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CAUSES OF CONSTRUCTION DELIVERY COMPLEXITY AND NONPERFORMANCE

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ABSTRACT
This article proposes the hypothesis that construction complexity and litigation are caused by the processes initiated to reduce risk and litigation. It relates the lack of information, bureaucratic processes, subjective expert opinion and the tasking of the management and inspection to construction nonperformance. It identifies that the construction nonperformance problem is being enlarged by engineering technical solutions to solve a business problem, bringing non-value added segments and results to the construction industry. This paper will theoretically discuss the problem of construction non-performance; propose solutions, the testing of the solutions, the results of the testing, and the recommendations. The test that will be discussed is a $1M design-build project delivered for the State of Hawaii Department of Transportation. The conclusion of the paper is that problems in construction delivery occur due to the difference in user's perception, expectations, and the level of information, and that construction performance can be increased significantly by changing the level of performance information in the procurement and delivery process.

KEYWORDS
Construction Nonperformance

1. INTRODUCTION

Nonperformance has been identified in the construction industry. Construction nonperformance can be defined as construction that is "not on time, not on budget, and not meeting quality expectations. The industry also shows shortage of skilled craftspeople and a lack of training programs, both that threaten the stability and continuity of the industry. Due to the complexity of the delivering of construction, the reason for the nonperformance is difficult to identify. This paper will analyze the nonperformance using the following:

1. Deductive logic, information theory, and business "best" practices.
2. Industry structure analysis based on performance and competition.

The analysis will identify the challenges the construction industry faces in order to change the trends of nonperformance. The study uses the State of Hawaii Department of Transportation case studies to collaborate the analysis. The research also identifies solutions based on the analysis.

1.1 Deductive Logic, Information Theory, and Business "Best" Practices

Information Measurement Theory (IMT) or the relative measurement of information is a deductive logic. It has the following theoretical foundation:

1. Every event has an initial state and a final state or outcome.
2. The laws of physics, which predict outcomes in an environment, are fixed and do not have a beginning or an end, and have no boundary (Hawking, 1995.)
3. If "all" the information is known about the initial state and the laws of physics, the changing event conditions, and the event outcome can be predicted.
4. The constraints of the event make the event different and predictable.
5. There is no event where the initial state does not affect the event and event outcome.
6. Therefore, everything is cause and effect (previous state affects the next state.)
7. All factors are related and relative (Hawking, 1995.)
8. Information predicts the future outcome (Kashiwagi, 2001) and minimizes uncertainty (Trout, 2001). Information therefore minimizes risk of the unexpected.
9. Information (laws and an accurate description of the initial state,) always exists, but must be perceived. Information is therefore understood by some, and misunderstood by others. By definition, information always exists.
10. Learning is defined by a cycle of perception of information, processing of the information and application of the information. When a person applies newly perceived information they will change, and the change leads to the perception of more information. The more times a person goes through the cycle of obtaining more information, the faster the speed of the cycle and the speed of perceiving, processing, applying, and changing.

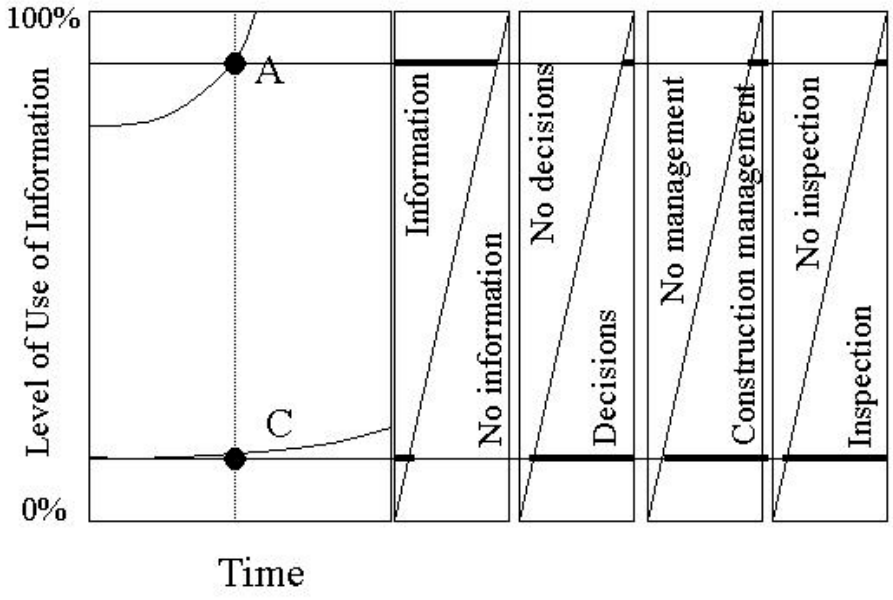

Figure 1: Use of Information/Change Rate and KSM

Figure 1 shows the rate of change (slope of the line) is defined by time vs. the use of information. The two way Kashiwagi Solution models (KSM) relates the level of information to various factors. The Level A perceives and uses more information than Level C. Level C therefore has a more difficult time identifying differences. If the person at Level C cannot differentiate between options, they must make a decision on whom to select. The more information a person has, the more accurate are their predictions, and the fewer decisions the person will make. A

decision is being defined, as when a person lacks information, they perceive that there are multiple outcomes for the same set of initial conditions. At Level C, which is a very low level of information with no differentiation (all options are treated the same,) decisions are made to identify if an entity is qualified to complete a future task. If an entity is qualified (met the minimum standards,) there is more of a risk that the entity may not perform due to the minimum qualifications in the specifications. The contractor must therefore be inspected and managed to ensure that the expected outcome is met. This is a definition of the specification, low-bid delivery system. Theoretically, this identifies a low level information event that either causes nonperformance or is present during nonperformance.

A research project using responses from 313 contractors (14%) identified the following characteristics and activities connected with the specification, low-bid award system, agreeing with the above proposed theory:

1. Ineffective and unfair
2. Poor quality construction (quick and cheap)
3. Low performance with a requirement for contractors with low capability
4. Poor relationship between owner, designer, and contractor
5. Litigious with change orders and late completions
6. Inaccurate construction estimates and costs
7. Higher costs (time and money)
8. Low profit
9. Leverage price to get work (do more work for less money)

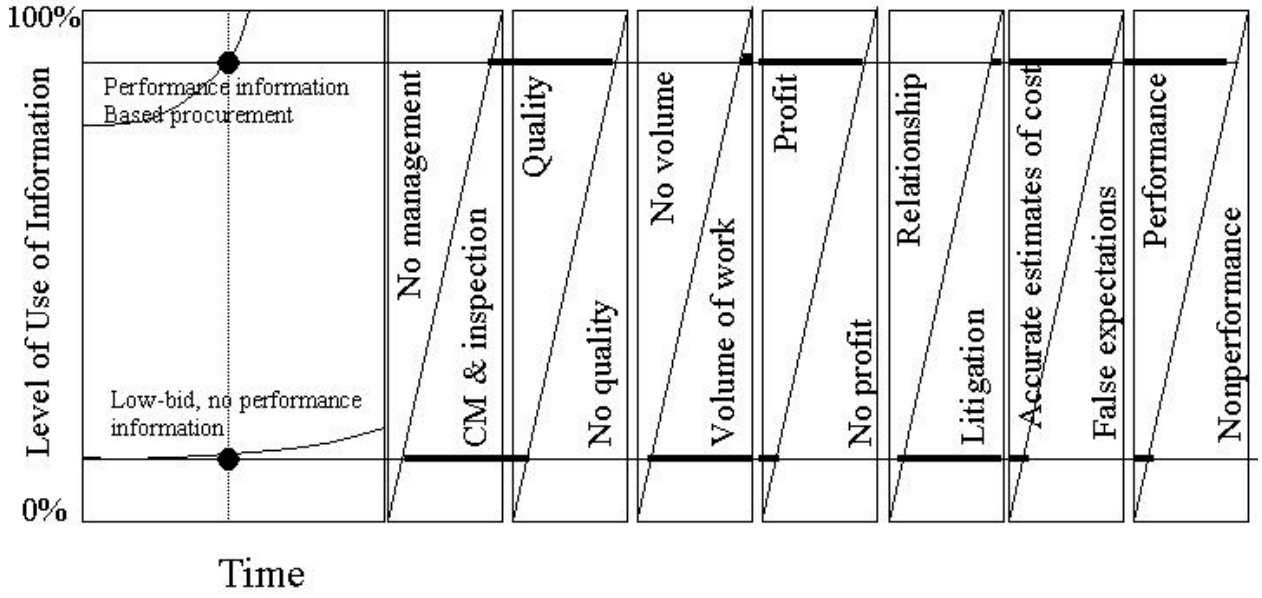

Figure 2: Characteristics of Performance

These characteristics all correlate to a low level of information. More information would result in the minimizing of all the other characteristics as well as minimize the functions of detailed specifications, construction management, and inspection (Figure 2.) Without identifying these components as the only causes of construction nonperformance, it can be identified as critical components of the initial state of events, which produce construction nonperformance.

1.2 Construction Industry Structure

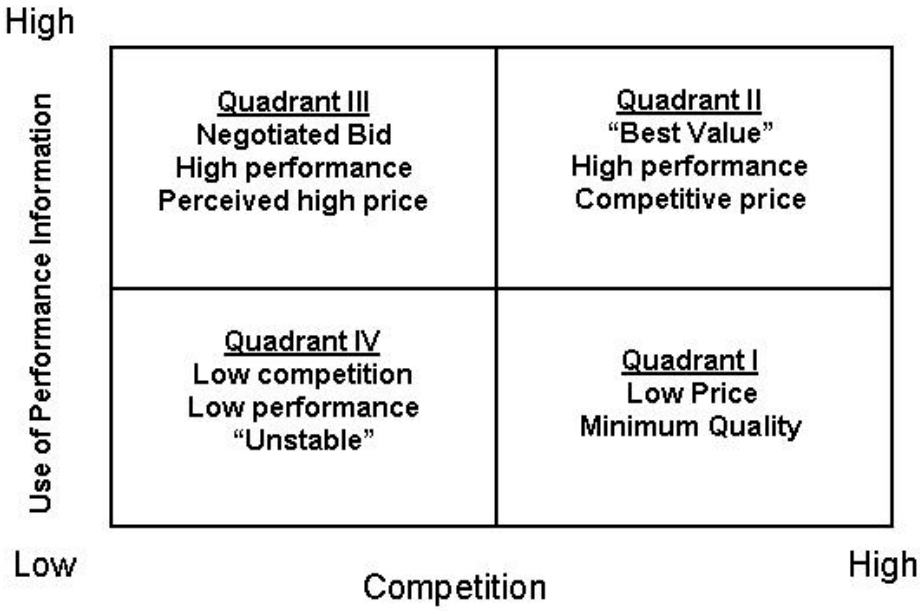

Figure 3: Construction Industry Structure

The construction industry can be graphed using two major components: competition and performance (Figure 3). The industry is divided into four quadrants:

1. Quadrant I. High competition and low performance. This is where the award is based on price. A minimum performance (low performance) is required. The contractors force the owner to identify when the performance does not meet minimum standards. The award is based on price. In many instances the low bid may also go to contractors who forget to include activities, force subcontractors and manufacturers to lower their price, and employ the "least expensive" management and craftspeople.
2. Quadrant II. High competition, high performance. This is the "best value" quadrant. Users consider both performance and price. It differs from both Quadrants I and III in that it requires performance information that minimizes risk (not being on-time, on-budget, and meeting quality expectations.)
3. Quadrant III. High performance and low competition. This is the negotiated contract. Users usually pre-qualify contractors, and subjectively select the best value. There is no way to identify the value of construction unless more than one contractor is employed.
4. Quadrant IV. Low competition and low performance. This quadrant is unstable and cannot maintain itself.

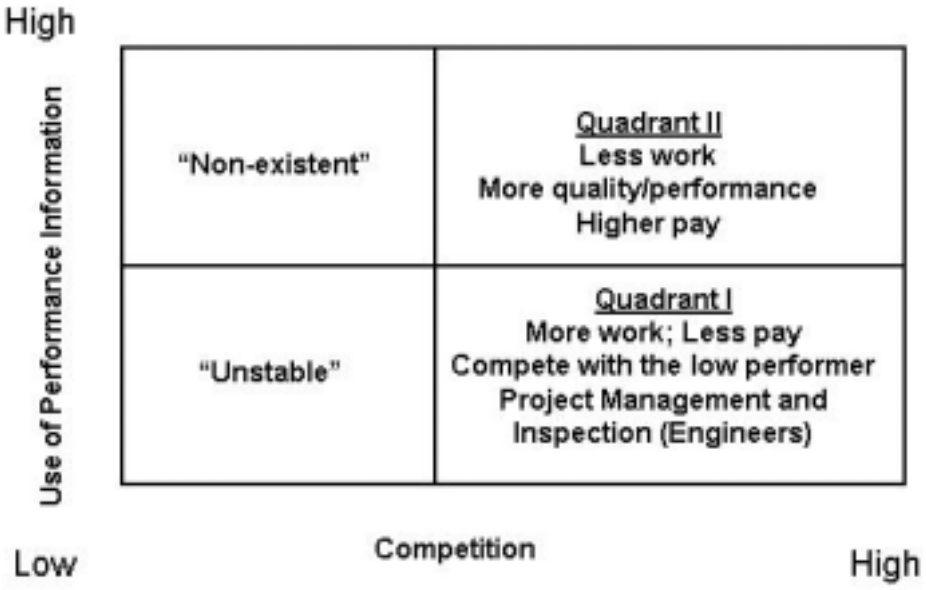

Figure 4: Work/Quality/Pay Issues

As a result of price pressure and no availability of performance information, Quadrant III will become nonexistent. The construction industry rarely uses performance information to directly impact the selection of contractors. The dominant environment becomes Quadrant I. This is confirmed by the survey results shown in Figure 2. Using the KSMs, it is important to identify who is successful in Quadrant I. Figure 4 shows the factors of quality, profit, volume of work, and control. Contractors who perform (high level of craft skill,) do less work, and make a higher profit. Conversely, contractors who do a lot of work, leverage volume to get work (lower their price) to cover their overhead and therefore make a smaller profit. High performance contractors who make a higher profit do so because the owner identifies their work as risky. Otherwise, the owner would hire someone else at a lower price. Successful contractors in Quadrant I are therefore the larger contractors who can leverage volume. A movement to Quadrant II would force the larger contractors to increase their quality to be competitive. This would include tasks such as training, quality control, and making a higher profit to increase pay to motivate higher performance. General contractors in the states of Utah, Georgia and Hawaii did not support the performance idea as much as the high skill mechanical and electrical contractors.

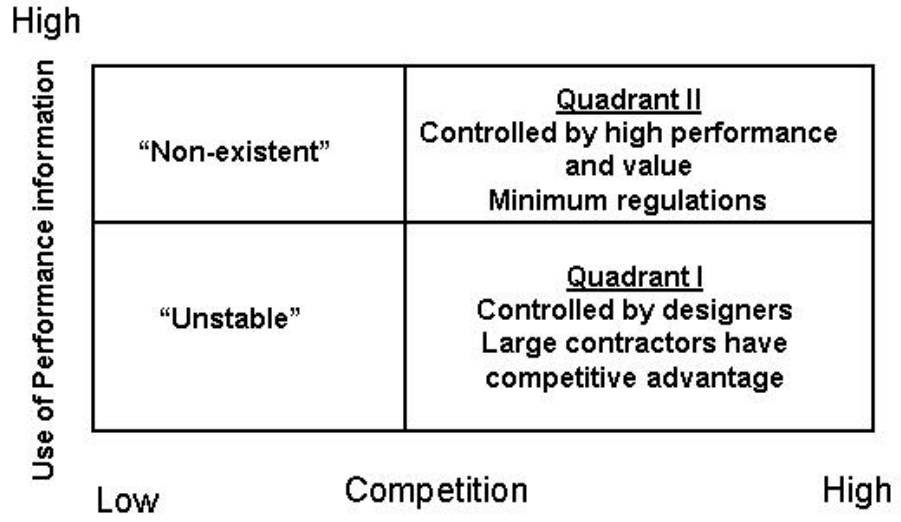

Figure 5: Dominance of Large Contractors and Control by Designers

A larger obstacle to moving to Quadrant II is the change in relationship of participants. The Quadrant I environment is specification, low-bid, minimal quality, inspection, and construction management by the owner's representative. It focuses on the functions of the designer and engineer. It also relieves the owner's representative of liability because the contractors can easily be blamed for nonperformance (bureaucracy or not passing information.) The lower the quality of the construction, the more owners perceive the need for "watchers" to ensure quality. A movement to Quadrant II, would be minimizing the functions of the designers and engineers to identifying design intent and construction requirements. Construction inspection and management tasks and risk would be minimized. The performing contractor would take over control, responsibility, and liability for their own performance. Designers in Utah and Hawaii heavily resisted the performance based contracting idea. As shown in Figures 5 and 6, designers direct the work in Quadrant I and large contractors are the most successful in Quadrant I. Both groups have resisted performance based contracting and are the main sources of complexity and nonperformance in the construction industry. The components in the delivery of construction, which are supposed to minimize the risk of nonperformance, are actually the obstacles from moving from a minimal to a higher level of performance. Rather than adding performance, these components of detailed specifications, the construction management, and the inspection, actually decrease the level of performance. This is in agreement with the theoretical explanation presented using the information theory in the previous section. The validity of this hypothesis can be proven by removing these components, and identifying if the performance can be raised to a higher level.

1.3 State of Hawaii, Department of Transportation (DOT)

The State of Hawaii DOT performed two performance based contracting tests in 2000-2001:

1. Design-build renovation of existing warehouse to construct a new cruise line terminal with a budget of $1M and a design/construction period of 5 months.
2. A paving project, which included handicapped access ramps, light controls, striping, and landscaping with a budget of $5M and a construction time period of 11 months.

Both projects were awarded based on performance and cost. However, the project that minimized the user driven specifications, construction management, and inspection, was far more successful than the other. The repaving project used a detailed means and methods specification, and the user had great difficulty minimizing the management and inspection of the contractor. The contractor also misunderstood the requirement of performance. Once understood, they attempted to change. However their capability to perform has to be nurtured. Although they were not as performance oriented as contractors in other areas, their performance was high in comparison to the low-bid environment.

The risks on the design-build project included:

1. The budget was $1M. The bids were $1.5M, $1.2M and $.975M. The budget was very restrictive.
2. A new shipping office had to be constructed and the personnel had to be moved out of the warehouse before the renovation could take place.
3. The State of Hawaii and the shipping lines were responsible to move a fiber optics cable, which required a high level of coordination.
4. The existing phone lines, electrical and water system was antiquated.

The larger contractors who normally did DOT work were both over budget. A smaller contractor specializing in interior renovation, who had never done work with the State, was attracted by the performance-contracting concept. The contractor finished the project in 3.5 months. The DOT contracting officer estimated that regular DOT contractors would have taken 1 – 1-1/2 years to complete the project. The largest obstacles on the project were:

1. The State of Hawaii DOT completing their action items.
2. The users keeping ahead of the fast pace of the construction.

The project was the first harbors project completed on time, on budget, and meeting the quality expectations of the users. As a result of the success of the project, the Harbors Division chief recommended that the next harbor renovation should also be procured performance based. The DOT Director decided that the low-bid system was preferable and a construction manager was hired to manage the construction.

The second DOT project was a paving project with electrical and handicapped access ramp construction. There were two large contractors with their own asphalt plants. Although the smoothness of the road was comparable to a freeway and the contractor did not generate a cost increasing change order, the contractor did not finish on time.

The main reason for the contractor not finishing on-time was that the contractor did not understand what was performance and the minimization of risk of not finishing on time and on budget. He assigned his senior site superintendent to the project. Half way through the project the site superintendent was removed, and replaced by the youngest site superintendent. The contractor's president stated the following:

1. The site superintendent assigned had the most experience. But it turned out to be the wrong kind of experience. He did not track and manage the schedule. He did not minimize risk for either the contractor or the DOT. Their experience was not in performance, but one of no liability, follow the direction and management of the DOT inspectors.
2. The company was not making sufficient profit and many of the personnel were not performing.
3. They were being managed by the DOT. The subcontractors asked the inspector instead of the site superintendent questions, and many times the site superintendent did not know the issues.
4. The company was losing its quality and profit due to the DOT controlled environment.

The contractor changed the construction team to a team led by the youngest, most proactive site superintendent in the middle of the project. He stated that if the company were to survive, they would have to perform to a much higher standard. He recognized that the way they were doing work under the low bid system was no longer acceptable. The low bid, specification environment with heavy inspection and construction management was not beneficial to the company. In the long term, the company would lose its competitive edge.

Despite not finishing on time, the contractor provided outstanding quality in surface smoothness despite the intersections and handicapped access ramp interfaces (seven inches per mile,) managed the project and minimized complaints from the general public to one complaint. The project was very successful.

Shortly after the project completion, the contractor was bought up by their competitor. The first actions of the new company were:

1. The firing of two thirds of the site superintendents and many of the support services.
2. Raised their prices to be able to buy equipment and make a profit.

The greatest lessons learned from the test were:

1. The contractor learned that the low-bid, specification, highly controlled and inspected environment was not advantageous to the company's profit margin or long term existence.
2. In a highly owner inspected and controlled environment, contractors do not manage construction.
3. The user (DOT) did not attempt to minimize the contractor's risk.
4. To stay competitive, the contractors merged and raised their prices. The logic is simple; contractors need a fair profit to provide quality.
5. One of the biggest obstacles is to educate the government representatives to assist the contractor to be successful.

2. CONCLUSION

Detailed specifications, the low-bid process, and construction management and inspection define Quadrant I. These practices do not increase performance. The two tests show the if an user can minimize specifications, inspection, and construction management, there is a possibility of increasing construction performance. Other tests must be conducted to verify if these concepts are correct. The low-bid situation forced the two major paving competitors to merge (one bought out the other) and their first actions included letting unqualified personnel go and the raising of their prices. Quadrant I is not an environment where a contractor can sustain longevity, profit, and quality construction. Quadrant I is controlled by the designers and inspectors. The environment can be changed to a Quadrant II performance based environment as shown by the first design-build performance contracting test if control can be minimized.

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