners who expect poor quality have minimal risk. Information (past data that predict the future outcome) minimizes the owner's risk. The PIPS minimizes the owner's risk by exposing the owner to past performance data and current capability in the form of a management plan, interview, and detailed cost breakout. The current low-bid system masks risk. The detailed plans and specifications give the owner a false security that all contractors can do the job and that the lowest price is the best value. The PIPS allows the owners to see differentials.

Performance Information Procurement System Results

Five general contractors bid on the Utah project. Table 2 gives the resulting distances in the various performance criteria areas. The relative distances are generated by the MDIM. The areas of strengths of contractors have small relative distances, and the areas of weaknesses have larger relative distances.

Contractors 1, 2, and 3 did not usually bid state of Utah projects; their performance number and bids are shown in Table 3.

The contractors were told that two major requirements had to be met:

1. The project, including the landscaping, had to be completed by May 1, 2000; and
2. The project budget was $53 million. Any bid over that would be nonresponsive.

The highest performing contractor's bids, submitted by a joint venture, were at $57 million and $55 million. The contractor was a joint venture including the design-build contractor who had worked on Phase I of the Housing Project (Contractor 1A) and another general contractor (Contractor 1B). Contractor 1A's bonding limit was exceeded by the project scope. Contractor 1A had the following background:

1. Performed Phase I work on a design-build contract;
2. Was selected through a design-build competition in Phase I. Contractor 1A usually did negotiated work and did not usually compete on low-bid work;
3. Was the only contractor to finish their Phase I contract on time;
4. Received a ''very satisfied'' rating from the Univ. of Utah for their quality; and
5. Had the highest performance rating of any contractor bidding for the Phase II project.

Contractor 1A left the final bid submittals to Contractor 1B because 1B was a firm that had performed prior low-bid work for the DFCM and therefore understood how to submit a bid to the state of Utah. However, Contractor 1A requested to change the

Table 2. Relative Distances in Performance Criteria

Number	Category	Contractor 1	Contractor 2	Contractor 3	Contractor 4	Contractor 5
1	Price	0.001	0.000	0.000	0.001	0.000
2	Management plan	0.014	0.069	0.057	0.063	0.071
3	Contractor interview	0.001	0.001	0.001	0.007	0.011
4	Superintendent performance	0.014	0.061	0.043	0.020	0.122
5	Superintendent interview	0.005	0.015	0.001	0.121	0.083
6	General performance line	0.015	0.040	0.089	0.078	0.100
7	Electrical performance line	0.044	0.004	0.047	0.037	0.047
8	Mechanical performance line	0.015	0.019	0.019	0.026	0.019
9	Framing performance line	0.039	0.004	0.040	0.042	0.042
10	Plumbing performance line	0.001	0.069	0.069	0.059	0.069
11	Masonry performance line	0.007	0.032	0.024	0.016	0.025
12	Drywall performance line	0.001	0.003	0.005	0.003	0.003
13	Roads performance line	0.008	0.026	0.026	0.020	0.020
14	Landscaping performance line	0.012	0.008	0.008	0.004	0.008

Ranging (total): 1st (0.175); 2nd (0.349); 3rd (0.428); 4th (0.498); and 5th (0.620).

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Table 3. Contractor Raw Scores

Number	Category	Contractor 1	Contractor 2	Contractor 3	Contractor 4	Contractor 5
1	Price	$55,574,429	$50,285,000	$48,756,500	$52,660,000	$49,900,000
2	Management plan	8.43	6.21	4.24	5.31	5.73
3	Contractor interview	8.94	9.06	9.13	7.25	6.52
4	Site superintendent performance	9.71	9.46	9.09	9.24	9.36
5	Site superintendent interview	8.97	8.75	9.10	5.57	6.75
6	General	9.09	9.19	8.40	8.96	8.52
7	Electrical	8.93	8.41	8.41	9.02	8.41
8	Mechanical	8.44	8.45	8.45	9.10	8.45
9	Framing	7.80	8.41	8.52	8.30	8.33
10	Plumbing	9.30	8.65	8.65	8.66	8.65
11	Masonry	8.15	8.41	8.50	9.01	9.01
12	Drywall	8.72	8.36	8.00	8.00	8.72
13	Roads	9.23	8.23	8.23	8.80	8.80
14	Landscaping	8.20	8.20	8.20	9.41	8.20

bid a day after the bid submittal. Contractor 1A gave the following reasons for the high-priced bid submittal:

1. Flaws in the design raised the project cost over the budget of $53 million. The major flaw was the omission of the Federal Housing Authority (FHA) requirements of the housing units, which eventually ended up costing the state of Utah approximately $3 million for Phase I. Contractor 1A claimed that their price included the FHA requirements;
2. Contractor 1A knew the expectations of the owner because of their Phase I work;
3. Contractor 1A experienced some of the confusion caused by the overall construction management of the project; and
4. At the time of the bid, the design for the village center (cafeteria facility for the new housing units) was not completed and was bid as an allowance (it later ended up costing $11 million instead of $7 million).

Contractors 1A and 1B felt that the true project cost was over the budget amount and did not fully realize that the over-budget proposal would eliminate their bid despite numerous reminders. Due to their experience and information on Phase I, the requirements of Phase II (construction time, incomplete design such as the FHA requirements, and late start due to other Phase I contractors being late), Contractors 1A and 1B probably had the most accurate knowledge of their bids.

Contractors 1A and 1B should have done the following, which is allowable under the PIPS rules:

1. Identified the design flaws or unstated requirements and priced them as additives; and
2. Identified the risk of working with the state of Utah and set rules and requirements that would reduce the cost.

However, because their bid was above the stated budget requirement, they were eliminated as nonresponsive.

Contractor 2 was the second-highest performer, with a bid of $49 million. However, Contractor 2's projected completion date for landscaping was 2 months beyond the May 1, 2000, deadline set by the Univ. of Utah. Contractor 2 gave the following arguments:

1. Substantial completion of the project would be by May 1, 2000.
2. It was impossible to finish the landscaping in the spring by May 1, 2000. The spring season was not long enough to do the landscaping effectively.
3. The contract documents called for substantial completion, including landscaping, by May 1, 2000. The university wanted no landscaping to occur once students occupied the facility and additionally wanted no landscape material tracked into the units.

Contractor 2 protested the bid award based on the above facts. The bid protest was denied for the following reasons:

1. Contractor 2 specifically asked in the preproposal meeting if the deadline for landscaping could be beyond May 1, 2000. The addenda listed their question with the answer ''no.''
2. The preproposal meeting presentation, which was also part of the addenda, covered the requirements that would eliminate a bid as nonresponsive. The requirements were to be within budget and finished by May 1, 2000.
3. The university requested that the landscaping be done by May 1, 2000, due to the projected immediate use of the housing units.
4. The successful bidding contractor proposed to install much of the landscaping the previous year. He also submitted a larger landscaping budget within the bid to take care of ''dead'' or damaged items.

The confusion on Contractor 2's bid could have been alleviated by

1. Changing the contract documents to correspond to the PIPS. The standard contract documents used created confusion by requiring *substantial* completion by May 1, 2000. However, the addenda, clearly stated that the landscaping was required by May 1, 2000. When using the PIPS, there is no substantial completion date, only a final completion date;
2. Left the landscaping finish date as a ''performance issue'' rather than as a requirement; and
3. Contractor 2 could have proposed a creative plan that would have accelerated the landscaper's schedule.

Contractor 3 was awarded the contract. It should be noted that the landscaping and finishing of several buildings were actually completed beyond May 1; however, the contractor was delayed through no fault of the contractor, resulting in the landscaping being finished in July 2000. Contractor 2 did not understand that the legal requirement was ''to have a construction plan finish by May 1, 2000, if the contractor is allowed to perform on their proposal.''

Contractors 1 and 2 were both disqualified due to a lack of understanding of the difference between the PIPS and the legal requirements of the state of Utah. Requirements cannot be altered by the PIPS, which has to work within the constraints of the

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user's requirements. The objective of the PIPS is to measure differences to prioritize alternatives to meet a unique requirement.

Contractor 3 had the following differentiating characteristics:

1. Was unknown to the state of Utah due to a past history of not bidding state work;
2. Assigned the ''best'' personnel to the project. Both the project management team and the site superintendent were very knowledgeable about the project. Their key personnel were quick-thinking and logical and passed information very quickly;
3. Had a workable plan that finished within the contract period;
4. Was creative in handling the critical areas of framing, sheetrock, and landscaping; and
5. Was the low-bid on the project.

Construction of University of Utah Housing

The project got under way very slowly, which can be attributed to

1. Phase I contractors, particularly the infrastructure contractor, procured under low-bid, were not finished on time, delaying the performance-based contractor;
2. Design specifically relating to utilities and site engineering requirements was not complete. Critical design components such as finished grade were not available until four months into Phase II;
3. The performing contractor changed his proposed construction plan twice to attempt to get construction under way;
4. One of the critical construction requirements, the $7 million Village Center design, was completed five months late. The contractor was asked to submit a $7 million allowance in their bid. However, the Village Center's final cost was $11 million;
5. The designer had difficulty staffing the construction management/engineering support functions; and
6. The DFCM and the university finally released the lead design firm, which was responsible for overall construction management, from the role. The Univ. of Utah personnel took over the daily construction coordination and management. It is interesting to note that the designer was not selected under the PIPS process.

The Village Center project was substantially complete on May 11, 2000. The contractor was paid a $350 thousand acceleration fee to make up the lost time (3–4 months). All but one of the remaining 10 buildings, the landscaping, and punch list items were completed by the end of August. The state of Utah made the determination that the contractor was delayed due to incomplete project drawings and a failure to respond to the contractor in a timely manner throughout the project. The contractor had meticulous records, which were verified by the DFCM and the PBSRG from ASU.

A major lesson learned on this project is a procedural step in the PIPS. The PIPS has a preaward and partnering meeting before the award. Before the meeting the following are accomplished:

1. The contractor with his critical subcontractors should review the drawings in detail;
2. All items that cannot be constructed or have incomplete information are identified;
3. A list of requests for information (RFIs) is submitted to the designer;
4. Responses at the preaward meeting are discussed; and
5. Very few open items should exist after the preaward meeting.
6. The interface and lines of communication should be fixed;
7. A construction information interface should be agreed to and implemented; and
8. The preaward meeting minutes and agreements become a part of the contract.

The preaward meeting has the following advantages:

1. Only one contractor spends the time to carefully coordinate with the critical subcontractors;
2. Errors or issues in the design are identified before construction;
3. The designer is forced to respond to the contractor's RFIs in a timely manner;
4. The contractor can be paid for unforeseen conditions or scope changes by the user; and
5. The information at the preaward meeting identifies responsibilities, ensures that information will be passed on in a timely fashion, and creates a partnering environment.

Unfortunately, the partnering meeting for the Univ. of Utah Housing project was held after the award, so the contractor did not get needed information from the designer. It is significant to note that the designer did not alert the contractor during the partnering meeting that their construction plan could not be accomplished based on the late finish of the Phase I contractors. Other information was also not passed onto the contractor. As previously stated, the project took 3–4 months to get into construction. The lack of response to the contractor with timely information led to confusion, difficulty in solving the problems, and finally to the transfer of the construction coordination from the lead designer to the Univ. of Utah.

Analysis of Performance Information Procurement System Implementation

The criteria for the performance of the PIPS system were

1. Identifying if the program objectives were completed;
2. Comparing the results with the other contractors hired under design/build and low-bid in Phase I; and
3. Getting customer satisfaction at the end of the project.

Program Objectives

Eight performance measures were analyzed for success or failure.

1. Award the project to a performing contractor on schedule and under budget in a competitive environment that met the legal constraints of the state of Utah procurement system. The project was awarded within the scheduled 2 $\frac{1}{2}$ months. This included the two education sessions (total of 3 $\frac{1}{2}$ days), data collection, management plan reviews and interviews, and the prioritization based on all the information. It also included the review of two protests on issues that did not address the PIPS.
2. Have performing contractors who do not usually bid state of Utah work bid on the project. Two of the five contractors did not usually bid state work due to the low-bid environment.
3. Select an innovative contractor with a clear plan of success. The successful contractor was well within budget, had excellent personnel, and had a plan to meet the user's needs by creative contracting. The contractor addressed the landscaping and framing by using innovative scheduling and prefabrication.
4. Have the construction finished on time and on budget (minimize contractor-generated change orders). All change orders were owner-directed scope changes and time acceleration. The contractor, with the aid of one of the subconsultants,

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Table 4. Delivery System Performance Results

Results	Low bid	Design/build	Performance based
Days added to schedule (%)	234	332	105
Actual days added until substantial completion	279	184	105
Percent change in scope	12.9	19.4	8.9
Percent change in unknown events	1.3	0.8	0.9
Percent change in error	2.4	4.8	1.3
Percent change in omissions	1.5	0.8	1.6

finished the village center ($11 million) in 11 months and opened the center on schedule. The entire project was finished according to the contractor's plan.

5. Rate the contractor on the work. The project manager rated the contractor.
6. Have a satisfied owner and facility manager. Both the facility manager and the DFCM project manager were satisfied with the contractor's performance.
7. Minimize the chances of nonperforming contractors getting the award. Of the five contractors who submitted bids, one of the contractors was already working on the site and having a difficult time meeting the schedule. This contractor was having the following problems on other state jobs:
   - Maintaining the construction site superintendents;
   - Finishing on time;
   - Finishing the projects for the bid amount without change orders; and
   - Paying of subcontractors.

   This contractor finished last on the performance rating. The contractor attempted to bid another PIPS job, but while eligible, had a difficult time competing on performance.
8. Have the state of Utah run the system again with the participation of top contractors. The state of Utah ran five more construction projects using the PIPS. The jobs are all on schedule and on budget and have satisfied construction project managers and end users.

Comparison of Contractors

The PIPS met all eight performance requirements. The next analysis is to compare the results of the PIPS contractor with the Phase I low-bid and design/build contractors (Tables 4 and 5). No two phases or portions of the Housing project were the same. The constants were the university environment, the same master planner designer, and the same facility management group. When compared with the other two, the PIPS contractor

1. Had the smallest change in schedule;
2. Finished the earliest in respect to the schedule;
3. Had the smallest change in scope (additional cost); and
4. Had the smallest charge for errors and omissions.

Table 5. Contractor Comparison

Factor	Low bid (%)	Design/build (%)	Performance based (%)
Change in scope	12.9	19.4	8.9
Change in unknown events	1.3	0.8	0.9
Change in errors	2.4	4.8	1.3
Change in omissions	1.5	0.8	1.6
Subtotal	18.2	25.8	12.6
Original contract	81.8	74.2	87.4
Adjusted Total	100.0	100.0	100.0

Table 6. Project Manager Evaluation of Performance

Number	Criteria	Unit	Weight
1	Is project currently running on schedule?	Yes/No	Yes
2	Is project currently running on budget?	Yes/No	Yes
3	How many contractor-caused change orders have been issued?	(Number)	0
4	Please rate your overall satisfaction with contractor.	(1–10)	9

Facility Management Rating

The facility manager rated the contractor as shown in Table 6. The purpose of this rating is to motivate the contractor to perform to a higher level the next time they are awarded a contract. It is recommended to give the contractors at least a ''9'' and possibly higher if the project was on time and on budget with acceptable quality. If it is not, a lower rating should be given. Ratings do not have to be in whole numbers. Table 6 shows the facility management and DFCM construction management scores. The user and facility management program director were very satisfied with the contractor's services.

Conclusions of Performance Information Procurement System Implementation

Using the analysis outlined in the previous section, the following conclusions can be made:

1. The state received value ($48 million). The difference from the most informed contractor was a savings of $5 million–$7 million on the project. The upgraded Village Center ($5 million) and the time acceleration ($2 million) cannot be attributed to the contractor. The government estimate of $53 million and the price of $55 million of the best-rated performer were an accurate measure of the project costs.
2. The contractor was delayed for a minimum of 3 months due to delays in Phase I and design delays.
3. The bid was awarded to the contractor with the best site personnel and project management.
4. The contractor's performance was predictable.
5. The PIPS minimizes the problems of construction.
6. There were no contractor-generated change orders (owner identified).
7. The contractor finished the project on time despite not having the completed drawings.
8. The DFCM project manager was very satisfied with the contractor's performance.
9. Change of scope, change orders, and time extensions were lower than the Phase I design/build or low-bid contracts.
10. The PIPS philosophy forced the general contractors to look at the performance of the subcontractors.

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11. Contractors who may be successful under the low-bid system, but who have problems completing jobs on time and within budget, have very little chance of being successful on a PIPS-procured job. The lowest-rated contractor who bid was having numerous problems with the state of Utah in finishing on time and within budget (minimizing change orders) and in maintaining its on-site management staff and has had problems with payments to subcontractors.
12. The designer plays an important role in the construction project. If the designer is not selected based on performance, an information system to motivate the designer to act in a responsible manner is required.

Recommendations

The following lessons were learned from the implementation:

1. Contractors need to be educated on the differences between legal requirements and PIPS requirements;
2. Critical subcontractors should have an index number that is very easy to understand;
3. Contractors need to understand that it is important for the industry to have a procurement system that requires the contractors to use information, to continuously improve, and to be responsible for their work;
4. An information interface that is posted on the Internet is required to quickly identify participants who are not passing on information. Information stops the bureaucratic process from pointing fingers when something goes wrong;
5. The PIPS process step of having a partnering and preaward meeting before the award is critical to get the project started in a timely manner; and
6. A PIPS contract should be written to include the specifications and drawings, management plan, interview minutes, and preaward meeting minutes.

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