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"Root of all evils" misunderstanding of construction industry structure

D.T. Kashiwagi
Arizona State University, Tempe, Arizona, USA

ABSTRACT: In tough economic times, the construction industry participants seek for efficiency, value, "win-win," low cost, maximized profit, and best value. In tough economic times, the problems of the industry are magnified, as construction services are commoditized. Analysis of the Construction Industry Structure (CIS) shows that a stable construction industry should maximize value, vendor profit, quality and performance, while minimizing cost and risk. PBSRG has been testing out the CIS concepts for 15 years on over 600 tests ($650 M of construction services) with dominant results: 98% on time, on budget, and meeting client expectations, minimizing up to 90% of client risk/project management functions. Movement from the low bid award environment to a best value environment will lower costs and increase profits. The answer lies in the transfer of risk and accountability to the industry participants who have the expertise to minimize risk (and not pass risk.)

1 INTRODUCTION

Construction industry performance has suffered issues with performance and capability for the past ten years (Lepatner 2007; CFMA 2006; Simonson 2006; Flores & Chase 2005; Adrian 2001). Academic research has had minimal impact in assisting the construction industry (Kashiwagi et al. 2008; Adeyemi et al. 2009):

1. Academic research is funded by government agencies that are bureaucratic and not accountable for results.
2. The cycle of research development is too long for results to be tested, modified, and implemented.
3. Industry does not run hypothesis testing with academic researchers.
4. Research is done by graduate students who continually change. There is no corporate knowledge that stops the reproduction of the same concepts. Many of the studies propose solutions that are never tested, are too complicated to be tested, and regenerated five years later.
5. Research effort durations and funding levels are not enough to have repeated hypothesis testing.

The construction industry and the academic research community have been reactive in nature. The method of research depends heavily on literature search and survey of industry participants. This mode of research forces the continuation of the existing status quo. Without actual tests and test results (customer satisfaction/expectation, on time, and change order rates), decision making by industry experts will maintain the status quo. Deming (1982) stated that two important ingredients of progressive thought were "theory" and deductive logic concepts. If problems continue over time despite a continual effort to improve, the system may be stable, and the only way to increase production is to overhaul the entire system structure. Deming (1982, p. 317) states that:

'We rely on our experience.' The answer is self-incriminating: it is a guarantee that this company will continue to pile up about the same amount of trouble as in the past. Why should it change? Experience without theory teaches nothing. In fact, experience cannot even be recorded unless there is some theory, however crude, that leads to a hypothesis and a system by which to catalog observations. Sometimes, only a hunch, right or wrong, is sufficient theory to lead to useful observation."

The industry has tried to improve the construction performance by using different delivery systems (Gransberg & Windel 2008; Lam et al. 2004; Kashiwagi et al. 2002):

1. Design-build (DB.)
2. Construction Management @ Risk (CM@Risk)
3. Indefinite Delivery Indefinite Quantity (IDIQ.)
4. Public Private Partnerships (PPP.)

Deductive logic or common sense proposes the construction industry nonperformance as a systems problem instead of an individual's or participant's nonperformance (Sullivan et al. 2009). Directed solutions toward industry participants will not solve a systems issue. For example, if the contractor's cannot manage themselves, putting a construction manager over the contractor is not a solution. If the contractor is forced to submit the lowest possible bid using the lowest priced subcontractors and materials, tighter inspection will not raise the level of performance. Management, direction, control, and inspection will not increase a vendor's performance (Deming 1982; Goldratt 1980).

A stable system's production cannot be increased by management and control. The entire system must be changed to increase production.

2 PROBLEM

The construction industry and construction management academic research groups have not been able to improve construction industry performance, nor assisted the industry to increase their technical expertise/craftsperson skill level, nor explain why the construction industry performance is continually low and problematic. The construction industry is one of the few industries that have the same problem as twenty years ago, and whose industry productivity has fallen in the last few years (Adrian 2001).

3 HYPOTHESIS

The construction industry performance is a system's problem. Deductive logic and dominant concepts will replace literature search and industry perceptions and be used to confirm the system's problem, and a systems solution will be created to correct the problem. The academic research community has actually increased the problem by using concepts such as management, technical solutions, and delivery systems that are unenforceable and are not consistent with the goals of efficiency, minimization of risk, dominant measurements and accountability.

4 CONSTRUCTION INDUSTRY STRUCTURE

The Construction Industry Structure (CIS) (Fig. 1) (Kashiwagi 2009) defines the construction or any industry based on performance and competition.

Due to the worldwide competitive environment, buyers of design and construction services have moved to the right hand side (Quadrant I—Price Based Award and Quadrant II—Value Based or Best Value). The price based system has the following characteristics (Goodridge et al. 2007):

1. The client's representative directs through specifications and controls and inspects the contractor's work for compliance to minimum standards.
2. There is no transfer of control and accountability to vendors/contractors.
3. The client's specification's minimum standards are turned to maximums due to the price based environment and driven downward by vendors (Fig. 2).
4. Contractors who are short on experience, reactive, and only do what they are directed, be-come more competitive because they can give a lower initial price, but increase the prices when the deviations are identified. Low performing contractors are far more likely to submit deviations due to a lack of perception, incomplete directions from the owner, unforeseen events which are normally identified and handled by the high performance contractors, but unknown to the inexperienced contractor.
5. Contractors who manage and minimize risk and who are the better value when considering total or actual project cost, become noncompetitive because they do not fully utilize the change order or deviation system (Fig. 3). The logic model here forces the vendors to not think of the client, to degrade performance, and to create profit from the lowering of quality and increasing of risk.

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Figure 1. Construction industry structure.
Source: (Kashiwagi 2009).

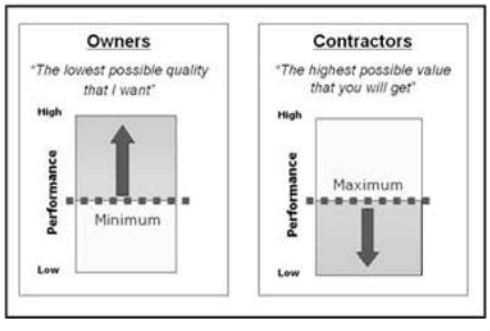

Figure 2. Minimum/Maximum dilemma.
Source (Goodridge et al. 2007).

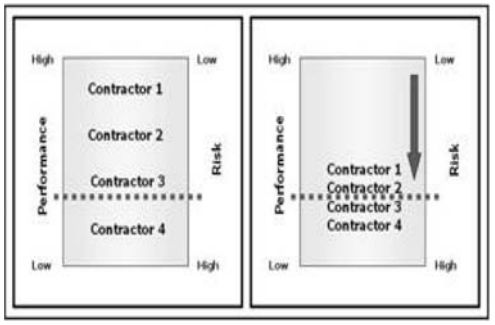

Figure 3. Price based award.
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The characteristics of the price based, specification driven, management, direction, and controlled environment include (Kashiwagi et al. 2004; Kashiwagi et al. 2002):

1. Subcontractors' prices are shopped.
2. Manufacturers continually lower quality.
3. Standards are subjective.
4. No performance measurements.
5. Social relationships are important.
6. Prices are meaningless due to no connection to performance.
7. Inefficient.
8. Incentives used.
9. No accountability.
10. No transfer of risk and control to vendor.
11. Increased transactions.
12. Increased management positions.
13. Increased inspections.
14. Detailed specifications.
15. Increased flow of information.
16. Contract and procurement officer become more important.
17. Reactive as contractors submit bids at the last minute.

In the best value environment, risk is transferred to the high performance vendor (who minimizes the risk.) The only vendor personnel who can reasonably accept the risk are the experienced, high performing individual(s) who have expertise and can minimize the risk. Low performing vendors and individuals bring both the vendor and the buyer risk and need to be managed, directed, and controlled by the client (Sullivan et al. 2005). They are never the best value.

5 BEST VALUE ENVIRONMENT

In the best value or value based environment, designers and contractors must do the following to be awarded work (Fig. 4) (Kashiwagi et al. 2006):

1. Show that they are the best value. Compete based on past performance of the company and key contractor components including project manager and site superintendent and critical sub-contractors, or lead architect, project manager, and critical sub-consultants/engineers.
2. Know what has to be done. Quantify the scope of work and the risk that they do not control that is not in the scope of the project and have a plan to manage and minimize the risk through preplanning and clear communications with the client.
3. Be able to communicate. Interview of their key personnel to identify if they can predict and create a baseline of the project from beginning to end, if they can manage and minimize the risk that they do not control, if they can preplan and be accountable, and

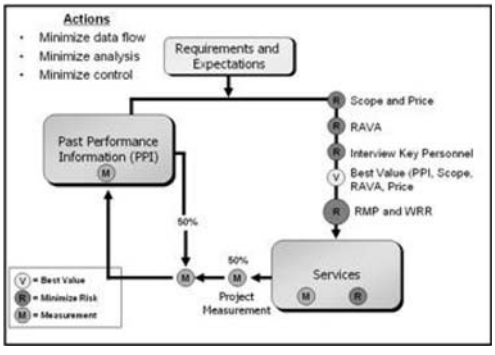

Figure 4. Best value requirements for selection.
Source: (Kashiwagi 2009).

to identify if they have the expertise to manage the project.

4. Fair price. The price is determined by the professional/vendor, and it must be competitive. If the value of the different proposers cannot be identified, the low price proposer will be awarded the project. There is not a client party to double check and assist the proposer, on their price and baseline plan. Professionals/Vendors must accept accountability and liability for submitting a correct price.

The best value professional/vendor is then required to have a baseline plan based on time and cost, to have a weekly risk report (WRR) and risk management plan (RMP) to manage and minimize all concerns and risks that they do not control before the project begins and track deviation of time and cost during execution of the contract, justifying and validating every deviation (Pauli et al. 2007). The designer and/or contractor and all their key components will then be rated on their performance, and that rating will become 50% of their future performance rating that will be a large factor on their ability to get future work with the client.

Figure 5 shows a vendor's business perspective of why best value environments motivate vendors to use highly trained personnel who can manage and minimize risk. Vendors respond to three types of owners: owners who transfer risk and control of projects to expert vendors, owners who partner with the vendors and share the risk, and the price based owner who directs, manages, and hires only the vendor who is the lowest price (assuming that all vendors are the same) (Sullivan et al. 2005). Vendors usually have high performers (who they must pay the highest salaries), medium performers, and inexperienced personnel (who earn the lowest salaries, need constant management and direction and are the most inefficient).

The most efficient relationship is between the best value client and the high performing personnel. The vendor can maximize their profit even though the high performance personnel have a higher salary cost.

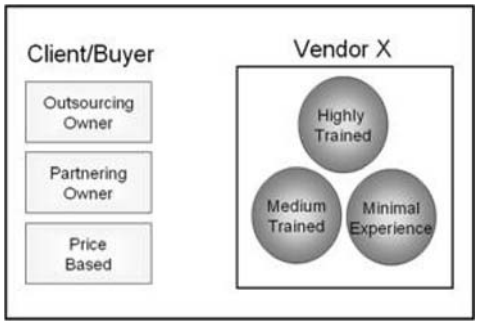

Figure 5. Vendor business model.
Source: (Kashiwagi 2009).

Figure 6. Construction industry structure.
Source: (Kashiwagi 2009).

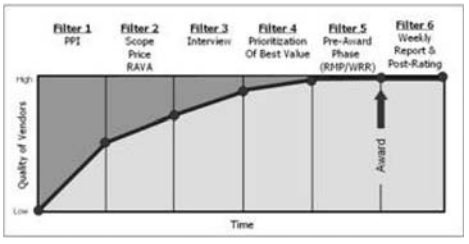

Figure 7. PIPS/PIRMS filters.
Source: (Kashiwagi 2009).

The efficiency and the ability of the high performing personnel to manage and minimize risk to finish on time, minimizing change orders, and doing quality work creates a win-win between the client and vendor (high value, lowest possible cost and maximized profit for the vendor).

However, many clients do not understand this principle as they do not transfer risk and accountability, they maximize their decision making, and they buy based on low price and use the management, direct, control, and inspect approach. The Vendor Business Model (Fig. 7) identifies the client who uses the management, direction, and control approach as the source of the risk of nonperformance. By selecting the price based award with its management, direction, control, and inspection approach, the client has forced the vendor (whose objective is the maximization of profit) to send the most inexperienced personnel to the client. Another drawback of the price based system approach is that there is no motivation of the vendor's personnel to become highly trained, proactive, and quality oriented. This describes the dilemma of the design and construction industry as they attempt to maintain the professionalism of their practices. Their two largest problems are the inability to increase the number of highly trained craftspeople and the turnover of contractors without regard to experience (Angelo 2003; Krizan & Winston 1998; Post 2000; Simonson 2006).

6 PRICE BASED ENVIRONMENT IS A SYSTEM ISSUE

The description of the price based environment matches the design and construction industry performance

previously discussed. The Construction Industry Structure (CIS) (Fig. 1), the Minimum Requirement/ Maximum Value (Fig. 2), the Price Based Contractor Reaction (Fig. 3) and the Vendor Business (Fig. 5), all identify the design and construction price based delivery system as the major source of nonperformance, no accountability, and diminishing industry skill levels. The price based environment is setup and controlled by the client/buyer. The deductive logic shows that the potential solution lies in changing the system from a price based system to a best value system.

7 PIPS/PIRMS

The Performance Information Procurement System/ Performance Information Risk Management System (PIPS/PIRMS) creates a best value environment and is a system solution to the design performance issue. PIPS/PIRMS has the following major phases (Fig. 6):

1. Phase I: Selection of the best value.
2. Phase II: Pre-award/pre-planning, and creation of weekly risk report (WRR) and risk management plan (RMP.)
3. Phase III: Project delivery by risk management.

The process has six major filters if awarded based on performance and price (Fig. 7):

1. Past performance of the vendor, critical personnel (project manager/lead designer), and critical sub-vendors (engineering and professional consultants).
2. Identification of the general scope of the project described in two pages.
3. Risk Assessment/Value Added submittal that identifies the risk that the vendor does not control and that is not in the scope, and how they will minimize that risk, and add value (that is not in the scope as a requirement, and it will a dominant difference between vendors) that makes them different from their competitors.
4. Interview of the critical personnel of the vendor.
5. Prioritization of the best value based on performance (the past performance information, scope rating, RAVA rating, and interview rating and price.)
6. Creation of the WRR and RMP.

7.1 *High performers have minimal technical risk*

A major departure from the traditional practices is the handling of risk. Information Measurement Theory (IMT) identifies that by definition, high performance/expert design firms and their personnel have minimal or no technical risk. The only risk they have is risk that they do not control (risk that is brought by other participants, mainly the client in the form of over-expectations, items outside of the scope, decision making at the wrong time during the process, and the changing of expectations) (Fig. 8). High performers/experts see the project from beginning to end, before they compete for a project, and know the risk that they do not control before they accept the project.

High performance firms (Fig. 9):

1. Minimize risk before they start a project by putting the right expertise on the project who knows how to do the project based on experience.
2. Identify the scope of the project, a baseline schedule, what the project will cost, and the solution of the project before project award.
3. Can also identify what risk that may affect the project due to client over-expectations, client nonperformance, problems caused by other participants (permitting, review bodies, client related individuals) potential unforeseen conditions (defined by the scope and baseline schedule.)
4. High performance vendors maximize their profit by finishing ahead of schedule.
5. High performance vendors are motivated by profit (finishing ahead of schedule and meeting client expectations of time, cost, and quality.)

Figure 8. Inexperienced vs. experienced vendor risk model. Source: (Kashiwagi 2009).

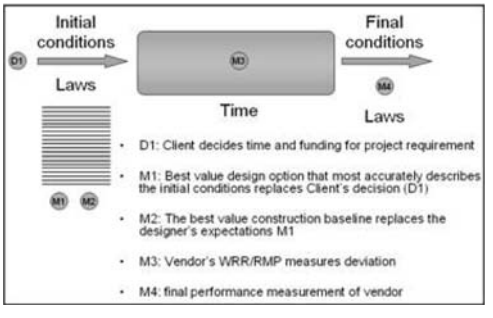

Figure 9. New risk model. Source: (Kashiwagi 2009).

The authors propose that the client's misunderstanding of risk minimization is the biggest risk, and their management, direction, inspection, and decision making approach allows risk to be maximized because it allows non-expert vendors who do not have the expertise in minimizing risk to "seem competitive" and "qualified." As decisions and expectations are made by the client and the designer, they are actually creating risk that will occur as the project unfolds (Fig. 10). Traditionally the clients believe that the difference between their expectations and the actual state is risk and it is the vendor who is creating the risk.

7.2 *Transfer risk and accountability to vendor*

Inexperienced vendors cannot see from beginning to end, are reactive to the client's behavior and needs, and are concerned with technically being qualified to do the project. They do not consider the non-technical risk that they do not control. Procurement processes that use contracts that concentrate on the technical requirements of a project attract vendors and personnel who are inexperienced and reactive (Figs. 7, 10). The PIPS/PIRMS process forces the vendors to identify their relative level of expertise by:

1. Identifying what they think the scope of the project is.
2. Identifying what may be expected that is not in the scope, or what may stop them from completing their project that is not identified in the scope (the risk that they do not control) and propose how they will manage and minimize the uncontrolled risk.
3. Identify what makes them dominantly better than their competition.
4. Having their key individuals interviewed to identify their level of perception, vision, and capability to preplan and create a conservative baseline plan.

The selected best value vendor must then:

1. Propose a milestone schedule, manage and minimize the risk that will deviate from the miles-tone schedule, and force all participating parties who integrate with them, to be accountable for their actions by documenting all deviations to the scope.
2. Preplan and create a baseline plan, and thus have the technical skills to do the design.
3. Quality Control. Review and correct their own work.

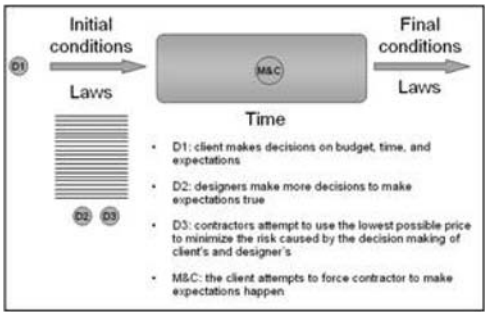

Figure 10. Traditional risk model.
Source: (Kashiwagi 2009).

8 PIPS/PIRMS TEST RESULTS

The best value Performance Information Procurement System (PIPS) and follow-on Performance Information Risk Management System (PIRMS) has been undergoing tests for the past 15 years. The results include (Kashiwagi 2009):

1. Over 600 tests delivering $650 M of design and construction services.
2. 98% performance (on time, no contractor generated cost change orders, and client satisfaction.)
3. Client project/risk management minimized up to 90%.
4. Vendors make 5–15% greater profit.
5. Process has been used successfully by Arizona State University to deliver $1.5 B of non-construction services (IT Networking, Food Services, and other professional services.)
6. Processes used by the U.S. Army Medical Command and has minimized change orders by 68% and time delays by 52%.

The former procurement director and now Associated Vice-President of University Business Services Ray Jensen stated that:

> "I have been successful in the business of procurement and services delivery for the past 30 years. I saw in PIPS/PIRMS, improved solutions of performance/contract administration issues that are so dominant, that I am willing to change my approach to the business after 30 years" (Jensen 2009).

9 CONCLUSIONS AND RECOMMENDATIONS

The construction industry and the academic research community have not had a significant impact on improving construction performance because they may not have perceived it to be a systems/environmental problem. One of the reasons that the systems solution was not perceived or considered is the traditional research methodology of construction management of using literature search and survey of experts which maintains the status quo approach of using management techniques to solve the industry problems. The authors replace the traditional approach by using Deming and Goldratt's analysis of stable systems and

theory of constraints to hypothesize that a continually broken industry may actually be a "stable system." The traditional client management, direction, and control approach to increasing construction performance and minimizing construction risk was identified by deductive logic as a system that cannot increase construction performance. Two more critical analyses were done:

1. A 15 year research test of over 600 deliveries resulted in 98% performance, up to 90% less management and control function and increased the vendors profit by as much as 15% (100% increase.)
2. The process was taken outside of the construction industry and successfully run on $1.5 B of services at Arizona State University, resulting in over $100 M of efficiency.

This research has tremendous impact on future construction management research because it proposes that the management, direction, and control approach is actually the source of the construction performance risk. It proposes that the systems problem requires the use of leadership/alignment techniques, quality control and quality assurance (dominantly understood in the manufacturing industries), and will affect the future roles of all the participants in the construction industry.

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