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Motivating Contractor Performance Improvement through Measurement

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Abstract
In construction, motivating systematic change and improvement is a task often met with frustration. Benefits of proposed systematic change are often hard to define, measure, and "sell" to those parties involved. If implemented, changes commonly fade from an organization's structure and revert to the status quo. Faced with these realities, the director of the United States Army Medical Command, the division responsible for the construction and maintenance of all the hospitals in the US Army, when tasked with improving the performance of construction and facility management, decided not to adjust the system, but instead to measure the comparative performance of the critical system elements. Through the capturing and distribution of performance information, a nature competition and self-assessment ensued. Contractors, motivated by their comparative standing in relation to each other, strove to improve each performance measurement. The relative rise in efficiency has resulted in contractors seeking additional education in performance methodologies and the creation of an elite class of general contractors who are constantly rated on their project performance and report to a third party evaluator. This paper presents the research process, program, and results tracking the implementation of performance measurements, comparative analysis, and contractor responses in the US Medical Command.

Keywords
Efficiency, Contractor Performance, Measurement, Customer Satisfaction

1. Introduction

Throughout the past decades, the construction industry has designed and developed alternative delivery methods to overcome the negative effects commonly associated with the price based environment (AGC 2006, CII 2006, Post 1998). These methods have been aimed at identifying the best value vendor (highest performance in relationship to allotted resources) and creating contracts that transfer the project risk from the owner to the vendor, in order to create a high quality product. As with any change, relocating the system's focus from price to value has not been easy. In analyzing several alternative methods, it was found that one prevalent problem in sustaining a value driven system was the owner's inclination to revert to price based tendencies, methods, and characteristics (Gransberg et al. 2004, Kashiwagi 2004, Molenaar et al. 2003). While the alternative structures were designed to provide a process that drove quality performance from the vendors, the owner's program was unable to support the system over a long period of time. As a result, the benefits of the value based system were unrealized.

It is proposed that the difficulty in successfully integrating a value based vendor procurement system into an organization stems from the differences and contradictions within the owner's environment. As the alternative delivery system seeks to change the product of the price based system, a change in the vendor's paradigm is not enough to redirect the results. Joshua Hammond, president of the American Quality Foundation, stated, "If quality is going to have a payoff, it's got to be a routine part of the way you do business." Likewise, if a system is designed to produce high quality and high performing work, everyone involved in the system, both owner and vendor representatives, will need to function and work in an environment that supports characteristics of quality, performance, and value. In the current price based environment, this will require a cultural change not only from the contractor, but more importantly the owner. It is also proposed that if the owner is capable of transitioning from a price based to value based culture, due to the industry's robustness and high level of competition, the performing contractors will follow through the transition as well.

In order to test this hypothesis, a literature review will be performed in order to first identify the characteristics of a value based environment. A case study will then be addressed that details the testing of the hypothesis in the United States Army Medical Command (MEDCOM) division, a division of the US Army responsible for the maintenance, repair, and modifications to medical facilities. Finally, conclusions, observations, and areas for future research will be discussed.

2. Characteristics of Value Based Systems

Research in regards to performance, value, and measurement has blossomed over the past 30 years (Bassioni et al. 2004). As a result, the construction industry has attempted to absorb this wealth of knowledge. Due to the unique and volatile nature of the work, the industry has been unsuccessful at agreeing on a standard for tracking, comparing, and incorporating the relative value of projects into construction procurement and delivery. Although there are several theories and assertions, the researchers found no existing value based system that had been extensively tested and documented over time. For this purpose, the research from the business industry will be drawn upon to identify the characteristics of a value based system.

The best value practices taught by twelve noted leadership experts in the business industry were examined and compared to the current practices in the price based construction industry. The experts analyzed were (in alphabetical order) Buckingham and Clifton (1999), Covey (2003), De Brabandere (2005), Deming (1982), George (2003), Gladwell (2005), Kouze and Posner (2002), Maxwell (1998), Peters and Waterman (1982), Senge (1990), Welch (2001), and Womack and Jones (1996). From these experts, five directives were identified that contradicted the current construction environment:

1. Minimize project management and inspection; force entities to become information workers
2. Minimize design direction and specifications (owner decision making)
3. Minimize over-communicating/the transfer of an excess amount of information
4. Transfer risk and accountability (outsource), requiring contractor Quality Control
5. Measure status through performance information; encourage competition and self-assessment

It was found that an average of 73 percent of the five business practices were addressed in each of the books regarding the efficiency of an organizational system. This inferred a strong likelihood of correlation between the five practices, as well as the substantial impact of each individual item to a leadership model of efficiency. These directives became the foundation of the characteristics needed to transform a managerial model to a value model based on leadership, measurement, accountability, and performance.

Many of the business experts addressed their best value directives to leaders of an organization. Traditional leadership models rely upon a unique leader, or person, that can drive change and

improvement through an organization. Collins (2001) defines this as a "Level 5 Leader," an individual capable of efficiently aligning resources and setting the vision and organizational roadmap that will lead the organization through change. However, Collins also observes that people of this caliber are scarce and often difficult to find. In response, the authors propose that the concepts of Deming and other researchers be applied to create a process structure or organizational framework that cultivates and drives efficiency, instead of depending upon a traditional leadership figure. This system would allow an organization to realize the benefits of a traditional leader without the presence of a traditional leader. These five directives were the foundation of the tools designed to create the best value environment described in the following case study.

3. US Army Medical Command (MEDCOM)

The US Army Medical Command (MEDCOM) is the division of the US Army responsible for the maintenance, repair, and modifications to medical facilities across the United States. The MEDCOM uses the Corps of Engineers (COE) contracting/procurement offices to deliver approximately $100M of construction per year (maintenance, repair, and modification). This is done through a delivery system called Indefinite Delivery, Indefinite Quantity (IDIQ). IDIQ is a system that pre-qualifies contractors before allowing them to compete for individual task orders. The advantage of the IDIQ delivery system is the time savings. Competing IDIQ contractors is far easier and involves a shorter time period than attempting to get a multitude of jobs through the traditional design-bid-build process (FAR 1997). The contractors can be selected by low price or the COE's best value process which is heavily influenced by price. However, despite the flexibility the IDIQ system provided and the COE's attempts to produce best value results, the MEDCOM division was still unable to satisfy the demands to the division.

The director of MEDCOM identified the current construction procurement process as inefficient. There were constant emergencies to handle, low contractor performance (finishing projects on time, on budget, and with owner satisfaction), an inability to keep up with the construction demand, a lack of definable roles of accountability, and constant passing of reports, with little recognizable use or substance. There was no existing system or ability to measure the performance information of the division, or each procurement agent, site personnel, IDIQ contractor, or subcontractor.

The MEDCOM was introduced to the Performance Information Procurement System (PIPS) research, a best value approach to construction procurement, supported by the Performance Based Studies Research Group (PBSRG) at Arizona State University (ASU). The MEDCOM saw that the research provided results that supported the idea that theoretical concepts, processes, and structures based on leadership principles (accountability, alignment, performance measurement, and value-based), rather than management principles (control, direction, no performance measurements, and price-based), would optimize the delivery of construction (Kashiwagi et al. 2006) as well as the documented bureaucracy of the Corps of Engineers (COE) (Antonovich 1997, Putten 1999). MEDCOM noted the testing results of the Best Value PIPS system over a 12 year period, and the validity they added to the research theory. Results included (www.pbsrg.com) 440 tests on $480M of construction, 98% performance (on time, on budget, meeting client's expectations), zero contractor generated cost change orders on 98 percent of the projects, construction management decline by as much as 80 to 90 percent, and contractors profit increase from 5 to 20 percent and minimized fiscal risk on 100 percent of the projects

The COE decided there were too many changes and believed that some of the changes were not legally allowed (this is a point of disagreement between several COE agencies). Some of the changes/ misunderstandings included that the COE will be mentioned. First, the COE was under the misunderstanding that the process was proprietary and that Arizona State University (ASU) would be running their procurement. It is illegal for the COE to outsource its procurement (FAR 2002). Second, the COE also felt that non-COE personnel could not be on the selection team. Next, the Army Federal Acquisition Regulation (AFAR) would not permit the use of weights and numbers in a best value

selection (FAR 2002). Forth, the pre-award phase where the best value contractor creates their quality control (QC) plan, quality assurance (QA) checklist, and schedule, was not allowed by the Federal Acquisition Regulation (FAR), due to the requirement to have discussions with all the offerors before the award of the contract (FAR 2002). Lastly, the COE did not feel comfortable changing the existing COE quality management plan which served as verification of the technical requirements, to the Best Value/PIPS quality management plan that focused on minimize risk that the contractor did not control. The above points of resistance were either misunderstandings or items that could easily be adapted to ensure regulation compliance. The bureaucracy of the system overrode the PIPS results, as well as the ability to affect division goals, efficiency level, and performance.

4. Achieving Best Value Results through a Best Value Environment

The Director of the MEDCOM division realized that the cultural change required to implement Best Value/PIPS in the COE was too drastic, and he proposed to obtain higher performance results another way. With offshore assistance from the Performance Based Studies Research Group, a research division at Arizona State University, the Director of MEDCOM proposed to overcome the COE's resistance to change and policies by using the theoretical concepts of a best value environment as a component of the technical requirements/specifications of the IDIQ contract that the COE would award to the IDIQ contractor. The Director proposed that the best value environment and an information environment as presented by Kashiwagi (2004), were the same, and therefore was specifiable. In other words, the Director of MEDCOM proposed that instead of forcing the COE to change its Best Value procurement process to procure services from higher performing IDIQ contractors (by definition: efficient, experienced, capable of being on time, minimize risk and change orders, and meet the client's expectations), that the best value practices/information environment could be created within the system through control minimization tools and measurement tools designed to motivate best value. The tools used to support the best value environment would force contractors who won the COE awards to comply with the best value practices of a high performing contractor. This hypothesis makes one of the following assumptions:

1. A lower performing contractor can become a high performer by using a best value/information structure; or
2. A contractor who competes on a specification that requires them to report the delivering of construction through a best value/information environment structure will educate/train their personnel to act in a manner to deliver performing results; or
3. An information environment forces accountability regardless of the selection process.

5. Creating a Best Value Environment

The Director of MEDCOM requested that the Performance Based Studies Research Group at Arizona State University set up an information environment in the IDIQ contract where performance metrics of all parties (owner and contractor) would be constantly measured. The goal was to create a best value information environment, embed within the technical specifications like a Trojan horse within the COE bureaucracy, and then to measure the results. Through measurement, accountability would be realized and the information environment would in essence encourage the contractors to improve and perform. The environment would make every participant accountable as all would be measured (contractors, MEDCOM personnel, COE personnel, etc.). Performance based specifications have been proposed before (FAR 1997); however, simultaneously using specifications with minimum standards, best value concepts, and an information environment, is a new contribution to the delivery of construction. The MEDCOM decided to incorporate the following into their specifications:

1. Checklists that forced the use of preplanning and a quality control plan that minimized the risk that the contractor did not control. These checklists applied to both the design stage (work plan) and the construction stage.
2. The use of a quality control plan (focused on risk identification and minimization), a quality assurance checklist, a schedule, and a weekly reporting system tracking the risk that the contractor did not control.

The MEDCOM then used the information system to compile multiple weekly risk reports and develop current performance barcodes or measurements for the entities involved. Performance measurements were computed for the contractors, as well as the COE project managers, the MEDCOM project integrators, and the procurement offices.
The key component of the best value environment uses the concept from the Information Measurement Theory (IMT) asserting that an individual who is experienced and understands the system can (Kashiwagi 2004):

1. Identify what they are responsible, and what others are responsible for.
2. Understand that the greatest risk comes from parties who they have no control over.
3. Understand that while an individual can only control themselves, they must understand the role of others in order to minimize risk through simple coordination/ communication.
4. Act as a team player and facilitates a "win-win" with those they work with.
5. Minimize risk that they do not control.

There are four key components to the information system. First, the contractor is asked to separate the risks they control from those that they do not by identifying the latter. The contractor is then told that whatever is not on the QC plan (risks that they do not control), is risk that they do control (except for unforeseen risks). The contractor is then directed to identify how they will minimize the concerns or risks. The authors are making the assumption that it is much easier to have the contractor identify risks to the project that they do not control, than it is to identify all the risks that the contractor does control. It also transfers the risk to the contractor by having the contractor identify the risks. The authors are also assuming that a non-experienced contractor cannot as efficiently identify the risks that they are not responsible for. This is because (Figure 1: Experienced vs. Non-experienced Sphere of Perception):

1. Experienced contractors know the roles and impact of different participants.
2. Inexperienced contractors are reactive, and only know their risk in terms of what they are supposed to do.
3. Experienced contractors do not need to be managed and directed.

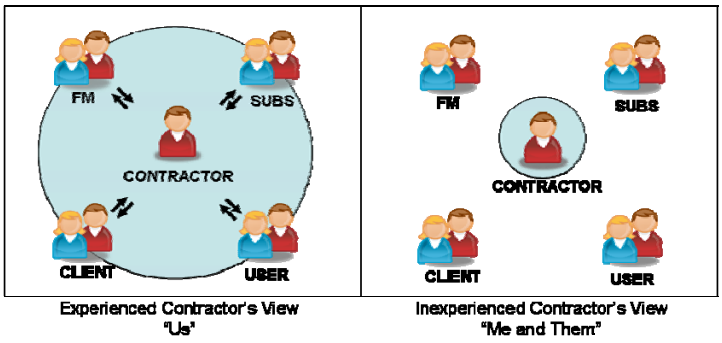

Figure 1: Experienced vs. Non-experienced "Sphere of Perception"

The second key component is to make it a requirement that the vendor/contractor minimizes risk that they do not control. If they execute their risk minimization steps, and are not able to minimize the risk, the

risk will be placed on the weekly report which identifies four items. Why the contractor was not able to minimize the risk, what or who is the source of the risk, what needs to be done by the source of the risk to minimize the risk, and what the impact to the project will be in terms of time, cost, and expectation. The third concept is that it is by contract, and in the best interest of the contractor, to report the risk on the weekly report (Figure 2.1 – 2.4 : Information Environment). The QC plan, QA checklist, and weekly report protect the contractor. All documents identify the risks that the contractor does not control and, by definition, protects the performing contractor. The contractor will not be held responsible for risks identified as out of their control. The weekly risk report is sent to the COE PM, but also is directly inserted into a system that compiles the information from all MEDCOM projects into a Director's Report which identifies: 1) The top ten projects that bring the greatest risk, 2) Relative performance numbers of the contractors and client representatives involved, 3) Identification of the relative performance of the contractors' critical personnel and subcontractors, and 4) Performance of the client's organization in delivering construction services.

The fourth concept is that the contractor is rated on the finished project, and that rating becomes 50% of their future performance rating. All key individuals on the project and critical subcontractors also receive the same rating.

6. Preliminary Test Results

The MEDCOM performance before the test was run included:

1. A problem a day floated up through the bureaucracy and was presented to the MEDCOM construction manager.
2. Fifty percent of the projects are on time, and on budget.
3. Contractors on 80 percent of the projects do not preplan and minimize risk.
4. None of the contractors had a QC plan that protected themselves and the clients.
5. Twenty five percent of the projects are delayed and the reason is unclear.
6. None of the contractors had their own QC plan, QA checklists, and weekly risk report.
7. No contractors came to the annual training at ASU seeking education.

The information environment was initially pilot tested on six projects and within eight months it was expanded to encompass 87 projects. In the past year it has been implemented on all projects with a budget value greater than $300,000 (USD), which, is at the time of publication, a total of 189 projects with a construction value of over $289,000,000 (USD). In summary, the current estimate of the number of projects with performance issues is 15 (out of 189) or eight percent. Out of the projects with performance issues, only 5 (2.6% of total) are due to the contractor. Other results include:

1. 99% of projects currently on budget (no contractor changes to budget)
2. Average contractor budget increase is .03%
3. 95% of projects currently on time (no contractor changes to schedule)
4. 9.8 owner satisfaction on completed projects (1-10 scoring, 10 being the highest)

Figure 2 displays the results of the Information Environment. Figure 2.1 shows the overall output of the construction delivery. Figure 2.2 shows the overview of a project showing client and contractor generated risks. Figure 2.3 shows the top ten risk projects. Figure 2.4 shows the differential of the contractor performance. However, any entity's performance who is involved in the project can be compared (COE, PM, PI, etc.). Once the project is finished, the project is rated and modifies the new contractor performance line.

There has been a change in attitude of the contractors. In the first year when the contractors were exposed to the process, none of the contractors expressed an interest in an education of the process or running the

process except through forced tests. The second year, four of the six contractors invested in further education of the process. In the third year, three contractors invested heavily into education of their personnel. All six contractors spent additional time with MEDCOM personnel learning about the system. All six contractors are attending the annual education/training at Arizona State University at their own expense. One of the contractors is bringing other clients to the training, encouraging them to use the Best Value approach. All contractors are sending in the weekly reports which generated the performance/ risk information.

DIVISION OVERVIEW	11/03/06
Total Awarded Budget	$172,751,944.23
Current Cost	$174,484,794.47
Over Budget	$1,732,850.24
PROJECT OVERVIEW	
Total Number of Projects	116
% Projects On Time	85%
# of Jobs Delayed	17
% Projects On Budget	86%
# of Jobs Over Awarded Budget	16
# of Projects Missing Owner Ratings	0
AVERAGE PROJECT	
Project Budget	$ 1,489,240.90
# of Risks per Job	3.14
Owner Generated Risks	1.66
Number of overdue risks	0.25
% Over Awarded Budget	3.39%
% over budget due to owner	3.23%
# of Days Delayed	8.76
# of days delayed due to owner	7.62
Owner Rating	9.17
Risk Number	2.42

2.1 Overall organization performance

UNFORESEEN (UF) & OWNER (O) RISK	
# UF Risks affecting budget/schedule	0
Days Delayed (Calendar)	0
Additional Cost	$ -
# O. Risks affecting budget/schedule	1
Days Delayed (Calendar)	0
Additional Cost	$ 2,000.00
**Above risks include both potential and resolved **	
CONTRACTOR RISK	
# of Unaddressed/Overdue Risks	1
# Unrated Risks	0
# Risks affecting budget/schedule	2
Risk to Schedule (calendar days)	15
Risk to Cost	$ 1,000.00
Contractor Satisfaction Rating	**10.0**
**Above risks include both potential and resolved **	
OVERALL CURRENT STATUS	
Days Delayed (Calendar days)	5
% Delayed	0.8%
Contractor % Delayed	0.8%
Additional Cost	$ 2,000.00
% Over Award	9.2%
Contractor % Over Award	0.0%
Project Satisfaction Rating	**10.0**
Risk Number	**1.16**
**Above Schedule and Budget additions include only resolved risks **	

2.2 Individual project performance

TOP 10 RISK RANKING PROJECTS		
No.	**Project**	**Risk #**
1	Design for Two HVAC(s) & Windows	52.94
2	Tpe III WP	17.71
3	WP Replace C Tower HVAC Sys	13.61
4	Rpr/Rpl Elec Distr Sys	11.91
5	Renew Troop Medical Clinic	11.07
6	Fire Damage Repair	10.51
7	Construct Hyperbaric Chamber	10.50
8	Fault Current & Over Dev CS	10.35
9	Convert Warehouse to Admin. Area	10.10
10	WP Fire Protection Upgrade	10.07

2.3 Risk ranking of projects

CONTRACTOR OVERVIEW	Contractor A	Contractor B	Contractor C
Total Awarded Budget	$15,725,858	$52,274,179	$ 2,885,433
Current Cost	$16,480,244	$52,274,179	$ 2,885,433
OVERVIEW OF PROJECTS			
Total Number of Projects	25	18	6
# of Jobs Delayed	4	2	4
# of Jobs Over Awarded Budget	9	0	0
AVERAGE PROJECT			
% Over Awarded Budget	13.93%	0.00%	0.00%
# of Days Delayed	6.84	2.33	9.50
Owner Rating	8.03	8.89	10.00
Risk Number	**4.15**	**2.94**	**2.41**

2.4 Comparing vendor performance

Figure 2.1 – 2.4: Results of an Information Environment

Other preliminary results include:

1. Projects started with the best value environments have had no outstanding issues where the contractor is at fault.
2. The information system has quickly identified that the biggest source of risk is the client and procurement/contracting offices.
3. There have been no disagreements or arguments over who is the source of risk that is identified by the process.
4. Contractors are slowly learning about minimizing risk that they do not control.
5. Meaningful quality control plans have been a challenge.
6. The contractors and users have had a difficult time understanding the connection and use of the QC plan, QA checklist, and the weekly report.

7. Conclusion

The authors proposed that an information environment can be directed into the technical specifications and force best value practices. This hypothesis is dependent on the contractor using a QC plan that minimizes risk that they do not control. The use of the QC plan, QA checklist, weekly risk report, and information environment director's report, all of which are documented by the contractors, has provided MEDCOM with an accurate performance history of construction projects on a weekly basis. Preliminary results indicate that the more efficient environment has maximized the profit of the contractors (Welker 2007). Most of the projects are still in the design phase, and construction results will be forthcoming.

8. References

AGC (2005/2006) Associated General Contractors of America. Accessed on March 7, 2007, at http://www.agc.org/index.ww.

Antonovich, M D (1997) A Bureaucratic 'Rain' of Terror. *National Wildlife Magazine*, Accessed on January 1, 2007, at http://antonovich.co.la.ca.us/pressrel/2/pasgop.htm.

Bassioni, H.A., Price, A.D.F., and Hassan, T.M. (2004) Performance Measurement in Construction. Journal of Management in Engineering, ASCE; 20:2(42).

Buckingham, Marcus and Coffman, Curt (1999) First, Break All The Rules, Simon & Schuster, NY.

CII (2005/2006) Construction Industry Institute. Accessed on March 7, 2007, at http://www.construction-institute.org/scriptcontent/Index.cfm.

Collins, Jim. (2001). Good to Great. HarperCollins Publishing Incorporate. New York, New York.

Covey, Stephen R. (2003). Principle-Centered Leadership. New York, New York: First Free Press.

De Brabandere, Luc (2005). The Forgotten Half of Change. Chicago, Illinois: Dearborn Trade Publishing.

Deming, Edwards W (1982) Out of the Crisis. Massachusetts: Massachusetts Institute of Technology.

Federal Acquisition Regulations (FAR) (1997) Best Practices for Multiple Award Task and Delivery Order Contracting, Interim Edition. Accessed on January 1, 2007, at http://www.whitehouse.gov/omb/procurement/interagency_acq/best_practices_multiple_award_task_contracting.html

Federal Acquisition Regulations (FAR) (2002) 15.306(d)(1), 15.306(e)(1), 37.204, and 15115.304, Accessed on January 1, 2007, at URL: http://www.arnet.gov/far/

George, Michael L. (2003). Lean Six Sigma for Service. NY, NY: McGraw-Hill Co.

Gransberg, D. and Molenaar, K. (2004) Analysis of Owner's Design and Construction Quality Management Approaches in Design/Build Projects. Journal of Management in Engineering, ASCE, 20:4(162).

Gladwell, Malcolm (2005). Blink. New York, NY: Time Warner Book Group.

Kashiwagi, DT (2004) Best Value Procurement. Arizona State University, Tempe, AZ.

Kashiwagi, DT, Sullivan, K, Kashiwagi, M, Chong, N, Pauli, M (2006) Reduced Information Flow Maximizes Construction Performance. *International Conference in the Built Environment in the 21st Century (ICIBE 2006)*, Kuala Lumpur, Malaysia, (June 13-15, 2006).

Kouzes, J. and Posner, J. (2002) Leadership Challenge. San Francisco, CA: John Wiley and Sons, Inc.

Maxwell, John C. (1998). 21 Irrefutable Laws of Leadership. Nashville, Tennessee: Thomas Nelson, Inc.

Molenaar, K. and Johnson, D. (2003) Engineering the Procurement Phase to Achieve Best Value. Leadership and Management in Engineering, July 2003, p137.

Peters, T. and Waterman, R. (1982) In Search of Excellence. New York, NY: Harper & Row Publishers.

Post, N.M. (1998). Building Teams Get High Marks. Engineering News Record, 240 [19], pg. 32-39.

Putten, M V (1999) National Wildlife Introduction. *National Wildlife Magazine*, Feb/Mar, 37(2).

Senge, Peter M. (1990). The Fifth Discipline. New York, NY: Currency Doubleday.

Welch, Jack. (2001). Straight from the Gut. New York NY: Warner Books, Inc.

Welker, Rob (2007) Performance Based General Contractor, Best Value / Leadership Conference Presentation, Arizona State University, Chandler, Arizona.

Womack, James and Jones, Daniel. (1996) Lean Thinking. New York, NY: Simon and Schuster